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**1**

## A RANDOMIZED PHASE III TRIAL COMPARING HEALTH-RELATED QUALITY OF LIFE AFTER LOW DOSE RATE (LDR) OR HIGH DOSE RATE (HDR) PROSTATE BRACHYTHERAPY BOOST COMBINED WITH EXTERNAL BEAM PELVIC RADIOTHERAPY (EBRT)

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**Purpose:** This randomized Phase III trial compared health related quality of life (HRQOL) in urinary, bowel, and sexual domains in men with intermediate (IR) and high-risk (HR) prostate cancer treated with combined EBRT and prostate brachytherapy (BT) using either LDR or HDR.

**Materials and Methods:** Eligible men receiving pelvic EBRT (46 Gy/23) combined with prostate BT were randomized to either an LDR (110 Gy) or HDR (15 Gy) boost. HDRBT preceded EBRT by one week while LDRBT followed. Time 0 for QOL evaluations was day 1 of any radiotherapy. The Expanded Prostate Cancer Composite (EPIC) questionnaire was used to evaluate HRQOL q3 months for the first year, q6 months to three years and then annually. The Mann-Whitney U test was used to compare mean EPIC scores for urinary, bowel and sexual summary domains.

**Results:** From January 2014 to January 2020, 191 men were randomized: 42% IR and 58% HR. Median age was 71 years. T stage was T1c/T2a:34%, T2B:28%, T2C:24% and T3:13%. 57% had Gleason 7, 13% Gleason 8 and 30% Gleason 9. 74% received ADT with at least three months neoadjuvant and for a median duration of 12 months. Median follow-up was 48 months. HDR patients had higher (better) HRQOL urinary domain scores at three months (79.0 versus 69.4; p<.001) and six months (84.0 versus 76.9; p<.001), and higher bowel domain scores at three months (87.0 versus 82.1; p=.005) and six months (88.7 versus 82.8; p=.023). Better bowel domain scores were sustained at 24, 36, and 48 months. In contrast, HDR patients had worse HRQOL urinary domain scores at one month (73.6 versus 80.7; p=.003). There was no statistically significant difference in HRQOL sexual domain scores between the two arms.

**Conclusions:** The effect of HDRBT on urinary and bowel domains was evident one month post implant but had recovered at three and six months, while LDR patients were still experiencing significant QOL impact of their ongoing LDRBT. Although HDR patients sustained an advantage in long term bowel function compared to LDR, there was no difference in long term urinary QOL between the two types of BT after the acute phase subsided. The patient treatment experience of combined EBRT/BT is improved with HDR.

**2**

## IMPACT OF MGMT PROMOTER METHYLATION STATUS ON TUMOUR DYNAMICS DURING WEEKLY ADAPTIVE RADIOTHERAPY FOR GLIOBLASTOMA

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**Purpose:** Adaptive MRI-guided radiotherapy (RT) on a 1.5T MR-Linac with a 5 mm clinical target volume (CTV), reduced from the current standard of a 15 mm, for glioblastoma (GBM) is currently being evaluated on the UNITED clinical trial (NCT04726397). We present a preliminary comparison of morphological changes during a course of adaptive RT with concurrent temozolomide between tumours with MGMT promotor methylation (MGMT-m) and those that are MGMT promoter unmethylated (MGMT-um).

**Materials and Methods:** The first 30 patients with GBM (all IDH wildtype) enrolled on the UNITED trial were analyzed. RT consisted of 60 Gy in 30 fractions (n=12) or 40 Gy in 15 fractions (n=18) (Fx). Expansions on the gross tumour volume (GTV) consisted of a 5 mm CTV, with the provision of including FLAIR hyperintense areas at-risk, and a 3 mm planning target volume (PTV). Following a reference treatment plan based on a standard planning MRI (FxRef), on-line fully adaptive re-planning was performed once a week at Fx1, Fx6, Fx11, etc., based on a gadolinium contrast-enhanced MRI acquired on the MR-Linac. Remaining fractions were image-guided by pre-beam-on onboard non-contrast MRI, to ensure stability of the treatment volumes. The GTV and CTV were quantified by their absolute volumes, volumes relative to the FxRef, Dice Similarity Coefficients (DSC) and the maximum linear migration distance of contours relative to FxRef ($d_{mig}$). MGMT promoter methylation status was explored as a fixed effect in a linear mixed statistical model.

**Results:** The median change in GTV relative to FxRef at Fx1, Fx6, Fx11, Fx16, Fx21, and Fx25 in tumours with MGMT-m (n=18) was 3.4%, 0.0%, -8.6%, -11.3%, -11.3% and -5.6%, respectively, while for MGMT-um tumours (n=12) was 10.3%, 9.2%, 10.6%, 14.5%, 18.0% and 17.3%, respectively (p=0.021). A similar significant trend was observed for the CTV analyses. With a median time interval of 6 days (range, 1-18 days) from the FxRef to Fx1 MRI, the GTV volume increased by over 10% in 58% of MGMT-um tumours compared to only 33% of MGMT-m tumours. The median DSC for the GTVs relative to FxRef decreased from 0.92 to 0.81 between Fx1 and Fx26 in MGMT-m, as compared to 0.88 to 0.73 in the MGMT-um group (p=0.004). MGMT-um tumours had significantly larger maximum $d_{mig}$ compared to tumours with MGMT-m, with a median $d_{mig}$ of 9.6 mm versus 5.8 mm (p=0.018). The maximum GTV migration distance was greater than 5, 10 and 15 mm in 83%, 50% and 17% of MGMT-um tumours but only 56%, 11% and 0% for MGMT-m tumours, respectively.

**Conclusions:** GBM with MGMT-um exhibited significant changes in morphology and migration distance throughout a course of RT, and from the time of treatment between planning to the first treatment delivered. In this population, our results support a greater frequency of imaging and plan adaptation when applying personalized small CTV margins.

**3**

## ASSESSING TREATMENT RESPONSE AFTER LUNG SABR: AN EVALUATION OF THE PREDICTIVE VALUE OF RECIST CRITERIA

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**Purpose:** Response Evaluation Criteria In Solid Tumours (RECIST) – version 1.1 is a commonly used framework to assess treatment response. However, response assessment after lung stereotactic ablative radiotherapy (SABR) can be difficult due to radiation-induced lung changes. The goal of this study was to assess how frequently lung lesions treated with SABR triggered RECIST criteria for recurrence and to correlate RECIST findings with actual treatment outcomes.

**Materials and Methods:** We reviewed patients who were treated with lung SABR at least five years prior to the chart review. Prescribed dose was 54-60 Gy in 3-8 fractions. Both primary lung and metastatic lesions were included. All lesion measurements were based on maximum diameter on CT axial slices. After treatment, progressive disease (PD) by RECIST was based on strict RECIST criteria and defined as: 1) increase of ≥ 20% compared to

post-treatment minimum and 2) ≥5 mm absolute increase. The final assessment of recurrence (i.e. the gold-standard outcome) was based on subsequent changes in lesions size after PD by RECIST and, when available, PET scan and/or pathology. When assessing subsequent changes in lesion size, stability (≤20% change) in size for at least one year or a decrease (>20%) in size indicated no recurrence, while subsequent growth (>20%) indicated recurrence. The assessment of lesion response by the treating radiation oncologist (RO) in the clinical record was also recorded when available.

**Results:** Between 2010-2015, a total of 85 patients, with 88 lesions, met inclusion criteria. Seventy-five of these lesions were lung primaries, the remainder were metastases. Median patient age was 79 years (IQR: 73-85) and mean lesion size was 2.1 ± 0.9 cm. Median follow-up was 52 months (IQR: 33-68).
66% (58/88) of treated lesions met criteria for PD by RECIST. However, on final assessment only 10% (9/88) were found to have recurrence. The positive predictive value (PPV) of RECIST criteria was 0.16. In the subset of patients with primary lung tumours only, 64% (48/75) were classified as PD by RECIST, but only 12% (nine of 75) were categorized as recurrence on final assessment. PPV was 0.19.
The predictive value of RECIST was lower when PD by RECIST was triggered ≤ 12 versus > 12 months post-treatment (PPV 0.08 versus PPV 0.21). Median time to PD by RECIST was 19 months (IQR: 12-27) for those with recurrence versus 15 months (IQR: 8-24) for those without recurrence on final assessment (p=0.13).

Assessment by treating RO was only available for 57% (50/88) of cases, but concordance with final study assessment was 0.85, translating to an overall predictive accuracy of 94% (47/50).

**Conclusions:** Using strict RECIST criteria, two-thirds of patients treated with lung SABR met criteria for PD. However, on further follow-up only a minority of these patients were felt to have recurrence, leading to a poor PPV for RECIST criteria in this setting. Further work is needed to develop validated criteria for designation of recurrence after lung SABR.

**4**

**A PHASE II TRIAL OF CONCURRENT SUNITINIB, TEMOZOLOMIDE AND RADIATION THERAPY FOLLOWED BY ADJUVANT TEMOZOLOMIDE FOR NEWLY DIAGNOSED GLIOBLASTOMA PATIENTS WITH AN UNMETHYLATED MGMT GENE PROMOTER (A01-M121-11A, MCG1132)**

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**Purpose:** Despite advances in treatment modalities, the overall prognosis of Glioblastoma remains dismal, particularly for patients with unmethylated MGMT promoter. In this Phase II trial, we tested for the first time the combination of Sunitinib with radiotherapy and Temozolomide in newly diagnosed MGMT unmethylated Glioblastoma patients.

**Materials and Methods:** Thirty-seven patients diagnosed with WHO-Grade IV Glioblastoma and unmethylated MGMT, age 18-70 and KPS ≥70 were eligible. Patients received 12.5 mg of daily Sunitinib for seven days, followed by concurrent chemoradiation and 12.5 mg Sunitinib x6 weeks, then adjuvant Temozolomide x6 cycles. Primary objective was progression-free survival (PFS) as per RANO criteria, secondary objectives were overall survival (OS), safety and Neutrophil-to-Lymphocyte ratio (NLR).

**Results:** Median follow-up time was 15.3 months (95% CI: 13.8-19.4). Median PFS was 7.15 months (95% CI: 5.4-10.5 months) and six-month PFS was 54.0%. Median OS was 15.0 months (95% CI: 13.8-19.4 months) and two-year OS was 17.1%. Having received >3 cycles of adjuvant Temozolomide and surgery at progression significantly predicted for better OS with hazard ratios of 0.32 (p=0.017) and 0.46 (p=0.049) respectively, whereas age >65 and post-treatment NLR>6 predicted for worse OS with hazard ratios of 3.92 (p=0.037) and 2.64 (p=0.021) respectively. Grade ≥3 thrombocytopenia occurred in 22.9%, Grade ≥3 neutropenia in 20% and Grade ≥3 thromboembolic events in 14.3% of patients. There were no Grade 5 events.

**Conclusions:** Addition of Sunitinib to RT and Temozolomide was safe and survival outcomes compared favorably to the current standard of care for GBM patients with unmethylated MGMT promoter status.

**5**

**LONG TERM TOXICITIES OF ADOLESCENT AND YOUNG ADULT SURVIVORS OF CERVIX CANCER WHO UNDERWENT RADIATION THERAPY: A CROSS-SECTIONAL ANALYSIS**

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**Purpose:** Survivors of adolescent and young adult (AYA) cervical cancer who undergo radiation therapy are at risk of significant long-term health sequelae. This study seeks to evaluate long-term toxicities and their impacts on survivors.

**Materials and Methods:** Patients treated for cervical cancer with radiation therapy between ages 18-39 in the years 2000-2009 from any centre from our province were eligible. One hundred patients with current mailing addresses were identified and mailed a package containing a questionnaire devised by a multi-disciplinary team, which included open-ended questions, and validated patient-reported quality of life surveys for cervical cancer patients, the EORTC QLQ-30 and CX-24.

**Results:** A total of 22 responses were received (22% response rate). The mean age of respondents was 53.1 years (range: 41-62). The mean age at treatment was 35.6 years (range: 25-40), and the average time since treatment was 17.0 years (range: 12-22). The majority (73%) were married or common-law.

A relationship status change following cancer treatment was reported by 32%, and 60% noted a change in sexual function/desire as the cause. Most respondents (77%) had children prior to treatment, with a mean of two children (range: 1-4). A single respondent had a child after treatment through adoption, none had children through embryo banking and surrogacy. Fertility preservation prior to treatment was discussed with 41% of respondents and offered to 36%. Nearly all respondents (86%) had used hormone replacement therapy since treatment completion, with 23% presently taking hormone replacement.

EORTC scores are calculated on a scale of 0-100, with higher scores being positive for quality of life and functioning, and worse for symptoms. Mean Quality of Life score was rated as 63.9. Most patients maintained adequate functional status, with mean scores of 84.4, 83.3, 67.1, 70.6, and 77 for physical, role, emotional, cognitive, and social functioning, respectively. Elevated symptom scores include sexual/vaginal functioning (53.5), sexual worry (55.6), fatigue (35.4), diarrhea (38.1), body image concerns (41.7), peripheral neuropathy (39.7), and menopausal symptoms (38.1).

A wide array of bothersome symptoms were reported by patients in the open-ended questions. Most frequent (32%) were symptoms related to sexual and vaginal health. Other common symptoms include permanent bowel changes (27%), bladder changes (27%), mood disorders (27%), and lymphedema (18%). Multiple respondents (18%) specifically commented on regrets for not pursuing fertility preservation or explicit statements that more thorough fertility counselling should be offered prior to treatment.

**Conclusions:** Long-term survivors of AYA cervix cancer who participated in this study have significant late toxicities. Many patients experience ongoing sexual health concerns, GI issues, body image concerns, mood disorders, premature menopausal symptoms, and fertility issues. Respondents in our study indicated a desire for improved fertility counselling.

## 6
## SAFETY AND EFFICACY OF STEREOTACTIC BODY RADIOTHERAPY FOR ULTRA-CENTRAL THORACIC TUMOURS

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**Purpose:** While stereotactic body radiotherapy (SBRT) is increasingly utilized in the management of ultra-central thoracic tumours, concerns regarding the potential for significant toxicity remain. We sought to evaluate the toxicity and efficacy of SBRT in these tumours at our institution.

**Materials and Methods:** Patients with ultra-central lung tumours or nodes treated at our institution with SBRT between 2009 and 2019 were retrospectively reviewed. Ultra-central location was defined as having the planning target volume (PTV) overlapping or abutting the central bronchial tree and/or esophagus. Per institutional policy, patients were planned with homogenous dose distributions, with target coverage objectives of ITV V100 >99%, PTV V95 >99%, and PTV Dmax <105%. All SBRT plans were reviewed in radiation quality assurance rounds by a team of dosimetrists and radiation oncologists. The primary endpoint was SBRT-related Grade ≥3 toxicities, defined using the Common Terminology Criteria for Adverse Events (CTCAE) V5.0. Secondary endpoints included Grade ≥2 toxicities, local control (LC), progression-free survival (PFS) and overall survival (OS). Competing risks analysis was used to estimate LC. Kaplan-Meier method was used to estimate PFS and OS.

**Results:** A total of 160 patients who received 169 ultra-central courses of SBRT were included, with a median follow-up of 21.6 months. The median age was 69 years, and most patients were of good performance status (94%, ECOG 0-2). The most frequent tumour histologies were NSCLC (42%) and RCC (26%). Treatment intent was most commonly for oligoprogression (46%) and oligometastasis (31%), followed by primary lung cancer (18%). SBRT prescription doses ranged from 30-55 Gy in 5 fractions (BED10 range 48-115 Gy). The most common prescription was 50Gy in 5 fractions (44%). Thirteen (8.1%) patients experienced Grade ≥3 toxicity and 26 (16.2%) experienced Grade ≥2 toxicity. There was one case of Grade 4 esophagitis and two cases of Grade 4 pulmonary toxicity (bronchopleural fistula and bronchial obstruction). There was 1 possible treatment related death (pneumonia/pneumonitis). The one- and two-year LC rates were 94.7% and 87.6%, respectively. Median PFS was 8.7 months (95% confidence interval [CI], 7.4-10.5), with one- and two-year PFS being 35.5% and 23.7%. Median OS was 3.7 years (95% CI, 2.7-not reached), with one- and two-year OS being 77.5% and 66.1%.

**Conclusions:** In one of the largest case series of ultra-central thoracic SBRT reported to date, homogenously prescribed SBRT plans were associated with relatively low major toxicity and encouraging LC rates across a variety of treatment indications. Future work to evaluate predictors of major toxicity is planned.

## 7
## RATES OF REGIONAL RADIOTHERAPY RECEIPT OVER TIME IN LOW-RISK, NODE POSITIVE BREAST CANCER

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**Purpose:** An increased rate of regional radiotherapy receipt has been observed for women with node-positive breast cancer over time. In patients with biologically low-risk node positive breast cancer with 1-3 nodes involved, the benefit of regional nodal irradiation (RNI) and post-mastectomy radiotherapy (PMRT) is unclear and is the subject of ongoing clinical trials. The purpose of this study was to determine if there is increasing use of RNI and PMRT for low-risk, N1 breast cancer.

**Materials and Methods:** We conducted a population-based study of all patients diagnosed between 2005 to 2014 in the province of British Columbia, who underwent breast conserving surgery (BCS) or mastectomy for breast cancer. We based our definition of low-risk on the original inclusion criteria of MA.39/TAILOR RT trial, which is a non-inferiority clinical trial examining whether the omission of RNI is non inferior. We included: pT1-2 pN1 (macroscopically node-positive) breast cancer. To define a biologically low-risk population, we included patients with a Luminal A subtype. This was approximated by: ER Allred 6-8/8, PR Allred 6-8/8, HER2-negative, and Grade 1-2. Patients who underwent a BCS and mastectomy were analyzed separately. The primary outcome was RNI receipt for patients who had a BCS, and PMRT receipt for those who had a mastectomy. We performed a multivariate, logistic regression to see whether year of diagnosis predicted for receipt of radiation. Other variables included in the multivariate model were defined a priori, based on factors known to influence RNI and PMRT receipt in the literature.

**Results:** We identified 637 women who had BCS alone, and 532 who had mastectomy. For patients who had BCS, the rates of RNI receipt by years were: 2005-2008 68%, 2009-2011 79%, 2012-2014 89%. For patients who had a mastectomy, the rates of PMRT receipt by years were: 2005-2008 67%, 2009-2011 68%, 2012-2014 80%. During this time period, decreasing rates of ALND were observed: 2005-2008 92%, 2009-2011 74%, 2012-2014 42%. On multivariate analysis of patients who had a BCS, RNI receipt was associated with number of involved macroscopic nodes (p=0.002) and date of diagnosis (p<0.001), but not age (p=0.2), presence of LVI (p=0.2), ALND (p=0.08), or chemotherapy receipt (p=0.9). For patients who had a mastectomy, PMRT receipt on multivariate analysis was associated with number of involved macroscopic nodes (p=0.02) and chemotherapy receipt (p=0.004), but not age (p=0.09), LVI (p=0.3), or diagnosis date (p=0.1).

**Conclusions:** Between 2005 and 2014, there was an increased rate of RNI receipt, and a trend for increased receipt of PMRT for patients with low-risk, node-positive breast cancer. On a population level, this data shows the high proportion of women who may be spared RNI if MA.39 determines omission of RNI is safe for this population, and highlights the importance of continued accrual onto MA.39.

**8**

## FIRST PAN-CANADIAN CONSENSUS RECOMMENDATIONS FOR PROTON BEAM THERAPY ACCESS IN CANADA

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**Purpose:** Proton Beam Therapy (PBT) is a new treatment option for select cancer patients. It is currently not available in Canada. Assessment and referral processes for out of country treatment for eligible patients vary by jurisdiction, leading to variability in access to this treatment for Canadian cancer patients. The purpose of this initiative was to develop a framework document to inform consistent and equitable PBT access for appropriate patients through the creation of pan-Canadian PBT access consensus recommendations.

**Materials and Methods:** A modified Delphi process was used to develop pan-Canadian recommendations with input from 22 PBT clinical and administrative experts across all provinces, external peer-review by provincial cancer and system partners, and feedback from a targeted community consultation. This was conducted by electronic survey and live discussion. Consensus threshold was set at 70% agreement.

**Results:** Four consensus rounds resulted in a final set of 27 recommendations divided into three requirement categories: patient eligibility (n=9); program level (n=10); and system level (n=8). Patient eligibility included: anatomic site (n=4), patient characteristics (n=3), clinical efficacy (n=2). Program level included: regulatory and staff requirements (n=5), equipment and technologies (n=4), quality assurance (n=1). System level included: referral process (n=5), costing, budget impact and quality adjusted life years (n=2), eligible patient estimates (n=1). Recommendations were endorsed by the Canadian Association of Provincial Cancer Agencies and its member organizations in June 2021 and distributed to all 43 cancer programs in Canada.

**Conclusions:** The consensus-building approach resulted in evidence-based, peer-reviewed suite of recommendations that support application of consistent clinical criteria to inform treatment options, facility set-up and access to high quality proton therapy. Annual review will ensure alignment with best practices, emerging evidence, and status of PBT availability in Canada.

**9**

## TRENDS IN RADIOTHERAPY FRACTIONATION IN ONTARIO FROM 2011/12 TO 2020/21 FOR THE MAJOR DISEASE SITES AND THE IMPACT OF COVID19

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**Purpose:** Over the past nine years, there has been a consistent trend in Ontario towards hypo-fractionation for external beam treatment across the major disease sites. COVID-19 has accelerated the adoption of hypofractionation across the province, but the size and spread of the impact provincially are not known. This work quantifies the trends in fractionation in Ontario and discusses implications on provincial megavoltage treatment machine capacity planning.

**Materials and Methods:** A cross-sectional retrospective analysis of radiation treatment activity from 2011/12 to 2020/21 was conducted to examine fractionation trends in Ontario. The provincial Activity Level Reporting database provided information on the number of radiation treatment visits to megavoltage treatment machines and the number of radiation treated cases by facility and major disease sites (breast, genitourinary, gastrointestinal and lung). Fractionation was estimated by examining the annual ratio of radiation treatment visits to treated cases. Descriptive statistics were used to evaluate the provincial impact of COVID-19 on fractionation trends and to describe the variation in trends across the different facilities in Ontario.

**Results:** In 2011/12, there were 14 radiation treatment facilities in Ontario with a total of 100 megavoltage treatment machines. 615,507 radiation treatment visits were seen for 34,406 radiation treated cases for a facility median ratio of 17.4 (range: 15.1 to 21.3). In 2020/21, there were 17 radiation treatment facilities in Ontario with a total of 108 megavoltage treatment machines. 567,575 radiation treatment visits were seen for 40,946 radiation treated cases for a facility median ratio of 13.2 (range: 11.8 to 16.9).

This represents an overall nine-year reduction of 24% in the ratio of radiation treatment visits to treated cases, with an average, pre-COVID-19 year over year reduction of 1.7%. During COVID-19, the ratio dropped by 11% from 2019/20 to 2020/21, more than five times the drop compared with 2018/19 to 2019/20. Similar trends in the ratio of visits to treated cases were observed for breast (-16% from 2019/20 to 2020/21; six times the drop compared with 2018/19 to 2019/20), genitourinary (-11%; two times the drop), gastrointestinal (-10%; four times the drop) and lung (-8%; eleven times the drop).

**Conclusions:** This work shows the size and spread of the impact of COVID-19 on fractionation trends in Ontario. The continued move towards hypofractionation has implications on megavoltage treatment machine capacity planning, potentially reducing the number of machines required to support the same patient caseload. Further work is required to understand the other variables that affect machine capacity, specifically treatment visit durations and hours of operation.

**10**

## COST MINIMIZATION ANALYSIS OF CONVENTIONAL VERSUS SHORT-COURSE RADIOTHERAPY WITH TEMOZOLOMIDE FOR NON-ELDERLY PATIENTS WITH NEWLY DIAGNOSED GLIOBLASTOMA

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**Purpose:** Standard of care for adults aged 70 years or younger with an ECOG performance status of 0-2 and newly diagnosed glioblastoma is maximal safe resection followed by radiotherapy/RT (60 Gy in 30 fractions) with concurrent temozolomide/TMZ (75mg/m2) followed by 6-12 months of adjuvant TMZ (150-200 mg/m2). Recently a Phase III non-inferiority trial compared conventional (60 Gy in 30 fractions) RT with TMZ versus short-course (60 Gy in 20 fractions) RT with TMZ and found that short-course RT with TMZ was non-inferior on two separate interim analyses conducted to date.

**Materials and Methods:** We performed a cost minimization analysis to determine the cost savings of short-course RT with TMZ versus conventional RT with TMZ for patients with newly diagnosed glioblastoma. All the resources necessary to deliver the two treatment regimens including the time and expertise of various health care professionals, supplies, infrastructure, and other means were identified by experienced clinicians at our institution. Shared costs between the two different treatment regimens were identified, as they cancel each other out, and were not included in our analysis. Costs were obtained from several sources including institutional databases, collective bargaining agreements, Minister of Health cost documents, and expert elicitation. All costs were analyzed in 2022 Canadian dollars (CAD).

Any cost parameters used within the model that are older than the year 2021 were inflation adjusted using the Bank of Canada inflation adjustment calculator.

**Results:** The non-shared treatment costs of one patient treated using conventional RT with TMZ versus short-course RT with TMZ was $22 532.97 and $15 021.98 respectively. Short-course RT with TMZ therefore saves $7510.89 dollars per patient treated relative to conventional RT with TMZ. For every 60 patients treated with short-course RT with TMZ, the salary of one full time radiation oncology staff position equivalent in Alberta and 600 treatment slots are recovered.

**Conclusions:** For patients with newly diagnosed glioblastoma, short-course RT with TMZ leads to cost savings compared to conventional RT with TMZ. Short-course RT with TMZ also reduces the number of treatment slots needed for these patients, which has potential for improved wait times and access to RT for other cancer patients.

**11**

## HEALTH-ECONOMICS AND EVIDENCE-BASED HYPOFRACTIONATION: A EUROPEAN CLUSTER ANALYSIS WITH RELEVANCE TO NORTH AMERICA

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**Purpose:** Health-economic factors have been suggested to affect evidence-based hypofractionation (HF) uptake (HFU) in curative breast and prostate cancer, and palliative radiotherapy (RT). Health care systems and health-economic factors vary significantly among European countries, rendering Europe an ideal platform to investigate clusters of different socio-economic and RT service-related factors and their influence on HFU.

**Materials and Methods:** A hierarchical clustering analysis based on principal components was performed to assess HFU for curative breast (breast-conserving, node negative) and prostate cancer (low-risk), and palliative irradiation of uncomplicated bone metastases in 36 European countries. Variables included GNI/capita, MV units/million and actual RT courses (% incident cancer cases; % optimal number of courses). Country-specific 5-year relative survival was included for curative irradiation. HFU data was derived from the 2018 ESTRO-GIRO survey, RT service-related factors from the ESTRO-HERO project. Socio-economic data were extracted from publicly available databases. Once the clusters were defined, the variable average within each cluster was calculated, including hypofractionation-specific reimbursement (HFSR).

**Results:** The optimal number of clusters is four: Eastern, Southern (incl. Estonia, Hungary), two clusters of Western countries (Central Europe, Mixed). GNI/capita impacts cluster definition, with Eastern and Southern clusters having lower GNI/capita (Eastern 10,526-11,882, Southern 19,548, Central 38,230-44,605, Mixed 46,257-49,388 [current USD]) and lower number of MV units/million compared to Western clusters (Eastern 2.7, Southern 3.9, Central 6.1-6.7, Mixed 6.6-7.6). Higher HFU is observed in Western countries compared to Eastern and Southern clusters for breast cancer (Eastern 37.6%, Southern 31.9%, Central 75.5%, Mixed 71.4%), while Southern countries have highest HFU for prostate cancer (Eastern 14.8%, Southern 65.1%, Central 51.9%, Mixed 43.0%), indicating that countries with the lowest average GNI/capita and RT availability may be underutilizing HF for breast and prostate cancer. For the two clusters with high average GNI/capita and RT availability, there was a negative correlation in palliation and HFSR (Central 98.2% HFU, 60.0% HFSR; Mixed 86.6% HFU, 85.7% HFSR).

**Conclusions:** Four clusters of European countries were identified based on their HFU and health-economic factors, revealing a major link between GNI/capita and RT availability, both variably impacting HFU. As a general observation, HFU is less utilized in low-income areas, while HFSR plays a negative role in HFU in palliative indications in high-income clusters. These insights from Europe may support national policymakers and scientific societies in their pursuit of optimal HFU and endorsement of better evidence implementation within and across involved countries. In addition, it provides an exemplar of how population-based data can support policy-making to optimize care.

**12**

## TUMOUR AND PATIENT FACTORS INFLUENCING THE USE OF ADJUVANT RADIOTHERAPY IN LOCALLY ADVANCED HEAD AND NECK CANCER

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**Purpose:** Many patients with locally advanced head and neck cancer (HNC) with resectable primary tumours undergo upfront surgical management followed by a risk-adapted approach to adjuvant radiotherapy (RT). When indicated, adjuvant treatment can improve loco-regional control and overall survival compared to surgery alone. Unfortunately, not all patients who would benefit from adjuvant RT receive it. Socioeconomic factors such as race and income have been shown to influence patterns of care and survival outcomes for various cancers, including HNC. Our aim was to gain insight into patterns of adjuvant RT utilization for locally advanced HNC through population-based analysis, and characterize the ways in which tumour and patient factors influence the omission of RT.

**Materials and Methods:** Data were obtained from the Surveillance, Epidemiology, and End Results (SEER) database. Selected patients from 2009-2018 had undergone upfront surgery, were found to have locally advanced HNC, and were eligible for adjuvant RT. Tumour subsite and stage, patient age, marital status, rural/urban residence, race, and county-level income were extracted for each patient. Logistic regression and chi-squared test were conducted.

**Results:** A total of 12,549 patients underwent statistical analysis. 84.5% of patients underwent adjuvant RT, 15.5% did not. Significant differences in RT uptake were observed based on patient and tumour factors. Those least likely to receive adjuvant RT were patients with Stage IV tumours (19.15% of whom did not undergo adjuvant RT), patients with cancers of larynx (19.09%) and gingivae (23.80%), patients age 80 and above (41.64%), unpartnered patients (18.80%), and patients living in nonmetropolitan areas (17.78%). Trends indicate lower RT uptake among patients of non-white ethnicities but the differences were not statistically significant.

**Conclusions:** Barriers to adjuvant RT in locally advanced HNC exist depending on various tumour and patient factors including tumour subsite and stage, age, marital status, and rural/urban residence. Our results support the hypothesis that barriers to care faced by patients of racial minorities and low income may primarily be barriers to upfront surgery, not adjuvant therapies.

**13**

## PHOTON VERSUS PROTON WHOLE VENTRICULAR RADIOTHERAPY FOR INTRACRANIAL NON-GERMINOMATOUS GERM CELL

**TUMOURS - A REPORT FROM THE CHILDREN'S ONCOLOGY GROUP**

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**Purpose:** The hypothesis is that dose to normal CNS structures is lower for children treated with proton therapy, as compared to photon therapy for children receiving whole ventricular radiotherapy (WVRT) for non-germinomatous germ cell tumours (NGGCT)**.** We present data from patients enrolled in stratum 1 of the Children's Oncology Group study ACNS1123.

**Materials and Methods:** Dosimetric data for NGGCT patients on ACNS1123 who received 30.6 Gy WVRT were compared in a post-hoc analysis. Target segmentation was standardized using a contouring atlas as per the study protocol. The PTV was created by creating a 3-5mm geometric expansion from the CTV. Doses to cranial organs-at-risk (OARs) were compared between proton and photon treatments. Clinically relevant dose-volume parameters that were compared included mean dose and dose to 40% of the OAR volume (D40). A subgroup analysis of patients treated with 3 mm PTV margins was performed. Dosimetric comparisons between proton and photon plans were conducted using two-sided Wilcoxon's rank sum test for continuous variables.

**Results:** Fifty-eight patients had WVRT dosimetry available and were included; 13 (22%) received proton treatment and 45 (78%) received photon treatment. Median age was 10 years old (range 0-21). Mean doses to the supratentorial brain (1504 cGy versus 1792 cGy, p<0.001), cerebellum (1479 cGy versus 2061 cGy, p<0.001), and bilateral temporal, parietal and frontal lobes were statistically significantly lower in proton-treated patients compared to photon-treated patients, respectively. In a subgroup analysis of patients uniformly treated with a 3 mm planning target volume, patients who received proton therapy continued to have statistically significantly lower doses (supratentorial mean dose 1504 cGy versus 1791 cGy, p=0.0017) to brain OARs as compared to photon treatment, respectively.

**Conclusions:** Children treated with proton therapy for WVRT had lower doses to normal brain structures when compared to those treated with photon therapy. Future work will help elucidate whether this dosimetric advantage of proton therapy translates to a reduction in toxicities for these patients.

**14**

**KNOWLEDGE-BASED PLANNING TO IMPROVE AND AUTOMATE PATIENT-SPECIFIC QUALITY ASSURANCE PROCEDURES IN CLINICAL TRIALS - UPDATED SECONDARY ANALYSIS OF CCTG HN6**

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**Purpose:** Radiotherapy (RT) quality assurance (QA) is a critical component of clinical trials; current RTQA methods are rule-based and evaluate plans on generic dosimetric criteria, not what is achievable for a specific patient. To individualize and improve the RTQA process, we explored the use of knowledge-based quality assurance (KBQA) in patients treated on the CCTG HN6 clinical trial, a multicentre Phase III trial comparing standard-fractionation RT plus high-dose cisplatin versus accelerated-fractionation RT plus panitumumab in patients with locally advanced head and neck (H&N) cancers (Siu, JAMA Oncol 2017).

**Materials and Methods:** Eclipse Rapidplan™ KB planning software was utilized to replan the cases submitted in the HN6 trial. The planning target volume (PTV) coverage was normalized so the $PTV_{70}$ $V_{100\%}$ was equivalent for the investigator-submitted (IS) and replanned cases. Dosimetric endpoints were compared for PTVs and organs-at-risk (OAR), and two-sided Wilcoxon signed rank test was used with a p value of <0.05 indicating statistically significant differences.

**Results: T**he HN6 trial included 320 Canadian patients randomized between December 30, 2008 and November 7, 2011. Among the 315 cases submitted for protocol-specified RTQA review to the Quality Assurance Review Center (Rhode Island), analysis was performed on 161 cases. These cases were originally planned with IMRT, Tomotherapy or VMAT, and were replanned with 9-field IMRT using the openware WUSTL Rapidplan™ H&N model. Target coverage was numerically similar between the IS and KB plans, as measured by mean $PTV_{70}$ $D_{99\%}$ (68.7 versus 69.1 Gy, p<0.001), mean $PTV_{70}$ $D_{95\%}$ (70.3 versus 70.4 Gy, p=0.07), mean $PTV_{56}$ $D_{99\%}$ (54.6 versus 55.3 Gy, p<0.001) and mean $PTV_{56}$ $D_{95\%}$ (56.5 versus 56.7 Gy, p=0.003). OAR dosimetry was similar between the IS and KB plans for the following endpoints: spinal cord $D_{max}$ (42.5 versus 42.3 Gy, p=0.05), larynx $D_{max}$ (66.0 versus 64.9 Gy, p=0.004), mandible $D_{max}$ (73.5 versus 72.8 Gy, p=0.007) and contralateral parotid $D_{mean}$ (30.0 versus 29.7 Gy, p=0.5). KB plans showed improved OAR sparing for the following endpoints: brainstem $D_{max}$ (43.2 versus 40.0 Gy, p<0.001), larynx $D_{mean}$ (52.4 versus 43.0 Gy, p<0.001), ipsilateral parotid $D_{mean}$ (41.4 versus 38.0 Gy, p<0.001), composite salivary gland $D_{mean}$ (37.6 versus 35.8 Gy, p<0.001), and oral cavity $D_{mean}$ (45.8 versus 33.2 Gy, p<0.001).

**Conclusions:** Updated analysis of 161 HN6 cases continues to demonstrate the feasibility of automated KB planning to produce acceptable H&N RT plans, which can be used to benchmark and evaluate plan quality in clinical trials. Further work is underway to correlate suboptimal dosimetry with clinical toxicities observed in the HN6 trial.

**15**

**A COMPARISON OF THREE DIFFERENT BREATH HOLD TECHNIQUES USED FOR REDUCING CARDIAC DOSE FOR PATIENTS RECEIVING LEFT-SIDED BREAST CANCER RADIATION THERAPY**

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**Purpose:** Cardiac toxicity is a major concern for left-sided breast cancer patients receiving radiation therapy (RT). Different breath-hold techniques may be used to reduce cardiac dose including voluntary deep inspiration breath hold (vDIBH), the Elekta Active Breathing Coordinator (ABC), and the AlignRT system from VisionRT. The purpose of this study is to evaluate the differences in heart position and mean heart dose for these three techniques during RT of left-sided breast cancer patients.

**Materials and Methods:** In this prospective study, left-sided breast cancer patients receiving post-operative RT and requiring the use of a breath-hold technique were assigned to vDIBH, ABC or AlignRT. Patients were set up daily to tattoos and cone-beam computed tomography (CBCT) imaging was performed weekly to verify patient position. During weekly CBCT, patients were matched to chestwall and all shifts were applied prior to treatment. Weekly CBCTs were retrospectively assessed in the Pinnacle Treatment Planning System. The delivered mean heart dose was calculated by adjusting the heart contour from the planning CT scan to match the heart position observed on each weekly CBCT. The mean cardiac dose was re-calculated using the planned treatment fields and the adjusted heart contours for patients receiving any of the three breath-hold techniques. Three-dimensional cardiac displacement between the planned (CT) and treated (CBCT) heart positions was obtained from the changes in coordinates of the heart centroids.

**Results:** Sixty-three patients were accrued to the study, five patients withdrew, and a total of 55 participants had CBCT scans available for analysis. Seven of these patients received a dose of 5000 cGy in 25 fractions, 45 patients received 4256 cGy in 16 fractions and three patients received 4005 cGy in 15 fractions. Sixteen of these patients received RT with VBH, 19 patients were treated with ABC and 20 patients were treated with AlignRT. The change in mean cardiac dose between planning CT and treatment CBCT was 2.9% (vDIBH), 2.0% (ABC) and 6.6% (AlignRT). The median standard deviations for change in interfractional heart dose on treatment were 11.0 cGy (vDIBH), 13.6 cGy (ABC) and 16.1 cGy (AlignRT). The mean cardiac displacement between planning CT and treatment CBCT were 0.37 cm (vDIBH), 0.35 cm (ABC), and 0.35 cm (AlignRT). All cardiac displacements were found to be statistically non-significant in comparing the three breath-hold techniques ($p>0.15$). All differences in the dosimetric data were also found to be statistically non-significant in comparing the three breath-hold techniques ($p>0.25$).

**Conclusions:** This study demonstrates that the differences in heart position on treatment are negligible for vDIBH, ABC and AlignRT, and that the cardiac dose sparing is equivalent for these three breath-hold techniques.

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**RADCURE: A LARGE OPEN SOURCE HEAD AND NECK RADIATION THERAPY DATASET FOR DATA SCIENCE**

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**Purpose:** Data science requires large datasets to successfully apply computational analysis and machine learning methodology to retrospective cancer imaging data. The purpose of our work is to generate the largest single-institution head and neck cancer (HNC) datasets openly available for research to capture the heterogeneity and complexity of this disease which provides unparalleled opportunities for discovery and innovation.

**Materials and Methods:** An in-house data mining and processing system was used to extract and translate radiation treatment planning imaging and structure set data from our institution's treatment planning (TPS) and oncology information systems. The input to the data extraction was a set of patient identifiers, radiation treatment start dates and radiation dose-fractionations provided from our institution's HNC anthology. DICOM images were extracted directly from our TPS and custom RT structure sets were generated by translating TPS-specific data files. We attempted to include all patients covered under an REB approved study treated at our institution with IMRT between 2005 and 2017.

**Results:** Within the time period covered, 4000 patients were available, of which 2745 were able to be fully reconstructed including both CT images and RT structures and linked to the existing prospectively collected outcomes data for each patient. The final dataset includes a population of patients with a median age of 63, comprised of 80% males. 50% of the population has a diagnosis of oropharyngeal cancer, with larynx, nasopharynx, and hypopharynx comprising 25%, 12%, and 5% respectively. The median follow-up for the group was five years with 60% of the patients alive at last follow-up. The final dataset includes nearly 350 GB of imaging data and 14 associated clinical variables and outcomes data for each patient including age, sex, smoking status, disease site, local failure, regional failure, distant failure, and follow-up data. There are on average 50 RT structures per patient including nearly 20 normal tissues and all associated radiotherapy targets including GTV and CTVs for primary and nodal targets. The resultant dataset is being released via The Cancer Imaging Archive (TCIA).

**Conclusions:** Open source data sets are critical for advancement of AI/ML. The automatic extraction of RADCURE represents a unique contribution to the field of cancer imaging research due to its size. Future plans to amend the data and include additional data types will continue to expand the reach and usability of the data.

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**INITIAL ASSESSMENT OF A COMMERCIAL AUTO-SEGMENTATION SOFTWARE BASED ON DEEP-LEARNING MODELS IN THE CONTEXT OF ARTIFICIAL INTELLIGENCE-ASSISTED RADIATION TREATMENT PLANNING**

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**Purpose:** In modern radiation treatment planning, dose assessment of organs-at-risk (OAR) requires these structures to be contoured. Reliable auto-segmentation software (AS) is not commonly available. We aim to validate an FDA approved commercial AS in thoracic cancer treatment planning.

**Materials and Methods:** Our AS running on Ubuntu Linux was previously trained on several hundreds of thorax CT, but not from our own population. Gold standard contouring (GSC) was done by two experienced planners and one radiation oncologist (RO). We used 30 previously peer-reviewed plans to generate GSC and AI contouring (AIC). Objective analysis included Dice Similarity Coefficient (DSC) and 95% Hausdorff distance (95% HD). Another two RO assessed the quality of both anonymized GSC and AIC. The contours were scored 1 to 3 (1: requiring no modification; 2: requiring minor modification but adequate for clinical use; 3: needing major modification and not suitable for clinical use).

**Results:** Almost all our retrospective peer-reviewed OAR contouring missed some less important structures on CT slices typically far away from the isocenter of the radiation fields of the 30 patients, with median age 75 year (range 54-90), including 22 males and 8 females, with 28 average pixel density data-sets from 4D-CT for lung cancer and 2 fast helical scans for esophageal cancer. We had to re-contour most of the OARs to generate GSC. The median AIC and GSC contouring times were 2.5 versus 60 minutes (range 30-105 minutes) for up to 12 OARs, some of which only partially available on CT (e.g. stomach and liver). Due to the inconsistency of contouring organs far away from the planning target volume (PTV), we only chose six main OARs for initial validation and analysis. Comparing AICs to GSCs, the mean DSC and 95% HD

were: esophagus 0.61 and 16 mm, heart 0.85 and 13.1 mm, left lung 0.97 and 5.9 mm, right lung 0.96 and 5.7 mm, spinal cord 0.82 and 10.7 mm, trachea and proximal bronchial tree (TPB) 0.67 and 19.1 mm, respectively.

The two RO agreed with 100% of four OARs on GSC, i.e. both RO scoring 1 or 2 meaning adequate for planning purpose, with the exception of esophagus having 96.7% versus 100% and right lung having 100% versus 96.7% agreement, respectively. They had less agreement on AIC, with esophagus 90% versus 60%, heart 83.3% versus 86.7%, left lung 100% versus 96.7%, right lung 100% versus 96.7%, spinal cord 100% versus 100%, TPB 96.7% versus 86.7% agreement, respectively. The inter-observer variabilities are significantly larger when RO evaluating esophagus and heart AIC (p=0.046 and 0.05, respectively, Student's t-test).

**Conclusions:** Our findings demonstrate that the accuracy of externally trained deep learning-based AS might not be suitable for institutions using different protocols likely due to inter-observer variability. Retrospective peer-reviewed OAR contours might not be good enough in the training and evaluation of AS. It needs extensive modifying to be ready to train AI. Our next step is to train AS using our GSC and then validate the software again.

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## A RANDOMIZED BLINDED ASSESSMENT OF A MACHINE LEARNING BASED AUTOCONTOURING TOOL FOR BREAST CANCER RADIOTHERAPY COMPARED TO PEER-REVIEWED RADIATION ONCOLOGIST CONTOURS

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**Purpose**: Machine-learning based contouring software has not yet been compared to the gold standard. In a novel randomized blinded peer-review interface, contours authored by a Machine-learning based Autocontouring tool for Breast Radiotherapy (MABR) were compared to the gold standard, peer-reviewed Radiation Oncologist (RO) contours.

**Materials and Methods**: Delivered peer-reviewed breast radiotherapy plans with all Clinical Target Volumes [CTVs] contoured, including Internal Mammary Lymph Nodes [IMNs], were screened as either Complete (all CTVs & Organs at Risk [OARs] contoured) or Training (any contour incomplete). Training and excess Complete contours further optimized the MABR. Plans were duplicated, anonymized, then autocontoured to produce contour-pairs (MABR- and RO-authored). RO-evaluators assigned contours grades via a randomized blinded assessment platform - No Changes or Minor Change(s) were Passes; Major Change(s) or Complete Revisions were Fails. If any contour was graded as a fail, the entire contour set was scored a failure. At least 110 contour-pairs were estimated to be required to assess for the MABR's non-inferiority by McNemar's test ($\alpha$=0.05, $\beta$=0.8).

**Results**: Of 216 screened plans, 149 were Complete, 124 were randomized for inclusion, and one case was excluded secondary to further missing data. Eight ROs evaluated contours. The MABR was inferior to RO contouring when considering entire contour sets (CTVs and OARs) and CTV sets, with 2.29 (95%CI 1.3-4.3, p=.005) and 2.52 (95%CI 1.4-4.7, p=0.001) the odds of failure, respectively. The proportion of Breast, Axillary, or IMN contours failing blinded peer review were 0.01 vs 0.06 (p=0.18), 0.18 vs 0.15 (p=0.60), and 0.20 vs 0.46 (p<0.01) for RO vs MABR-authored contours, respectively. The odds ratio of the MABR-authored OAR contours failing blinded peer review were not significantly different than a RO-authored contours – 1.12 (95%CI 0.4-3.4, p=1.00). Qualitative assessment demonstrated MABR systematic over-contouring of IMNs inferiorly. When foregoing IMNs in an assessment of contouring performance, both the MABR and the ROs had equal proportions of failed contour sets (0.20).

**Conclusions**: Excepting IMN contours, integration of a machine-learning based autocontouring program could occur with similar contouring fidelity to board-certified ROs. Future studies should prospectively evaluate both efficiency and contouring fidelity.

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## EVALUATION OF SIMULATION-BASED VIRTUAL PATIENT ENCOUNTERS FOR LEARNING ONCOLOGIC EMERGENCY MANAGEMENT

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**Purpose:** Managing oncologic emergencies is a fundamental competency for radiation oncology trainees and is evaluated through an entrustable professional activity (EPA) in the competency-by-design curriculum. Simulation-based learning has been extensively studied in medical education as an effective learning strategy to support achieving specific clinical skill goals. This study aims to evaluate the effectiveness of virtual cases in improving trainee knowledge and readiness to assess oncologic emergencies.

**Materials and Methods:** Three virtual patient modules simulating common oncologic emergencies encountered throughout residency training in radiation oncology were developed using a simulation-based online learning platform. These modules include spinal cord compression, superior vena cava syndrome, and tumour-induced hemorrhage. Clinical vignettes were designed to mimic the clinical presentation and evolution of a patient exhibiting signs and symptoms of these common oncologic emergencies. Each module consisted of pre- and post-module questions compared to assess immediate knowledge acquisition. Questions focused on physical examination, imaging interpretation, staging, anatomy, epidemiology, differential diagnosis, prognostication, radiation planning, communication skills, and pertinent literature. We recruited radiation oncology residents from across Canada to participate over a 6-month period from June to December 2021.

**Results:** A total of 13 radiation oncology trainees across Canada (PGY2-6) completed 32 virtual patient scenarios. The modules were completed by junior residents (PGY2-3) 24 times and by senior residents (PGY4-6) 8 times. For all residents, the mean pre-module completion score was 66% (range 60-71%). Mean pre-module completion scores were 65% (range 63-68%) and 69% (range 50-80%) for junior and senior residents, respectively. Mean post-module completion scores were higher, at 92% (range 89-95%) for all residents, 92% (range 90-94%) and 91% (range 88-95%) for junior and senior residents, respectively. Pre-module completion scores were lowest for the tumour-induced hemorrhage scenario, identifying a potential knowledge gap. Resident feedback was unanimously positive, and residents reported that these online modules were useful for their learning.

**Conclusions:** Online virtual patient modules can be used as complementary learning and assessment tools in the management of different oncologic emergencies. There is a significant improvement in knowledge acquisition after completion of each module, and this improvement is seen across all years of residency. Overall, residents find this learning method useful.

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## OPTIMIZING PATIENT-CENTERED INCLUSIVE CARE IN ONCOLOGY: HEALTHCARE PROFESSIONALS' KNOWLEDGE, ATTITUDES AND PRACTICES CARING FOR LGBQT2+ INDIVIDUALS

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**Purpose:** Lesbian, gay, bisexual, transgender, queer/questioning, Two-Spirit, plus (LGBTQ2+) individuals experience cancer-related health disparities and inequities. Our objective was to examine healthcare professionals' (HCPs) knowledge, attitudes, practices and education interest when caring for LGBTQ2+ individuals with cancer, and to identify gaps and opportunities to improve care.

**Materials and Methods:** A 38-item electronic survey was sent to all Gynecologic oncology staff (n=92) within a tertiary care cancer centre in Toronto via REDCap. Items included respondent demographics (n=7), and LGBTQ2+ knowledge (n=7), attitudes (n=15), practice behaviours (n=5) and education interest (n=1). There were three open-ended items exploring personal experiences, reservations, and suggestions for improving LGBTQ2+ care. Knowledge and attitude items were anchored on a five-point Likert scale with additional options for not sure and prefer not to answer. Practice behaviours and education interest items were measured using categorical response options. Descriptive statistics summarized survey responses. Thematic analysis was used to analyze open-ended questions.

**Results:** Seventy-five of 92 HCPs completed the survey (82% response rate). Almost all respondents reported comfort (87-96%; strongly agree/agree) treating LGBTQ2+ individuals, most reported a lack of knowledge about LGBTQ2+ health needs (55-73%). Respondents strongly agreed/agreed it was important to know a patient's sexual orientation and gender identity, while less respondents strongly agreed/agreed that they felt comfortable asking patients (sexual orientation 58% versus 41% p=0.023 and gender identity 82% versus 36% p<0.001). Almost all (96% strongly agreed/agreed) were interested in receiving LGBTQ2+ specific education. Two main themes were identified: (i) HCPs experience fear of offending LGBTQ2+ individuals because of their lack of knowledge, and (ii) HCPs desire LGBTQ2+-specific health training, especially in asking a patient's pronouns, sexual orientation, gender identity, and in caring for transgender patients.

**Conclusions:** Although HCPs report feeling comfortable caring for LGBTQ2+ individuals, most report a lack of knowledge and awareness in caring for this population. We recommend institutions implement cultural competency training for HCPs to improve inclusive patient-centered care.

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## DOES A MENTORSHIP AWARD IN RADIATION ONCOLOGY INSPIRE MEDICAL STUDENTS TO PURSUE THE SPECIALTY? A SURVEY ANALYSIS OF MEDICAL STUDENTS, RESIDENT MENTORS, AND RESEARCH PROJECT SUPERVISORS

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**Purpose:** The CARO Annual Scientific Meeting (ASM) Medical Student Research and Mentorship Award (CARO ASM MSRMA) was established in 2020 to aid in recruitment of medical students to radiation oncology (RO). This study aims to determine the impact of the award on student interest in RO research and RO as a career, as well as its impact on mentorship and teaching from the perspective of RO residents and research supervisors.

**Materials and Methods:** Three separate surveys were created: one for medical student mentees, one for resident mentors, and one for attending physician research supervisors. These surveys were developed using best practice strategies for medical education surveys and circulated for peer-review amongst experts in oncology medical education. The surveys were sent to the 7 students, 7 residents, and 7 supervisors who participated in CARO ASM MSRMA 2020. All students were Canadian medical students, with four from Ontario, two from British Columbia, and one from Saskatchewan. After anonymization, quantitative answers were analyzed using descriptive statistics and narrative responses were evaluated using a grounded theory approach.

**Results:** There was a 100% survey response rate. For the medical student mentees, the award maintained or increased interest in pursuing a career in RO for all respondents. According to students, the most important aspect of the research award was financial coverage of CARO ASM registration costs and mentorship with an RO resident. Through the mentorship program, 50% of students felt they attained valuable information about a career in RO, 33% gained insight into RO residency, and 33% received helpful CaRMS (residency matching) advice. From the perspective of the resident mentors, all respondents felt the program either maintained or increased motivation to mentor students in RO. Mentors and mentees met an average of 2 times; the most popular medium was video call. Research project supervisors unanimously enjoyed their role in this program and would participate in this program again. Some suggestions to improve the program included shadowing opportunities, meeting reminders, and more in-person networking. All three cohorts agreed or strongly agreed that it would be useful for there to be a network of mentors/mentees/supervisors to share experiences in RO and help students find opportunities to present their research.

**Conclusions:** CARO ASM MRSMA is an innovative award that has had a positive impact on participants. Medical students appreciated registration cost coverage as well as resident mentorship, motivating many to continue pursuing research and a potential career in RO. The program also enhanced mentorship skills in residents and research supervisors, which will encourage further mentorship and exposure to RO for the next generation of students. Further research can be done with future iterations of the award and with potential expansion of this type of award or opportunity at other research conferences.

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## VALIDATION OF THE BC-BRAIN PATIENT REPORTED OUTCOME QUESTIONNAIRE FOR PATIENTS WITH CENTRAL NERVOUS SYSTEM TUMOURS TREATED WITH RADIOTHERAPY

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**Purpose:** The BC-brain questionnaire was developed by BC Cancer to detect health problems in patients with central nervous system (CNS) tumours in routine clinical care, treated with radiotherapy (RT), as part of the Prospective Outcomes and Support Initiative (POSI). This study aimed to present and validate the BC-brain questionnaire in patients with brain metastases (BrM) treated with RT.

**Materials and Methods:** The BC-brain questionnaire was constructed with 3 subscales: Mobility, Thinking and CNS Symptoms. Patients with BrM from 5 BC Cancer centres completed this questionnaire at first visit and subsequent follow-up appointments. Summary scores of each subscale were calculated. Reliability, validity, known-group differentiation responsiveness were tested.

**Results:** 365 patients finished the first and 105 finished the follow-up questionnaire. Mobility, Thinking and subtotal score showed good reliability with Cronhach's α > 0.7. Multitrait scaling analysis showed good convergent and divergent validity. The subscales correlated well with the general QoL question and the subtotal score. The correlations between subscales range from 0.262 to 0.456 for baseline and from 0.378 to 0.597 for follow-up. Patients on dexamethasone had worse score on Mobility (p<0.001), Thinking (p=0.006), CNS symptoms (p=0.003), the general QoL (p=0.010) and subtotal score (p<0.001) than patients not on dexamethasone. Patients with a KPS of </= 70 had worse score on Mobility (p<0.001), Thinking (p=0.001), CNS symptoms (p<0.001), the general QoL (p<0.001) and subtotal score (p<0.001) than patients with a KPS of > 70.

**Conclusions:** This BC-brain questionnaire has good reliability and validity. It is short in length and is easy to administer without adding much patient burden in routine clinical care. It is a new Patient Report Outcome (PRO) instrument to measure the quality of life in BrM patients treated with RT, especially for use in routine clinical care. Future research could explore the feasibility of including HRQOL in patient selection and treatment decision making for brain metastases patients.

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## LONG TERM RESULTS OF A LONGITUDINAL STUDY OF UNMET SURVIVORSHIP NEEDS IN PATIENTS WITH HEAD AND NECK CANCER

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**Purpose:** Cross-sectional studies show many unmet needs in patients with head and neck cancer (HNC); prospective studies are lacking. Our purpose was to determine the number, type, and predictors at baseline of unmet needs over time.

**Materials and Methods:** Patients with non-metastatic HNC were enrolled prior to curative treatment. Demographics, the Cancer Survivors' Unmet Needs (CaSUN), Functional Assessment of Cancer Therapy (FACT-HN) and EuroQol 5D (EQ-5D) were collected at baseline, 3-, 6-, 12- and 24-months post-treatment. Mean unmet needs at each time point and predictors for number of unmet needs were identified.

**Results:** Of 197 patients (median age 64, 80% male), 153 (78%) completed questionnaires at baseline, 126 (64%) at 3, 104 (53%) at 6, 103 (52%) at 12 and 97 (49%) at 24 months. Education was beyond high school in 118 (60%) and 85% had internet access. Most patients had oropharynx (n=88; 46%) and hypopharynx/larynx (n=45; 24%) cancer.

The mean number of unmet needs at baseline, 3, 6, 12 and 24 months was: 7.5 ± 9.1, 3.8_±_6, 5.3 ± 8.4, 2.9 ± 5.8 and 2.8 ± 6.5 respectively. At least one unmet need was reported at these timepoints by 68%, 52%, 56%, 41% and 39% of patients.

The mean FACT-HN scores were 110.7 ± 21.6, 109.4 ± 21.9, 108.3 ± 22.9, 117.1 ± 20.5 and 118 ± 22.3 respectively, while the mean EQ-5D VAS scores were 72 ± 20.5, 73.3 ± 17.3, 75.9 ± 15.5, 79 ± 15.6 and 78.2 ± 15. The top three needs at baseline, 6, 12 and 24 months are shown in Table 1; qualitative change was seen. Multivariable analysis showed that education greater than high school (p < 0.01), living alone (p=0.02), cancers of the lip and oral cavity (p < 0.01) and lower baseline FACT HN scores (p<0.001) were associated with increased unmet needs at baseline. Having no computer access (p<0.01) and lower baseline FACT HN scores (p=0.03) are associated with increased unmet needs at 24 months.

**Conclusions:** HNC patients' unmet needs decrease and change over time. Survivorship resources are needed that serve different issues through the cancer journey.

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## EQUITY AS AN EMERGING FOCUS IN THE CANADIAN CANCER CARE SECTOR: RESULTS OF A RAPID SCOPING REVIEW

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**Purpose:** Despite advances in research and treatment, and a publicly funded healthcare system in Canada, alarming inequities exist across the cancer continuum. Although attention to these inequities is increasing, it is unclear how organizations are acting upon calls to address health equity. Our purpose was to identify how health and healthcare equity are being discussed as a goal or aim within the Canadian cancer care sector.

**Materials and Methods:** A rapid scoping review was conducted for published and unpublished literature on health equity in the Canadian cancer care sector. As this review was part of a larger initiative aimed at informing policy recommendations and research priorities with specific time constraints, we also drew on the WHO's guidance for conduct of rapid reviews to strengthen health policy and systems. Five biomedical databases, 30 public health and multidisciplinary websites and databases, and Google were searched. Documents available in English, published between 2008 and 2021, and that discussed health or healthcare equity in the Canadian cancer context were included.

**Results:** Of 3,678 documents screened, 83 were included for full text analysis. The focus on health equity within the Canadian cancer care sector increased 3-fold between 2015-2021 when compared with the period 2008-2014. Only 25% of documents included a definition of health equity. Concepts such as inequity, inequality, and disparity were frequently used interchangeably or in a tokenistic way, resulting in conceptual muddling. Less than half of documents included an explicit health equity goal. Stated health equity goals ranged from broad to specific, with examples from across the cancer continuum. A range of actions were described to address equity goals, including health system improvements and policy and planning considerations. Most actions were framed as recommendations rather than actions taken or underway, and few documents described measurement of progress toward health equity goals.

**Conclusions:** Health equity is a growing priority in the cancer care sector, however conceptual clarity is needed to guide the development of robust equity goals, specific objectives, and meaningful action. Moreover, evaluation mechanisms to understand the impacts of actions on equity goals are urgently needed. If we are to advance health equity in the cancer care sector, a coordinated and integrated approach will be required to enact transformative and meaningful change.

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## ONCOLOGIC OUTCOME, TOXICITY AND COSMESIS AFTER SINGLE-FRACTION NEOADJUVANT RADIOTHERAPY FOR LOW-RISK BREAST CANCER

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**Purpose:** Breast-conserving surgery followed by several weeks of adjuvant radiotherapy is the current standard of care for low-risk breast cancer. A novel approach using single-fraction neoadjuvant radiotherapy is under study. We sought to investigate the rate of pathologic response, toxicities and cosmetic results related to this new treatment strategy.

**Materials and Methods:** Women 65 years of age or older with a new diagnosis of Stage I unifocal luminal A breast cancer were eligible for inclusion in this Phase I prospective trial. A single 20 Gy dose of radiotherapy to the breast tumour was given, followed by breast-conserving surgery three months later. The primary endpoint was the pathologic response rate assessed by microscopic evaluation using the Miller-Payne system. The secondary endpoints were the incidence of radiation toxicity and the cosmetic results, graded according to the Common Terminology Criteria for Adverse Events and the European Organisation for Research and Treatment of Cancer Cosmetic Rating System, respectively. Secondary outcomes were assessed at 6 weeks, 4 months and yearly after radiotherapy.

**Results:** To date, 13 patients have been successfully treated with a median age of 71 years (range: 65-83 years). As previously reported, neoadjuvant radiotherapy resulted in a tumour pathologic response in 11 of 13 patients with a median residual cellularity of 1% (range: 0-10%). With an average follow-up of 31.9 months (range: 24.4-39.2 months), no disease recurrences or deaths were recorded. Acute radiation toxicities were limited to Grade 1 dermatitis and breast pain. At the one-year follow-up, 11 patients had Grade 1 toxicities (dermatitis, fibrosis, breast pain and chest wall pain), one patient had a Grade 2 fatty necrosis, and two patients had Grade 3 toxicities (wound infection and hematoma). Only Grade 1 toxicities remained at the two-year follow-up. One-year cosmetic results were good or excellent in 46% of patients according to their self-assessment and in 54% of them according to the nurse's evaluation. Two-year cosmetic results were unavailable due to in-person visits cancellations during the COVID-19 pandemic.

**Conclusions:** This study demonstrates that a single fraction of neoadjuvant radiotherapy preceding breast-conserving surgery is feasible, relatively well tolerated and leads to a high level of pathologic response for most patients. The Grade 3 toxicities and underwhelming cosmetic results may indicate that the 3-month interval after radiotherapy places surgery in a post-radiation inflammatory phase. Larger trials are needed to better assess the long-term toxicities as well as the optimal timing and fractionation of this novel technique in the management of early-stage breast cancer.

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## ADJUVANT RADIOTHERAPY (RT) FOR BREAST CANCER PATIENTS WITH REMOTE RECONSTRUCTION: INSTITUTIONAL OUTCOMES

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**Purpose:** Postmastectomy radiotherapy (RT) in patients with immediate breast reconstruction has well known risks of complications including delayed wound healing, capsular contracture and poor cosmesis. For patients with a remote history of either augmentation mammoplasty with implants (AMI) or postmastectomy reconstruction (PMR) followed by a later diagnosis of breast cancer and adjuvant radiotherapy (RT), the risk of complications is not well documented. Due to concerns about cosmesis, patients receiving adjuvant whole breast irradiation (WBI) with prior AMI or PMR receive either 25 or 28 fractions rather than a hypofractionated approach as per institutional policy. The purpose of this quality assurance project is to review outcomes for patients who received RT with remote AMI or PMR.

**Materials and Methods:** Using the Varian Aria Interface (Varian, Palo Alto, CA), patients were identified who underwent adjuvant RT to the breast, chest wall and/or regional nodes in 25 to 28 fractions between January 1, 2013, and December 31, 2019. Chart review was performed to determine type of reconstruction, complications, subsequent unexpected re-operations due to cosmesis, and dosimetry. EQD2 calculations were generated assuming an $\alpha/\beta=3.4$ for normal breast tissue.

**Results:** Thirty-six patients underwent WBI with prior plastic surgery. Thirty-four patients had remote AMI, while two had remote autologous PMR prior to RT. The mean timeline from prior plastic surgery to RT was 144.3 months (16.3-429.8 months). Nineteen (52.8%) patients received 45-50 Gy in 25 fractions, with 16 receiving a boost (10-16 Gy in 5-10 fractions). Seventeen (47.2%) patients received 50.4 Gy in 28 fractions, 2 with a boost (10-14.4Gy in 5-8 fractions). Two patients had bolus, one to the whole chest wall for 20 of 28 fractions and the other had bolus to the surgical scar for all RT fractions. Five patients (13.9%) had documented cosmetic complications after adjuvant RT requiring reoperation. Complications included rupture (n=1), contracture (n=3), and asymmetry (n=1). The mean time from radiation to reoperation was 18.8 months (2.3-34.4 months). The total EQD2 for WBI and boost was statistically higher in the group of patients requiring reoperation for cosmesis (58.7 Gy versus 52.0 Gy, *p=0.006*).

**Conclusions:** For our cohort of patients receiving RT after remote AMI or PMR, the rate of cosmetic complications requiring reoperation was low (13.9%). This rate is lower than previously documented rates of reoperation for cosmetic complications in patients with immediate reconstruction followed by adjuvant RT (30-40%). It is worthwhile to note that the rate of reoperation was statistically related to the total radiation dose delivered. While numbers here are small, future investigation should consider the risk/benefit profile of surgical cavity boost for patients with AMI.

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## EARLY INSTITUTIONAL EXPERIENCE OF ULTRA-HYPOFRACTIONATED BREAST RADIOTHERAPY IN A LARGE ACADEMIC CANCER CENTRE

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**Purpose:** Ultra-hypofractionated radiotherapy (U-HFRT) is non-inferior to moderate hypofractionation (M-HFRT) for local control following breast-conserving surgery for early-stage breast cancer and is safe in terms of normal tissue toxicity. Our objective was to evaluate early institutional experience of U-HFRT in a real-world setting at a large academic cancer centre.

**Materials and Methods:** Stage 0-II breast cancer patients who received adjuvant whole breast irradiation (WBI) or partial breast irradiation (PBI) between May 2020 and March 2021 were compiled. Patients were divided into 2 cohorts: U-HFRT (26Gy in 5 daily fractions) and M-HFRT (40.05Gy in 15 fractions). Clinical and treatment characteristics were extracted from medical records and displayed using descriptive statistics. Physician-assessed skin toxicity was collected for patients treated with U-HFRT during RT

and at follow-up visits using the RTOG radiation morbidity scale. Associations between toxicity and clinical/treatment characteristics were determined using mixed effects logistic regression, accounting for time. Comparisons between the U-HFRT and M-HFRT cohorts were performed using the Wilcoxon rank sum test (continuous) and Chi-square/Fisher's exact test (categorical).

**Results:** Median age at diagnosis for the entire cohort was 60.5 years: U-HFRT 66.2 years and M-HFRT 55.1 years (p<0.001). For the U-HFRT cohort, 70% had hormone-receptor positive invasive breast cancer (70% pT1c, 95% pN0) and 20% had DCIS. WBI/PBI was delivered to 385 patients, of which 188 (49%) received U-HFRT. For these patients, the majority (72%) received WBI, 28% PBI and a boost was used in 26%, compared to 96%, 4% and 47%, respectively, for those treated with M-HFRT (p<0.001). Grade 1 RTOG skin toxicity significantly improved over time for patients who received U-HFRT: 37% during RT, 57% within 90 days post-RT and 6% >1-year post-RT (p<0.001). Grade 2 toxicity was minimal (5% within 90 days post-RT) and there were no Grade 3 toxicities. Age, RT volume (WBI versus PBI) and chemotherapy were not associated with toxicity for U-HFRT; however, increased toxicity was observed for patients who received a boost (p<0.001). Factors associated with increased usage of U-HFRT were older age, use of PBI, no boost and no breast reconstruction (p<0.001).

**Conclusions:** U-HFRT was rapidly adopted at our institution for early-stage breast cancer and is associated with low rates of reported skin toxicity. The use of U-HFRT was greatest in patients with low-risk breast cancer, consistent with a conservative approach to implementation in a real-world setting.

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## DOSIMETRIC PARAMETERS CORRELATED WITH TOXICITY WITH SHORT COURSE RADIATION IN THE NEOADJUVANT TREATMENT OF RECTAL CANCERS

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**Purpose:** The aim of this study was to identify the incidence of late small bowel (SB) toxicity and late pelvic bone (PB) fractures associated with neo-adjuvant short-course radiation (RT) and to identify correlations of these toxicity events with radiation dosimetry.

**Materials and Methods:** 138 consecutive patients with rectal cancers (clinical T2/T3, N0-N2) who received short course RT (2500 cGy in 5 fractions) followed by surgery and had dosimetric data available for analysis were included in this study. The correlation of late SB toxicity and late PB fractures with radiation dosimetry was evaluated using Receiver Operating Characteristics (ROC) and regression analysis.

**Results:** Among the 138 patients with a median follow-up time of 82.5 months, 11 (8.0%) patients experienced ≥ Grade 2, and 9 (6.5%) developed ≥ Grade 3 late SB toxicity respectively, five (3.6%) patients required surgical intervention for SB toxicity, and two (1.4%) patients developed PB fractures. Median time to SB event was 15 months with a range of 1 to 104 months. Dosimetric analysis revealed no correlation of radiation dose with SB toxicity or PB fractures.

**Conclusions:** This study demonstrates no significant association between SB and PB dosimetry and late Grade ≥3 toxicity. Potential areas for further research include involving a larger population and a longer period of follow-up to better assess any potential correlative findings between late toxicity and dosimetric parameters.

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## AN EXAMINATION OF RECTAL ANATOMY DEFINITIONS AND FUTURE DIRECTIONS

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**Purpose:** There remains considerable controversy surrounding anatomical definitions of the rectum, which in turn impacts clinical decision making surrounding indications for chemotherapy and radiation. This study examines the definitions used by landmark clinical trials relative to the updated 2020 NCCN rectum definition to illustrate the historical evolution of rectum definitions, and how these definitions in turn may be affecting treatment decision making in the present.

**Materials and Methods:** A focused literature search identified 22 landmark rectal cancer clinical trials between 1985 and 2021. These trials were separated into postoperative, preoperative, and total neo-adjuvant studies and eligibility criteria were recorded. If explicit study definitions of the rectum were not provided, eligibility criteria were extrapolated as representative of what the study considered a rectal tumour. Definitions of the rectum were split into three separate categories—distance from the anal verge, palpable on digital rectal exam (DRE), and anatomically based.

**Results:** Of the 22 examined studies, 20 defined the rectum using a distance measured from the anal verge; one based their definition on palpability on DRE; and one study used anatomical definitions. More variability in definitions were observed in studies from the post-operative era, with one study using anatomical definitions and another basing definitions on DRE palpability. All preoperative and total neo-adjuvant studies used distance based definitions. The single study utilizing an anatomical definition used gross anatomy, with no studies using radiographic anatomical landmarks in line with 2020 NCCN recommendations. Considerable variability was present in the distance measures used, with one study using 10cm, seven studies using 12cm, eight studies using 15cm, three studies using 16cm, and a single study using 18cm.

**Conclusions:** The majority of landmark clinical trials examined defined the rectum utilizing distance measures from the anal verge. No identified studies used radiographic anatomical definitions similar to those suggested by the NCCN. This is worth noting as recent NCCN and Delphi expert panels have found distance based definitions suboptimal due to an inability to account for body habitus and its reliance on rigid proctoscopy instead of more accurate anatomical markers seen on MRI. Given the prevalence of influential studies using distance based rectal definitions, oncologists should ensure they are adapting up to date imaging based definitions, in conjunction with distance definitions, to properly delineate rectal and sigmoid cancers.

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## STATIN THERAPY IN PATIENTS UNDERGOING SHORT-COURSE NEOADJUVANT RADIOTHERAPY FOR RECTAL CANCER

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**Purpose:** To determine the effect of statin use on response to short-course neoadjuvant radiation therapy for rectal cancer.

**Materials and Methods:** Single-centre, retrospective cohort including all patients with Stage II or III rectal cancer receiving short-course neoadjuvant radiation for rectal adenocarcinoma between 2014 and 2020. Patients without metastatic disease, without recurrent rectal cancer, and who had oncologic resection at least six weeks after completing neoadjuvant therapy, were included. The primary outcome was pathologic complete response

(pCR). Secondary outcomes included presence of any treatment response and incidence of radiation-associated toxicity. Outcomes were analysed with univariable logistic regressions and stepwise multivariable logistic regressions. Descriptive statistics were used to characterize the sample population.

**Results:** Ninety-seven patients met inclusion criteria. The median Charlson Comorbidity Index was 5. The median clinical T- and N-stage were 3 and 1, respectively. 37.5% of patients had threatened circumferential resection margins, and the median tumour distance from the anal verge was 6cm. Patients received a radiation dose of 25 Gy in five fractions. 11% of patients received short-course radiation as part of total neoadjuvant therapy (TNT), and were excluded from further analysis. 44% of patients were using statins during neoadjuvant therapy. 9.2% of patients had pCR and 29% had no treatment response on pathology. 43% of patients had radiation-associated toxicity, with 6.3% of patients having toxicity of Grade 3 or more. Statin use was not associated with increased pCR (OR 1.63, 95%CI 0.38-7.02, p=0.51), however it was associated with a significantly lower incidence of no pathologic response (OR 0.31, 95%CI 0.10-0.93, p=0.04). On stepwise multivariable logistic regression, statin use (OR 0.20, 95%CI 0.04-0.94, p=0.04) and male gender (OR 0.19, 95%CI 0.04-0.77, p=0.02) were associated with decreased incidence of no pathologic response. Incidence of radiation-associated toxicity was unchanged with statin use (OR 0.83, 95%CI 0.36-1.90, p=0.66).

**Conclusions:** Statin use during neoadjuvant short-course radiation for rectal cancer did not increase pCR, but was associated with pathologic treatment response. Further prospective study evaluating the use of statins in conjunction with neoadjuvant short-course radiation is warranted.

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## SINGLE FRACTION PERIPHERAL LUNG SBRT DURING THE GLOBAL COVID-19 PANDEMIC AT A CANCERCARE MANITOBA: AN ANALYSIS OF TECHNICAL FEASIBILITY AND CLINICAL SAFETY

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**Purpose:** In response to the COVID-19 pandemic, a single fraction peripheral lung SBRT program was established to minimize potential COVID-19 exposures. This analysis aims to review clinical and treatment characteristics with associated toxicities in appropriately selected patients for this newly implemented technique.

**Materials and Methods:** From May 2020 until April 2022, patients with peripheral lung tumours who met eligibility for 3400cGy/1 fraction SBRT were treated at CancerCare Manitoba, a tertiary academic cancer center. Patient, treatment, and toxicity parameters were retrospectively collected. Radiation dosimetric parameters were tabulated. Toxicities were quantified using CTCAE v5.0. Fisher's exact was used to assess the differences in toxicities with clinical and dosimetric parameters. P-value < 0.05 was considered significant.

**Results:** 26 patients were analyzed with a median age of 74 (IQR: 67-80) and 62% were females. 92% were smokers and 54% had COPD. All patients were ECOG ≤ 2. The majority of patients (96%) had early-stage primary lung cancer while 4% had pulmonary oligometastatic cancer. 38% of patients were medically inoperable while 35% were treated on SABR-BRIDGE protocol and 27% refused surgery. A total of 26 peripheral lesions were treated with median maximal dimension of 1.7 cm (IQR: 1.4-2), ITV 4.9 $cm^3$ (IQR: 3.5-8.6) and PTV 17.9 $cm^3$ (IQR: 12.7-26.5). 81% of patients had PTV located within 1 cm form chest wall. After a median follow-up of 6 months (IQR: 3.5-17), 65% of patients experienced grade ≤ 2 toxicities and no patients experienced ≥ grade 3 toxicity. Radiation pneumonitis was the most common toxicity (42.3%; 5/11 with asymptomatic radiographic) followed by chest wall pain (35%; 4/9 with grade 2) and fatigue (30%). Two patients (8%) had rib fractures. Both radiation pneumonitis and chest wall pain rates were significantly higher in patients with tumour diameters >1.5 cm (p= 0.005 and 0.036). No other significant differences were observed between clinical or dosimetric parameters and development of any grade radiation pneumonitis or chest wall pain (p > 0.05). Patients with ribs fractures were observed to have larger tumours diameter (mean 3.2 vs. 1.7 cm), ITVs (mean 30 vs. 6.2 $cm^3$), PTVs (mean 61 vs. 20 $cm^3$), chest wall $V30_{Gy}$ (mean 4.8 vs. 0.5 $cm^3$), and ribs $V30_{Gy}$ (mean 1.1 vs. 0.1 $cm^3$). 2/3 patients with disease failure who were treated on SABR-BRIDGE underwent salvage surgeries. 35% and 20% viable tumors were found after 12 and 17 months respectively.

**Conclusions:** Single fraction peripheral lung SBRT is a practical and safe option with no grade ≥ 3 toxicities. Radiation pneumonitis and chest wall toxicities were higher in patient with larger tumours. Also, patients with rib fractures were observed to have larger tumours and higher $V30_{Gy}$ to chest wall and ribs. Careful patients' selection and dosimetric efforts to limit high dose fall-off to chest wall and ribs may limit these toxicities.

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## SETUP AND TREATMENT EFFICIENCY OF TWO PROSTATE SBRT RECTAL PREPARATION TECHNIQUES: EXPERIENCE FROM PROGRAM DEVELOPMENT AT A COMMUNITY CENTRE

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**Purpose:** Stereotactic body radiotherapy (SBRT) for definitive prostate treatment is becoming increasingly utilized and as a result more community centres are implementing regional programs. Our centre developed a local program in 2020 and since inception has employed two strategies for rectal preparation taken from existing literature and larger partnering centre experience. Individual patient preparation was based on shared patient and physician decision-making. The goal of this retrospective observational study was to evaluate each in terms of initial image-guided match, treatment time and rectal size.

**Materials and Methods:** Rectal preparation for all patients included self-administration of a fleet enema (FE) the night prior to fiducial marker insertion and CT-simulation (done on the same day) as well as the night prior to the first treatment fraction. Subsequently patients either continued with pre-treatment FE for each fraction [Group FE] or took 17g daily of polyethylene glycol 3350 [Group PEG]. Treatments were given every other weekday over a 10-day period. Evaluation consisted of total time per treatment session (taken as the recorded time interval from the start of first cone-beam CT (CBCT) and the end of treatment) and a 'ready-to-treat' assessment based on initial image-guided CBCT match. Assessments were categorical (yes or no) based on whether a radiation therapist (RT) would accept the match to proceed to 'beam-on' according to prostate and rectal anatomy. 3 RTs trained in image-guidance for prostate SBRT evaluated all fractions, blinded to rectal preparation. Analysis is also planned for maximal rectal diameter contoured on CBCT image for each fraction.

**Results:** The first 24 patients (120 fractions) were analyzed. A cluster-based logistic regression was performed. The odds of FE resulting in a 'yes' to beam-on was 2.86-fold greater (95% CI, 1.03-8; p=0.04) than PEG. Median treatment time in the FE group was 11.05 minutes (IQR, 9.37-17.67) compared to 13.95 minutes (IQR, 9.2-39.13) in the PEG group (p=0.16). Analysis for rectal diameter is in progress and will be available for final presentation.

**Conclusions:** Daily pre-treatment FE resulted in a higher rate of favourable rectal anatomy for prostate SBRT. There was no statistical difference in overall treatment time.

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**A PROSPECTIVE RANDOMIZED PARALLEL-CONTROLLED PILOT TRIAL OF STEREOTACTIC BODY RADIATION THERAPY VERSUS RADIOFREQUENCY ABLATION FOR THE MANAGEMENT OF SMALL RENAL MASSES - INITIAL RESULTS**

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**Purpose:** The potential of ablative technologies in replacing surgery for the treatment of small renal masses (SRMs) ≤4cm is unclear. Our objective was to evaluate the feasibility and toxicity of stereotactic body radiation therapy (SBRT) and radiofrequency ablation (RFA) for SRMs to determine the utility of a future multicentre trial.

**Materials and Methods:** Patients scheduled for SRM treatment at a single academic centre were approached for this pilot trial (RADSTER, NCT03811665), with the aim of recruiting 24 patients. Participants were randomized 1:1 to SBRT or RFA following biopsy demonstrating proof of renal cell carcinoma (RCC). SBRT included an initial simulation session and a single image-guided treatment session with a prescribed dose of 25 Gy. RFA was conducted by either percutaneous or laparoscopic access with 2 cycles of 8 minutes duration each, upon reaching target temperature. Imaging (CT or MRI) was completed at 3-, 6-, 9-, and 12-months post-procedure. Crossover if ineligible for treatment after randomization was allowed. Renal mass biopsies were completed at 12 months to assess early response to therapy.

**Results:** Twenty-four patients were recruited and randomized over 18 months (SBRT=11; RFA=13). Fourteen patients eventually had SBRT, eight RFA, and two became ineligible. Median age for all patients was 67 (range 53-85) and 17 were male. Seventeen patients had clear cell RCC, six had papillary RCC, and one had chromophobe RCC. All patients had T1a disease. Mean procedure length (minutes) for SBRT and RFA was 15.5±7.4 and 10.5±3.9, respectively. Two of five patients (four SBRT, one RFA) who had a 12-month biopsy demonstrated viable tumour (both SBRT) without radiographic change in tumour growth. An additional five patients (one RFA, four SBRT) have had nine-month imaging demonstrating no tumour growth. Follow-up for remaining patients is ongoing. No Grade 3 or higher toxicity has been observed in either arm.

**Conclusions:** Recruitment and randomization of patients with SRMs to SBRT and RFA is feasible on a timeline that allows for regular follow-ups and imaging, with good initial oncological outcomes and no safety signals of concern.

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**OUTCOMES OF STEREOTACTIC BODY RADIOTHERAPY FOR METASTASES TO THE HEAD AND NECK**

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**Purpose:** To report clinical outcomes for patients with metastatic disease to the head and neck (HN) treated with stereotactic body radiation therapy (SBRT) at a large academic centre.

**Materials and Methods:** A retrospective review of SBRT patients treated to the HN from 2012 to 2020 was conducted. Treatment indications included: oligometastases, oligoprogression, and local control of a dominant area of progression (DAP). Kaplan-Meier method was used to estimate local control (LC), regional control (RC), overall survival (OS), and progression-free survival (PFS). Univariable (UVA) and multivariable analyses (MVA) were performed to determine the relationship between clinical characteristics and outcomes. Grade 3—4 acute and late toxicities were reported by the Common Terminology Criteria for Adverse Events v5.0.

**Results:** Fifty-six patients (58 lesions) were analyzed with a median follow-up of 16 months. Primary cancer sites included lung (25%), kidney (19.6%), breast (19.6%) and other (35.8%). SBRT indications were: oligometastases (n=24, 42.9%), oligoprogression (n = 11, 19.6%), and local control of a DAP (n = 21, 37.5%). Most patients received SBRT to a single neck node (n = 48, 82.8%). Median SBRT small - dose was 40 Gy (range: 25-50 Gy) in 5 fractions, with a median biologically effective dose ($BED_{10}$) of 72 Gy (range: 37.5-100 Gy). One- and two-year LC and RC rates were 97.6% and 72.7% and 100% and 86.7%, respectively. Median OS was 19.2 months (95% confidence interval [CI], 14.8-69.4) and median PFS was 7.4 months (95% CI, 5.2-11.9). The one-year OS and PFS rates for oligometastases, oligoprogression and DAP were 95.8%, 63.6% and 38.1% (p=0.0039), and 56.5%, 27.3% and 19.1% (p=0.0004), respectively. On MVA, treatment indication and histology were found to be predictive for OS and treatment indication and prior systemic therapy were the predictive factors for PFS. Ten patients (18%) developed acute Grade ≥3 treatment-related toxicity and six patients (11%) experienced late Grade ≥3 toxicity.

**Conclusions:** The use of SBRT for metastatic disease to the HN provided excellent LC rates with low rates of regional failure. Patients with oligometastatic disease had better OS and PFS than others. This treatment resulted in an acceptable toxicity profile.

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**IMMUNOTHERAPY AND THE RISK OF RADIATION NECROSIS IN BRAIN METASTASES PATIENTS TREATED WITH STEREOTACTIC RADIOSURGERY**

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**Purpose:** Cancer is a leading cause of death in the U.S.A with almost 700,000 deaths annually. Up to 40% of cancer patients develop brain metastases at some point during their disease course and are often treated with stereotactic radiotherapy. The use of immunotherapy, including PD-1, PD-L1, and CTLA-4 directed therapies, in patients with metastatic cancer has risen rapidly in recent years and is, anecdotally, suspected of leading to increased rates of radiation necrosis. The purpose of this study is to determine whether treatment with immunotherapy increases the risk of radiation necrosis in patients treated with stereotactic radiosurgery (SRS).

**Materials and Methods:** After IRB approval (2017P000635), we identified and reviewed the online medical records of all patients with metastatic lung, renal, breast, and melanoma treated with SRS between 2017-2021. Demographic, histological, staging, radiation and systemic therapy details, and follow-up imaging and treatments were recorded. The rate of radiation necrosis was calculated in those who did and did not receive immunotherapy and was compared using a chi square test.

**Results:** One hundred and seventy-three patients treated with 287 courses of stereotactic radiation were identified. Eighteen patients were excluded due to incomplete information. One hundred and fifty-five patients and 267 courses of SRS were included in the final analysis. Primary malignancies were 69% lung, 10.3% melanoma, 9% renal, 1.3% breast, and 4.5% more than one. Seventy-seven percent (n=120) patients received some form of immunotherapy during their disease course. The overall rate of radiation necrosis was 11.6% (n=18). The rate of radiation necrosis in patients receiving immunotherapy was 12.5% (n=15) versus 8.6% (n=3) in patients not receiving immunotherapy. Chi square statistic 0.4074 (p=0.523).

**Conclusions:** Although the relative risk of radiation necrosis was increased by 46% in patients receiving immunotherapy, no statistically significant difference could be shown between the groups, presumably due to the low numbers of patients and events in the non-immunotherapy group. The absolute rates of radiation necrosis are reassuringly low in both groups. We are currently working with our statistics team to determine how many patients are needed in each group to adequately power future statistically analyses.

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## PROGRESSION-FREE SURVIVAL AND LOCAL CONTROL FOLLOWING STEREOTACTIC ABLATIVE RADIOTHERAPY FOR UP TO FIVE OLIGOMETASTASES: AN ANALYSIS FROM THE POPULATION-BASED PHASE II SABR-5 TRIAL

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**Purpose:** Despite increasing utilization of stereotactic ablative therapy (SABR) for oligometastatic cancer, prospective outcomes are lacking. The purpose of this study was to determine progression-free survival (PFS), local control (LC) and prognostic factors from the population-based Phase II SABR-5 trial.

**Materials and Methods:** The SABR-5 trial was a single arm Phase II study with the primary endpoint of toxicity, conducted at the six regional cancer centres across British Columbia, during which time SABR for oligometastases was only offered on trial. Patients with up to five oligometastases (total or not controlled by prior treatment, and including induced oligometastatic disease) underwent SABR to all lesions. Patients were 18 years of age or older, ECOG 0-2 and had life expectancy ≥ 6 months. The secondary outcomes of PFS and LC, calculated using the Kaplan-Meier method, are presented here. Univariable and multivariable analyses were performed using Cox regression modelling.

**Results:** Between November 2016 and July 2020, 381 patients underwent SABR on trial. Prostate was the most frequent primary tumour histology (32%), followed by colorectal (17%) and breast (11%). A total of 62 patients (16%) had oligoprogressive lesions. The majority of patients received SABR to one metastasis (69%), with 10% receiving SABR to 3 or more lesions. Median follow-up was 27 months (IQR 18–36). Median PFS was 15 months (95% CI 12–18). LC at one and three years were 91% (SE=2%) and 81% (SE=2%), respectively. On multivariable analysis, increasing tumour diameter (HR=1.09, p<0.001), declining performance status (HR=2.13, p<0.001), disease-free interval < 18 months (HR=1.52, p=0.003), four or more metastases at SABR (HR=1.48, p=0.048), initiation or change in systemic treatment (HR=0.50, p<0.001) and oligoprogression (HR=1.56, p=0.008) were significant independent predictors of PFS. Tumour diameter (HR=1.32, p<0.001), histology other than breast/prostate (3.06, p<0.001) and current smoking (HR=1.5, p=0.003) were associated with worse local control.

**Conclusions:** In this population-based cohort including patients with genuine oligometastatic, oligoprogressive, and induced oligometastatic disease, the median PFS was 15 months and LC at three years was 81%. This supports ongoing efforts to randomize patients on Phase III trials, even outside the original 1-5 metachronous oligometastatic paradigm.

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## CLINICAL OUTCOMES OF MEDULLOBLASTOMA PATIENTS TREATED WITH PROTON RADIOTHERAPY: A SYSTEMATIC REVIEW

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**Purpose:** The aim of this study was to comprehensively review all studies examining clinical outcomes of proton therapy for craniospinal irradiation of medulloblastoma, to determine whether theoretical dosimetric advantages have translated into superior clinical outcomes, including survival and toxicities.

**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 (inception to December 2021). The study was registered with PROSPERO, CRD42022302455. Articles in the English language reporting on clinical outcomes of pediatric and/or adult medulloblastoma patients treated with proton therapy were included. Individual study quality was scored using Newcastle Ottawa Scale and overall evidence base by National Academy of Medicine GRADE scale.

**Results:** Thirty-five studies were included, representing 629 unique patients. Publication dates ranged from 2011 to 2021, with the majority (n=32) from the United States. None of the studies were randomized, 12 were comparative, nine were prospective, three mixed and 22 retrospective. Average mean/median follow-up was 5.0 years (range = 4 weeks to 12.6 years). The majority of studies (n=19) reported on treatment with passive scatter proton beams exclusively. Average study quality score was 6.08 out of 9 (SD 0.688, median 5). Seven studies scored ≥8 out of 9 on the Newcastle Ottawa Scale; an overall "moderate" GRADE score was assigned.

Well-designed comparative cohort studies with adequate follow-up demonstrate superior neurocognitive outcomes, lower incidence of hypothyroidism (23% versus 69%) and reduced acute toxicities (including myelosuppression, esophagitis, diarrhea, weight loss and nausea/vomiting) in patients treated with protons compared to photons. The 10-year cumulative incidence of secondary malignancy is also lower for proton cohorts (2.1-4.9% versus 8%), but did not reach statistical significance in any individual study. Overall survival (10-yr) (85.3-86.9% for standard-risk disease), progression-free survival (10-yr), patterns of failure, and other endocrine outcomes such as incidence of GH deficiency, adrenal insufficiency and precocious puberty were similar to those reported for photon therapy. Quality of life, ototoxicity and incidence of CNS injury were also found to be comparable between proton and photon cohorts, albeit with lower quality evidence. Overall, quality of evidence was most robust in the domains of intellectual outcomes, endocrinopathies and acute toxicity.

**Conclusions:** Moderate grade evidence supports proton beam therapy as a preferred treatment for craniospinal irradiation of medulloblastoma based on equivalent disease outcomes and comparable-to-improved toxicity versus photon beam radiotherapy.

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## MALIGNANT SALIVARY GLAND TUMOURS AND LONG-TERM PATIENT OUTCOMES BASED ON THE AMERICAN JOINT COMMITTEE ON CANCER 8TH EDITION STAGING SYSTEM

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**Purpose:** The revised AJCC Staging 8th edition staging system for malignant salivary gland tumours (MSGT) now takes into account extranodal extension (ENE). Long-term outcomes for patients with MSGT are particularly important as many patients survive beyond 5-years of diagnosis, and there is a lack of studies to date reporting long-term outcomes by AJCC 8th edition staging. Moreover, there are conflicting reports on the prognostic impact of ENE in MSGT. The purpose of this study was to evaluate long-term recurrence data on this patient population and to identify factors associated with patient outcomes.

**Materials and Methods:** A retrospective population study was conducted on all cases of MSGTs diagnosed in our province between January 1, 1999 and December 31, 2008, to allow for a median follow-up of greater than 10-years. Patients were analyzed by treatment intent and modality: radical surgery alone (surgery), radical surgery followed by adjuvant radiotherapy (adjuvant RT), radical radiotherapy (radical RT), and palliative treatment or best supportive care (palliative). The primary outcome of interest was overall survival (OS), and our secondary outcome of interest was progression-free survival (PFS). Cox regression analysis, with variables chosen a priori was used for multivariable analysis.

**Results:** There were 279 patients included. Presentation by AJCC 8th edition staging was as follows: I 104, II 62, III 45, and IV 68. Median follow-up was 11.2 years. Patients had a high-grade MSGT in 30% of cases. There were 48 patients who were node-positive, of which 13 had ENE. The presence of ENE upstaged the nodal stage in 11 patients (comparing between AJCC 7th versus 8th edition staging systems). The patient numbers by treatment groups were as follows: 54 surgery, 169 adjuvant RT, 22 radical RT, and 34 palliative. Of those undergoing radical treatment, 87% of those with a high-risk feature received adjuvant RT (high-risk features included: high grade, perineural invasion (PNI), margin positivity, T3/4, and N+ MSGT). Ten-year OS by AJCC 8th edition staging was: I 82%, II 77%, III 43%, and IV 24%. Factors associated with worse OS on multivariate analysis included: older age at diagnosis, stage, high grade tumour, presence of PNI, and palliative treatment (all $p<0.05$). ENE was not statistically significant for OS (HR: 1.8, $p=0.1$). Ten-year PFS by AJCC 8th edition staging was: I 76%, II 63%, III 33%, and IV 17%. On multivariate analysis, significant factors for PFS were: stage, high grade tumour, presence of PNI, and palliative treatment ($p<0.05$) whereas ENE was not statistically significant ($p=0.1$).

**Conclusions:** A modest number of patients will have nodal upstaging in the AJCC 8th edition based on the presence of ENE. ENE was not an independent predictor of worse outcomes, although the small number of patients with ENE in our series limits firm conclusions. Our work presents updated, population-level survival outcomes with the 8th edition staging system.

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## A NOVEL, RAPID AND SIMPLE (RAPPLE) PARTIAL BRAIN RADIOTHERAPY TECHNIQUE TO TREAT BRAIN METASTASIS: A RETROSPECTIVE REVIEW OF OUTCOMES

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**Purpose:** A third of cancer patients will develop brain metastases (BrM), which can degrade their neurologic status and quality of life (QoL). Since these patients have a guarded prognosis, treatment should balance improving QoL while reducing toxicity. Whole brain radiotherapy (WBRT) has been the conventional standard of care for patients with poor prognosis. However, due to treatment of the entire brain, WBRT may reduce QoL without improving survival, thereby limiting its utility in a palliative setting. RAPid simPLE partial brain radiotherapy (RAPPLE) may serve as an alternative treatment for these patients, by treating contoured BrM using volumetric modulated arc therapy (VMAT). This spares more normal brain tissue than WBRT to potentially reduce neurocognitive toxicity. This retrospective study aims to review the oncologic outcomes of patients treated with RAPPLE, in a population-based cohort.

**Materials and Methods:** All patients treated with a first course of RAPPLE between January 2017 to December 2021 were identified using a provincial database. Clinical factors, including patients' disease-specific graded prognostic assessment (DS-GPA), were recorded. Intracranial progression free survival (icPFS) and overall survival (OS) were calculated from the date of BrM diagnosis using the Kaplan-Meier method. Log-rank tests and Cox regression were used for group comparisons. Median follow-up time was calculated using the reverse Kaplan-Meier method. The resulting OS was compared to a weight median OS predicted by DS-GPA (for standard primary diagnoses) and GPA (for non-standard diagnoses).

**Results:** A total of 61 patients with 42 months median follow-up were available for analysis. The median age at BrM diagnosis was 69 years [range: 42-94], and median ds-GPA was 1.0 [range: 0.5-3.0]. Primary cancer diagnoses were: non-small cell lung cancer (43%), breast (15%), small cell lung (13%), gastrointestinal (10%), and other cancers (19%). The median icPFS was 5.5 months [95% confidence interval (CI): 2.5-8.5], and median OS was 7.0 months [95% CI: 3.6-10.5]. When predicted using DS-GPA and GPA, the median OS was 7.3 months [range: 3-13]. Patients with DS-GPA $\geq 1.5$ exhibited better OS, with a hazard ratio of 0.47 [95% CI: 0.26-0.87, $p=0.02$] than those with DS-GPA $\leq 1.0$.

**Conclusions:** To our knowledge, this is the first report of outcomes for patients treated with RAPPLE. The survival outcomes of this cohort are consistent with survival estimates using DS-GPA and GPA. This comparison was consistent when evaluated over all types of primary cancer diagnoses. RAPPLE appears to provide an intracranial control of around half a year, even in patients with poor prognosis. To better characterize the utility of RAPPLE, future work is required to evaluate the outcomes from quality of life, and outcomes in comparison to WBRT.

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## EVALUATING MULTIDISCIPLINARY PEER REVIEW: A RETROSPECTIVE STUDY OF PLAN MODIFICATIONS IN RADICAL AND PALLIATIVE INTENT RADIATION THERAPY TREATMENTS

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**Purpose:** Multidisciplinary peer review of radiation therapy treatment plans is recognized as an integral component to improving quality and safety. Our institution has established a goal of 100% peer review completion for all radiation therapy treatment plans, of both radical and palliative intent. This study

investigates whether treatment intent influences the rate of plan modifications (PM) arising from peer review recommendations, and whether the timing of when peer review is conducted may modulate any effect.

**Materials and Methods:** Peer review primarily focused on target volume, dose, and fractionation. Pertinent clinical and treatment plan characteristics were extracted, including intent (radical/palliative), whether the treatment plan followed institutional protocol or not, and anatomical target site. The primary endpoint was PM rate, defined as any change implemented following recommendations from peer review. All treatment plans peer reviewed between November 2015 – November 2016 (cohort 1) and November 2016 – November 2017 (cohort 2) were analyzed. Between the first and second cohort, a new institutional policy was introduced requiring peer review to occur prior to commencement of treatment planning. To evaluate the effect, we developed a causal model involving intent as the exposure variable, PM as the outcome variable, and both target site and protocol treatment, as confounding variables. Logistic regression analysis was used to describe the relationship between the variables influencing the PM decision process.

**Results:** A total of 3807 radiation therapy treatment plans involving 2608 patients were included in the analysis. Among the initial cohort (1740 treatments, 1195 patients), plans with palliative intent were 35% less likely to have a PM (OR = 0.65, CI = 0.49 - 0.86) compared to those with radical intent. However, following the policy change, in the second cohort (2067 treatments, 1413 patients), the probability of PM for plans with either palliative or radical intent was equally likely (OR = 1, CI = 0.76 – 1.31).

**Conclusions:** We found that treatment plans of palliative intent were initially 35% less likely to be modified than those of radical intent, however, this difference was nullified by the change in timing of when peer review occurred in the treatment planning process. This may be explained by possible biases against PM in palliative intent treatments where the perceived clinical impact may not be felt to outweigh the additional work required. Earlier integration of peer review within the treatment planning process may contribute to reducing potential intent bias in decision making regarding peer review recommendations.

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## OUTCOMES OF EXTRACRANIAL OLIGORECURRENCE AFTER PRIOR METASTASES DIRECTED STEREOTACTIC BODY RADIOTHERAPY FOR OLIGOMETASTATIC DISEASE

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**Purpose:** The Consortium of Oligometastatic Research (CORE) database consists of 1033 patients who presented with either synchronous or metachronous oligometastatic disease and were treated with ablative therapy to all sites. Of this cohort, a subset of patients had subsequent extracranial oligometastatic recurrence. These patients represent a unique cohort and we aim to report their outcomes in an effort to appropriately select patients who would benefit from further ablative therapy.

**Materials and Methods:** A retrospective review of patients in the CORE database was conducted. Oligorecurrent disease was defined as ≤5 new metastases after having previously received ablative treatment to all known sites of oligometastatic disease. Our primary endpoint was time to widespread progression (WSP), estimated using competing risk analysis where death was the competing risk. Widespread progression was defined as developing metastatic dissemination not amenable to further ablative treatment, inclusive of developing ≥6 new sites of extracranial metastases or a malignant effusion. WSP was measured from the date of initial diagnosis and from the date of first oligorecurrence. Secondary endpoint was overall survival (OS), estimated using Kaplan-Meier method.

**Results:** A total of 375 patients had oligorecurrent disease and 233 received further ablative therapy to all metastatic sites. Of the 233 patients, 83 had a subsequent oligorecurrent event and 57 received further ablative therapy to all metastases. Of the 375 patients, 161 developed widespread progression by last follow-up. The median time to widespread progression from initial diagnosis was 80.7 months (95% CI: 68.2-90.9) and from first oligorecurrence was 55.1 months (95% CI: 33.3-not reached). The two- and five-year WSP rates from initial diagnosis were 11.0% (95% CI: 7.6-14.3) and 40.6% (95% CI: 34.3-46.9) and from first oligorecurrence were 38.8% (95% CI: 33.6-43.9) and 52.5% (95% CI: 45.3-59.8). The median OS was 44.8 months (95% CI 37.0-51.0). The 1 year, 2 year and 5 year OS rates were 85.0% (95% CI: 81.9-89.1), 69.8% (95% CI: 64.9-74.6) and 33.3% (95% CI: 25.5-41.1) respectively.

**Conclusions:** Individuals who recur in a limited number of sites represent a favourable subgroup of metastatic patients. In this retrospective cohort, oligorecurrent patients demonstrate favourable natural histories with regards to time to widespread progression and overall survival that may benefit from further metastases directed ablative therapy.

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## A COMPETING RISK ANALYSIS OF PROGNOSTIC FACTORS FOR LOCAL AND REGIONAL RECURRENCE AND SURVIVAL OUTCOMES IN EARLY-STAGE NON-SMALL CELL LUNG CANCER TREATED WITH STEREOTACTIC ABLATIVE RADIATION THERAPY

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**Purpose:** To assess the patterns and risk factors of recurrence after stereotactic ablative radiotherapy (SABR) in medically inoperable early-stage non-small cell lung cancer (ES-NSCLC), including survival after first recurrence.

**Materials and Methods:** We performed a retrospective analysis on 1055 ES-NSCLC patients, with 1130 lesions treated at our institution between 2009 and 2019 using a patient-adapted treatment method selection (robotic radiosurgery, volumetric modulated arc therapy and helical tomotherapy). Between group differences were estimated using competing risk analysis and sub-distribution hazard ratios (SHR) were calculated. Remaining overall survival (OS) after first recurrence was calculated.

**Results:** Among the 1055 patients, 572 died with a median OS of 52.0 months (95%CI, 47.7-55.0) and 171 (30.4%) died from cancer progression. After recurrence, there was no difference in the remaining OS between loco-regional recurrence (19.5 months) and distant metastasis (DM) (18.0 months) (p=0.55). Median OS after first recurrence was 14.8 months (95%CI 12.6-18.1). Among 1130 lesions treated, 289 were central (27.7%) and 755 were peripheral (72.3%). Median follow-up until recurrence was 37.2 months. We observed 116 (10.3%) patients who experienced local recurrence (LR) with or without other sites of recurrence, 131 (11.6%) with regional recurrence (RR) without LR, while 141

(12.5%) patients had DM only. Central lesions were significantly associated with shorter disease-free survival (HR=1.67 p<0.0001) and OS (HR=1.21, p=0.05), although there was no difference in post-recurrence survival (p=0.49). Biologically Effective Dose (BED) > 120 Gy was associated with a decreased risk of both LR and RR (SHR 0.57, p=0.004 and SHR 0.62, p=0.01, respectively). There also was a trend towards fewer DM (p=0.08). BED and tumour location were highly correlated (Chi-squared test p<0.001). We observed that central lesions were significantly associated with an increased risk of both, LR and RR (SHR 1.98 and SHR 2.08, p<0.001, respectively). Age < 70 years was associated with a trend for LR and RR risk (SHR 1.44, p=0.06 and SHR 1.38, p=0.07, respectively). Multivariate analysis revelated that central location was the only significant factor associated with increased LR and RR risks (SHR 1.87, p=0.049 and SHR 2.32, p=0.005, respectively).

**Conclusions:** The main prognostic factor for LR and RR risks was central location – likely due to lower doses delivered as well as proximity to lymph nodes. Central location was however not prognostic of OS after recurrence. Our study suggests that central tumours might benefit from treatment intensification strategies such as dose escalation and/or the addition of systemic therapy to potentiate radiotherapy.

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## PREDICTIVE FACTORS FOR SURVIVAL AND RADIATION NECROSIS IN PATIENTS WITH RECURRENT HIGH-GRADE GLIOMA TREATED WITH RE-IRRADIATION

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**Purpose:** To analyze the predictors of survival and radiation necrosis in adult patients with recurrent high-grade gliomas (rHGG) who have undergone re-irradiation (ReRT).

**Materials and Methods:** All adult patients with rHGG who had ReRT from 2009 to 2020 at our institution were retrospectively reviewed. Demographic, clinical, dosimetric, and radiological data were obtained from the electronic medical records. The primary outcome was to identify predictors of overall survival (OS) and radiation necrosis (RN), and secondary outcome was to identify patterns of failure after ReRT.

**Results:** Were included 79 patients with a median age of 52 years (19-79), 62% were male, 85% had Grade 4 glioma at presentation and 98% at ReRT. The most common fractionation schedules were 40Gy/15Fx (9%) and 50-60Gy/28-33Fx (91%) for the primary treatment, and 17-24Gy/1Fx (9%), 20-35Gy/5Fx (38%), 25-35Gy/10Fx (48%) and 36-54Gy/18-30Fx (5%) for ReRT. The median cumulative EQD2 (a/b=2) was 103Gy (81-216). The median OS and progression-free survival (PFS) were 9.9 and 4.1 months, respectively. The OS rate at 6/12 months was 69.6%/34.2% and PFS 29.1%/7.5%, respectively. The prognostic factors for improved OS on multivariable analysis were interval from initial treatment to first progression ≥16.3mos (p<0.001), re-resection prior to ReRT (p=0.049), ECOG 0 at ReRT (p=0.009) and PTV volume at ReRT <112cc (p=0.008). Grade 2 and 3 toxicities were 22% (8.8% RN) and 5% (2.5% RN), respectively. Concurrent use of bevacizumab (p<0.001) and lower cumulative EQD2 (p<0.001) were predictors for lower incidence of RN on MVA with an exploratory analysis suggesting an EQD2 of ≤98 Gy as protective against RN. The failures after ReRT were in-field, marginal or distant in 67%, 6%, and 27% of patients who had follow-up imaging, respectively.

**Conclusions:** Re-irradiation is a safe and effective treatment for GBM. We describe predictive factors for OS and RN to guide patient section.

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## LONG-TERM OUTCOMES OF SABR TO PRIMARY RENAL CELL CARCINOMA: A MULTI-CENTRE ANALYSIS FROM THE INTERNATIONAL RADIOSURGERY ONCOLOGY CONSORTIUM FOR KIDNEY (IROCK)

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**Purpose:** For patients with renal cell carcinoma (RCC) not suitable for surgery, thermal ablative options have diminishing efficacy in RCC > 3 cm. Stereotactic ablative radiotherapy (SABR) is an emerging alternative for this patient population, but is limited by lack of long-term outcome data. We hypothesize that SABR represents an effective, safe, and nephron-sparing option for RCC in the long-term.

**Methods and Materials:** Individual patient data from 12 IROCK institutes were pooled. Patients with M1 disease and/or upper tract urothelial carcinoma were excluded. Minimum eligible follow-up was ≥ 2 years. Demographics, treatment, oncologic, and renal function outcomes were assessed using descriptive statistics. Kaplan-Meier estimates and multivariable Cox proportional hazards regression models were generated for oncologic outcomes.

**Results:** In 190 patients, the median follow-up was 5.0 years. The mean ± SD tumour diameter was 4.2 ± 2.2 cm and 95 patients (50%) had ≥ T1b (≥ 4 cm) primaries. Median age was 74 years (interquartile range [IQR]: 66-82), 73.2% were male and 87.6% had good performance status (ECOG 0-1 or KPS ≥ 70%). In patients for whom operability details were reported, 75.0% were defined as inoperable by the referring urologist, mostly for cardiovascular comorbidities (46.9%) and for existing or anticipated renal dysfunction (18.0%). Baseline tumour complexity was moderate (median RENAL nephrometry score of 7 out of 12 [IQR: 5-9]), and 56 patients (29.5%) had a solitary kidney. Mean ± SD BED10 delivered was 88.3 ± 24.7 Gy. Patients received either single (42.6%) or multi-fraction regimens (57.4%). Mean ± SD baseline estimated glomerular filtration rate (eGFR) was 58.9 ± 22.6 mL/min (mild-to-moderate dysfunction) with 53 patients (28.0%) of the cohort having moderate-to-severe dysfunction (eGFR < 45 mL/min). At three and five years following SABR, mean ± SD eGFR decreased by 10.8 ± 16.6 mL/min and 13.5 ± 14.9 mL/min, respectively. Nine patients (4.7%) required dialysis. Seventy patients (36.8%) had a Grade 1-2 toxicity. No Grade 3 events were reported and one

patient (0.5%) experienced Grade 4 toxicity (gastrointestinal). Local, distant and any failure at five years were 5.5%, 10.8% and 13.0% (cumulative incidence function with death as competing event). Sixty-six patients died during the follow-up period, the majority (92.4%) from non-malignant causes. Cancer-specific survival (CSS) and progression-free survival (PFS) at three years were 95.5% and 72.1%, and at five years were 92.0% and 63.6%, respectively. On multivariable analysis, increasing tumour size was associated with inferior CSS (HR per 1 cm increase: 1.41; 95% CI: 1.15-1.71; p < 0.001), PFS (HR: 1.10; 95% CI: 1.01-1.19; p=0.030), and any failure (HR: 1.20; 95% CI: 1.10-1.32; p < 0.001).

**Conclusions:** At five years, SABR for primary RCC in this older, largely medically inoperable cohort was associated with local efficacy, good oncological outcomes and had modest impact on renal function.

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**TREATMENT PATTERNS AND OUTCOMES OF PATIENTS WITH HIGH-GRADE GLIOMA DURING THE COVID-19 PANDEMIC**

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**Purpose:** During the first year of the COVID-19 pandemic there was global disruption in the provision of healthcare, causing significant pressure on hospital resources. High-grade gliomas (HGG) are rapidly progressive tumours, so patients with delays in diagnosis or treatment due to COVID-19-related disruptions might have poor outcomes. Therefore, we retrospectively evaluated the impact of the COVID-19 pandemic on treatment patterns and outcomes of patients with HGG in British Columbia (BC).

**Materials and Methods:** A case cohort with a pathologic diagnosis of HGG (Grade 4 astrocytoma and glioblastoma) treated at BC Cancer centres with radiotherapy between March 1, 2020 – March 1, 2021 ("COVID era"), and a control cohort treated between March 1, 2018 – March 1, 2019 ("pre-COVID era") were identified. Patient demographics, tumour characteristics, treatment details, and dates of radiographic progression and death were included in the chart review. Analyses were performed with one-way ANOVA and Chi-squared tests for comparisons between eras. The Kaplan-Meier method was used to assess progression-free survival (PFS) and overall survival (OS) and differences in outcome between eras were investigated using the log-rank test.

**Results:** 164 patients were identified: 85 in the pre-COVID era and 79 in the COVID era. There was no statistically significant baseline difference in age, sex, comorbidities, ECOG, tumour diameter, IDH mutation status, or MGMT methylation status between eras. There was also no statistically significant difference between time from symptom onset to first imaging, time from first imaging to surgery, time from surgery to oncologic consultation between eras, and time from surgery to radiotherapy. Significantly more patients were managed with biopsy relative to partial or gross total resection during the COVID era 22% (17/79) than the pre- COVID era 13% (11/85) (p=0.04). However, radiation treatment (RT) did not differ between eras, with similar rates of conventionally fractionated RT in the pre-COVID era (87%, 74/85) and the COVID era (82%, 65/79) (p=0.23). Use of concurrent and/or adjuvant temozolomide also was not significantly different between eras (p=0.27 and p=0.19, respectively). Median PFS was 7.0 months in
both eras (CI95 = 5.5 – 8.5 months for pre-COVID era, CI95 = 5.8 – 8.2 months for COVID era, p=0.3), and median OS was 13 months in the pre-COVID era (CI95 = 10.3 – 15.7 months) and 16 months in the COVID era (CI95 =11.5 – 20.5 months), though this difference was not significant (p=0.09).

**Conclusions:** To our knowledge, this is the first study to assess outcomes of patients treated for HGG during the COVID-19 pandemic. We found that, despite less use of surgery in the COVID era, the outcomes of patients with HGG were not affected.

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**PSMA-PET/CT GUIDED INTENSIFICATION OF RADIOTHERAPY FOR PROSTATE CANCER (PSMAGRT): FINDINGS OF DETECTION RATE, IMPACT ON CANCER MANAGEMENT, AND EARLY TOXICITY FROM A PHASE 2 RANDOMIZED CONTROLLED TRIAL**

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**Purpose:** Prostate specific membrane antigen (PSMA) ligand positron emission tomography (PET) is increasingly integrated in prostate cancer management due to its improved lesion detection performance. We conducted a prospective trial to evaluate the impact of PSMA-PET/CT-guided intensification of radiotherapy on patient outcomes. Here, we report secondary endpoints including new lesion detection rate, impact on prostate cancer management, and treatment-related toxicities.

**Materials and Methods:** In this Phase II cohort multiple randomized controlled trial across 2 institutions, men with prostate cancer planned for definitive radiotherapy (RT) and conventionally staged per standard-of-care were randomized across 4 strata: oligometastatic, high risk (CAPRA ≥ 6 or cN1), salvage post-RT, and salvage post-prostatectomy (RP). The primary endpoint was failure-free survival at 5 years, with analysis pending further follow-up. Secondary endpoints include new lesion detection yield of PSMA-PET/CT, acute and delayed toxicities, impact on prostate cancer management, and health-related quality of life outcomes. NCT03525288 companion to registry NCT03378856

**Results:** Between May 2018 and February 2021, 262 patients were enrolled in the registry and randomized. Nine patients who did not receive radiotherapy were excluded, leaving 253 patients for analysis (23 oligometastatic, 86 high risk, 16 salvage post-RT, and 128 salvage post-RP). New lesions were detected on PSMA-PET/CT in 5/11 oligometastatic patients (45.5%), 17/43 high-risk patients (39.5%), 1/7 salvage post-RT patients (14.3%); and in 33/64 salvage post-RP patients (51.6%). Overall, PSMA-PET/CT led to intensification of radiotherapy in over half of patients (52.0%), with minimal intensification of systemic therapy (5.6%). The most frequent type of intensification of RT was pelvic nodal boost (24.8%), followed by addition of pelvic RT (17.6%), prostate/prostate bed boost (13.6%), and RT to oligometastases (7.2%). Overall, 40 patients (32.0%) received RT in a new region, while 48 patients (38.4%) received a higher dose of RT. With a median follow-up of 12.9 months, this intensification was associated with three attributable Grade 3+ events (2.6% of patient undergoing PSMA-PET/CT), but no difference in the rate of Grade 2+ events attributable to radiotherapy compared with controls (43%, both arms).

**Conclusions:** PSMA-PET/CT led to intensification of radiotherapy in more than half of patients deemed at high risk of harbouring undetected disease. Longer follow-up is required to determine whether this intensification translates to impact on cancer control and long-term toxicity and quality of life outcomes.

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## MATURE LOCAL CONTROL AND REIRRADIATION RATES COMPARING SPINE STEREOTACTIC BODY RADIOTHERAPY TO CONVENTIONAL PALLIATIVE EXTERNAL BEAM RADIOTHERAPY

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**Purpose:** Stereotactic body radiotherapy (SBRT) improves complete pain response for painful spinal metastases compared to conventional external beam radiotherapy (cEBRT). We report mature local control and reirradiation rates in a large cohort of patients treated with SBRT versus cEBRT enrolled previously in the Canadian Clinical Trials Group Symptom Control (SC).24 Phase II/III trial.

**Materials and Methods:** 137/229 (60%) patients randomized to 24 Gy in 2 SBRT fractions or 20 Gy in 5 cEBRT fractions were retrospectively reviewed. By including all treated spinal segments, we report on 66 patients (119 spine segments) treated with SBRT, and 71 patients (169 segments) treated with cEBRT. The primary outcomes were MR-based local control and reirradiation rates for each treated spine segment.

**Results:** The median follow-up was 11.3 months (IQR:5.3-27.7 months), and median OS in the SBRT and cEBRT cohorts were 21.6 and 18.9 months (p=0.428), respectively. The cohorts were balanced with respect to radioresistant histology and presence of "Mass" (paraspinal and/or epidural disease extension). Risk of local failure after SBRT versus cEBRT at 6, 12 and 24 months were 2.8% versus 11.2%, 6.1% versus 28.4% and 14.8% versus 35.6%, respectively (p<0.001). cEBRT (HR:3.48, 95%CI:1.94-6.25, p<0.001) and presence of "Mass" (HR:2.07, 95%CI:1.29-3.31, p=0.002) independently predicted local failure on multivariable analysis. The 1-year reirradiation rates and median times to reirradiation after SBRT versus cEBRT, were 2.2% versus 15.8% (p=0.002) and 22.9 months versus 9.5 months respectively. Radioresistant histology (HR:2.66, 95%CI:1.43-4.94, p=0.002) and cEBRT (HR:2.34, 95%CI:1.14-4.78, p=0.002) independently predicted for reirradiation. 8/12 iatrogenic vertebral compression fractures (VCFs) were after SBRT and 4/12 after cEBRT; Grade 3 toxicities were isolated to the SBRT cohort (5/12).

**Conclusions:** Risk of local failure and reirradiation is lower with SBRT compared to cEBRT for spinal metastases. Although the iatrogenic VCF rates were within expectations, Grade 3 VCF were isolated to the SBRT cohort.

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## STEREOTACTIC BODY RADIATION THERAPY FOR NON-SPINE BONE METASTASES: LOCAL CONTROL AND FRACTURE RISK

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**Purpose:** Stereotactic Body Radiation Therapy (SBRT) is increasingly being utilized to treat non-spine bone metastases (NSBM) with both palliative and radical intent. There remains limited data on the long-term outcomes and toxicity of this treatment approach and thus, a review was conducted on a large cohort of patients treated with this strategy.

**Materials and Methods:** Patients with NSBM who were treated with SBRT were identified from 2011 to 2021. The primary endpoint was radiographic local failure (LF). Secondary endpoints included rate of in-field pathologic fracture (PF), overall survival (OS), and late (>3 months post-SBRT) Grade ≥3 toxicity (Common Terminology Criteria for Adverse Events, version 5.0). Competing risks analysis was used to assess rates of LF and PF. OS was estimated using the Kaplan-Meier method. Multivariable regression (MVR) was performed to investigate predictive factors for LF and PF.

**Results:** A total of 373 patients with 505 NSBM were included in this study. Primary indications for SBRT included oligometastatic disease (52.6%), pain relief (23.8%), and oligoprogression (19.7%). Median follow-up was 26.5 months. The most common primary tumour sites were prostate (33.7%), RCC (20.7%), breast (16.9%), and lung (14.8%). The predominant target locations were the pelvis (42.3%) and ribs (30.5%). Overall, 217 (42.7%) of lesions were lytic and 230 (45.3%) of lesions were symptomatic. The most common dose prescriptions were 35 Gy in 5 fractions (33.3%) and 24 Gy in 2 fractions (25.2%), and 239 (47%) of targets had an MRI as part of the planning process. The cumulative incidence of LF at 6, 12, and 24 months were 5.7%, 7.9%, and 12.6%, respectively. The cumulative incidence of PF at six, 12, and 24 months were 3.8%, 6.1%, and 10.9%, respectively. There were three instances of late Grade ≥3 toxicity. Median OS was 53.9 months (95% confidence interval.

**Conclusions:** This study demonstrates that SBRT is an effective modality to treat NSBM with high rates of radiographic local control. The incidence of fracture was low and comparable to well-reported fracture rates with spine SBRT. These data suggest lytic and rib metastases are at increased fracture risk which may be informative when consenting patients to treatment.

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## AUTOMATED CATHETER TRACKING IN 3D ULTRASOUND IMAGES FROM HIGH-DOSE-RATE PROSTATE BRACHYTHERAPY USING DEEP LEARNING AND FEATURE EXTRACTION

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**Purpose:** Manual catheter tracking for ultrasound-based prostate high-dose-rate brachytherapy (HDR-BT) is a laborious process that can be subject to human error and variation, with the potential to impact dosimetric outcomes. A tool for automatically tracking catheters in three-dimensional (3D) transrectal ultrasound (TRUS) images can provide a secondary check to the manual tracking process, and help to identify catheters hidden within the shadowed regions of the ultrasound images. We propose a novel two-step pipeline involving a deep learning approach to automatically segment catheters in prostate HDR-BT using a U-Net neural network, followed by a 3D Hough transform algorithm for feature extraction.

**Materials and Methods:** The 3D TRUS images and their corresponding ground truth catheter positions were obtained for 97 prostate HDR-BT patients treated at Kingston Health Sciences Centre between 2017-2021. The ground truth catheters were manually tracked by medical physicists during procedures. After pre-processing, the data was exported for training on the 3D U-Net architecture. The resulting predictions from the deep learning model were then transformed using the 3D HoughTransform for line detection.

**Results:** The proposed pipeline correctly identified (within 3mm) the positions of 321 of the 343 catheters while identifying 21 false positives. The average distance between the ground truth and predicted positions was 1.57 ± 0.14 mm with the average largest distance being 2.01 ± 0.07 mm. The assumption of linearity when

predicting catheter position using the Hough Transform was found to account for the largest discrepancies in distance between the predicted models and the non-linear ground truth.

**Conclusions:** Catheter tracking during Prostate HDR-BT is a laborious time intensive process. The proposed deep learning model in combination with Hough transform delivers a way of reducing time spent on verification of the initial manual catheter tracking, and equips clinicians with an aid to reduce uncertainties and improve clinical workflow during procedures. Further work on non-linear detection and end-length identification is needed prior to being used in routine clinical practice.

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**A PILOT STUDY OF SALVAGE HDR BRACHYTHERAPY IN RECURRENT PROSTATE CANCER: 5 YEAR TOXICITY AND OUTCOMES**

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**Purpose:** Until recently, Androgen Deprivation Therapy (ADT) was the main treatment option for recurrent prostate cancer after primary radiation treatment. However, ADT is not curative and is associated with several side effects. Local ablative therapy can be curative and reduce long-term side effects associated with ADT. We designed a single institution prospective pilot study to evaluate the toxicities and outcomes of HDR brachytherapy as a salvage local therapy.

**Methods and Materials:** Sixty (60) patients with a biopsy-proven local relapse after a previous treatment with radiation were included in this study. A negative bone scan and CT scan of the abdomen and pelvis at the time of relapse was mandatory. Primary objective was to assess both early and late genitourinary (GU) and gastrointestinal (GI) toxicities. Biochemical disease-free survival (bDFS) was also assessed as a secondary objective. Toxicities were reported using CTCAE v5 scale and the IPSS. Short-course ADT could be used if deemed clinically indicated by the physician. HDR brachytherapy regimen was 32 Gy delivered in 4 fractions to the whole prostate and, for the last 10 patients recruited, 27 Gy in 2 fractions administered focally, due to concerns with toxicities. CT-based treatment planning using an inverse planning algorithm (IPSA) was performed for patients with whole prostate treatment (n = 50). Real-time ultrasound-based treatment planning was used for patients undergoing focal salvage radiation (n = 10).

**Results:** Median follow-up was 58.4 months (0.8-106.8 months). GI toxicities were acceptable with 3.6% and 14.5% of patients experiencing early and late grade 2 toxicities. No G3 GI toxicities were reported. Early G2 GU toxicities were overestimated at 100% (all patients used an alpha-blocker in the postoperative setting) and one patient had G3 early toxicity. Late GU toxicities were significant, with 14.5% of patients experiencing late G3 toxicity (10.0% at the last follow-up). Of interest, the use of ADT before HDR brachytherapy (n = 17) was associated with lower GU toxicities (no G3) although the association was not statistically significant (Chi-Square p-value 0.201). Good biochemical control was achieved with a bDFS of 73.9% at 48 months.

**Conclusion:** Salvage HDR brachytherapy after primary radiation to the prostate offers good biochemical control but at the cost of significant G3 GU morbidities. Patients can benefit from local therapy after primary radiation but whole gland radiation should be used with caution because of concern with toxicities. Focal therapy to partial gland might be a good alternative to achieve local control and avoid severe toxicities.

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**PATIENT'S REPORTED OUTCOMES (PROS) OF AN ULTRA-HYPO FRACTIONATED (UHF) PROSTATE IMAGE GUIDED RADIATION THERAPY (IGRT) WITH HDR BRACHYTHERAPY BOOST (BB) AS COMPARED TO A MODERATE HYPO FRACTIONATED (MHF) APPROACH: INTERIM ANALYSIS OF A PHASE TWO STUDY**

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**Purpose:** To report and compare PROs of an HDR BB combined to an UHF prostate IGRT regimen as opposed to a MHF.

**Materials and Methods:** This interim analysis of a prospective monocentric Phase 2 study includes 75 intermediate risk prostate cancer patients, recruited between July 2015 and September 2021. Using an IGRT technique, 25 Gy in 5 fractions plus 15 Gy HDR BB were delivered to the experimental arm (Exp). The control groups consisted of contemporary patients treated with IGRT and HDR BB (15 Gy) with 36 Gy in 12 fractions (Ctrl; n=119). IGRT treatment time is reported. PROs were collected using the International Prostate Symptom Score (IPSS) questionnaire at baseline and follow-up (FU) visits. A comparative linear mixed model analysis was performed on log transformed IPSS values. Expanded prostate cancer index composite-26 (EPIC-26) was reported and compared between groups with a mixed model analysis. Biochemical relapse-free survival (BRFS) is reported.

**Results:** The groups showed no statistical differences (NS) regarding median age (68 years), Stage (T1C), Gleason scores (7), PSA (<10) and risk grouping. Median FU was 8 and 49 months respectively for Exp & Ctrl. The mixed model analysis showed that mean IPSS scores diverge with a significant difference in favor of Exp at 6, 12 and 24 months. Analysis of EPIC-26 data showed no differences throughout FU in all domains. UHF median treatment was delivered in 7 days as compared to 17 days for MHF. Considering a short FU in the Exp group, its BRFS was 100% compared to 94.6 for Ctrl (NS).

**Conclusions:** At interim analysis, IPSS PROs for UHF IGRT with HDR BB seems significantly better tolerated at multiple FU time points. However, the EPIC-26 revealed no differences between groups. UHF treatment shorten treatment span by 10 days and given the short FU, seemingly provides similar BRFS. Therefore, we will pursue accrual to our Phase 2 study.

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**EARLY CLINICAL OUTCOMES AFTER PELVIC INTERSTITIAL BRACHYTHERAPY USING 3D-PRINTED PATIENT-SPECIFIC CUSTOM VAGINAL TEMPLATES IN BRITISH COLUMBIA**

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**Purpose:** Interstitial pelvic brachytherapy (BT) is standard of care in locally advanced vaginal cancers and pelvic recurrence of gynecological malignancies. Without intraoperative imaging, such insertions can be challenging and are, therefore, only available in highly specialized centres. We have developed a pre-planned insertion technique using 3D printed patient specific custom vaginal template (PSCT) requiring no intraoperative image guidance.

**Materials and Methods:** Our 3D printing process in pelvic interstitial brachytherapy was previously presented. Cylindrical vaginal templates are created using a pre-operative MRI. These templates are customized for individual patients and are used to guide the insertion of all vaginal and pelvic interstitial needles

without the use of MRI, CT or ultrasound during the insertion procedure. We now report the clinical results of our first treated cohort with a minimum follow-up of three months.

**Results:** The patient cohort includes six patients, treated over a period of 12 months, with a median age of 65 years and median FU of six months, treated with curative intent for primary vaginal cancer (n=1, 17%) and pelvic recurrence of endometrial (n=3, 50%) and cervical (n=2, 33%) cancers. All patients received pelvic external beam radiotherapy (EBRT) (45 Gy) prior to BT. Using a single insertion, BT was delivered over 5 fractions BID with a median dose of 25 Gy. The median number of needles per implant was eight. Final treatment dosimetry showed a median V100=96.8%, D90=111.8% and V150=54.0%. The absolute difference between the pre-plan and the post-plan (treated) was 0.3%, 0.4% and 11.9% respectively. The median dose per fraction to 2cc of bladder was 3.66Gy, rectum 3.13 Gy, sigmoid 2.01 Gy and small bowel 1.55 Gy, meeting the EMBRACE constraints. The absolute difference between the pre and post plans was 0.5 Gy or less for all organs at risk. In all six patients, no needles perforated the organs at risk (OARs). At three months, all patients showed complete response on examination and imaging and had no acute complications.

**Conclusions:** Complex pelvic interstitial BT is feasible and safe when using 3D printed patient specific custom vaginal template and the insertions can be done without intraoperative image-guidance. The pre-plans were reproducible on final dosimetry and there were no needle perforations in OARs in all patients. This technique could be used to expand the availability of pelvic interstitial BT in Canada.

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## COMPARING DOSIMETRY OF LOCALLY ADVANCED CERVIX CANCER PATIENTS TREATED WITH 3 VERSUS 4 FRACTIONS OF MRI-GUIDED BRACHYTHERAPY

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**Purpose:** MR-guided BT (MRgBT) with plan optimization enables dose escalation to the target and dose reduction to organs at risk (OAR), thereby improving patient outcomes. Worldwide, 28 Gy/4 fractions (F) is one of the most common MRgBT fractionations. There are limited data on a less resource-intensive 3-fraction regimen of 24 Gy/3F and its ability to meet EMBRACE II planning aims. This study compares target and OAR dosimetry of patients treated with 28 Gy/4F versus 24 Gy/3F MRgBT.

**Materials and Methods:** This was a retrospective review of 224 patients with Stage IB-IVA cervix cancer treated with radical chemoradiation at a single centre, where MRgBT fractionation transitioned from 28 Gy/4F (n = 91) to 24 Gy/3F (n = 133) gradually between 2016-2021. MR imaging and brachytherapy planning were performed for each fraction. The following were collected: stage, tumour size at diagnosis, dose fractionation, minimum equivalent dose in 2-Gy fractions to 98% of residual gross tumour volume (GTVres D98%), 90% of high-risk clinical target volume (CTVHR D90%), 98% of intermediate-risk (CTVIR D98%), 2 cm3 (D2cm3) of sigmoid, rectum, small bowel, and bladder, and ICRU rectovaginal (RV) point. Continuous and categorical variables were compared using two-sided Wilcoxon's rank sum test and Fisher's exact test, respectively. Multivariable linear regression models were fitted to compare dosimetric parameters between the 4F and 3F group, adjusting for CTVHR volume and T stage

**Results:** The majority of patients had squamous cell carcinoma (86%), T2b disease (62%), and were treated with interstitial needles in addition to an intracavitary applicator (96%). There were no significant differences between those treated with 28 Gy/4F versus 24 Gy/3F in histology, T stage, tumour size at diagnosis, number of interstitial needles, $GTV_{res}$ $D_{98\%}$, $CTV_{HR}$ $D_{90\%}$, sigmoid and small bowel $D_{2cm3}$. The 28 Gy/4F group had higher $CTV_{HR}$ volume (median 28 versus 26 $cm^3$, p=0.04), $CTV_{IR}$ $D_{98\%}$ (mean 65.5 versus 64.5 Gy, p=0.03), rectum $D_{2cm3}$ (mean 61.7 versus 59.2 Gy, p=0.04) and bladder $D_{2cm3}$ (81.3 versus 77.9 Gy, p=0.03). There were no significant differences in the proportion of patients meeting the EMBRACE II dose limits between 28 Gy/4F and 24 Gy/3F respectively: $GTV_{res}$ $D_{98\%}$ > 90 Gy (91 versus 97%); $CTV_{HR}$ $D_{90\%}$ > 85 Gy (95 versus 98%); sigmoid $D_{2cm3}$ < 75 Gy (100 versus 99%); rectum $D_{2cm3}$ < 75 Gy, bladder $D_{2cm3}$ < 90 Gy, small bowel $D_{2cm3}$ < 75 Gy (100% for all); and ICRU RV < 75 Gy (95 versus 99%). There were also no significant differences in the proportion of patients meeting the EMBRACE II planning aims, except fewer patients treated with 28 Gy/4F met rectum $D_{2cm3}$ < 65 Gy (73 versus 85%, p=0.027) and ICRU RV <65 Gy (65 versus 84%, p=0.005).

**Conclusions:** Cervix cancer patients treated with 24 Gy/3F MRgBT had comparable target doses and lower OAR doses compared to those treated with 28 Gy/4F. A less-resource intense fractionation schedule of 24Gy/ 3F is an alternative to 28 Gy/4F in cervix MRgBT.

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## RADIOBIOLOGICAL RESPONSE TO BRACHYTHERAPY: CERVICAL SQUAMOUS CELL CARCINOMA VERSUS ADENOCARCINOMA PARAMETERS, QUANTIFIED IN VITRO

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**Purpose:** Adenocarcinoma (AC) histology in cervical cancer (CC) carries a worse prognosis compared to squamous cell carcinoma (SCC). However, curative intent radiation dose prescriptions for locally advanced CC, delivered by external beam radiotherapy (EBRT) with a brachytherapy (BT) boost, are not tailored to histological tumour type. This study explores differences in the radiosensitivity of SCC and AC cells through radiobiological (RB) parameters ($\alpha/\beta$ and $T_{1/2}$) determined *in vitro* using clinically relevant BT schedules.

**Materials and Methods:** Clonogenic assays were performed with four SCC (CaSki, SiHa, SW756 (all HPV+), and C-33A (HPV-)) and three AC (HeLa, SiSo (both HPV+) and JHUCS-3 (unknown HPV status)) cell lines. Using a novel brachytherapy afterloader *in vitro* radiation delivery apparatus, cells were irradiated with single acute fraction (≤ 6 Gy) and 8 hourly fraction (0.04 - 0.97 Gy/fr) schedules using high dose rate (HDR) and pulsed dose rate (PDR) afterloaders, respectively. $\alpha/\beta$ and $T_{1/2}$ were determined by fitting dose-survival relationships to the linear-quadratic model using least chi-squared estimation for single acute fractions and hourly fraction experiments, respectively.

**Results:** *In vitro* derived $\alpha/\beta$ were not statistically different for SCC (mean [95% confidence interval]; 5.6 [4.6 - 6.6] Gy) and AC (4.3 [2.8 - 5.8] Gy). However, $T_{1/2}$ was significantly different ($p < 0.01$): 3.4 [1.5 - 5.3] hr for SCC, 1.0 [0.3 - 1.7] hr for AC. Furthermore, statistically significant differences from the conventional values ($\alpha/\beta$ = 10 Gy, $T_{1/2}$ = 1.5 hr) used in routine clinical practice were observed for both histological types (for $\alpha/\beta$: $p < 0.01$ for SCC and AC; for $T_{1/2}$: $p < 0.05$ for SCC, no statistically significant difference for AC). Using the range of experimentally determined RB parameters, SCC tumours would receive 13.4 [5.1 - 31.9] $Gy_{EQD2}$ less dose from an HDR BT boost of 4 fr of 7.75 Gy/fr and AC tumours would receive 16.6 [2.4 - 30.9] $Gy_{EQD2}$ more from an equivalent PDR BT boost (58 pulses of 0.73 Gy/pulse; both HDR and PDR BT

boosts deliver approximately 46 $Gy_{EQD2}$ using conventional RB values). Hence, if the experimentally derived parameters can be demonstrated to reflect clinical tumour response, PDR BT boost for a SCC treatment (combined EBRT (45 Gy/25 fr) and BT boost dose of 90 $Gy_{EQD2}$, calculated assuming conventional RB values) may deliver significantly higher RB dose (> 26 $Gy_{EQD2}$) than its conventionally estimated HDR equivalent. Conversely, an HDR BT boost to achieve the prescribed 90 $Gy_{EQD2}$ for AC may deliver > 24 GyEQD2 more for the conventional PDR equivalent.

**Conclusions:** RB parameters identified *in vitro* support differences in the RB sensitivity of SCC versus AC in CC. BT boosts conventionally assumed to be equivalent may differ as a result, with PDR and HDR delivery potentially corresponding to greater recalculated RB dose to SCC and AC cells, respectively. Clinical applicability has yet to be established, due to the inherent limitations of the experimental methodology.

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**EVALUATION OF PATIENT REPORTED OUTCOME DIFFERENCES BY RADIOTHERAPY TECHNIQUE FOR BONE METASTASES IN A NON-INCENTIVIZED HEALTH CARE SYSTEM**

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**Purpose:** We previously demonstrated a low utilization, but mild increase over time, of advanced radiotherapy (RT) techniques (3D conformal RT [3DCRT], intensity modulated radiotherapy [IMRT] and stereotactic ablative radiotherapy [SABR] from 2009-2016) for bone metastases. Patient reported outcome (PRO) data was not yet available in our previous publication. This analysis therefore compares PROs by RT technique in a public, salary-funded, non-incentivized health care system.

**Materials and Methods:** From 2017-2021 inclusive, patients with bone metastases who completed the brief pain inventory (BPI) PRO questionnaire at one of five BC Cancer centres before and after RT were identified, and RT technique was categorized as simple (e.g. parallel opposed pair) or advanced (e.g. 3DCRT, IMRT, or SABR). Pain response was compared using chi-square tests. Patient reported interference in quality of life secondary (QoL) to pain was compared with t-tests. Multivariable analyses of pain response and pain impact on QoL was compared with logistic and linear regression, respectively.

**Results:** 1712 patients completed the BPI, with an average age of 64 (SD 12.4). From 2017 – 2021 the rate of advanced RT technique use increased significantly (p<0.001; 2.4%, 2.5%, 9.6%, 4.7%, 7.9%). Comparing simple versus advanced techniques, neither the complete response (12.2% versus 11.9%;p=0.93) nor the partial response (50.1% versus 50.6%; p=0.92) were significantly different. There was no significant patient reported difference in pain interfering with general activity (p=0.70), mood (p=0.26), walking ability (p=0.89), normal work (p=0.37), relationships (p=0.63), sleep (p=0.94), or enjoyment of life (p=0.31). Controlling for age, gender, primary histology, and treatment region, there was no significant association between advanced RT (versus simple RT) and a partial (OR 1.04; 95% CI: 0.66-1.64) or complete (OR 0.97; 0.48-1.93) pain response, nor pain's impact on QoL (p>0.1 for all categories).

**Conclusions:** In this publicly funded, non-incentivized health care system, there was no patient reported difference in pain or impact of pain on quality of life between simple versus advanced RT techniques. Given there is increasing utilization of advanced RT techniques in our cohort and other jurisdictions internationally, there is further need for randomized trials to assess the benefits of advanced techniques given their increased cost and inconvenience to patients.

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**PHASE 2 TRIAL OF NEOADJUVANT METFORMIN AND TEMOZOLOMIDE FOLLOWED BY HYPOFRACTIONATED ACCELERATED RADIOTHERAPY WITH CONCOMITANT AND ADJUVANT METFORMIN AND TEMOZOLOMIDE IN PATIENTS WITH NEWLY DIAGNOSED GLIOBLASTOM**

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**Purpose:** Metformin (MTF) inhibits the proliferation of glioblastoma (GBM) cells by activating adenosine monophosphate-activated protein kinase (AMPK), inhibiting mammalian target of rapamycin (mTOR), with subsequent sensitization to ionizing radiation (IR) and Temozolomide (TMZ). Furthermore, MTF reduces blood glucose levels and growth factors including insulin and insulin-growth factors. This study aimed to assess the feasibility and safety of neo-adjuvant MTF/TMZ followed by hypofractionated accelerated radiotherapy (HART) and concomitant and adjuvant MTF/TMZ.

**Materials and Methods:** Adults with newly diagnosed GBM were accrued within four weeks from surgery and received neo-adjuvant MTF (850 mg PO BID) and TMZ (75 mg/m$^2$PO QD) for two weeks prior to HART (60 Gy in 20 daily fractions over four weeks) given with concomitant and adjuvant MTF/TMZ. Adjuvant TMZ/MTF was given for six cycles at 150–200 mg/m$^2$.

**Results:** Between April 15, 2015 and September7, 2021, 50 patients with GBM were accrued. As of December 15, 2021, 19 patients are alive. With a median follow-up of patients of 17.5 months (5.2-79.5) for all patients and 34.3 months (17.5-47.0) for patients at risk, the median survival time (MST) was 29.5 months with a median progression-free survival (PFS) of 13.7 months. Patients with methylated (n=16) Methylguanine-DNA Methyltransferase (MGMT) have a longer OS of 41.9 versus 24·0 months for 34 patients with unmethylated (n=34) MGMT (p=0·003, HR 0.46 95%CI, 0.22–0.96). The MST of patients with an average blood glucose levels of < 5_mmol/L has not been reached compared to MST of 25.7 months for patients with blood glucose levels ≥ 5 mmol/L, (p=0·03 HR 0·30 95%CI, 0·13–0.67 Log-rank). Twenty-one patients had a second surgery for suspected recurrence with a median of 12.25 months from initial surgery, 15 had recurrence and six had treatment-related changes only. Protocol treatment was discontinued in two patients, one for disease progression and another one for prolonged Grade 4 thrombocytopenia during the concomitant phase. One patient developed PE. One patient died from pneumocystis pneumonia. At the time of last follow-up, 33 patients had an ECOG of 0-1, while 17 patients had a score of 2-3. Ten out of the 19 alive patients were receiving steroids.

**Conclusions:** This is the first report on the prospective use of neoadjuvant, concomitant and adjuvant MTF/TMZ and HART in patients with GBM. It is novel, safe and feasible with encouraging MST and PFS, notably for the group of patients with unmethylated MGMT. In addition, it allows for a valuable shortening of radiotherapy treatment time. The results suggest a potential impact of glycemic control on outcomes in GBM.

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**ACCELERATED PARTIAL BREAST IRRADIATION (APBI) USING FIVE DAILY FRACTIONS: A PROSPECTIVE, PHASE II, MULTI-CENTRE TRIAL OF COSMETIC OUTCOMES AND TOXICITY (THE ACCEL**

**TRIAL): FINAL RESULTS**

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**Purpose:** To report final results of a clinical trial of APBI using intensity modulated radiotherapy (IMRT) to deliver 27 Gy in 5 daily fractions following breast conserving surgery (BCS) prospectively designed to assess the efficacy and cosmetic outcomes of a one-week, APBI regimen among women with early breast cancer.

**Materials and Methods:** Women ≥ 50 years, with lymph node-negative, ER positive, HER-2 negative breast cancer or ductal carcinoma in situ (DCIS), ≤ 3cm diameter, following BCS with margins ≥ 2mm, and excellent or good baseline cosmesis received 27 Gy in 5 daily fractions to the seroma plus 1 cm CTV and 0.7 cm PTV margins. Clinical photographs, patient and provider cosmetic scores, breast fibrosis, telangiectasia and pain were collected prospectively, prior to RT and at 6 weeks, 1 and 2 years after RT. The primary endpoint was the proportion of women who retained Excellent or Good cosmesis at 2 years using the EORTC Cosmetic Rating System. Cosmetic failure was deterioration from Excellent or Good to Fair or Poor. A panel of 5 radiation oncologists independently assessed the cosmetic photographs. Secondary endpoints were rates and grades of breast fibrosis, telangiectasia, breast pain, ipsilateral breast tumour recurrence (IBRT), overall (OS), breast cancer-specific survival (BCSS) and subsequent mastectomy. Efficacy outcomes were assessed at clinic visits and by review of charts. ClinicalTrials.gov registration: NCT02681107.

**Results:** A total of 298 patients were treated between April 25, 2016, and October 31, 2019. At a median follow-up of 48 months, the four-year OS was 98.5% (95% CI 96.1% - 99.5%) and BCSS was 99.7% (95% CI 97.6% - 99.9%). The four-year IBRT rate was 3.3% (95% CI 1.1% - 6.4%). There were 10 contralateral breast events for a four-year rate of 3.9% (95% CI 2.2% - 6.9%). There were 10 ipsilateral and six contralateral mastectomies. Two patients died of unrelated causes prior to two years; 79 patients declined in-clinic attendance due to COVID or competing comorbidities and 217 women had two-year cosmetic photographs and clinical assessments performed. Consensus of the photo-panel cosmesis at baseline was: Excellent: n=116 (53%), Good: n=102 (47%), Fair: n=1 (0.5%) and Poor: n=0. Consensus overall cosmesis at two years was: Excellent: n= 141 (65%), Good: n=78 (35%), Fair: n=0 and Poor: n=0. Most patients had either improved (n=168; 77%) or no change (n=43; 20%) in cosmesis at two years. No patient had cosmetic failure but 6 (3%) had a change from Excellent to Good at two years. Most patients reported either no (79%) or mild (21%) pain, with no moderate or severe pain. Two patients (0.9%) had Grade 2 fibrosis and five patients (2%) had visible telangiectasia that did not detract from overall cosmesis.

**Conclusions:** APBI using 27 Gy in 5 fractions using a conformal IMRT technique, achieved excellent two-year cosmesis with minimal toxicity. The IBRT risk was comparable to the contralateral new breast cancer risk and to local recurrence rates of recently published early breast cancer trials.

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**EVALUATING THE SHORT-TERM ENVIRONMENTAL AND CLINICAL EFFECTS OF A RADIATION ONCOLOGY DEPARTMENT'S RESPONSE TO THE COVID-19 PANDEMIC (STEER COVID-19)**

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**Purpose:** During the COVID-19 pandemic, hypofractionated regimens and virtual care was adopted by our institution to preserve hospital capacity and reduce foot traffic. This study's primary objective was to assess the collective environmental impact of these strategic changes by identifying sources of carbon dioxide equivalents ($CO_2e$). As sustainable healthcare is only justifiable if the quality of the care is maintained, we also evaluated the rate of radiation-related acute adverse event.

**Materials and Methods:** All patients treated with external beam radiation therapy from April 1, 2019 to March 31, 2021 at our single institution were identified (n=10,175) along with their radiotherapy visits (176,423 fractions), and visits to the radiation nursing clinic (RNC) or emergency (ER) department. Out-patient hospital and virtual visits (n=75,853) during this same period were also analyzed. Environmental impact measures, including linear accelerator power usage, patient travel distances, and personal protection equipment (PPE) consumption were all converted into $CO_2e$.

**Results:** The use of curative hypofractionated regimens increased from 17% to 27% during the pandemic year. Carbon footprint was reduced by 39% during the pandemic year (1,332,388 kg $CO_2e$) as compared to the pre-pandemic year (2,024,823 kg $CO_2e$). For comparison, the 744 tonnes of $CO_2e$ saved during the pandemic year equates to the $CO_2e$ produced by the annual energy consumption of 182 Canadian households or the $CO_2e$ sequestered by 12,000 seedling trees planted and grown for 10 years. Comparing patients in the pre-pandemic versus pandemic year, there was a significant reduction in the proportion of hypofractionated patients who needed a visit to either the RNC (39% versus 25%; $p<0.001$) or ER (6% versus 2%; $p<0.001$) during and within 90 days of radiotherapy.

**Conclusions:** This is the first study to demonstrate the environmental benefits of increased use of hypofractionated regimens and virtual care, while assuring that there was no added acute radiation-related adverse event. Our findings support their continued use as one of many long-term strategies to reduce the environmental footprint of healthcare delivery. Treatment efficacy and side-effects will need to be assessed in subsequent years to further support the sustainability of these strategies.

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**ELIMINATING TATTOOS FOR SHORT COURSE PALLIATIVE RADIOTHERAPY: SET-UP ERROR, SATISFACTION AND COST**

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**Purpose:** Palliative patients are living longer thanks to advancements in systemic therapies and radiotherapy technologies. Prior to image guided radiotherapy, permanent ink tattoos were used to ensure set up accuracy. Permanent marks can cause psychological damage, physical pain and can reduce a patient's quality of life. In recent years, image guided radiation therapy (IGRT) has become standard practice and may eliminate the need for permanent tattoos in this patient population.

**Materials and Methods:** Twenty-five patients were consecutively chosen from the Palliative Radiation Oncology Program (PROP). Each received 5 fractions of radiotherapy commencing within 72

hours of CT simulation. In place of permanent tattoos, patients were marked with permanent marker and an adherent transparent film dressing (TegadermTM) was placed over the mark. Patients were educated on maintaining the marks and dressing. Daily cone beam CT (CBCT) isocentre mismatch values were compared with 25 patients who received tattoos for radiotherapy to similar body regions. Radiotherapist concerns, cost, variations in isocentre shift values and additional imaging requirements were obtained.

**Results:** Isocentre shift values were similar ($p<0.05$) for TegadermTM versus tattoo patients in the anterior-posterior (AP) and right-left (RL) directions. The mean shift value in the superior-inferior (SI) direction was larger for TegadermTM than for tattoos ($p=0.01$), however the magnitude was only 2mm, which is clinically insignificant as these shifts were prior to IGRT guided correction. No patient required a repeat CBCT or a resimulation. The cost of the TegadermTM dressing was substantially less than the tattoo group. Radiation Therapists' satifaction with TegadermTM was overall high, however some expressed concerns with their durability and longevity.

**Conclusions:** We found that the use of TegadermTM dressing did not result in increased set-up time, mismatch error or additional imaging procedures (CBCT or CT simulation) and moreover cost substantially less than permanent ink tattoos.

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## DOES A SUBSPECIALTY GYNECOLOGIC PATHOLOGY REVIEW CHANGE MANAGEMENT OF ENDOMETRIAL CANCER PATIENTS: A BC CANCER- VICTORIA EXPERIENCE

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**Purpose:** Endometrial cancer is the fourth most common malignancy affecting women in BC, and the most common gynecologic malignancy. Current provincial guidelines recommend management based on pathologic characteristics; thus, an accurate histologic assessment is essential for prognosis and treatment planning. This current state analysis was completed to assess the impact of subspeciality gynecologic pathology reviews on the clinical management of endometrial cancer patients at BC Cancer Victoria, to inform the gynecologic tumour group and guide provincial policy on the use of pathology reviews for this patient population.

**Materials and Methods:** Patient records from January 1, 2017 to December 31, 2019 were accessed retrospectively from the BC Cancer Agency Information System (CAIS) and from Island Health's pathology database (CoPath). Patients who did not have a report completed by an Island Health pathologist or did not have an epithelial endometrial cancer were excluded. Baseline, clinical and disease characteristics were collected using Redcap. Descriptive statistics were completed using R software.

**Results:** Two hundred and three patients were identified having two pathological (original and review) reports, with 83 (41%) having a difference in at least one histological parameter. The majority (61%) had only one difference, with 35% and 3% had two and three differences respectively. The most common difference was the presence of LVSI, followed by histologic tumour type. Fifty six percent of reviews happened after hysterectomy. Of the differing reviews that happened prior to hysterectomy (42%), at least 38% resulted in a change of surgery. Of those with differing reviews, 39 (47%) had a change in non-surgical management, with at least 18 (46%) resulting in treatment escalation. Treatment escalation included recommending any treatment from observation, pelvic radiation from brachytherapy, or addition of chemotherapy.

**Conclusions:** Our analysis shows that a significant number of patients had a discrepancy upon pathology review, which is in keeping with previous reports. In addition, these discrepancies were clinically meaningful with a change in management in almost half of cases. This study supports the continued use of subspecialty gynecologic pathology review for endometrial cancer patients.

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## THE NON-OPERATIVE MANAGEMENT USING SBRT FOR TECHNICALLY RESECTABLE, BUT MEDICALLY INOPERABLE, PANCREATIC ADENOCARCINOMA

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**Purpose:** Pancreas cancer is the 4th leading cause of cancer death in the Canada and the United States. The only curative treatment option is surgery, yet <20% of patients are surgical candidates at presentation due to advanced disease or medical inoperability. The purpose of this study is to determine the outcomes of technically resectable, but medically inoperable, pancreatic cancer patients treated with definitive stereotactic body radiation therapy (SBRT) with or without chemotherapy.

**Materials and Methods:** After IRB approval (2021P001000), we identified and reviewed the medical records of all technically resectable, but medically inoperable, pancreas adenocarcinoma patients treated with SBRT between 2012-2021. Staging information, performance status, CA 19-9 at diagnosis, radiotherapy and systemic treatment details, date of local failure, date of metastasis, and acute and late toxicities were recorded. We evaluated overall survival (OS) at 1 year and 2 years from diagnosis, local control, rate of metastases, and toxicity information.

**Results:** Twenty-three patients met the inclusion criteria and had sufficient follow-up information. The median age at diagnosis was 73.5, all patients had ECOG performance status ≤ 2, 83% (n=19) of patients received systemic therapy with gemcitabine/abraxane and FOLFIRINOX the most common regimens. The median CA 19-9 at diagnosis was 281 U/ml. The median survival was 10.5 months. OS was 48% and 18% at one and two years. For patients alive at one and two years, LC was 82% and 100% respectively. By one and two years from diagnosis, 26% and 39% of patients had developed metastatic disease. CTCAE Grade ≥ 3 acute toxicity occurred in 22% (n=5) of patients.

**Conclusions:** Technically resectable but medically inoperable patients with pancreatic adenocarcinoma achieve excellent local control and minimal toxicity with SBRT but have limited survival likely due elevated rates of distant metastases and medical comorbidities.

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## ACUTE TOXICITY IN HIGH-RISK PROSTATE CANCER PATIENTS TREATED WITH EXTREME HYPOFRACTIONATION (HRPC-SBRT)

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**Purpose:** To report acute GU and GI toxicity in high-risk prostate cancer patients treated with extreme hypofractionation in our institution.

**Materials and Methods**: Patients with localized, high-risk prostate cancer (T3/4, or PSA >20, or Gleason score 8-10) were treated with a stereotactic body radiation therapy (SBRT) regimen of 36.25 Gy to the prostate volume delivered in 5 fractions every other day (2 weeks), using an inverse plan VMAT technique. Some patients were also simultaneously treated to the pelvic nodes, with 25 Gy

in the same 5 fractions. Image guided radiation treatment (IGRT) was performed daily in all patients. Androgen suppression started in all patients two to three months before HRPC-SBRT. Acute GU and GI toxicity was prospectively assessed during and 1-3 months after treatment, graded according to the CTCAEv5.

**Results:** Between May 2019 and June 2021, 161 patients were treated and reviewed here.
53 patients received SBRT to both prostate and pelvic nodes, and 108 received SBRT to the prostate alone. All patients were followed for at least four months (median 10 months). Median age was 73 years (range: 55-88). For the cohort treated with SBRT to both prostate and pelvic nodes, acute GU toxicity was as follows: Grade 0 seen in 45% of patients, Grade 1 in 30%, Grade 2 in 25%; while acute GI toxicity was not seen in 60% of patients (Grade 0), Grade 1 was documented in 36% and Grade 2 in 4%. For the cohort treated with SBRT to the prostate alone, acute GU toxicity was not seen in 26% of patients, Grade 1 seen in 47%, and Grade 2 in 27%; while acute GI toxicity was not observed in 79% of patients, Grade 1 was seen in 17% and Grade 2 in 4%. Grade ≥3 acute GI or GU toxicity was not seen in any patient.

**Conclusions:** In our experience, Grade 2 or greater acute GI or GU toxicity was similar regardless of the irradiation of pelvic nodes. The addition of pelvic nodes to the SBRT volume does not seem to increase acute toxicity.

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## DOSE TO THE INTERNAL MAMMARY CHAIN LYMPH NODES IN CASES WITH INTERNAL MAMMARY LYMPH NODE RELAPSE: A CASE CONTROL STUDY

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**Purpose:** Studies of sentinel lymph node biopsy of internal mammary nodes (IMN) in breast cancer show a 15% positivity rate, if untreated these may serve as a reservoir for regional recurrence (RR) and/or distant metastases. Randomized clinical trials examining the benefit of IMN radiotherapy (RT) haven't demonstrated an overall survival or disease-free survival benefit. However in one study an ad hoc sub-analysis of patients with inner/central tumours showed a 7-year breast cancer mortality of 10.2% without IMNRT and 4.9% with IMNRT (Kim Y. JAMA Oncol 2022;8(1):96-105). IMNs often get some incidental dose from tangent RT, but this dose isn't known and we hypothesize that it might diminish the apparent benefit of deliberate IMNRT.

**Materials and Methods:** Patients diagnosed with non-metastatic breast cancer between 2005 and 2014, who relapsed with IMN disease, were identified in a population-based database. They were matched 1:3 by age, diagnosis year, pathological features and treatment received. An IMN CTV was outlined on planning CT scans covering the internal mammary vessels in the first 3 intercostal spaces. The equivalent dose in 2Gy fractions (EQD2) to the IMNs was calculated to account for different RT prescriptions. A two sample t-test and Cox regression analysis were used to evaluate the effect of IMN dose as a continuous variable on RR and breast cancer-specific survival (BCSS).

**Results:** Seventy patients with IMN relapse were identified and 210 cases without relapse were matched. Median follow-up was 10.8 years and median age 59 years. The matching of relapse and non-relapse cases, respectively, gave well balanced cohorts: most were pT2 (47.1% and 47.6%), pN2 and pN3 comprised 25.7% and 20.5% and tumour location was inner/central in 35.3% and 35.2%. RT was delivered to 43 (61.4%) relapse patients and 130 (61.9%) matched patients with 11 (15.7%) and 52 (24.8%) receiving intentional IMN coverage. The mean IMN dose was 44.90Gy (94.1%) for intentional coverage and 13.31Gy (28.3%) for incidental coverage. The average minimum dose to the IMNs was 6.81Gy (14.4%) for the relapse cases and 14.78Gy (31.0%) for the matches (p=0.008). The average mean dose to the IMNs was 18.42Gy (38.7%) for the relapse cases and 26.93Gy (56.7%) for the matches (p=<0.001). For the whole cohort, Cox regression modelling showed that the mean IMN dose was not significantly associated with RR (HR 0.87, 95% CI 0.74-1.02, p=0.08) or BCSS (HR 0.94, 95% CI 0.82-1.09, p=0.4). Similar results were shown for an N2/N3 subset, RR (HR 0.80, 95% CI 0.62-1.03, p=0.08) and BCSS (HR 0.86, 95% CI 0.70-1.07, p=0.2), and for a subset with inner/central tumours, RR (HR 0.87, 95% CI 0.65-1.17, p=0.4) and BCSS (HR 0.99, 95% CI 0.78-1.25, p=1.0).

**Conclusions:** Patients with IMN relapse received significantly lower mean IMN doses than those who didn't relapse, however our sample size did not show a difference in clinical outcomes. The impact on relapse in IMNs from incidental RT dose should be considered when planning future studies in this field.

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## POPULATION-BASED OUTCOMES OF GYNECOLOGIC CANCER PATIENTS TREATED WITH WHOLE BRAIN OR STEREOTACTIC RADIOTHERAPY FOR BRAIN METASTASES

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**Purpose:** Gynecologic cancers (GyneCa) rarely metastasize to the brain. Thus, prognostication and management of these patients can be challenging. Modern evidence suggests that the prognosis for these patients is improving. This may be driven by advances in diagnostics such as increasing use of magnetic resonance imaging, or advances in radiotherapy (RT) such as stereotactic radiosurgery (SRS), compared to conventional whole brain radiotherapy (WBRT). An updated review of outcomes is needed to describe the current landscape of GyneCa related brain metastases (BrM). This study reviewed the local control, survival outcomes, and prognostic factors in a population-based cohort of patients treated with radiotherapy for BrM from GyneCa.

**Materials and Methods:** All patients with a primary GyneCa diagnosis who received RT for BrM between January 1997 to December 2019 were retrospectively reviewed from a provincial database. Patients were stratified by the type of RT received, either WBRT or SRS. Patients were excluded if they had another active primary cancer diagnosis, or if they received surgery for BrM. Intracranial progression free survival (icPFS), time to intracranial progression (TTicP) and OS, were calculated from the date of BrM diagnosis, using the Kaplan Meier method. Log-rank tests and Cox regression were used for group comparisons, and multivariate analysis (MVA).

**Results:** A total of 65 patients were available for analysis, of which 46 received WBRT and 19 received SRS. Primary diagnoses included: uterine (68%), cervical (17%), and ovarian (15%) cancers. The median age at BrM diagnosis was 61 (range: 37-84), and the median Eastern Cooperative Oncology Group (ECOG) performance status was 2 (range: 0-4). All patients had died at the time of analysis. Patients treated with SRS had a better icPFS (median 18.7 months) and OS (median 23.2 months), compared to those treated with WBRT (median icPFS and OS were 3.1 months, p < 0.001). The median TTicP for patients treated with SRS was 32.8 months (95% confidence interval: 30.4-35.3); TTicP could not be assessed in patients treated with WBRT. On MVA, age, ECOG performance status, and type of RT were each significant for OS

($p < 0.001$). Number of BrM, presence of extracranial disease, and status of primary disease were not statistically significant on MVA.

**Conclusions:** This study reports the survival outcomes of GyneCa patients who received modern treatment for BrM. Patients who received SRS had a significantly improved median OS and icPFS compared to those who received WBRT. This is consistent with other small case series describing an improvement in prognosis of patients with good performance status and limited burden of BrM. This study also highlights the poor prognosis of BrM in the majority of GyneCa patients with adverse clinical factors, and those not eligible to receive more aggressive therapy such as SRS. Future work is needed to better characterize the outcomes for this rare group of patients in other populations.

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**PREDICTORS OF EARLY POLYMETASTATIC RELAPSE FOLLOWING STEREOTACTIC ABLATIVE RADIOTHERAPY FOR UP TO 5 OLIGOMETASTASES: A SECONDARY ANALYSIS OF THE PHASE II SABR-5 TRIAL**

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**Purpose:** A subset of patients with oligometastatic cancer experience early widespread cancer dissemination and do not benefit from metastasis-directed therapy such as stereotactic ablative radiotherapy (SABR). This study aimed to identify factors associated with early polymetastatic relapse (PMR).

**Materials and Methods:** The SABR-5 trial was a single arm Phase II study conducted at all six regional cancer centres across British Columbia. SABR for oligometastases was only offered on trial. Patients with up to 5 oligometastatic lesions (total, progressing or induced) received SABR to all lesions. Patients were 18 years of age or older, ECOG 0-2 and life expectancy ≥ 6 months. This secondary analysis evaluated factors associated with early PMR, defined as disease recurrence within six months of SABR which is not amenable to further local treatment. Univariable and multivariable analyses were performed using binary logistic regression. The Kaplan Meier method and log-rank tests assessed PMR-free survival and differences between risk groups, respectively.

**Results:** Between November 2016 and July 2020, 381 patients underwent treatment on SABR-5. Prostate was the most frequent primary tumour histology (32%), followed by colorectal (17%) and breast (11%). Most patients (69%) underwent SABR to one metastasis and only 10% received SABR to three or more lesions. Oligoprogression represented 16% of cases. A total of 16% of patients experienced PMR. Worse performance status (ECOG 1-2 versus 0; HR=2.01, p=0.018), non-prostate/breast histology (HR 3.64, p<0.001) and oligoprogression (HR=3.84, p<0.001) were independent predictors for early PMR. Risk groups were identified with median PMR-free survival ranging from five months to not yet reached at the time of analysis. Rates of three-year OS were 0%, 53% (SE=5%), 77% (SE=4%) and 93% (SE=3%) in groups 1-4, respectively (p<0.001).

**Conclusions:** Four distinct risk groups for early PMR are identified, which differ significantly in PMR-free survival and overall survival. The group with all three risk factors had a median PMR-free survival of five months and may not benefit from local ablative therapy alone. This model should be externally validated with data from other prospective trials.

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**DO ANTHROPOMETRIC INDICES CORRELATE WITH PROSTATE CANCER IN NIGERIAN MEN?**

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**Purpose:** Despite prostate cancer (PCa) being a public health problem globally, much remains unknown of its etiology. Though obesity is a probable risk factor measurable by anthropometric indices, its impact on PCa development with other risk factors has not been explored among Nigerian men. This study was designed to test the hypothesis that anthropometric indices are higher in PCa patients compared to age-matched healthy controls.

**Materials and Methods:** The study was a case-control study conducted in four tertiary hospitals in Nigeria. The cases were newly diagnosed prostate cancer patients, while the controls were age-matched healthy men confirmed to be cancer-free with normal PSA. Patients with weight loss (self-reported) in the past month, ECOG ≥3, and uncontrolled comorbidities were not eligible. Socio-demographics and clinical history (including risk factors and Gleason score [for cases]) using an interviewer-administered questionnaire, and anthropometric measures (weight, height, body mass index, waist circumference, hip circumference, and waist-hip ratio [WHR]) were obtained from all participants. T-test and chi-square were employed to compare the variables between the cases and the controls.

**Results:** Seventy-three PCa cases and seventy-five age-matched healthy controls were recruited. The majority (58.9%) of the cases had high-grade diseases (Gleason Score 8-10). Case and control groups (PCa/Co) differ by occupation (particularly with the retired category 36PCa:21Co), regular exercise (32PCa:51Co; p=0.005), family history of PCa 14PCa:3Co; p=0.004), tobacco smoking (38PCa:12Co; p=0.003), and alcohol consumption (57PCa:41Co; p=0.003). Compared to the controls, only the mean WHR was higher in the cases (0.98 [SD0.71] PCa: 0.93 [SD0.60] in Co). There was no correlation between any anthropometric indices and the disease grade.

**Conclusions:** Patients with PCa had higher WHR and were more likely to be retired, physically inactive, have a family history of prostate cancer, smoke tobacco, or drink alcohol. PCa in Nigerian men are predominantly high-grade, and there was no correlation between Gleason grade and anthropometric indices.

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**ENSURING SUPERIOR REPORTING OF NON-INFERIORITY RADIOTHERAPY CLINICAL TRIALS: A SYSTEMATIC REVIEW**

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**Purpose:** Non-inferiority clinical trials are used to investigate whether a new treatment is not worse than a control by a pre-specified, acceptable amount. These new treatments can be more convenient, cost-effective, or tolerable than the standard of care. Although the frequency of this trial design is increasing,

the consistency of reporting and interpretation of these trials can vary. The aim of this systematic review was to assess the methodologic quality of non-inferiority radiotherapy clinical trials.

**Materials and Methods:** A literature search of PubMed, EMBASE and Cochrane databases of randomized controlled radiotherapy trials with non-inferiority hypotheses published in English between January 2000 and July 2021 was performed by an information scientist. Exclusion criteria included study protocols, and follow-up or interim analyses. Records were screened and full texts were reviewed by two authors with discrepancies settled by a third reviewer or by consensus. Descriptive statistics pertaining to study size, primary cancer type, type of comparison, endpoint, and statistical measures were performed. This review was prospectively registered on PROSPERO: CRD42021270644.

**Results:** Of 260 records identified on initial search, 44 (17%) trials were included after full-text review. The mean number of participants was 876 (SD 1057). All studies were open label and were published after 2004. Four (9%) trials were funded by industry. The most common primary cancer type was breast (n=10, 23%). The majority of studies (n=37, 84%) had 2 treatment arms. The most common types of interventions included altered radiation fractionation (n=13, 30%) and changes to systemic therapy agents (n=10, 23%). Six (14%) studies compared radiation to another treatment modality (e.g., surgery, radiofrequency ablation, etc.), and 3 (7%) studies examined the omission of radiation. The most common primary endpoints were progression-free survival (n=12, 27%) and local/regional control (n=12, 27%). Forty (91%) studies reported the non-inferiority margin. The median non-inferiority margin was 10% (IQR: 5–10%). Sample size calculation was reported in 42 (95%) studies, and 42 (95%) studies reported confidence intervals of the primary endpoint. Both intention-to-treat and per protocol analyses were reported in approximately half (52%) of studies. In 23 (52%) trials, a non-inferiority claim of the primary endpoint was reached.

**Conclusions:** There are variations in reporting quality of non-inferiority clinical trials involving radiotherapy. Standardization of required data to report and statistical methodology would be helpful to ensure proper interpretation of trial results.

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## RADIATION DOSE, TECHNIQUE, AND USE OF BRAIN RADIATION ON OVERALL SURVIVAL IN PATIENTS WITH LIMITED-STAGE SMALL CELL LUNG CANCER

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**Purpose:** The standard of care for limited-stage small cell lung cancer (LS-SCLC) currently involves concurrent chemoradiation +/- prophylactic cranial irradiation (PCI). Previous research has presented conflicting data regarding the optimal radiation therapy (RT) technique, RT dosage, and impact of brain RT on long term overall survival (OS). This study aimed to explore prognostic factors of OS in LS-SCLC cancer patients using a population-based cohort.

**Materials and Methods:** Data on all patients diagnosed with LS-SCLC in Ontario, Canada from 2005-2017 was obtained using the Institute for Clinical Evaluative Sciences (IC/ES) Data & Analytic Services. Eligible patients received curative intent chemoradiation, and OS was estimated from a landmark date of six months post-diagnosis to avoid survivor bias. Kaplan-Meier methods and Cox regression were used to estimate OS and explore differences between RT dose (40-49, 50-59, 60+ Gy), RT technique (3DCRT, IMRT, VMAT), and use of brain RT (PCI – 25 Gy, whole brain RT – 20 or 30 Gy, other brain RT, no brain RT). Multivariate analyses adjusted for sex, age, income quintile, Charlson comorbidity index, disease stage, prior history of cardiac disease, brain RT dose, and laterality.

**Results:** A total of 1360 LS-SCLC patients who received chemoradiation were included. Median OS (95% CI) was 18.1 months (16.6-19.4). Higher RT dose had significantly improved OS when compared to 40-49 Gy on univariate analysis (HR=0.83, 0.71-0.95, 60+ Gy), however, this did not persist when adjusting for other prognostic factors on multivariate analysis (HR=0.90, 0.77-1.06, 60+ Gy). The use of whole brain RT was associated with worse OS on both univariate (HR=1.47, 1.24-1.74) and multivariate (HR=1.42, 1.18-1.70) analyses. OS (95% CI) at five years for RT dose were 40-49 Gy: 16% (13-19%), 50-59 Gy: 23% (18-29), and 60+ Gy: 20% (16-25). For RT technique, OS (95% CI) at five years were 3DCRT: 19% (13-22), IMRT: 18% (13-23), and VMAT: 12% (4-25). Multivariate analyses demonstrated that male sex (HR=1.36, 1.20-1.55), more advanced stage disease (HR=1.35/1.94/3.08/1.67 for Stage 2/3/4/Unknown versus 1), and older age were prognostic for worse OS.

**Conclusions:** Analyses of population-based data demonstrated that male sex, older age, and more advanced disease stage were notable predictors of OS in LS-SCLC. RT dose, when adjusting for other important prognostic variables did not predict for improved OS. However, use of whole brain RT (versus PCI or no PCI) was associated with worse OS. Use of PCI versus no PCI did not influence survival in this cohort, nor did RT technique.

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## MULTI-TARGET THORACIC STEREOTACTIC BODY RADIOTHERAPY - TOXICITY AND EFFICACY ANALYSIS

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**Purpose:** With the increasing utilization of stereotactic body radiation therapy (SBRT) for primary and metastatic cancer, use of multi-target thoracic (MTT) SBRT is rising. Given the limited safety and efficacy data on MTT, the purpose of this study was to report the experience of this strategy from a large academic centre.

**Materials and Methods:** Between 2012 and 2021, patients who received SBRT for ≥2 thoracic targets within one year were retrospectively reviewed. The primary endpoint was clinically significant radiation pneumonitis (CSRP) requiring steroids, oxygen, or intubation. Secondary endpoints included late Grade ≥3 toxicity (Common Terminology Criteria for Adverse Events, version 5.0) apart from pneumonitis, local failure (LF), initiation or change of systemic therapy (ICST), progression-free survival (PFS), and overall survival (OS). Competing risk analysis was used to evaluate the cumulative incidence of CSRP, LF, and ICST. PFS and OS were estimated using the Kaplan-Meier method. Univariate and multivariable analyses were performed to look for predictive factors of CSRP.

**Results:** In total, 190 patients (481 lesions) were treated with MTT SBRT with a median follow-up of 19.7 months. Primary histologies included colorectal (29.9%), lung (28.1%), kidney (17.5%), and breast (6.0%). Indications for SBRT were oligoprogression (n=180; 37.4%), oligometastases (n=164; 34.1%), curative intent (n=81; 16.9%), and control of dominant areas of progression (n=56; 11.6%). Thirty-two patients (16.8%) had systemic therapy within three months of SBRT. Number of irradiated tumours ranged from 2-7 and the majority of SBRT courses were delivered concurrently (88.2%). Of concurrent courses, 157 (62.3%) used multiple isocentres and 95 (37.7%) used a single isocentre. Median SBRT dose was 50 Gy (range: 25-60 Gy) delivered in 1-8

fractions, with a median biological effective dose of 105.6 Gy (range: 37.5-150 Gy). Overall, 14 patients (7.4%) had CSRP, with five cases requiring oxygen. The cumulative incidence of CSRP at six and 12 months was 5.3% and 7.7%, respectively. Two other patients had late Grade ≥3 toxicity: one Grade 3 rib fracture and one Grade 4 esophageal perforation. The cumulative incidence of LF was 10.5% at two years. The cumulative incidence of ICST at one and two years was 28.8% and 44.0%, respectively. Median PFS was 9.9 months (95% confidence interval (CI): 7.6-11.9) and median OS was 47.4 months (95% CI: 33.5-58.6). On univariate and multivariable analyses, >2 tumour targets (HR=2.92; p=0.047) was predictive for a higher risk of developing CSRP and shorter time between treatments (HR=58.8; p<0.0001) was predictive of a lower risk of CSRP.

**Conclusions:** In one of the largest institutional series of MTT SBRT, rates of CSRP requiring intervention were low. As the use of SBRT increases in the metastatic setting, treating multiple thoracic targets appears to be safe and effective. Further work to identify dosimetric predictors will be presented.

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**PERSON-CENTERED RADIATION THERAPY FOR BREAST CANCER PATIENTS: PATIENT EXPERIENCES FROM A PROSPECTIVE RANDOMIZED TRIAL (PERSON)**

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**Purpose:** Person-centered models of care may address the unmet care needs of patients with breast cancer and improve their experiences and outcomes. Our institution is conducting a prospective randomized Phase 2 study (PERSON) evaluating a person-centered model emphasizing the role of Radiation Therapists (RTT) to tailor patient education and provide continuity of care during treatment compared to our standard process. The primary objective of this study is to measure patient reported anxiety. A further qualitative sub-study was conducted to explore patients' experiences with this new model and to compare their experiences to those receiving the standard of care (SOC).

**Materials and Methods:** Patients requiring loco-regional irradiation who provided informed consent were randomized on the main study to be partnered with a single RTT throughout their radiotherapy (e.g. pre-treatment education, simulation, treatment) or to receive SOC. Optional semi-structured one-on-one interviews were completed by telephone by a single facilitator within 2 weeks post-treatment to explore the lived experiences of patients receiving SOC and intervention model of care. Interview questions investigated the opinions of both groups on their overall care, personal experiences with the RTTs, and factors influencing preparedness for treatment. Interviews were conducted, transcribed, and coded (NVivo v.12) for thematic analysis until data saturation was achieved.

**Results:** Of the 105 out of 109 patients enrolled to date, 41 (21 intervention, 20 standard care) participated in the optional sub-study interviews. Two main themes emerged. The first theme focused on the consistency of RTT staff. Twenty three patients (15 intervention, 8 SOC) reported additional familiarity and personal rapport either when partnered with one RTT or when the team was small and consistent. However, 2 patients receiving SOC noted that this might be negated if the personality of the RTT did not match their own. Seven participants (4 intervention, 3 SOC) indicated particular value in having the same RTT across specific transitions (e.g. between CT-sim and beginning of treatment), or reserving this model for specific populations (e.g. elderly). The second theme focused on preparedness for radiotherapy. Eleven patients (6 intervention, 5 SOC) described that an RTT-led education session would increase feelings of preparedness and indicated it would also reduce anxiety. Conversely, 3 participants who received SOC stated the session would have little impact if they were already engaged in self-directed learning.

**Conclusions:** Overall, the reported patient experiences support the role of RTTs in a person-centered model of care for radiation treatment delivery. These results reveal approaches to reduce patient anxiety which we aim to confirm pending trial completion.

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**INCIDENCE AND MANAGEMENT TRENDS IN LOCALLY ADVANCED HEAD AND NECK NON-MELANOMA SKIN CANCER**

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**Purpose:** Non-melanoma skin cancer is the most commonly diagnosed malignancy in Canada, however, the incidence and burden of disease are not well described. Patients with locally advanced head and neck non-melanoma skin cancers (LA-HNSC) often require complex care including surgery and/or radiotherapy (RT). This study describes the incidence and outcomes of LA-HNSC treated with surgical resection in Ontario, Canada between 2003-2019. Secondarily, this study describes the rate of radiation oncology consultation and radiotherapy utilization in this patient population.

**Materials and Methods:** A population-level administrative data analysis of Ontario patients was performed through the Institute of Clinical Evaluative Sciences (ICES) Data Analytic Services. All patients with an International Classification of Diseases (ICD) 10 code corresponding to non-melanoma skin cancer of the head and neck region between 2003 and 2019 were included. LA-HNSC was defined as AJCC 8$^{th}$ edition T3-T4 disease and/or lymph node involvement without distant metastasis. Provincial physician billing codes were used to identify patients with resected LA-HNSC and to determine radiation oncology consultation and RT treatment. Kaplan-Meier methods were used to estimate overall survival (OS) and a landmark date of 120 days post-diagnosis to account for immortal bias. Logistic and Cox regression were used to investigate factors prognostic for receipt of adjuvant radiation and OS.

**Results:** A total of 55,294 cases of non-melanoma skin cancer were initially identified. Of those cases, 11,308 involved the head and neck region and 4,602 met the pre-defined study criteria for resected LA-HNSC. The median age was 70-74 years old and 66.6% of cases were male. The incidence of resected LA-HNSC increased steadily from 158 in 2003 up to 386 cases in 2019. 5-year OS was 70% (95% CI; 69-72). Radiation oncology was consulted in 37.3% of resected LA-HNSC cases and 26.0% of patients received RT. Adjuvant RT in patients with resected T3-T4 disease without nodal involvement was associated with a hazard ratio of 1.52 (95% CI; 1.26-1.85); for patients with lymph node involvement, adjuvant RT was associated with a hazard ratio of 2.00 (95% CI; 1.24-3.21).

**Conclusions:** To our knowledge, this is the first study to report on the incidence of LA-HNSC in the province of Ontario. The incidence of resected LA-HNSC increased steadily between 2003 to 2019 at a rate which exceeded population growth during the same period. Radiation oncology consultation and radiotherapy utilization in this higher risk patient population was not routine. Adjuvant radiotherapy was associated with poorer overall survival in patients with resected LA-HNSC, possibly indicating more advanced presentation of disease.

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## PAIN AND INTERVENTIONS IN STAGE IV NON-SMALL CELL LUNG CANCER: A PROVINCE-WIDE ANALYSIS

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**Purpose:** Pain is a common symptom in advanced lung cancer. The objective of this cohort study was to characterize Stage IV non-small cell lung cancer (NSCLC) patients who reported high pain scores, and examine the utilization and factors associated with interventions for pain.

**Materials and Methods:** Using health services administrative data, a population-based cohort study in Ontario, Canada was conducted of patients diagnosed with Stage IV NSCLC from January 2007 to September 2018. Patients were excluded if they had histology inconsistent with NSCLC or if they had another cancer diagnosis during the study period. Patient characteristics assessed included age, sex, rural residence, income quintile and comorbidity burden. The primary outcome was a high pain score that was defined by an Edmonton Symptom Assessment System (ESAS) score ≥4. Interventions for pain included palliative care, radiation therapy, nerve block and use of opiates. The latter was only evaluable in patients ≥65 years, through the Ontario Drug Benefit (ODB) program. The association between patient characteristics and intervention use was estimated using multivariable modified Poisson regression models

**Results:** The study cohort included 13,159 patients with Stage IV NSCLC, of which 68.5% (n=9,008) reported at least 1 high ESAS pain score. Most of the lung cancer patients were managed with a palliative assessment (85.4%), and the most common therapeutic intervention was radiation therapy (73.2%). For patients ≥65 years of age, 59.6% received an opiate prescription. The use of nerve block was relatively uncommon (0.8%). Patients with high pain scores were more likely to receive an intervention for pain (95.7% versus 91.2%; p<0.001), including palliative assessment (88.1% versus 79.6%; p<0.001) or radiation therapy (77.1% versus 64.8%; p<0.001). Compared to younger patients (age 18-59), older patients who reported high pain were less likely to receive radiation therapy (age 70-79: RR 0.90 [0.88-0.93], age ≥80: RR 0.86 [0.82-0.90]). Patients with more comorbidity burden and high pain were less likely to receive palliative care (RR 0.96 [0.93-1.0]) and radiation therapy (RR 0.90 [0.85-0.96]). In addition, patients with high pain from a rural (RR 0.86 [0.83-0.90]) or non-major urban (RR 0.95 [0.94-0.97]) residence were also less likely to receive palliative care. Female patients who reported high pain were 1.78 (1.14-2.79) times more likely to receive nerve blockers. For patients ≥65 years of age with high pain, no significant association was found for receiving prescription opiates.

**Conclusions:** Factors and interventions associated with high pain in metastatic lung cancer were described in this study which will help to inform symptom management in this population.

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## ERECTILE FUNCTION AFTER 60 GY IN 20 FRACTIONS EXTERNAL BEAM RADIOTHERAPY TO THE PROSTATE

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**Purpose:** To determine which factors predict for worsening erectile function after highly conformal, modestly hypofractionated radiotherapy to the prostate.

**Materials and Methods:** All patients who received 60Gy in 20 fractions, volumetric modulated arc therapy to the prostate across four centres were included in this study. The provincial electronic medical record was interrogated to identify any new prescriptions for erectile dysfunction (ED) medication, any change in prescription of ED medication or any permanent discontinuance of ED medication persisting beyond six months post completion of any androgen deprivation therapy. The penile bulb, penile crux and glans penis structures were retrospectively contoured. A Youden receiver-operator-curve analysis and logistic regression were then used to determine dependencies between worsening ED and clinical factors including mean doses to these structures.

**Results:** Two-hundred-twelve patients with median (inter-quartile-range) follow-up of 3.6 (3.2-4.4) years were identified. Median age was 72 (67-76) years. 104 (49%) patients received androgen deprivation therapy. Prior to treatment, 52 (25%) patients were on ED medication: 20 (9%) on sildenafil, 28 (13%) on tadalafil and 4 (8%) on vardenafil. Median PTV volume was 158.9 (129.8-192.1) cc. Median penile bulb, penile crux and glans penis volumes were 4.7 (3.6-6.2)cc, 6.5 (5.1-8.5)cc and 93.3 (80.6-106.2)cc, respectively. PTV V95 was 99.8 (99.5-99.9)%. Mean doses to penile bulb, penile crux and glans penis were 2094.8 (1306.2-3036.3)cGy, 2094.8 (1306.2-3036.3)cGy and 444.4 (313.2-650.5), respectively.
Fifty-nine (28%) patients had a worsening of ED after treatment: 25 (12%) started a new ED medication, 6 (3%) had a prescription change and 28 (13%) stopped ED medication. On univariate analyses pretreatment use of ED medication predicted for worsening ED: OR yes versus no: 10.2 (5.0 – 20.8; p<0.001). A trend towards mean dose to penile bulb [OR ≤2343.9 versus >2343.9: 1.7 (0.9-3.2; p=0.08)] predicting for worsening ED was observed. Mean doses to penile crux [OR <1725.8 versus > 1725.8: 2.6 (1.3-5.2; p=0.005)] and glans penis [OR ≤344.9 versus >344.9: 5.2 (2.2-12.2; p<0.001)] predicted for worsening ED. Use of androgen deprivation therapy, and age at time of radiotherapy were not predictive of worsening ED. On multivariate analysis, only mean dose to glans penis [OR ≤344.9 versus >344.9: 6.3 (1.9-20.3; p=0.002)] and pretreatment use of ED medication [OR yes versus no: 11.1 (5.3-23.2; p<0.001)] predicted for worsening ED.

**Conclusions:** In this limited analysis, pre-treatment use of ED medication and mean dose to glans penis predicted for worsening ED after treatment with modestly hypofractionated radiotherapy for prostate cancer.

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## NEUROMODULATORY EFFECT AND DOSE RESPONSE OF FUNCTIONAL RADIOSURGERY ON CORTICAL NEURONS

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**Purpose**: The effects of functional radiosurgery on neuronal circuits remain poorly understood. Neurons of the prefrontal cortex communicate via precisely-timed action potentials that control decision making, working memory, and executive control. Here, we examined the dose response of ablative radiation dose on the patterns of communication of neural circuits in prefrontal acute slices.

**Materials and Methods**: Serially escalating doses from 20 Gy to 100 Gy of ablative radiation were applied to a population of rodent cortical neurons using the robotic Radiosurgery device (CyberKnife(R) G4) at a standard dose rate (SDR) of 10 Gy/min. Neuronal communication within irradiated prefrontal slices were compared to control slices (sham radiation); and assessed by plating slices on a multielectrode array that captured high-resolution (18 kHz) extracellular activity across 4,096 channels simultaneously. Comparisons also with recordings of slices treated with a pro-epileptiform solution containing a potassium channel blocker, 4-AP, reduced extracellular magnesium, and increased extracellular potassium and finally, correlated with staining for cell death.

**Results**: Compared to control slices (mean rate of 0.06 Hz), the post-radiosurgery slices yielded a 40-fold increase in discharge rates (mean rate of 2.87 Hz for 20 Gy, 2.44 Hz for 50 Gy, and 1.95 Hz for 100 Gy radiation). Pearson cross-correlations were computed across all pairs of channels, yielding a matrix of 4,096-by-4,096 interactions. Radiated slices exhibited decreased correlations relative to control slices. A total of 7,446 neuronal interactions were above a threshold correlation of 0.5 in control slices, compared to none following a 20 Gy dose, 50 interactions following a 50 Gy dose and 28 interactions following a 100 Gy dose. Slices treated with pro-epileptiform solution slices yielded large seizure-like events characterized by increased discharge rates and increased pairwise correlations.

**Conclusions**: Post-radiosurgery slices yielded a unique signature of neuronal activity with increased rates; but with a pronounced decrease in correlations; suggesting diminished communication across neurons to create a neuro-modulatory effect on target tissue; or result in cognitive toxicity on organ-at-risk respectively. We speculate on an interaction between two competing mechanisms: (i) widespread neuronal disinhibition leading to an increase in neuronal firing; and (ii) dose-dependent cell death and synaptic dysfunction accounting for a decrease in firing in elevated doses. These preliminary results offer a promising tool for high-resolution assays that study interactions with druggable targets for synergy or radioprotection. Analysis of the dose response with Very-high Dose rate (VHDR) will be completed in the near future.

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## STEREOTACTIC BODY RADIOTHERAPY FOR RENAL CELL CARCINOMA: ONCOLOGIC AND RENAL FUNCTION OUTCOMES

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**Purpose:** To evaluate oncologic and renal function outcomes of stereotactic body radiotherapy (SBRT) for medically inoperable patients with localized renal cell carcinoma (RCC).

**Materials and Methods:** Consecutive patients diagnosed with localized renal cell carcinoma treated with curative intent SBRT (30-45 Gy in 5 fractions or 42 Gy in 3 fractions) were included. Local control (RECIST v1.1), distant metastasis, impact on eGFR, and proportional ipsilateral and contralateral renal functions (measured through renal scans) were collected. Univariate and multivariable analyses were conducted to determine association of variables with oncologic and renal function outcomes.

**Results:** Seventy-four patients were analyzed. Median follow-up was 27.8 months (IQR 17.6-41.7). Fifty-seven percent had tumours T1b or greater. One, two and four-year cumulative incidence of local failure was 5.85%, 7.77% and 7.77%, respectively. Cumulative incidence of distant metastasis at two years was 4.24%. On multivariable analysis, lower PTV mean dose (p=0.019) and larger PTV volume (p=0.005) were significantly associated with risk of developing local failure. Lower PTV maximum dose (p=0.039) was significantly associated with risk of developing distant metastasis. The median change in eGFR (mL/min) from pre-SBRT levels was -7.0 (IQR -14.5 to -1.0) at one year and -11.5 (IQR -19.5 to -4.0) at two years following SBRT. The proportion of ipsilateral (differential) renal function decreased over time from 47% of overall renal function pre-SBRT to 36% at two years, while the proportion of contralateral renal function correspondingly improved. On multivariable analysis, higher volume of uninvolved renal cortex (p<0.0001) was significantly associated with a smaller decrease in eGFR over time.

**Conclusions:** Oncologic outcomes with RCC SBRT were favourable in this large institutional cohort, with a longitudinal decline in renal function in the ipsilateral kidney and compensatory increase in the contralateral kidney. Clinical and dosimetric factors were significantly associated with oncologic and renal function outcomes.

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## EVALUATION OF USE OF ADJUVANT RADIOTHERAPY AND SURGICAL APPROACH WITH RESPECT TO ONCOLOGIC OUTCOMES IN THE MANAGEMENT OF EARLY-STAGE CERVICAL CARCINOMA

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**Purpose:** The standard of care for early-stage cervical cancer is radical hysterectomy with pelvic lymphadenectomy. Adjuvant radiotherapy (RT) or chemoradiotherapy (chemoRT) may be administered to reduce the risk of recurrence in patients considered to be at elevated risk based on a combination of pathologic factors. Sedlis et al. and Peters et al. have described the factors that increase the risk of relapse after primary surgery and also demonstrated that adjuvant pelvic RT +/- chemotherapy reduces loco-regional recurrences and can potentially improve survival.

The aim of the study was to determine oncologic outcomes in patients treated for early-stage cervical carcinoma at our institution; and to determine if surgical approach impacted oncologic outcomes or the decision to use adjuvant therapy.

**Materials and Methods:** A retrospective review of all patients with cervical cancers treated by the division of gynecologic oncology at a single institution from June 1st, 2003 to July 31st, 2018 was carried out to identify patients treated for early-stage cervical cancer treated with radical hysterectomy and pelvic lymphadenectomy with or without adjuvant therapy. Recurrence and progression-free survival (PFS) were evaluated with Kaplan Meir methodology. All p-values < 0.05 were considered statistically significant.

**Results:** One hundred and seventy-four women underwent radical hysterectomy and pelvic lymphadenectomy over the 15-year period. Median age was 43. Of these women, 28 had minimally invasive surgery (MIS) and 146 had open surgery. Eighty-one had adjuvant pelvic RT; 76 in the open surgery group (52%) and five in the MIS group (18%). Median dose of radiation was 45Gy/25fr/5 weeks. The median follow-up was 49 months. There were 22 recurrences (12.6%) and 14 (8%) were loco-regional. Of these loco-regional relapses, nine were in the open surgery group (6%) and five in the MIS group (18%), seven (9%) of whom received adjuvant RT. There were 17 deaths; 13 in the open surgery group (9%) and four in the MIS group (14%), 11 of whom received adjuvant RT (p=0.11). Median PFS and median overall survival (OS) were not reached. Neither PFS nor OS was significantly associated with the use of adjuvant RT (p=0.53 and

0.61, respectively), even though these patients tended to have higher risk disease compared to those not receiving RT. PFS was significantly better in the open surgery compared to MIS (p=0.02), but this did not translate to an OS benefit.

**Conclusions:** We have demonstrated excellent outcomes in patients with early-stage cervical cancer after primary surgery and selective use of RT, with few recurrences and excellent survival. While there were few recurrences, they were more likely to occur in patients who had an MIS approach, and the PFS was significantly better in the open surgery group. Additionally, there is greater than 90% loco-regional control with the use of RT (+/- chemotherapy) even among patients with adverse pathologic features.

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## OUTCOMES OF 30GY IN 4 FRACTIONS FOR SPINE STEREOTACTIC BODY RADIOTHERAPY

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**Purpose:** At our institution, 30Gy in 4 fractions is delivered for larger volume or retreatment spine SBRT. This study aimed to analyze the local recurrence (LR) and vertebral compression fracture (VCF) for patients treated with 30Gy/4Fx of spine SBRT.

**Materials and Methods:** Retrospective analysis of patients with spine metastasis treated with 30Gy/4Fx from 2010 to 2021 from an institutional registry. The primary outcome was LR and VCF, and secondary outcome included overall survival (OS) and predictors for LR, VCF, and OS.

**Results:** Were included 116 patients and 245 segments. Kidney (25%), lung (20%), breast (19%), and prostate (19%) were the most common primary cancers. 54% of segments had previously been treated with radiation, while 25% had any fracture at baseline. 53% and 46% of segments had paraspinal and epidural disease, respectively. Median number of treated segments was 3 (1-7). The cumulative incidence of LR rate at 12 and 24 months was 10.7% (7.1-15.2) and 16% (11.5-21.2), and VCF was 7.3% (4.4-11.2) and 11.2% (7.5-15.8), respectively. No predictors of LR were identified, while age (p=0.017), volume of CTV (p=0.017), and previous surgical procedure at the segment (p=0.032) were predictors of VCF on UVA. The VCF rate at 24 months was 1.8% for patients with CTV volume <72 versus 14.6% for ≥72cc (p=0.03, HR 0.11, 95% CI 0.015-0.835). Median OS was 20.3 months (95% CI 14.8-27.1). Predictors of OS on UVA included epidural (p<0.001) and paraspinal disease (p=0.002), primary cancer (p=0.031), oligometastatic disease (p=0.039), neurological symptoms at treatment (p=0.010), and ECOG (p=0.040).

**Conclusions:** 30Gy/4Fx is a novel fractionation for spine SBRT. We report safety and efficacy in particular for those target volumes with a CTV<72 cc. Although our rate of VCF in very large treatment volumes (≥72cc) is comparable to the SBRT-induced VCF literature, optimal management remains an active area of investigation.

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## A BRITISH COLUMBIA BASED POPULATION STUDY ON THE TREATMENT AND LONG-TERM OUTCOMES OF THYMOMA: A 25-YEAR RETROSPECTIVE REVIEW

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**Purpose:** Thymomas are rare neoplasms arising from the thymic epithelium. There are a limited number of prospective studies in this setting to guide management. The purpose of this study was to conduct a population-based analysis of patient and tumour factors associated with overall survival (OS) and progression-free survival (PFS) in patients with thymoma.

**Materials and Methods:** All thymoma patients diagnosed and treated between January 1994 and December 2019 in British Columbia were identified and selected for a retrospective review. Baseline demographic, tumour, surgery, radiotherapy, chemotherapy, survival, and recurrence data were collected using the BC Cancer Agency Registry. Overall survival (OS) and progression-free survival (PFS) were analyzed using the Kaplan-Meier method. Cox regression analysis was used to identify risk factors for survival.

**Results:** A total of 245 patients were identified for analysis. The median follow-up was 77 months. A total of 214 patients underwent definitive surgery. Of these, 103 (48%) underwent surgery alone, 84 (34.2%) received adjuvant radiotherapy, three (1.4%) received adjuvant chemotherapy, and six (2.8%) received adjuvant concurrent chemoradiation. Ten (4.1%) patients underwent neoadjuvant chemotherapy followed by definitive surgery and 8 (3.7%) patients underwent neoadjuvant chemoradiation followed by definitive surgery. A total of 31 patients did not receive definitive surgery. Of these, nine (29%) received concurrent chemoradiation, five (16.1%) received palliative chemotherapy, seven (22.6%) received palliative radiotherapy, and 10 (32.3%) had supportive management. At presentation, 36 (14.7%) patients presented at Masaoka-Koga Stage I, 135 (55.1%) at Stage II, 37 (15.1%) at Stage III, and 20 (8.2%) at Stage IV. Among the patients who received definitive radiotherapy, a median dose of 50 Gy was given. A median dose of 30 Gy was given for palliative radiotherapy. 91 (81%) patients had 3DCRT, 18 (15%) had VMAT and 5 (4%) patients were treated with IMRT.

Preliminary analysis shows a 10-year OS and PFS rate of 74% and 70% respectively. The 10-year OS for Stages I, II, III, and IV were 89%, 82%, 67%, and 44% respectively. The 10-year PFS for Stages I, II, III, and IV were 89%, 78%, 64%, and 33% respectively. On multivariate analysis, worse OS was significantly associated with greater age at diagnosis (Hazard Ratio [HR], 1.03; 95% Confidence Interval [CI], 1.00-1.05; P=0.009), Masaoka Stage IV versus Stage I (HR, 3.51; CI, 1.07-11.50, P=0.038), and no definitive surgery versus definitive surgical management (HR, 3.47; CI, 1.10-10.98, P=0.034). Both age at diagnosis (HR, 1.04; CI 1.01-1.07, P=0.001) and Stage IV versus Stage I (HR, 11.20; CI, 3.45-36.38; P<0.001) were associated with worse PFS.

**Conclusions:** Thymoma is a clinically heterogenous disease with a wide variation in treatment practices. Survival rates in our population are comparable to previous published reports. Masaoka-Koga stage, age at diagnosis, and surgical management are important prognostic factors for overall survival.

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## PLANNING FOR THE IMPACT OF SC.24 ON SPINE STEREOTACTIC BODY RADIOTHERAPY (SBRT) UTILIZATION AT A TERTIARY CANCER CENTRE

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**Purpose:** CCTG SC.24 was a recently reported randomized Phase 2/3 trial that demonstrated superior complete response rates for pain following spine stereotactic body radiotherapy (SBRT; 24 Gy in 2 daily fractions) compared to conventional radiotherapy (CRT; 20 Gy in 5 fractions). These findings support a practice-changing

paradigm shift whereby a subset of eligible patients with painful spine metastases may be offered upfront spine SBRT over CRT. At many institutions, this would mark an increase in spine SBRT cases. Therefore, we sought to assess the potential real-world impact of this study on spine SBRT utilization by estimating the proportion of patients treated with CRT who would have been eligible for spine SBRT per SC.24 inclusion criteria.

**Materials and Methods:** All patients who received palliative spine radiation at the London Regional Cancer Program between August to October 2020 were reviewed retrospectively. Data extracted included eligibility criteria of the SC.24 study, provider-reported pain response, and overall survival. Descriptive statistics and survival analyses were performed.

**Results:** Of the 73 patients reviewed, 24 (33%) patients met eligibility criteria for SC.24. The most common exclusion factors included irradiation of more than 3 consecutive spinal segments (n=32, 44%), ECOG greater than 2 (n=17, 23%), symptomatic spinal cord compression (n=13, 18%), and frank mechanical instability (n=12, 16%) as measured using the Spinal Instability in Neoplasia Score (SINS). SINS was indeterminable in seven cases (10%) of epidural-only disease, which also renders a patient ineligible; otherwise, the median SINS was 9 (IQR: 7–10). Four (5%) patients had prior surgery and eight (11%) patients had prior overlapping radiation to the area, also rendering them ineligible. Of eligible patients, the mean age was 68.92 years (SD 13.84), median SINS was 8 (IQR: 7–9) and median ECOG was 2 (IQR: 1–2). The most common primary cancer types among eligible patients were lung (n=10) and breast (n=4). The median dose delivered to eligible patients was 20 Gy in 5 fractions (IQR: 8–20 Gy). Fifteen (63%) eligible patients had additional radiation to a site other than the spine at the same time. The median survival of eligible patients was 10 months (95% CI: four months–not reached) with 58% surviving longer than three months. 75% of patients had pain response documented and of these, 54% had at least some response after CRT.

**Conclusions:** Around one-third of patients who received palliative CRT to the spine met eligibility criteria for SC.24. This possible expanded indication for spine SBRT can have a substantial impact on resource utilization. In addition to increased MR simulation utilization, there can also be higher demand on contouring, planning and quality assurance resources. These data may be useful in guiding resource and workforce planning at institutions looking to commence or expand a spine SBRT program.

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## OPTIMIZING RESOURCES AND SKILLS IN A MULTIDISCIPLINARY WORKFLOW FOR PROSTATE MR-LINAC ADAPTIVE RADIOTHERAPY

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**Purpose:** Online adaptive MR-guided radiotherapy on the MR-Linac is resource intensive, requiring a team of radiation therapists (RTs), medical physicists (MPs), and radiation oncologists (ROs) for each fraction. A three-phase practice-based training strategy was developed to facilitate a RT-driven workflow for whole gland prostate MR-Linac radiotherapy to maximize treatment efficiency. We report the outcomes of Phase 1 delineation training and assessment.

**Materials and Methods:** A retrospective database consisting of treatment images from previously treated MR-Linac prostate patients was collated in the MR-Linac treatment planning system. Eleven patients were randomly selected from a cohort of 40 and triaged into 3 categories: A (prostate alone, distinct borders), B (target included seminal vesicles and/or median lobe), and C (poor image quality). Five participants (all MR-Linac RTs) attended a tutorial led by a RO with expertise in prostate delineation to review MR prostate anatomy, and discuss common contour-related pitfalls. To simulate the online adaptive workflow, RTs independently contoured the prostate, bladder, and rectum on images in the training database using the reference images and contours as a guide. Initial assessment through quantitative DICE comparison was performed by a MP, calculated against the RO-generated contours during the online session to provide a baseline for evaluation. A qualitative contour review was subsequently performed by a RO who ranked the contours on a 5-point Likert scale (range: 1 = very poor, 5 = excellent). A Likert score of 4 or higher for the assessed contours was required to pass the case. A pass rate of 90% was required before advancing to Phase 2. Review of images with RO was undertaken in the event of score of ≤ 3 followed by a further round of delineation assessment.

**Results:** The mean DICE scores for the prostate was 0.915 (range 0.833-0.969), the bladder 0.895 (range 0.643-0.99), and the rectum 0.989 (range 0.971-1). Mean Likert scores for the prostate was 3.62 (range 2.6-4), the bladder was 4.2 (range 3.6-4.8), and the rectum was 4.4 (range 3.4-5). While the bladder and rectum contours were acceptable, the main challenges identified qualitatively with prostate contours included under-delineation at the base in patients in category B (both median lobe and/or seminal vesicles), and variations in defining the apex in all categories. Four RTs did not attain a pass rate of 90% and attended follow-up one-on-one review. The participants subsequently performed additional contours on a further training set of cases and successfully advanced to Phase 2.

**Conclusions:** A training strategy has been developed for RTs to enable a RT-driven workflow for prostate adaptive radiotherapy using the MR-Linac. Phase 2 will involve supervised online contouring and adaptive plan assessment during live treatment fractions. The final phase will involve independent RT-driven contouring and planning supported by offline contour and plan review by a RO prior to the next fraction.

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## OUTCOMES OF LOCALLY ADVANCED, PT4 WELL-DIFFERENTIATED THYROID CANCER WITH OVERALL STAGE I DISEASE - A POPULATION-BASED STUDY

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**Purpose:** Non-metastatic, pT4 well-differentiated thyroid cancer (WDTC) diagnosed at age <55 years falls under Stage I by the American Joint Committee on Cancer (AJCC) 8th edition staging system. Thus these patients are expected to have excellent survival outcomes, despite locally advanced disease that may invade into critical neck structures such as aerodigestive organs. There are no published outcomes on this specific cohort of patients, and they may be underrepresented in published outcome series as they comprise of less than 5% of all WDTC patients.

**Materials and Methods:** We conducted a population-based retrospective study of all patients with pT4 WDTC diagnosed at age <55 years, treated in the [state/province] of [blinded] from 1985 to 2013 were extracted. Demographic and treatment factors were extracted. The primary endpoints were cumulative incidence of loco-regional recurrence (LRR), cause-specific survival (CSS) and overall survival (OS). Competing risk Fine-Grays analysis and Cox-proportional hazards model was used. Multivariate analyses

were conducted with variables chosen a priori based on variables reported to be significant in literature.

**Results:** There were 218 patients (median follow-up 18.2 years) with 137 under the age of 45. Most patients had papillary histology (96%), followed by follicular histology (4%). The cohort comprised of T4a 83% and T4b 17%, and N0/X 36%, N1a 39%, and N1b 25%. Patients were all treated with thyroidectomy. Adjuvant radioactive iodine was administered in 88% of cases, and 43% received adjuvant external-beam radiotherapy (EBRT). The 15-year LRR was 21%. On multivariate analysis, there was a trend towards EBRT receipt and lower LRR (HR:0.47, p=0.06). Of the patients who did not receive EBRT, but had a LRR (n=19), 11 were salvaged (with RAI, EBRT, and surgery) and only two died of WDTC (both from LRR). For the cohort as a whole, the 15-year CSS was 96%. There were four deaths secondary to LRR and seven deaths from distant disease. Advanced age, larger tumour size, higher T stage, and presence of LVI were associated with worse CSS (all p<0.05). The 15-year OS was 93%. Older age, tumour size, and lymphovascular invasion were significantly associated with worse OS (all p<0.05). On multivariate analysis, EBRT receipt was not associated with improved CSS or OS.

**Conclusions:** Despite very locally advanced disease, patients with non-metastatic pT4 WDTC, <55 years at diagnosis, have favourable long-term outcomes. Further prospective studies of adjuvant EBRT are needed in this population.

**82 Withdrawn**

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## DOSE-ESCALATED TWO-FRACTION SPINE STEREOTACTIC BODY RADIOTHERAPY: 28 GY VERSUS 24 GY IN 2 DAILY FRACTIONS

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**Purpose:** Stereotactic body radiotherapy (SBRT) for spine metastases improves pain response rates compared to conventional external beam radiotherapy, however, the optimal fractionation schedule is unclear. We evaluate local control and toxicity outcomes after dose-escalated two-fraction spine SBRT.

**Materials and Methods:** A prospectively maintained institutional database of over 600 patients and 1400 vertebral segments treated with spine SBRT using a consistent treatment technique was reviewed to identify those receiving 28 Gy and 24 Gy in two fractions. The primary endpoint was MRI-based local failure (LF), and secondary endpoints included overall survival (OS) and vertebral compression fracture (VCF).

**Results:** A total of 947 vertebral segments in 482 patients underwent two-fraction spine SBRT, of which 159 patients (301 segments, 31.8%) received 28 Gy and 323 patients (646 segments, 68.2%) received 24 Gy. Median follow-up was 23.5 months and median OS was 49.1 months. Radioresistant histologies and epidural disease grade were similar between cohorts, however, fewer patients receiving 28 Gy had paraspinal disease. The six-, 12-, and 24-month cumulative incidence of local failure was 3.5%, 5.4% and 11.1%, respectively, in the 28 Gy cohort compared to 6.0%, 12.5% and 17.6%, respectively, in the 24 Gy cohort (p=0.0075). On multivariable analysis, receiving 24Gy (HR: 1.572, 95%CI: 1.08-2.30, p=0.0196), and tumours with epidural (HR: 1.522, 95%CI: 1.10-2.10, p=0.0108) and paraspinal (HR: 1.517, 95%CI: 1.08-2.12, p=0.0151) extension independently predicted for increased risk of local failure. Risk of VCF was 5.5%, 7.6% and 10.7% at 6-, 12- and 24-months, respectively, and not different between the two dose-fractionation cohorts (p=0.573). Presence of spinal malalignment (p<0.001), baseline vertebral body collapse (p=0.0027), junctional spine segment (p=0.0296), and a greater PTV_D90 predicted for increased risk of VCF.

**Conclusions:** Dose escalated two-fraction spine SBRT to 28 Gy improves local control without increasing the risk of VCF. Consideration in dose selection should be given in tumours with epidural and/or paraspinal disease extension.

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## ADULT SURVIVORS OF CHILDHOOD CANCER: VIEWS ON COVID-19 AND VACCINATION

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**Purpose:** Adult childhood cancer survivors (ACCS) are at increased risk of developing late effects because of their childhood cancer treatment, including cognitive delay, diabetes, metabolic syndrome, and organ damage. Consequently, many ACCS may be at increased risk for worse outcomes with COVID-19 infection. It is important to determine ACCS views on the COVID-19 pandemic and vaccination.

**Materials and Methods:** A non-validated survey was created using multi-disciplinary input. Prior to the widespread rollout of COVID-19 vaccinations in Canada, we emailed an online survey to 235 ACCS followed through the BC Cancer Late Effects and Follow-Up clinic who had provided informed consent to email contact, receiving 89 responses (37.9% RR) which were analyzed.

**Results:** Survey respondents were majority female (61%). The most common age range was 30-39 (30%) followed by 20-29 (28%). Most were of European descent (47%) and lived in an urban centre (75%). The vast majority completed high school (97%), as well as post-secondary education (PSE, 73%). Only 29% did not use Complimentary or Alternative medicines (CAM), with herbal products being most common (48%), as well as massage therapy or other bodywork (46%). The most reported sources of health information were primary care practitioners (PCP, 80%), traditional media (60%), and specialized hospital clinics (46%).

Of all respondents, 67% believed that ACCS should be prioritized for vaccination, with 87% indicating they would receive a COVID-19 vaccination if available. 78% and 89% believed that COVID-19 was a serious health problem for themselves or others, respectively. Views were evaluated across multiple subgroups. All reported p-values were calculated using the Chi-Squared test of association. Respondents who had completed PSE were more likely to see COVID-19 as a risk to themselves (80% versus 71%, p=0.358), to others (94% versus 75%, p=0.012), and more likely to receive a vaccine (89% versus 79%, p=0.217). Respondents who received health information from traditional media felt COVID-19 was more likely to harm themselves (79% versus 75%, p=0.638), to harm others (93% versus 83%, p=0.181), and more likely to receive a vaccine (93% versus 78%, p=0.047). A similar trend was seen in those who receive information from a PCP, but without statistical significance. The opposite is true if health information is received from family or friends, with these respondents being less likely to feel COVID-19 poses a risk of harm to themselves (76% versus 78%, p=0.79), less likely to harm others (86% versus 90%, p=0.595), and a lower likelihood to get a vaccine (76% versus 92%, p=0.041). There was no discernable trend when examining by further subgroups, including CAM usage, age group, location, or other sources of health information.

**Conclusions:** Many ACCS appear to underestimate their risk from COVID-19; whether patients had completed PSE and the location from which they receive health information appeared to correlate most strongly with these results.

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**TEN-YEAR TRENDS IN CANADIAN FEMALE MEDICAL STUDENT INTEREST IN RADIATION ONCOLOGY**

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**Purpose:** Canadian medical student interest in Radiation Oncology (RO) residency training has varied over the last decade. Concerns related to job availability post-training, employment location flexibility, and extended training with fellowship experiences have affected medical student perceptions of RO and potentially deterred applicants in the past. With recent job market improvements, there has been increased medical student interest in the specialty. Despite this, the number of women entering RO residency remains disproportionately low. This study examines 10 years of resident match data to assess trends in gender-specific interest and match characteristics in RO.

**Materials and Methods:** Publicly available Canadian Residency Matching Service (CaRMS) data from 2012 to 2021 were compiled. Gender-based analysis focused on Canadian medical graduates (CMGs) ranking RO as their first-choice discipline in the first iteration of the match. No applicant gender data were available for the 1 to 8 first-year residency positions in the second iteration that occurred in 7 out of 10 matches over the study period. Pearson's chi-square test was used to evaluate whether the number of female applicants differed significantly from what could be expected if RO applicant gender breakdown reflected Canadian CaRMS participant demographics. Statistical analysis was performed using IBM SPSS version 25.

**Results:** The number of applicants ranking RO as their first-choice discipline has increased in recent years with 23-28 applicants ranking RO as their preferred discipline in 2018-2021 and exceeding available positions, compared to 9-18 RO-preferring applicants in 2012-2017. Total applicants ranged from 24 to 51per year over the study period. The number of female RO-preferring applicants has remained largely unchanged, with a 10-year average of 7 women per year, ranging from a nadir of 2/15 (13%) in 2016 to a peak of 12/27 (44%) RO-preferring applicants in 2018. Overall, 190 CMG applicants ranked RO as their first choice over the last 10 years, comprised of 73 females (38%) and 117 males (62%). Over the same period, 56% (17696/31618) of CMG applicants who participated in the CaRMS match were female. Comparative analysis using Pearson's chi-square test found female medical student application rates to RO versus all specialties combined differed significantly ($p < 0.01$).

**Conclusions:** Despite more applicants to RO recently, the number of RO-preferring female medical students has remained disproportionately low. These findings highlight the need for timely exposure of the specialty to female medical students and fostered mentorship to improve female representation in RO. A better understanding of factors influencing female medical students' career selection and CaRMS ranking decisions is required to develop improvement strategies.

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**RADIATION DOSE ENHANCEMENT USING GOLD NANOPARTICLES WITH A DIAMOND LINEAR ACCELERATOR TARGET: A MULTIPLE CELL TYPE ANALYSIS**

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**Purpose:** Radiotherapy (RT) is an effective cancer treatment modality, but standard RT often causes collateral damage to nearby healthy tissues due to limitations on confining a sufficient radiation dose to the tumour. To increase the therapeutic ratio, radiosensitization via gold nanoparticles (GNPs) has been shown to be effective via the photoelectric effect. One challenge is that megavoltage beams generated by clinical linear accelerators are poor initiators of the photoelectric effect due to the small proportion of low energy photons produced. Previous computer models predicted that a diamond target beam (DTB) will yield 400% more low-energy photons, increasing the probability of interacting with GNPs to enhance the radiation dose by 7.7-fold in the GNP vicinity. The purpose of this research is to characterize the effects of GNP-enhanced DTB radiation *in vitro* and *in vivo*.

**Materials and Methods:** Irradiation was performed with the 2.5 MV DTB and 6 MV standard target beam (STB), for comparison, housed in a TrueBeam linac. 15 nm gold nanoparticles were used and imaged in various cell lines using transmission electron microscopy. The alamarBlue and colony formation assays were used to measure *in vitro* cell viability and surviving cell fractions. Zebrafish xenotransplantation and proliferation assays were used to assess *in vivo* responses. Flow cytometry was used to detect reactive oxygen species, and immunohistochemistry was used to detect DNA double strand breaks following RT.

**Results:** We demonstrate decreased cell viability *in vitro* and enhanced cell-killing in zebrafish xenografts with the GNP-DTB RT compared to standard RT. Cell lines displayed increased double-stranded DNA breaks with DTB irradiation in the presence of GNPs.

**Conclusions:** This study presents preclinical responses to GNP-enhanced RT with the novel DTB. We provide the first data to support the theoretical evidence for radiosensitization via GNPs and highlight the potential of this approach to optimize the efficacy of RT in anatomically difficult-to-treat tumours.

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**PATIENT REPORTED OUTCOMES DURING HEAD AND NECK CANCER RADIOTHERAPY USING THE MD ANDERSON SYMPTOM INVENTORY- HEAD AND NECK MODULE (MDASI-HN)**

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**Purpose:** To evaluate and correlate patient reported outcomes (PROs) using the MD Anderson Symptom Inventory score for head and neck (MDASI-HN) cancers in English or Chinese, to assess symptom severity, and clinical support needs during radiation for head and neck cancer.

**Materials and Methods:** From 2018 to 2021, patients were prospectively enrolled in BC's Prospective Outcomes and Support Initiative (POSI) if they were receiving a radical course of radiotherapy or chemoradiotherapy for head and neck cancer. Patient demographics and clinical variables were prospectively recorded. PROs were collected electronically at baseline, weekly during treatment, and at 4-6 weeks post treatment, using MDASI-HN in English or Chinese. PRO questions were grouped into

general cancer (Core), H&N-specific, and Interference domains. For each group, the average score per patient was calculated over the course of treatment. Clinical endpoints including feeding tube insertion, IV hydration and radiation support visits were evaluated retrospectively.

**Results:** 132 patients were enrolled into POSI, with 126 (95% completion) questionnaires completed at baseline (112 in English and 14 in Chinese), 792 during treatment, and 65 (49% completion) at 4-6 week follow-up. The median age at diagnosis was 63 years (Interquartile Range 57-72 years) and 71% of patients were male. Primary tumour sites were: 57 oropharynx, 22 oral cavity, 22 hypopharynx & larynx, 18 nasopharynx & nasal cavity, and 13 salivary & thyroid. The questions with the highest average symptom score over the course of treatment were altered taste (5.04/10; 95% 4.63-5.45), dry mouth (4.50/10; 95% 4.06-4.92) and fatigue (4.35/10; 95% 4.01-4.69). There were no statistically significant differences in the average symptom severity for each domain when comparing patients treated with radiotherapy alone versus chemoradiotherapy (all p>0.05). Hypopharynx and larynx primaries were associated with lower Core (2.20 versus 3.35; p=0.014), H&N (2.58 versus 4.11; p=0.004) and Interference (2.39 versus 3.86; p=0.012) symptom subscales scores relative to oral cavity primaries. Salivary gland and thyroid primaries were associated with lower average H&N (2.37 versus 4.11; p=0.004) and Interference (2.43 versus 3.86; p=0.034) symptom scores. Nasopharynx/nasal cavity, and oropharynx had similar symptom scores to oral cavity (all p>0.05). Patients' average symptom subscale scores for the Core, H&N and Interference domains were higher for those needing IV hydration, requiring a feeding tube, and requiring RT support visits (all p<0.05).

**Conclusions:** In this prospective study, PRO collection was feasible and correlated with clinically meaningful endpoints. We recommend other Canadian provinces adopt the MDASI-HN PRO questionnaire to guide both routine clinical care and research, as endorsed by the Canadian Partnership for Quality Radiotherapy. In collaboration with BC's POSI this will enable large scale comparative effectiveness research.

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## OUTCOMES OF RADIOTHERAPY ALONE FOR LOCALLY ADVANCED NON-SMALL CELL LUNG CANCER (LA-NSCLC) IN PATIENTS UNFIT FOR CHEMO-RADIOTHERAPY

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**Purpose:** Over the past 30 years, treatment of unresected LA-NSCLC (AJCC Stage III) evolved from treatment with chest radiotherapy (RT) alone to the current standard of care (SOC) of concurrent chemo-radiation (cCRT) followed by consolidative immunotherapy. However, in patients with LA-NSCLC who are unfit for or refuse SOC therapy, RT continues to be utilized as sole treatment for the purpose of local control. Chest RT doses higher than those used in palliative regimens (≥40Gy) are often employed in these cases. However, survival outcomes of these treatments are not well described.

**Materials and Methods:** We retrospectively identified unresected LA-NSCLC (AJCC Stage III) patients who were treated at a single institution over a 10-year period (Jan. 2009 to Dec. 2019) with chest RT of ≥40 Gy. Patient cases were reviewed individually for disease characteristics, staging investigations, RT treatment parameters and survival outcomes. Analysis focused on RT alone treated patients. Patients were separated in two dose categories of 40-54Gy and >54Gy. Patients treated with cCRT of >54 Gy were analyzed to serve as a comparator of outcomes of SOC treatment.

**Results:** A total of 393 patients diagnosed with Stage III unresected NSCLC were identified. Of those, 86 were treated with RT alone, 151 with cCRT and 156 with sequential CRT. In the RT only group, the mean age of patients was 76 years (range 48-92) and slightly more than half (52%) of patients were male. Median, one-, two- and five-year overall survival in this cohort were 18.5 months, 64.6%, 42.6% and 12.6%, for the 40-54 Gy group (n=36) versus 18.5 months, 63.8%, 39.9% and 13% for the >54 Gy group (n=50), respectively. In comparison, the survival outcomes in the 151 patients that received >54 Gy cCRT were 36 months, 83.7%, 64.0% and 36.1%, respectively. Of note 82% of patients in radiation alone group and 94% of patients in cCRT had PET staging.

**Conclusions:** Our review suggests that in well-staged patients with LA-NSCLC, chest RT of ≥40Gy is associated with survival outcomes that compare favorably with historical results of definitive RT alone treatment. In this small cohort of RT alone treated patients we did not observe improved outcomes with use of higher definitive RT doses (>54 Gy). Outcomes of RT alone in LA-NSCLC should be further investigated in larger provincial and national datasets and in prospective clinical trials.

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## THE RADIATION INCIDENT SAFETY COMMITTEE INCIDENT REPORTING GUIDANCE TREE: A TOOL TO AID PROVINCIAL AND NATIONAL INCIDENT SHARING

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**Purpose:** In fiscal year 2018, Ontario transitioned its radiation treatment incident reporting to the National System for Incident Reporting – Radiation Therapy (NSIR-RT). The NSIR-RT database provides a platform for incident reporting and learning. Ontario Health, Cancer Care Ontario (OH-CCO) requires radiation treatment programs to report actual incidents, defined as events that have "reached the patient". The submission of near misses, although encouraged, are done so as per a program's available resources. Radiation Incident Leads (RILs) from each centre triage incident reports for submission to NSIR-RT. OH-CCO's Radiation Incident Safety Committee (RISC) recognized this triaging of submitted events as an opportunity to create guiding principles to improve the consistency of the types of events reported nationally. The impetus for this initiative was to develop a guidance tree for RILs to classify events that reach the patient and subsequently identify those with significant interest and/or with learning potential at a national level that should be submitted to NSIR-RT.

**Materials and Methods:** RISC members were surveyed to obtain feedback regarding current incident classification practices. Members were asked to classify cases as actual, near miss or neither. Integrating survey results, a guidance tree was created in lieu of simply amending the definition of "reached the patient". Introduced in June 2019, RISC was solicited for final feedback. The tool was then trialed and using an iterative process, finalized in June 2020.

**Results:** The RISC guidance tree not only provides clarity as to when an incident "reaches the patient" and by extension identifies an actual versus a near miss event, but also guides centres in determining those incidents with the greatest potential for incident learning. The tool also promotes reporting consistency between

centres and may support the maintenance of and or increased event reporting volumes. Finally the guidance tree highlights those incidents that may provide valuable insights that can be leveraged for learning for other NSIR-RT users at provincial and pan-Canadian levels. Further opportunities exist to refine the tool for incidents that prove challenging to classify and RILs are encouraged to share these events for discussion at RISC's regular quarterly meetings providing a mechanism for further refinement of the guidance tree.

**Conclusions:** The guidance tree can support RILs in the triage event submission to NSIR-RT. An often complex and time consuming exercise, with limited program resources. Featured in the spring 2020 NSIR-RT bulletin, the tool can be leveraged by other jurisdictions to harmonize reporting. As RISC reviews its initiatives, using the lens of continuous quality improvement, a 2021 survey identified continued support and described a positive impact with respect to their program's incident reporting and learning. RISC plans to review and refine the tool as part of the committee's upcoming initiatives.

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## AN INTERPRETABLE QUANTUM NEURAL NETWORK TO DIFFERENTIATE BETWEEN LARGE BRAIN METASTASES AND HIGH-GRADE GLIOMA USING QUANTUM-INFORMED MRI RADIOMIC FEATURE SELECTION

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**Purpose:** Solitary large brain metastases (LBM) and high-grade gliomas (HGG) are sometimes hard to differentiate on MRI. We explore herein the performance and interpretability of an MRI-radiomics Variational Quantum Neural Network (QNN) using a quantum annealing Mutual Information (MI) feature selection approach.

**Materials and Methods:** We retrospectively included patients with pathologically-proven diagnosis of LBM (diameter>2cm) and HGG who had a contrast-enhanced T1-weighted (CE-T1) MRI between 2012 and 2019. Tumours were manually segmented, and a 5mm peri-tumoural ring was created. MRI images were pre-processed, and 1813 radiomic features were extracted. The dataset was split into training (70%) and test (30%) sets.

Highly correlated features were eliminated, then a set (S) of best features based on MI was kept. MI and conditional-MI were embedded into a quadratic unconstrained binary optimization (QUBO) formulation that was mapped to an Ising model and submitted to D'Wave's quantum annealer to solve for the best combination of 10 features.

The 10 selected features were embedded into a 2-qubits QNN using PennyLane library. Circuit parameters were classically optimized, and the resulting model was evaluated for balanced accuracy (ACC) and area-under-the-receiver-operating-characteristic-curve (AUC) on the test set. The model performance was benchmarked against two classical models: Dense Neural Networks (DNN) and Extreme Gradient Boosting (XGB). Shapley values were calculated to interpret sample-wise predictions on the test set.

**Results:** Seventy-two HGG and 129 LBM were included. Median largest diameters for LBM and HGG were 3.4cm (IQR: 2.6-4.3 cm) and 4.8cm (IQR: 3.8-6.1 cm) respectively. Seventeen features were selected for the (S)-set. The best 10-features combination included 6 tumour and 4 ring features. For QNN, DNN, and XGB respectively: training AUC was: 0.86, 1, and 0.94; test AUC was: 0.76, 0.71, and 0.79; and test ACC was: 0.74, 0.61, and 0.71. The two most influential features were tumour Laplacian-of-Gaussian-GLRLM-Entropy and Sphericity.

**Conclusions:** We developed an accurate interpretable QNN model with quantum-informed feature selection to differentiate between LBM and HGG on CE-T1 brain MRI. The model performance is comparable to state-of-the-art classical models, with seemingly less overfitting.

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## PREDICTABILITY OF POST-NEOADJUVANT CHEMOTHERAPY MRI FOR PATHOLOGICAL COMPLETE RESPONSE IN TRIPLE NEGATIVE AND HER2 POSITIVE BREAST CANCERS

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**Purpose:** The use of neoadjuvant chemotherapy (NAC) has become the standard of care for triple negative (TN) and human epidermal growth factor-2 (HER2) positive breast cancer. The patients that achieve a pathological complete response (pCR) are known to have better outcomes. The use of magnetic resonance imaging (MRI) after NAC is a useful non-invasive test to predict post-surgical pathological complete response (pCR). The objective of this study is to investigate the predictability of post-NAC MRI to determine pCR.

**Materials and Methods:** All patients between 2010 and 2018 at the MUHC, receiving NAC with biopsy-proven HER2 positive or triple-negative breast cancer were included in the study. The imaging report from post-NAC MRIs and the pathological outcomes in the breast after surgery were retrieved from electronic medical records. The radiological and pathological complete response rates after NAC were calculated using proportions. Finally, the sensitivity and specificity of MRIs to predict pathological complete response were analyzed.

**Results:** A total of 63 HER2 positive and 36 TN patients were found to have post-NAC MRIs. A complete radiological response was seen in 52.8% of TN and 44.4% of HER2 breast cancer patients. The pathological complete response rates TN and HER2 breast cancer patients was 58.3% and 49.2%, respectively. In the TN group, the sensitivity of post NAC MRI to predict pCR was 85.7% and the specificity was 93.3%. In the HER2 group, the sensitivity of post NAC MRI to predict pCR was 77.4% and the specificity was 87.5%. The overall sensitivity and specificity across both groups was 80.8% and 89.4%, respectively.

**Conclusions:** Neoadjuvant chemotherapy provides a good complete pathological response rate in TN and HER2 positive breast cancer patients. The use of MRI post-NAC has an overall sensitivity of 80.8% and specificity of 89.4% to predict pCR. The accuracy of MRI pCR prediction in our institution is useful for the design of new clinical trials and to assess further clinical and pathological variables that can contribute to radiological discrepancies.

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## [177LU]LU-DOTA-TATE AS FIRST-LINE THERAPY FOR PATIENTS WITH GRADE 2 AND 3 ADVANCED GASTROENTEROPANCREATIC NEUROENDOCRINE TUMOURS (GEP-NETS): THE NETTER-2 STUDY

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**Purpose:** The NETTER-1 study demonstrated that [177Lu]Lu-DOTA-TATE, a radioligand therapy selectively targeting somatostatin receptors (SSTRs), plus 30 mg octreotide long-acting release (LAR), provided significantly increased progression-free survival (PFS) compared with 60 mg octreotide LAR in patients with GEP-NET previously progressing on octreotide (HR, 0.21 [95% CI, 0.13-0.33]). However, the NETTER-1 population predominantly consisted of patients with Grade 1 (G1) NET; G3 patients were excluded. Five-year survival declines by ~44% for patients with G3 NET versus G1, with limited data and few therapy options available. The ongoing NETTER-2 study is evaluating [177Lu]Lu-DOTA-TATE plus 30 mg octreotide LAR as a potential first-line radioligand therapy option in patients with advanced GEP-NET (G2 and G3) who have a high-risk profile and significant unmet medical need.

**Materials and Methods:** This multicentre, randomized, open-label, Phase III study (NCT03972488) is enrolling adult and adolescent patients (aged =15 years and body weight >40 kg) with SSTR-positive, high proliferative rate (G2 with Ki67 index =10% or G3 with Ki67 =55%), advanced GEP-NET diagnosed within six months before screening. Patients are randomized 2:1 to receive [177Lu]Lu-DOTA-TATE (7.4 GBq/200 mCi every 8 weeks [Q8W] x 4 cycles; cumulative dose: 29.6 GBq/800 mCi) plus octreotide LAR (30 mg Q8W with [177Lu]Lu-DOTA-TATE then Q4W after last [177Lu]Lu-DOTA-TATE treatment) or 60 mg octreotide LAR (Q4W). Both somatostatin analogue (SSA)-naïve and patients previously treated with SSAs without progression are eligible. Patients are excluded if other first-line therapies are considered more appropriate per investigator. Stratification factors are tumour grade and origin (pancreatic versus other NET). The primary endpoint is PFS (centrally assessed according to RECIST v1.1). Secondary endpoints include objective response rate, quality of life, overall survival, disease control rate, and safety. Cross-over is allowed for patients in the control arm who have centrally confirmed progression.

**Results:** Study is in progress.

**Conclusions:** Study is in progress.

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## AN EXPLORATION OF RADIATION-INDUCED SIDE EFFECTS FOR PALLIATIVE PATIENTS TREATED WITH VOLUMETRIC MODULATED ARC THERAPY VERSUS CONVENTIONAL RADIOTHERAPY TO THE SPINE

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**Purpose:** Given the increased frequency of volumetric modulated arc therapy (VMAT) in palliative radiotherapy planning, this study compares differences in patient-reported side effects for palliative patients treated with radiotherapy to the spine using VMAT versus conventional radiation therapy (CRT) techniques.

**Materials and Methods:** A single-centre retrospective study examined patient-reported Edmonton Symptom Assessment Scores (ESAS) for palliative patients with spinal metastases treated from April 18, 2016 to October 18, 2021. Scores were stratified by technique and site. Average ESAS scores were calculated for pain, tiredness, drowsiness, nausea, appetite, shortness of breath, depression, anxiety, and well-being. T-tests were used to detect differences ($p<0.05$) between ESAS baseline and treatment scores. Patients undergoing retreatment or treatment to multiple sites were excluded. The planning target volume (PTV) length of each treated site was measured and Pearson's r correlational coefficients were calculated to identify correlations between PTV length and patient-reported symptoms.

**Results:** For CRT patients treated to the lumbar/lumbosacral (L/LS) spine, significantly lower anxiety scores ($p=0.0498$) were noted on treatment (n=9) when compared with baseline (n=24). VMAT patients treated to the thoracic/thoracolumbar (T/TL) spine (n=43) reported significant decreased appetite compared with CRT patients (n=24; $p=0.0357$). CRT patients treated to the T/TL spine were significantly more tired and drowsy during treatment (n=32) when compared with CRT baseline scores (n=53; $p_{Tiredness}=0.0175$; $p_{Drowsiness}= 0.0102$), which was not observed in the VMAT arm. CRT patients also experienced more drowsiness and tiredness on treatment compared with VMAT patients ($p_{Drowsiness}=0.2003$; $p_{Tiredness}=0.0852$). The remaining scores demonstrate no significant differences between cohorts. A moderate positive correlation ($r=0.5741$) between PTV length and nausea scores was detected in CRT patients treated to the L/LS spine, which was not observed in the VMAT arm.

**Conclusions:** Patients treated with VMAT do not report a clinically significant increase in side effects compared with CRT. VMAT may help reduce nausea on treatment for longer PTV lengths, and may reduce drowsiness/tiredness during treatment. Although differences in patient-reported symptoms exist when comparing CRT versus VMAT for palliative spine radiotherapy, both are well-tolerated with average ESAS scores in the mild-to-moderate range, supporting continued use of VMAT for palliative spine treatments.

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## A PROSPECTIVE SINGLE CANADIAN STUDY FOR TARGETED INTRAOPERATIVE RADIOTHERAPY (TARGIT) DURING BREAST-CONSERVING SURGERY FOR PATIENTS WITH EARLY-STAGE BREAST CANCER

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**Purpose:** The objective of this Phase II prospective single arm trial is to assess the impact of targeted intraoperative radiation therapy (TARGIT) on loco-regional recurrence (LRR), post-operative complications, and radiation therapy side effects in patients with early-stage breast cancer treated with breast conserving surgery (BCT).

**Materials and Methods:** A total of 61 patients were enrolled in the study, from which 40 (65.6%) were assigned to arm 1 and 21 (34.4%) received further EBRT. The median follow-up was 3.9 years. The LRR in both groups was 0%. In arm 1, one patient had contralateral breast cancer 13 months after enrolment. In the group receiving further EBRT, one patient had metastatic disease from a second primary 1 month after enrolment. No radiation therapy toxicities Grades 3 or 4 were observed in either group. The most common post-operative complication was seroma and cellulitis, with no significant difference observed among the groups.

**Results:** A total of 61 patients were enrolled in the study, from which 40 (65.6%) were assigned to arm 1 and 21 (34.4%) received further EBRT. The median follow-up was 3.9 years. The LRR in both groups was 0%. In arm 1, one patient had contralateral

breast cancer 13 months after enrolment. In the group receiving further EBRT, one patient had metastatic disease from a second primary 1 month after enrolment. No radiation therapy toxicities Grades 3 or 4 were observed in either group. The most common post-operative complication were seroma and cellulitis, with no significant difference among groups.

**Conclusions:** The use of TARGIT for patients undergoing BCT at a median follow-up of 3.9 years, shows no significant difference in LRR, incidence of radiation therapy toxicities or post-operative complications. We conclude that TARGIT is a clinically safe treatment for carefully selected early-stage breast cancer patients with no pathological high-risk features. Further assessment of longer follow-up data, and cost-effectiveness analyses comparing both modalities are needed.

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**ADVANCED RADIATION ONCOLOGY LEARNING MODULES WITHIN THE INTERACTIVE SMARTPHONE APPLICATION: "THE RAD ONC HANDBOOK"**

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**Purpose:** Radiation oncology (RO) textbooks and primary sources are often complex, technically advanced, and rarely accessible to medical students. To address this, we designed a free, interactive smartphone application, developed to introduce trainees to the basics of RO. Initial survey feedback was overwhelmingly positive, however, senior medical student trainees with an interest in RO signaled a lack of detailed content relevant to common tumour sites encountered during elective rotations.

**Materials and Methods:** An advanced learning module focused on breast cancer was implemented and evaluated within our Apple iOS smartphone application, "The Rad Onc Handbook", beta version available for free download via the TestFlight app (https://testflight.apple.com/join/4A6qXjq2). The module, written by a senior medical student and a PGY-2 resident, and reviewed by an attending staff physician, was targeted for senior medical students with an interest in RO. In addition to key RO concepts, this module also covers epidemiology, genetics, screening, anatomy, pathology, workup, and management details of this complex oncologic disease. A questionnaire was implemented to elicit feedback on this learning module, which included five quantitative 5-point Likert-scale questions pertaining to: module design, relevance, complexity, perception of knowledge acquisition, and likelihood of recommendation to other trainees, and one qualitative freeform text question seeking suggestions for improvement of the module.

**Results:** 25 participants completed the survey. Of these, 16 were senior medical students, the target demographic of this educational evaluation. Nearly 70% of all survey participants "agree" or "strongly agree" to all questionnaire items, indicating that the module was very well received. Four participants "disagree" or "strongly disagree" regarding the appropriateness of the module complexity, among these were junior medical students (3) and one internal medicine resident. Furthermore, trainees expressed the desire for other advanced learning modules on common cancers such as lung and prostate.

**Conclusions:** In response to direct in-app feedback received by senior medical students interested in RO within the smartphone application "The Rad Onc Handbook", an advanced learning module focused on breast cancers was developed and evaluated. Initial feedback was very favourable and recommended use of this free RO learning resource among a wider group of trainees. In response to trainee feedback, future work will focus on the development of additional modules with interactive virtual patient cases in other tumour sites. As web-based learning continues to become increasingly popular, this application can be a useful educational resource for medical trainees.

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**A 20-YEAR REVIEW OF THE ONTARIO RADIATION THERAPY ACCESS TO CARE CRISIS: LESSONS APPLIED TO THE COVID-19 PANDEMIC**

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**Purpose:** Cancer systems across Canada are struggling with an acute access to care crisis resulting from the COVID-19 pandemic. Policies are being considered and applied across the country to address the backlog of patients needing access to cancer services, including radiation therapy (RT). The purpose of this research was to assess the impact of central (provincial health ministry and cancer agency) and regional (cancer centre) policies on access to RT in Ontario between 1997 and 2017 and consider their relevance to today's challenges.

**Materials and Methods:** The research design was a case study with multiple embedded units. The case was Cancer Care Ontario. The embedded units were four diverse regional cancer centres representing the 14 different Ontario cancer centres. Methods included a document review, longitudinal quantitative data collection, and 43 key informant interviews. The theoretical underpinning was an extension of Kingdon's Multiple Streams Framework, to examine the 'problem,' 'policy' solutions and 'politics' surrounding the crisis.

**Results:** The access to RT problem started as a wait time issue in the 1990s caused by inadequate RT facility capacity and a shortage of RT specialized staff and evolved into a shortfall in RT utilization. Thirty-seven policies were identified and categorized as: improving existing RT capacity (n=5), system planning (n=7), performance management (n=6), human resources (HR, n=12), and building new RT capacities (n=7). Ten of the HR policies implemented to address recruitment and retention had mixed success because of implementation and political context issues. Many of these same policies are now being applied across Canada to address access to cancer services during the COVID-19 pandemic.

**Conclusions:** A 20-year case study of the Ontario RT access crisis in the 1990s, and the post-crisis periods, offer many useful learnings that can be applied to current policy challenges in access to care due to the ongoing pandemic.

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**BARRIERS TO ACCESS PALLIATIVE RADIATION TREATMENT IN PROSTATE CANCER : A POPULATION BASED STUDY**

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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 life-prolonging therapies, 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 toaccess 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 received continuous androgen deprivation therapy and died of prostate cancer-specific death between 2013-2017. Baseline and treatment characteristics were analyzed for association with receipt of radiotherapy in a 2-year observation period prior to death.

**Results:** 3,788 patients died of prostate cancer between 2013-2017; 49.9% of patients who were included in the study received palliative radiotherapy in the two years preceding death despite 56.9% presenting with metastasis. There were statistically significant associations between age and stage at diagnosis, cancer centre registration, and the type of oncologist involved with receipt of radiation; however, there were no associations between receipt of radiotherapy and Local Health Integration Network (LHIN) region, distance to nearest cancer centre, home-care involvement, or number of hospitalizations. Also a majority of patients received radiotherapy in three to six months prior to death.

**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 ahigh 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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## SUSTAINABLE REMOTE WORK FOR RADIATION THERAPISTS: IMPLEMENTATION IN A LARGE URBAN RADIATION THERAPY CENTRE

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**Purpose:** The COVID 19 pandemic created an urgent need to reduce onsite staff at the hospital. Remote work was implemented for Radiation Therapists (RTs) to reduce COVID 19 transmission, conserve personal protective equipment and facilitate physical distancing for staff required onsite. We report our experiences with a rapid pivot to remote work for RTs during the pandemic and the plan for a sustainable remote work strategy.

**Materials and Methods:** On March 16, 2020, our multi-site healthcare network provided emergency guidelines for remote work. The guidelines included the ability to perform full job duties remotely, appropriate space and equipment, no impact on patient care, and operational feasibility.
RTs were asked to self-identify to their Supervisor if they met these requirements and wanted to work remotely. Commencing March 23, 2020, rotations were developed for on and offsite schedules balancing operational needs, skill mix, equity between team members, and cohorting to minimize COVID risk.

Those performing direct patient facing activities were not able to work from home. Activities that could be performed remotely included radiation therapy planning, process and protocol development, quality assurance checks, project or research activities, and telephone patient education.
Organizational implementation of technology solutions supported this rapid pivot to remote work. For example, remote access was required to clinical applications, email, and document management. Microsoft Teams was used for virtual communication and meetings.

**Results:** From March 2020 to Dec 2021, 133 (64%) RTs worked remotely for ≥1 day. 32% of RTs worked >100 shifts remotely, and 12% worked more than 200 shifts remotely. This resulted in 15,413 remote work shifts (25% of total shifts worked) for an average of 685 remote work shifts per month, peaking to a maximum of 1096 shifts during March 2021.

Generally, remote work was well received by RTs. Many RTs reported benefits, including eliminating lengthy commutes, improved flexibility, reduced distractions and a break from PPE. Initially, there were some IT challenges, such as slow connectivity and incompatible home equipment, that made remote work difficult. Some RTs reported a sense of social isolation. There was a perceived lack of fairness between those who could and could not work remotely. There were also some challenges communicating between onsite and offsite teams, shift coverage, and onsite support.

**Conclusions:** Overall, we demonstrated that RTs can successfully work remotely over a multi-year timeframe. Generally, this was a positive experience for RTs, who reported improved work-life balance and more flexibility with job duties. However, there were concerns about a lack of fairness for those in patient-facing roles. Despite these concerns, most RTs support continuing with remote work. Our department will continue with a long-term remote work strategy based on best practices for remote work and input from RTs.

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## INTENSITY-MODULATED RADIATION THERAPY WITH STEREOTACTIC BODY RADIATION THERAPY BOOST FOR UNFAVOURABLE PROSTATE CANCER: FVIE-YEAR OUTCOMES

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**Purpose:** Data suggests that intensity-modulated radiation therapy (IMRT) plus brachytherapy boost for unfavourable prostate cancer provides improved biochemical relapse-free survival over IMRT alone. Stereotactic body radiation therapy (SBRT) may be a less invasive alternative to brachytherapy boost. Early outcomes suggest low rates of high-grade toxicity with maintained patient reported quality of life. Here, we report the 5-year progression free survival (PFS) and disease specific survival (DSS) for patients treated with IMRT plus SBRT boost.

**Materials and Methods:** Between 2008 and 2019, 243 patients with prostate cancer were treated with robotic SBRT (19.5 Gy in three fractions) followed by fiducial-guided IMRT (45–50.4 Gy) on an institutional protocol. Patient's PSA was monitored every three months during the first year, and biannually for two years and annually thereafter. Biochemical failure was defined using the nadir+ 2 ng/mL definition. Detection of recurrence also included digital rectal examination, imaging studies such as MRI, CT, PET/CT, and/or bone scan. PFS and DSS were calculated using the Kaplan-Meier method.

**Results:** The median follow-up of all patients was 68 months. Per NCCN risk classification, 5% (12/243) of patients had favourable intermediate-risk disease, 23% (56/243) had unfavourable intermediate-risk disease, 40% (97/243) of patients had high-risk disease and 32% (78/243) had very high-risk disease. Androgen deprivation therapy was administered to 80% (195/243) of all patients. Elective pelvic lymph node IMRT was utilized in 24 patients (10%). DFS for all patients at five years was 81% (favourable intermediate risk: 91%, unfavourable intermediate risk: 90%,

high-risk: 81%, and very-high risk: 73%). DSS for all patients at five years was 97% (favourable intermediate risk: 100%, unfavourable intermediate risk: 100%, high risk: 100%, and very-high risk: 88%).

**Conclusions:** Incidence of failure following IMRT plus SBRT for unfavourable prostate cancer remains low at five years. Future studies directly comparing brachytherapy boost with SBRT boost are warranted.

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**ENDOBRONCHIAL IMPLANTED REAL-TIME RADIOFREQUENCY (RF) TRANSPONDER BEACON GUIDED, RESPIRATORY-GATED, STEREOTACTIC BODY RADIOTHERAPY FOR MOVING LUNG TUMOURS: INTERIM ANALYSIS OF A PROSPECTIVE PHASE I/II COHORT STUDY**

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**Purpose:** Endobronchially Implanted Calypso™ (Varian Medical Systems, USA) radiofrequency (RF) transponder beacons provide real-time, high precision, positional data of moving lung tumours. We report interim results of a Phase I/II prospective single arm prospective cohort study evaluating feasibility and dosimetric impact of Calypso™ beacons for patients undergoing SBRT for moving lung tumours (ClinicalTrials.gov identifier: NCT03322072).

**Materials and Methods:** Eligible patients were adults, ECOG 0-2, with T1-T2N0 Non-small cell lung cancer (NSCLC) or pulmonary metastasis ≤4cm of the right middle lobe, lingula, or lower lobes. Upper lobe tumours were eligible if they moved ≥5mm. Three Calypso™ beacons were endobronchially implanted at prespecified peritumoural locations using SuperDimension™ navigational bronchoscopy (Medtronic, USA). Four-dimensional free-breathing CT simulation scans were obtained & end-exhalation phases were selected to define a gating window (GW). A 3mm expansion of the $ITV_{GW}$ defined the PTV. Calypso-guided, respiratory phase-gated, SBRT (GW-SBRT) was delivered using 10MV VMAT photon arcs at 2400MU/min to total doses of 54Gy/3# or 48Gy/4#. For each GW-SBRT plan, a corresponding 10-phase treatment plan was generated for comparison to standard image-guided (IG)SBRT. PTV, and OAR metrics were tabulated and differences between GW-SBRT and IG-SBRT plans analysed using non-parametric Wilcoxon Signed-Rank pair test. Treatment related toxicity was graded using the Common Terminology Criteria for Adverse Events (CTCAE) version 4.0.

**Results:** From November 2017 to December 2021, 41 patients were screened and 17 patients consented to participate. Two patients did not undergo beacon implant: one had tumour progression; another withdrew consent. Of the 15 patients with beacon implants, median age was 73, with seven females. Forty-seven percent were T1 NSCLC, 40% were M1 and remaining 13% were T2 NSCLC. Median tumour dimension was 1.9cm. 73% of targets were located peripherally, and 27% centrally with a median respiratory tumour motion of 1.25 cm (range 0.53 cm to 4.04 cm). Of the n=12 tumour targets were treated with GW-SBRT, 47% of patients received 48Gy/4# and 53% received 54Gy/3#. GW-SBRT yielded an average relative reduction of PTV of 46.9% ($p<0.005$) compared with IG-SBRT. Lung V5, V10, V20 and D2 had mean relative reductions of 11.3%, 20.3%, 31.1% and 15.5% respectively ($p<0.005$). Dose to OARs was significantly reduced ($p<0.05$) except for spinal cord. At six months follow-up, mean radiographic tumour volume reduction was 53.5% ($p<0.005$); no treatment related Grade 3 toxicity was observed.

**Conclusions:** Endobronchial RF beacons are safe and effective at reducing SBRT treatment volumes for patients with moving lung tumours and can be considered for tumours with large motion amplitude or those located in close proximity to organs at risk.

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**SALVAGE PROSTATE BRACHYTHERAPY IN RADIORECURRENT PROSTATE CANCER: AN INTERNATIONAL DELPHI CONSENSUS STUDY**

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**Purpose:** Salvage prostate brachytherapy (BT) is an effective and well tolerated treatment option for radiorecurrent prostate cancer. While supported by multiple prospective studies, limited comparative data exists to guide optimal patient selection and treatment technique. We sought to generate international consensus statements on the use and preferred technique for salvage prostate BT.

**Materials and Methods:** International experts in salvage prostate BT were invited (n=34) to participate. A three-round modified Delphi technique was utilized. An a priori threshold for consensus of ≥ 75% was set, with a majority opinion being set at ≥ 50%.

**Results:** Two rounds of the Delphi consensus have been completed, with the third round currently underway. Response rates were 88.2% (30/34) and 93.3% (28/30) for the first and second round, respectively. After two rounds, consensus was achieved for 18 of 32 statements. Consensus was achieved in several areas of patient selection, including: 1) A minimum of 2-3 years from initial radiotherapy (RT) and consideration of salvage BT; 2) MRI and PET should be acquired prior to salvage; 3) Both a targeted and systematic prostate biopsy should be performed; 4) Salvage BT can

be considered after any initial RT technique; and 5) Any Gleason Score at recurrence could be considered for salvage. Several areas have not reached consensus and were controversial: 1) Whether ADT should be used (and duration); 2) Whether it was appropriate to combine local salvage with SBRT for oligometastatic disease and 3) Whether salvage BT may be repeated more than once. By majority opinion, most experts preferred High Dose-Rate salvage BT, and indicated that both focal and whole gland salvage could be appropriate depending on the clinical situation. There was no single preferred dose fractionation for salvage prostate BT.

**Conclusions:** These interim findings will inform development of an international expert consensus statement for salvage prostate brachytherapy, with final results will be presented at the conference. Areas of controversy identified would be suitable for collaborative efforts to inform optimal practice.

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## THE PROGNOSTIC VALUE OF 18F-FDG PET/CT PARAMETERS IN PATIENTS WITH SQUAMOUS CELL CARCINOMA OF THE ANAL CANAL TREATED WITH DEFINITIVE RADIO-CHEMOTHERAPY: A 10-YEAR RETROSPECTIVE ANALYSIS

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**Purpose:** We retrospectively assessed the prognostic value of pre-treatment 18F-FDG PET/CT parameters for the primary tumour and the involved lymph nodes to predict the outcomes in patients with SCC of the anal canal (ASCC) after radio-chemotherapy.

**Materials and Methods:** Every patient treated in our center from January 2010 to June 2020 for ASCC was screened for eligibility. Patients were included if treated with definitive RCT, had histologically confirmed SCC and had a pre-treatment as well as a post-treatment 18F-FDG PET/CT. All TEP/CT were reviewed by a nuclear medicine physician. We measured within the primary tumour (T) and the involved lymph nodes (N) the SUVmax, SUVpeak, SUVmean, MTV (2.5, 25%, 40%, 50%) and TLG (2.5, 25%, 40%, 50%). The optimal cutpoint for each parameter was found by several sensitivity analyses. Bivariate logistic regression and Kaplan-Maier curves were then used to assess the relations between the parameters and the complete response at six months (primary objective), at three months and the disease-free survival (DFS).

**Results**: Fifty patients were included in our analysis. The pre-treatment (T)-MTV2.5, (T)-SUVpeak and every (T)-TLG thresholds (2.5, 25%, 40%, 50%) showed a statistically significant predictive value for the complete response at six months (p 0.001, p 0.02, p 0.03, p= 0.02, p 0.02 and p=0.04 respectively). Moreover, all the thresholds analyzed for the (T)-TLG and the (T)-MTV2.5 showed a statistically significant predictive value for the complete response at three months. The lymph nodes parameters did not show any statistically predictive value for our primary objective. Although interesting tendencies were found in our Kaplan-maier curves, none of the pre-treatment parameters could statistically predict the DFS. The widely used (T)-SUVmax and (N)-SUVmax did not show any predictive value for the outcomes of our patients.

**Conclusions:** Uncommonly used but easily found parameters of the primary tumour [(T)-SUVpeak, (T)-MTV and (T)-TLG] on the pre-treatment 18F-FDG PET/CT showed a predictive value for the complete response after RCT in our patients.

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## THE IMPACT OF IMRT ON OUTCOMES IN THE PRIMARY TREATMENT OF CERVICAL CANCER: A SINGLE INSTITUTION EXPERIENCE

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**Purpose:** Locally advanced cervical cancer is treated with concurrent chemoradiotherapy with combined external beam radiotherapy (EBRT) and brachytherapy. Since 2016, our cancer centre has transitioned from using 3-dimensional conformal techniques (3D-CRT) to intensity-modulated radiotherapy (IMRT) techniques for EBRT treatments. A review was conducted to analyze effect of this change on patient outcomes.

**Materials and Methods:** A single-arm retrospective chart review was conducted of patients with locally advanced (FIGO Stage IB-IVA) cervical cancer treated with concurrent chemoradiotherapy with combined EBRT and high-dose-rate intracavitary brachytherapy (HDR-ICBT) with curative intent between 2016 and 2019. Outcomes for these patients were compared to the previous cohort of patients, treated between 2008 and 2014.

**Results:** In this analysis, 62 patients were included. Median age at diagnosis was 53.1 years and median follow-up was 3.2 years. Of these patients, eight (12.9%) developed loco-regional recurrence and nine (14.5%) developed distant recurrence. The analysis of outcomes for the previous cohort of patients showed a loco-regional and distant recurrence rate of 17.1% and 30.3% respectively, with a longer median follow-up time of 5.2 years. Therefore, this cohort of patients had lower loco-regional and distant recurrence rates than the previous cohort, though the follow-up has been considerably shorter.

**Conclusions:** Considering the difference in length of follow-up (3.2 years versus 5.2 years), outcomes are likely similar between the two cohorts of patients. Thus, the transition from predominantly 3D-CRT treatment to almost exclusively IMRT treatment at our institution since 2016 appears to still provide very good outcomes. This supports the widespread adoption of IMRT treatment, given its potential benefits in reducing toxicity without compromising outcomes. Further analysis will include continuing to monitor our results with longer follow-up and evaluating differences in toxicity between the two cohorts of patients.

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## EVALUATION OF POST-TREATMENT PET SCANS FOR CERVICAL CANCER

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**Purpose:** We evaluated how often incomplete responses were observed at the post-treatment PET scan in cervical cancer patients and what actions were taken in response to these PET results.

**Materials and Methods:** The provincial PET database was used to select study patients with both pre- and post-treatment PET scans in patients with cervical cancer between 2015 and 2020. Patient characteristics and treatment data were obtained from the institution's electronic medical record system. Clinical and disease characteristics were summarized as medians and ranges for continuous variables and as frequencies and percentages for categorical variables. Statistical significance was assessed using a Wilcoxon rank-sum test for continuous variables and a chi-square test for categorical variables. *P*-values < 0.05 were considered significant. The impact of post-treatment PET scans were analyzed using logistic regression, Kaplan-Meier statistics as well as univariate and multivariate Cox's proportional hazards models.

**Results:** Of the 127 patients included in the initial analysis, 84 (66%) had a complete response (CR), 23 (18%) partial response (PR), 3 (2%) stable disease (SD) and 17 (13%) had progressive

disease (PD) at the time of the post treatment PET scan. Mean age was 47 (Range: 27 to 86). Squamous cell histology was seen in 91 (72%), adenocarcinoma in 24 (19%) and other histology in 12 (9%) patients. Seventy-eight patients (61%) had node positive disease on PET at time of diagnosis. There was no SUVmax difference between patients who had a CR/PR versus SD/PD. When comparing clinical to PET evaluation for the likelihood of recurrence, the odds ratio of clinical exam was 1.4 in patients with a CR versus residual disease (p=0.48), but 9.8 for patients with PET CR/PR versus SD/PD ($p < 0.001$). On post-treatment PET scan, we observed local recurrence in 28 (22%), lymph node recurrence in 12 (9%), and distant recurrence in 12 (9%) patients. Patients with PET CR/PR survived significantly longer than patients with PET SD/PD (median survival: 11.4 versus 3.5 years, log-rank test: $p < 0.001$). We are currently evaluating post-PET action including imaging, biopsy and local surgery, as well as the high-risk CTV (HRCTV) volume and the total radiation dose to the HRCTV.

**Conclusions:** Post-treatment PET imaging does have predictive value in outcomes for cervical cancer patients. Further evaluation of this dataset will assess the likelihood of salvage in the setting of incomplete response to curative intent radiation treatment.

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## THE DOSIMETRIC UNDERPINNING OF BLADDER FILLING CRITERIA FOR PROSTATE IGRT

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**Purpose:** Prostate cancer patients are commonly instructed to achieve a 'comfortably full' bladder at the time of CT simulation and throughout the course of radiotherapy. At our institution, bladder status is considered acceptable when the dome is between 10-40mm above the superior aspect of the femoral head. Despite explicit drinking instructions, repeated CT imaging is common due to failure to achieve an acceptable bladder status. There is operational value in re-assessing the validity of the assessment criteria for bladder by comparing the quality of two plans optimized based on either an 'acceptable' or 'rejected' bladder status.

**Materials and Methods:** Thirty prostate patients who received repeated CT imaging due to suboptimal bladder filling were identified. These were treated with various dose/fractionation schemes. For each patient, the clinical plan was retrieved, and the delivered dose to the bladder was estimated by computing dose on the CBCTs for a minimum of 5 fractions. The bladder volume and height (bladder dome to femoral head) in fractions with a major dose violation to the bladder (>10% difference from dose constraint) were compared to the volume and height in fractions without a major dose violation. To evaluate if the 'rejected' planningCT bladder filling could have resulted in clinically acceptable dose-volume metrics, a second plan ($Plan_{rejected}$) was fully optimized based on the 'rejected' scan, and was compared with the clinical plan.

**Results:** A total of 258 fractions from 28 patients were included in the analysis (2 patients excluded due to truncated bladder on CBCTs). There were 40 fractions (15.5%) with major dose violations across 12 patients. In the fractions with a dose violation, median bladder volume and height were 96.9cm$^3$ [IQR: 75.5 – 125.0cm$^3$] and 9mm [IQR: 7 – 13mm], respectively. These metrics were significantly different from the 218 CBCTs without dose violations (median volume: 155.0cm$^3$ [IQR: 121.7 – 206.3cm$^3$], $p < 0.05$; median height: 15mm [IQR: 7 – 25mm], p=0.0014). Although the bladder in the 'rejected' CT images was smaller and shorter than in the 'acceptable' CT images (median volume: 107cm$^3$ versus 207cm$^3$; median height: 6mm versus 21mm), $Plan_{rejected}$ was clinically acceptable and comparable to the corresponding clinical plan in 26/28 patients. In addition, it delivered a lower dose to the bladder in 56% of fractions and was able to reduce the number of fractions with major dose violations to 27 (from 40).

**Conclusions:** Despite achieving an acceptable bladder size at the time of CT simulation, significant size reduction to <100cm$^3$ in volume and <9mm in height during the treatment course could result in major dose violation. The existing bladder assessment criteria could be revised from 10–40mm to 5–20mm between bladder dome to femoral head to reduce repeat imaging without compromising plan quality. Bladder dome should be >10mm above femoral head to avoid major dose violations during treatment

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## FENDING FOR FAMILIES: CHARACTERIZING THE NEED FOR CHILDCARE SUPPORT FOR CANCER PATIENTS

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**Purpose:** Approximately one in five newly diagnosed cancer patients are between the ages of 20 and 54, which are also prime years for childbearing and childrearing. As such, a significant portion of cancer patients are also the primary caregivers to young children, and struggle to balance their own needs with those of their dependents. This study aims to characterize the need for childcare support for cancer patients from the perspective of healthcare professionals providing care at a major Canadian cancer centre.

**Materials and Methods:** Healthcare providers at a major Canadian cancer centre were invited to partake in semi-structured telephone interviews. An interview guide was used, which was developed through collaboration with a multidisciplinary team and which aimed to elicit the opinions of healthcare providers on the value of supportive childcare programming services for their patients. The interviews also explored what specific benefits for patients these services could offer, as well as what would constitute optimal delivery. Interview transcript data was interpreted using thematic analysis.

**Results:** In total, 28 healthcare professionals providing care at a major Canadian cancer centre participated in semi-structured telephone interviews between May and April 2021. A wide range of providers were engaged, including medical, surgical and radiation oncologists, general practitioners, psychiatrists, radiation therapists, registered nurses and social workers. Interview responses indicated that healthcare providers felt that managing childcare responsibilities was a source of stress for cancer patients, and that the introduction of supportive childcare services at cancer centres would mitigate this stress. Other benefits of introducing supportive childcare services were also identified, including increased system efficiency, improved treatment compliance, increased trust in providers, and additional emotional support for children.

**Conclusions:** These findings indicate that childcare issues are a source of stress for cancer patients with children, and that there are medical and social benefits associated with the introduction of supportive childcare services for this population. As such, cancer centres could consider the implementation of childcare support services as a way of providing holistic care to patients who are parents.

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## PREVALENCE OF OLIGOMETASTASES AT INITIAL STAGING OF NEUROENDOCRINE TUMOURS? A 68GA DOTATATE PET (GA68PET) POPULATION-BASED REGISTRY ESTIMATE

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**Purpose:** Well-differentiated neuroendocrine tumours (NET) have a long natural history. Determining the prevalence of oligometastases (OM) in NET would facilitate trial design and guide novel treatment designs. The Ontario PET-NET registry (OntPNR) is a population-based registry (since April 2019) of patients approved for $Ga^{68}$PET fulfilling the provincial access criteria. The objective was to describe the prevalence of OM disease at initial staging of well-differentiated NET.

**Materials and Methods:** A retrospective analysis of the OntPNR was conducted. DICOM images, reports and registry data were used. Staging cohort (SC) included patients with localized primary NETS and/or limited metastasis (mets) where definitive surgery is planned. OM is defined as 1-5 metastatic lesions following $Ga^{68}$PET.

**Results:** Between May 2019 and Nov 2021, 1,084 patients underwent $Ga^{68}$PET. Of the 326 patients in the SC, M:F 1:1; Grade 1 (159; 49%) & Ki67 low (189; 58%) M1 (151;46%). The most common primary sites were midgut (121; 37%) pancreatic (73; 22.4%) and unknown primaries (57; 17.5%).
OM were identified in 30/326 (9.2%) patients [20 (13.2%) in the liver only and 10 (6.6%) extra-hepatic]. Median number of mets was 2 (Range 1-5). The most common mets site was liver (20; 67%), followed by bone (7; 23%) and peritoneal deposits (4: 13%). Patients in the OM cohort are more likely to be males (21/30; 70% OM versus 159/326; 49% SC); and had unknown primaries (eight out of 30; 27% OM; 57/326; 17.5% SC).

**Conclusions:** OM occurred in 9.2% of NET patients in the staging cohort. This estimate does not include patients who are OM that are induced (post treatment) or during follow-up. These results can serve as the basis for epidemiological investigations and clinical trials planning.

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## EARLY CLINICAL EFFECTIVENESS, TOXICITY, AND QUALITY OF LIFE OUTCOMES OF MAGNETIC RESONANCE IMAGING-GUIDED STEREOTACTIC ABLATIVE RADIOTHERAPY: A SYSTEMATIC REVIEW

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**Purpose:** Magnetic resonance imaging-guided stereotactic ablative radiotherapy (MRgSABR) is postulated to further improve the therapeutic ratio of stereotactic radiotherapy by increasing the certainty of dose delivery. As early phase data on MRgSABR have rapidly accumulated since 2014, we systematically reviewed the existing literature to summarize the clinical outcomes, toxicity and patient-reported outcomes following MRgSABR.

**Materials and Methods:** This systematic review was conducted in accordance with consensus guidelines. The PubMed, Embase, and Cochrane Library databases were queried from January 2014 to August 2021. Studies in the English language that evaluated the local control (LC), overall survival (OS), clinician-reported toxicity and patient-reported quality of life (QOL) outcomes of MRgSABR were included. Reviews or guidelines that did not contribute new results, studies with ≤3 total patients, and studies where MRgSABR results could not be disaggregated from radiotherapy using non-MR platforms were excluded. Results were summarized usings medians and ranges.

**Results:** A total of 849 sources were identified, with 34 (1148 patients) meeting all inclusion criteria. Most studies (19/34) were retrospective in nature, with the remaining being prospective single-arm studies. Median follow-up duration ranged from 4 to 25 months. Liver, prostate, and pancreas were the most common sites for MRgSABR studies. Eleven studies reported results on liver MRgSABR (199 patients). LC at one year was 86-95% (median: 88%) and LC at two years was 73-100% (median: 80%) for liver MRgSABR. OS at one year was high at 69-93% (median: 80%), though OS at two years was lower at 46-60% (median: 51%). Grade 3 toxicity ranged from 0 to 8% and no Grade 4+ toxicity was reported for liver MRgSABR. Six studies reported results for prostate MRgSABR (282 patients). Biochemical control ranged from 75% to 100% at a median follow-up of six to 12 months. Grade 3+ toxicity ranged from 0 to 2% and patients reported temporary increases in urinary symptoms during prostate MRgSABR that resolved over time. Six studies reported results for pancreatic MRgSABR (304 patients). OS at one year was 59-82% (median: 69%) and OS at two years was 38-52% (median: 45%). LC was 57-95% at one year (median: 86%) and 59-83% at two years (median: 77%). The risk of acute Grade 3+ toxicity was 0-4% (median: 1.5%) and the risk of late Grade 3+ toxicity was 3-13% (median: 5%) following pancreatic MRgSABR. Remaining studies that reported on a variety of treatment and primary sites showed good LC of 72-96% at one year (median: 92%). Grade 3+ toxicity was ≤5% except for lung (8-20%) and head and neck MRgSABR (43%).

**Conclusions:** Early phase data on MRgSABR indicate good LC and limited toxicity across different clinical indications. Prospective comparative clinical trials are needed to quantify the improvement in clinical outcomes with MRgSABR relative to non-MR-guided radiotherapy technologies.

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## PROSTATE CANCER-SPECIFIC DEATH RATES IN LOCALIZED PROSTATE CANCER: DATA FROM TWO RANDOMIZED TRIALS

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**Purpose:** Aiming to determine the prostate cancer-specific death rate at patient's death from any cause in localised prostate cancer, we analysed our long-term follow-up data from two prospective randomized trials (PCS III - IV).

**Materials and Methods:** From October 2000 to September 2010, 1230 patients were randomized. In one trial, 600 patients with intermediate risk prostate cancer (IRPC) received prostate radiotherapy (RT) with or without short term androgen deprivation therapy (ADT) and in the other trial, 630 with high-risk prostate cancer (HRPC) received prostate and pelvic RT with long term ADT. Causes of death were compiled until January 2022. Prostate cancer control was based on the last disease status reported for each patient by investigators. Comparisons of death attributed to prostate cancer between HRPC and IRPC was analyzed with competing risks methods. Overall survival (OS) was analyzed with Kaplan Meier method and the log rank test.

**Results:** Results are reported with a median follow-up of 13.4 years. Median age at last follow-up was 82 years without significant difference between HRPC and IRPC p=0.2. At the end of January 2022, 663/1230 (53.9%) patients had died. Of the total deaths 8.5% (105/1230) were attributed to prostate cancer and 15.8% (105/663) of patients died from prostate cancer. For the remaining 558 patients (84.2%) who died, 354/558 (63.4%) were considered free from prostate cancer. In 106/558 patients (19%), even though the cause of death was known, there was no information on the prostate cancer status, in 27/558 patients (4.8%) the cause of death and the prostate status was unknown, and 8.8% (49/558) developed biochemical failure, but were not considered dead from prostate cancer. Upon our review, for those patients with prostate cancer status known at death, another 3.9% (22/558) died with prostate cancer progression, bringing the overall death rate from prostate cancer to 10.3% (127/1230). Overall death rate was significantly higher in HRPC 61.7% (389/630) versus IRPC patients 45.7% (274/600) p<0.001. 10-year OS rate was significantly worse in HRPC 63% versus 73%, Hazard Ratio (95% CI) = 1.31 (1.12-1.52), p<0.001. Similarly, deaths attributed to prostate cancer were significantly higher in the HRPC compared to IRPC 11.9% (75/630) versus 5% (30/600), p<0.001. 10-year cumulative incidence of death attributed to prostate cancer was higher in HRPC (9.5% versus 2.9%, sub distribution HR = 2.01 (1.38-2.93), p<0.001.

**Conclusions:** In this retrospective cohort study, the overall documented death rate from prostate cancer upon review was 10.3%. As expected, HRPC patients had a significantly higher death rate from prostate cancer. Regardless of risk stratification, a large number of deaths were attributable to non-cancer causes. The overall death rate from prostate cancer may be substantially underestimated. Caution should be exercised when interpreting results considering the competing causes of death, reporting bias of death certificates and lack of proper documentation.

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## ACCESS AND EQUITY: AN INTER-INSTITUTIONAL COMPARISON OF RADIOTHERAPY PLANNING AND DELIVERY

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**Purpose:** Alignment of population cancer care needs with system capacity is essential to ensure all patients have equitable access to high-quality, timely care, at an appropriate location. Vulnerable populations may face barriers to care including economic or geographic burdens and may experience poorer outcomes. Differences in regional imaging, planning and treatment resources, and operational processes may further discrepancies. The objective of this study was thus to analyze both patient and cancer program barriers impacting on equity and access to quality radiotherapy (RT) by comparing metrics between two Ontario RT programs (CC1, CC2).

**Materials and Methods:** A quality assurance analysis was undertaken for RT delivered to patients with gynecological (Gyne), gastrointestinal (GI) and head and neck (HN) malignancies in one fiscal year (2019/2020) for CC1 and CC2.

Data were organized based on 2016 Canadian census data, geography, disease site and stage. Patient encounters, fractions delivered and RT planning wait-times were captured for treated cases. Utilizing Google Maps, road-distance and travel time between masked patient postal codes and treating CC was calculated. Sankey Diagrams were generated to visualize travel relationships. Out-of-province patients were censored to model the local system.

Utilization of MRI Simulation (MRS) and time to MRS as a component of radiotherapy planning wait-times were benchmarked between institutions as indicators of infrastructure capacity and treatment quality.

**Results:** Model data included 3,008 new patient consultations, 2,465 RT plans, and 40,274 treatment visits across two CCs. Mean travel times (mins) to CC1 for Gyne, GI and HN patients were 82, 62 and 72 per visit, versus 45, 37 and 49 at CC2. Distances (km) per visit (one direction) to CC1 for patients with Gyne, GI and HN malignancies were: 102, 66; and 83; versus 46, 32, and 52 at CC2. Total travel distance and time per patient for all treatments were: 1302 and 1130 for CC1 and 1314 and 1350 for CC2. Between programs, differences were observed for all sites.
MRS utilization differed markedly between programs with the greatest difference in Gyne, followed by GI and HN. Mean time to MRS differed between programs at 8 (CC1) versus 2 days. Comparison of wait-time to treatment revealed a difference of 20% for cases meeting the provincial benchmark (72% to 92%) and a mean time (days) 8.7 to 10.4 for planning. Overall consult to treatment time 3.5 days longer at CC1 than CC2.

**Conclusions:** Substantial differences in patient convenience, timeliness, and quality exist between programs in Ontario, attributable to geography, centre-specific resources, and internal processes. Opportunities to advance health equity and access exist with regards to patient travel time, distance and technologies (MRS) between programs. Addressing health equity and variations in care through data, policy and resource allocation will benefit Ontarians who require cancer care and those who manage and provide it.

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## INDIVIDUALIZED PREDICTION OF DISTANT METASTASES RISK IN ORAL CAVITY CARCINOMA: A VALIDATED PREDICTIVE-SCORE MODEL

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**Purpose:** We aimed to develop and validate a risk-scoring system for distant metastases (DM) in oral cavity carcinoma (OCC).

**Materials and Methods:** In this IRB-approved retrospective study, OCC patients treated at 4 tertiary cancer institutions with curative surgery +/- postoperative radiation/chemo-radiation (PORT/PO-CRT) were divided into discovery and validation cohorts (randomly selected in 3:2 ratio). Staging was reviewed based on TNM 8$^{th}$edition. Predictors of DM identified on multivariable analysis in the discovery cohort were used to develop a DM risk-score model to classify patients into risk groups using the Contal and O'Quigley method for cut-off optimization. The utility of risk classification was subsequently evaluated in the validation cohort. C-index was used to assess the predictive ability of the continuous risk score.

**Results:** Overall 2749 patients were analyzed. Predictors (risk score coefficient) of DM in the discovery cohort were: pT3-4 (0.4), pN+ (N1:0.8; N2:1.0; N3:1.5), histologic Grade 3 (G3, 0.7) and lymphovascular invasion (LVI, 0.4). The DM risk groups were defined by cumulative sum of risk score coefficients: high risk (sum

>2), intermediate risk (sum=1-2), and standard risk (sum<1). In the discovery cohort, 5-yr DM for high versus intermediate versus standard risk groups was 33% versus 19% versus 6%, p<0.001 (C-index=0.79). Similarly, in the validation cohort, 5-yr DM for high versus intermediate versus standard risk groups was 36% versus 23% versus 7%, p<0.001 (C-index=0.77). When applied to the entire study population, this predictive model showed excellent discriminative ability in predicting DM only without loco-regional failure (29% versus 18% versus 3%, p<0.001), late (>2 yr) DM (11% versus 5% versus 3%; p<0.001), DM in patients treated with surgery only (26% versus 11% versus 6%, p<0.001), PORT (37% versus 23% versus 7%, p<0.001), and PO-CRT (42% versus 29% versus 9%, p<0.001). Finally, 5-yr OS for high versus intermediate versus standard risk groups in the overall cohort was 24% versus 38% versus 66%, p<0.001.

**Conclusions:** A predictive-score model for DM utilizing pT3-4, pN1/2/3, G3 and LVI demonstrated a validated utility in identifying patients at higher risk of DM who may be evaluated for individualized risk-adaptive treatment escalation and/or surveillance strategies.

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## AN"EARLY ADOPTER" OF CPQR'S PATIENT REPORTED OUTCOME (PRO) INITIATIVE: LESSONS LEARNED THROUGH IMPLEMENTATION OF AN ELECTRONIC PRO PLATFORM ACROSS A MULIT-CENTER RADIATION ONCOLOGY DEPARTMENT

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**Purpose:** Beyond patient symptom management during treatment, patient reported outcomes (PRO) play a critical role in oncology survivorship. Although considered standard of care, PRO collection and use is challenging for radiotherapy (RT) centres lacking electronic PRO (ePRO) infrastructure. This work outlines facilitators and barriers to the implementation of an ePRO program across a multicentre radiation oncology department.

**Materials and Methods:** Dalhousie University's Department of Radiation Oncology (DRO) is composed of four RT centres across three provinces. Department-wide implementation of ePRO was precipitated by several key events: In 2009, a Canadian Partnership Against Cancer (CPAC) grant enabled 2 centres to begin paper-based PRO using the Canadian Problem Checklist (CPC) and Edmonton Symptom Assessment System (ESASr). In 2015, the Department's research retreat set ePRO as a priority. In 2017, Accreditation Canada mandated routine evaluation of patient outcomes and in 2018, the Canadian Partnership for Quality Radiotherapy (CPQR) identified Dalhousie's DRO as an early adopter within the pan-Canadian PRO initiative. In 2019, three DRO centres were awarded CPAC funding to launch ePROs. The fourth centre now hopes to use lessons learned in order to facilitate their ePRO implementation.

**Results:** ePRO was launched in September 2021 with a phased approach across centres and tumour sites so that user feedback can inform the roll out. Clinic workflows now includes ePRO at consultation, first and last RT review as well as follow-up. Within the ePRO application (Noona), CPQR-endorsed PRO tools include CPC, ESASr, and the Brief Pain Inventory (BPI), with use of other tumour-site specific questionnaires planned.

Project charter included needs assessments (human resource, staff /patient education) and change management strategies required to obtain buy-in from front line staff. Although coordination of such a large-scale initiative was challenged by COVID restrictions, project priority was escalated with ePRO recognized as a powerful tool to assess patient symptoms in clinic or remotely. Research unit support was invaluable to navigate IT project complexities including vendor/collaborator contracts, processes of Privacy Impact Assessments and IT architectural reviews. From the advisory board to PRO working groups, mullti-stakeholder feedback and collaboration has been key, including representatives of patients, cancer program leadership, project managers/principle investigators, administrative staff, nurses, radiation therapists, radiation oncologists, industry, IT and legal.

**Conclusions:** Multi-centre implementation of an ePRO program has been feasible but complex and time intensive. It is hoped that our lessons learned may benefit those RT centres aiming to transition from paper-based to ePRO systems. With critical electronic infrastructure now in place, we await data to analyze ePRO amongst other patient outcomes in ongoing RT Big Data initiatives.

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## CAN CT-BASED CALCIUM SCORES PREDICT CARDIAC DEATHS IN BREAST CANCER PATIENTS TREATED WITH RADIOTHERAPY? A POPULATION BASED CASE-CONTROL STUDY

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**Purpose:** To determine the risk of cardiac death following breast radiotherapy from the change in coronary artery calcification (CAC) scores, and to examine the association of CAC scores with radiation dose to determine dose constraints for coronary arteries.

**Materials and Methods:** We used previously published study data on early-stage breast cancer; patients had received adjuvant radiotherapy between 2002 and 2006 in BC. We searched electronic medical records for diagnostic CT scans at the time of diagnosis and at least 1 year post radiotherapy. Using validated methods, we computed CAC scores of the left anterior descending (LAD) and right coronary artery (RCA) before and after radiotherapy; we categorized CAC scores as mild (<100), moderate (100-399), severe (400-999), and extensive (> 1000). From radiotherapy plans, we computed doses to the LAD and RCA. Using available information on cardiovascular risk factors and cause of death, we examined their association with CAC scores and coronary doses.

**Results:** There were 95 left and 102 right breast patients. CT scans were available for 25 patients (12 left and 13 right). Mean time interval between CT scans was 10.8 years (4-19 years; min-max). Of the 25 patients, 3 patients had no cardiovascular risk factors. CAC score was 0 for both the LAD and RCA at baseline with no significant change in 7-16 years post treatment. No cardiac death was recorded in them. Six (24%) patients progressed from mild/moderate to severe/extensive CAC category in the LAD, and in the RCA. These patients had 1 to 4 cardiovascular risk factors and 2 of them died of cardiac death; both left sided. There was no significant association between radiation dose to coronary arteries and CAC scores.

**Conclusions:** CAC score appears to be associated with cardiovascular risk factors but not with radiation doses to coronary arteries. Thus, a safe dose constraint cannot be established. Further research is warranted.

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## PERSPECTIVES OF PATIENTS WITH METASTATIC LUNG CANCER ON SYMPTOM SCREENING AND UTILIZATION OF PATIENT-REPORTED OUTCOMES DATA FOR PATIENT EDUCATION

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**Purpose:** Symptom screening and collection of patient-reported outcome (PRO) data are increasingly prevalent in the care of patients with metastatic non-small cell lung cancer (mNSCLC). We explored the perspectives of patients with mNSCLC on symptom screening and utilization of PRO data for patient education.

**Materials and Methods:** Ten patients with mNSCLC were selected by convenience sampling at a Canadian tertiary cancer centre to participate in a qualitative study. Baseline participant and treatment characteristics were obtained via chart review. Semi-structured interview guides were designed by a multidisciplinary team of lung cancer and PRO investigators. One-on-one interviews were conducted with each participant by two investigators. Interviews were audio-recorded and transcribed verbatim. Anonymized transcripts underwent inductive coding by two investigators and thematic content analysis was performed.

**Results:** Participants were 50% female and had a median age of 68 years (56-77). Sixty percent of participants had smoking histories. Median time since diagnosis was 28.5 months (6-72). The most common treatments were palliative radiotherapy (80%) and EGFR inhibitors (60%). Participants believed that they initiated communication about symptoms with their healthcare team and perceived that the management of symptoms was timely. Participants identified a knowledge gap regarding expected symptom trajectory through treatment and recovery. Participants sought symptom trajectory information from a variety of sources, including informational websites and informational documents from pharmaceutical companies as the most common sources. Seven themes were identified in total. Three themes were identified regarding symptom screening: 1) symptom screening is useful for symptom self-monitoring and disclosure to the healthcare team, 2) symptom screening tools are variably utilized by participants and their healthcare providers, and 3) screening of additional quality-of-life domains (smoking-related stigma, sexual dysfunction, and financial toxicity) is commonly desired. Four themes were identified regarding utilization of symptom trajectory PRO data for patient education: 1) symptom trajectory data provide reassurance and motivation to improve symptoms, 2) symptom trajectory data should be disclosed after an oncologic treatment plan is developed, 3) symptom trajectory data should be communicated via in-person discussion with accompanying patient-education resources, and 4) communication of symptom trajectory data should include reassurance about symptom stabilization, acknowledgement of the variability in patient experience, and strategies to improve symptoms.

**Conclusions:** Symptom screening tools require more standardized utilization and should include common quality-of-life concerns of patients with mNSCLC. Symptom trajectory PRO data derived from routine screening should inform novel knowledge translation tools to satisfy an unmet need for patient education.

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## A RETROSPECTIVE ON A CAREER AS A RADIATION ONCOLOGIST: A QUALITATIVE STUDY

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**Purpose:** Oncology is a rewarding but challenging specialty as it often requires physicians to make pressing life-and-death decisions in continuously changing medical environments. 42% to 69% of oncologists feel stressed at work with 27% having high psychiatric morbidity. This could lead to consequences in all aspects of their life and affect the quality of care they are providing. It was found that 80.4% of oncologists were satisfied with their choice of specialty, however, the factors that lead to career satisfaction are rarely explored. It is imperative to explore the factors that may lead to burnout and satisfaction as it will be helpful to inform mental health initiatives, administration and department leads on a local and institution.

**Materials and Methods:** This is an exploratory qualitative study, where retired 14 Canadian radiation oncologists (7 who identified as women) were interviewed using a semi structured guide to capture general demographic information, greatest rewards, challenges, regrets, and advice regarding their career.

**Results:** The median age of participants was 71 (range 62-86) and the median years in retirement was 6 (range 1-21 years). Overall, participants reported that Radiation Oncology is a career with meaningful patient interactions, good work life balance, and opportunity to work in teams with low number of regrets. Patient care were identified as the point of satisfaction for most participants. One aspect of dissatisfaction that appeared to grow over the years before retirement was the evolving technology. Other stressors included difficult professional relationships and the pressure of leadership. Many physicians see the value in and the need for informal and formal mentorships and there was emphasis on importance of life outside of medicine. More female physicians expressed concerns around work life balance compared to their male counterparts. Limitations include sample size and selection bias lack of anonymity during survey.

**Conclusions:** Radiation Oncology is an area of medicine that is versatile and rewarding but has drawbacks that may be addressed with wellness initiatives. Future steps would include larger scale questionnaire-based study.

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## DYSPNEA IN PATIENTS WITH STAGE IV NON-SMALL CELL LUNG CANCER: A POPULATION-BASED ANALYSIS OF DISEASE BURDEN AND PATTERNS OF CARE

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**Purpose:** Patients with metastatic non-small cell lung cancer (NSCLC) experience significant morbidity because of their disease burden. Dyspnea is a predominant symptom, with a reported prevalence of up to 70% in lung cancer patients overall. The objective of this study was to determine factors associated with a high dyspnea score based on the Edmonton Symptom Assessment System (ESAS), as well as resultant patterns of intervention and factors correlated to treatment receipt.

**Materials and Methods:** Using health services administrative data, we conducted a population-based study of all patients diagnosed with metastatic NSCLC treated from January 2007 to September 2018 in the province of Ontario. Exclusion criteria consists of patient age <18 or >99, less than six months of follow-up without death, or if they had another cancer diagnosis 5 years preceding or within one year following their NSCLC diagnosis. The primary

outcome of interest was the prevalence of high dyspnea scores, defined as at least a single ESAS score of ≥4 at anytime. Baseline characteristic differences between high dyspnea and non-high dyspnea score cohorts were assessed by Student's t-test and chi square test for continuous and categorical covariates, respectively. Predictors of treatment receipt were estimated using multivariable Poisson regression. P-values less than 0.05 were determined to be statistically significant.

**Results:** The initial study cohort included 13,159 patients diagnosed with metastatic NSCLC and completed at least one ESAS survey. Of these, 9,434 (71.7%) reported a high dyspnea score. Compared to patients who did not report high dyspnea scores, those who reported a high dyspnea score were more likely to complete more ESAS surveys, be male, have a higher ECI score, live in less ethnically diverse areas, and receive subsequent systemic therapy after diagnosis. Most patients with a high dyspnea score received intervention (94%), of which the most common were palliative care management (87%), thoracic radiotherapy (56%) and thoracentesis (37%). Multivariable regression identified older patients to be less likely to undergo pleurodesis. Thoracentesis was less common for patients living in rural and non-major urban areas, lower income areas, and earlier year of diagnosis. Thoracic radiotherapy receipt was less common for older patients, females, those with ECI ≥4, patients living in urban areas, and those with later year of diagnosis. Finally, palliative care referrals were less frequent for patients with ECI ≥4, non-urban habitation, lower income areas, and earlier year of diagnosis.

**Conclusions:** Dyspnea is a prevalent symptom amongst patients with metastatic NSCLC and is associated with various baseline characteristics. Most patients reporting significant dyspnea received intervention. Predictors of individual treatment modality receipt are defined and can help elucidate patterns of care discordant to usual clinical indications.

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## FRAMELESS COBALT60-BASED HYPOFRACTIONATED STEREOTACTIC RADIOSURGERY (HSRS) FOR BRAIN METASTASES: IMPACT OF DOSE AND VOLUME

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**Purpose:** Frameless, gated, image-guided, Cobalt$^{60}$-based hypofractionated stereotactic radiosurgery (Co$^{60}$-HSRS) is a novel technical paradigm in the treatment of brain metastases that allows for both the dosimetric benefits of the Co$^{60}$ based stereotactic radiosurgery (SRS) platform as well as the biologic benefits of fractionation. We report mature local control (LC) and adverse radiation effects (ARE) outcomes following 5 fraction Co$^{60}$-HSRS for intact brain metastases.

**Materials and Methods:** All patients with intact brain metastases treated with 5-fraction Co$^{60}$-HSRS between 2017-2020 were retrospectively reviewed. Patients were typically selected for HSRS as opposed to single fraction SRS if the metastases were larger (>2cm diameter), were in eloquent areas, or were in proximity to another lesion receiving HSRS. Survival estimates were determined per patient using Kaplan Meier methods, and LC as well as symptomatic ARE rates determined per lesion using competing risk methods. Univariable competing risk regression using Fine and Gray's methods were performed, and subsequent multivariable (MVA) regression using a backwards step-wise selection technique generated the final adjusted models.

**Results:** In total 299 metastases in 146 patients were identified. The median clinical and radiologic follow-up was 10.6 and 10.7 months, respectively. The median maximum tumour diameter and volume were 1.7 cm (range, 0.2-3.9 cm) and 2.38 cc (range, 0.004-24.92 cc), respectively. The median total dose was 27.5Gy (range, 20-27.5 Gy) in 5 daily fractions, and median prescription isodose was 52% (range, 45%-93%). The median overall survival (OS) was 12.7 months and the 1-year LC rate was 85%. MVA identified a total dose of 27.5Gy versus <27.5Gy (hazard ratio [HR] 0.59, p=0.042), and prior chemotherapy exposure (HR 1.99, p= 0.015), as significant predictors of LC. The 1-year ARE rate was 10.8% and symptomatic ARE rate was 1.8%. MVA identified a gross tumour volume of ≥4.5cc (HR 7.29, p < 0.001) and a mean intra-tumoural dose of ≥39Gy (HR 3.17, p < 0.034) as significant predictors of symptomatic ARE.

**Conclusions:** Co$^{60}$-HSRS was associated with high rates of LC and a low incidence of ARE. A prescription dose of 27.5Gy was superior to ≤25 Gy in 5 daily fractions in terms of local control. Target volumes of 4.5cc or larger as well as mean dose >39Gy, are associated with higher rates of symptomatic necrosis. Further study will help refine the optimal dosimetric constraints for Co$^{60}$-HSRS.

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## THE IMPACT OF TUMOUR SPECIFIC GROWTH RATE AS A PREDICTOR OF SURVIVAL IN OLIGO-PROGRESSIVE DISEASE TREATED WITH STEREOTACTIC BODY RADIOTHERAPY

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**Purpose:** Histologic classification alone does not fully represent the distribution of tumour behaviours due to within histology heterogeneity. The aim of this study is to assess the variation and the impact of pre- and post- tumour specific growth rate (SGR) on survival of metastatic patients with oligo-progressive (OP) disease treated with SBRT.

**Materials and Methods:** Patients with known metastatic disease and £3 radiologically progressing metastases were enrolled in a prospective Phase II study. For the purpose of this analysis, treated metastases were retrospectively contoured on pre-SBRT diagnostic images (GTV1 - within 3-months), at time of SBRT (GTV2) and post-SBRT (GTV3 -within 3-months). SGR was calculated using the time interval (t=days) and volume changes (GTVx/GTVy) for each metastasis ($ln$(GTV2/GTV1)/t). Pre-SBRT growth (SGR1) was defined as $GTV2 - GTV1$, and post-SBRT (SGR2) as $GTV3 - GTV2$. High SGR was defined as greater than the median SGR value for each population. For patients with multiple lesions, the highest SGR was used for survival analysis. Kaplan-Meier was used to estimate overall survival (OS). A Log-rank test was used to assess the impact of high SGR on OS.

**Results:** Thirty-four patients with 53 metastases from breast (10, 29.4%), gastro-intestinal (GI) (14, 41.2%) and genito-urinary (GU) (10, 29.4%) cancers were analysed. Median follow-up was 11.2 (interquartile range (IQR): 8.0-15.9) months. The probability of survival at 12 months was 64% for the entire cohort; 90%, 27% and 90% (p<0.001) for, Breast, GI and GU patients respectively.

The median volume of GTV1, GTV2 and GTV3 was 3.8 (IQR 0.9 - 6.6)cc, 7.1 (IQR 1.9-15.3)cc and 2.7 (IQR 0.8-7.9)cc respectively. Median SGR1 and SGR2 was 0.007 (IQR 0.003 - 0.013) and -0.009 (IQR -0.01 to -0.001), with median SGR1/SGR2 per histology 0.004 (IQR 0.002 – 0.007)/-0.009 (IQR -0.018 to -0.005) breast, 0.011 (IQR 0.006 – 0.01)/-0.009 (IQR-0.013 to -0.002) GI and 0.007 (IQR 0.001 – 0.015)/-0.01 (IQR-0.013 to -0.001) GU. There was no statistically significant difference seen between histologies and SGR1 (p=0.08) and SGR2 (p=0.77). 52% (27/52) of metastases had a high SGR1 and 43% (22/51) a high SGR2.

At 12-month, 64 % versus 75% of patients with high versus low SGR1 were alive (p=0.29) while 63% and 64% of patients with high versus low SGR2 were alive (p=0.60).

**Conclusions:** SGR measurements varied broadly within histological subgroups, however with overlap between groups. The impact on pre-SBRT tumour SGR on local control and survival requires validation in larger cohorts of oligo-metastases and OP patients.

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## HIGH-QUALITY DNA EXTRACTION AND GUT MICROBIAL DETECTION TO EVALUATE PATHOLOGIC RESPONSE FOLLOWING NEOADJUVANT TREATMENT FOR LOCALLY ADVANCED RECTAL CANCER

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**Purpose:** There is a lack of biological predictors for pathological response, following neoadjuvant treatment for locally advanced rectal carcinoma. The association between the rectal microbiome and the degree of response has not yet been widely explored. Microbial diversity and amount can be analyzed by determining the presence of 16S ribosomal DNA (16S rDNA), as it is highly conserved between different species of bacteria. The objectives of this study were to determine: 1) if high-quality total bacterial 16S rDNA could be recovered from rectal cancer specimens following neoadjuvant treatment as a proof of principle; 2) whether quantifying 16S rDNA in rectal cancer specimens could serve as a marker of pathologic response rates.

**Materials and Methods:** We conducted a retrospective analysis of patients with pT3-4 pNX or pTX pN+ rectal adenocarcinomas treated with neoadjuvant short-course or long-course radiotherapy (RT) and total mesorectal excision (TME) from 2014-2018. Tumour blocks from patients' TME were reviewed by a pathologist to determine degree of pathological response (complete, near-total, partial, or no response). For total DNA extraction, sections from tissue blocks were deparaffinized and purified with elution columns (Qiagen). Quantitative polymerase chain reaction (qPCR) was performed to amplify 16S rDNA using Caporaso 515 FW and 806 RW primers. The relative amount of 16S rDNA was calculated from the number of PCR cycles (Cq) required to amplify 16S gene above the background fluorescence threshold. A Cq<31 indicates a high amount of genetic product present. We aimed to (1) determine the proportion of specimens with bacterial genetic material present defined as a Cq<31, and to (2) compare the calculated Cq values of specimens based on the degree of pathological response using the Kruskal-Wallis test.

**Results:** There were 82 cases that met our inclusion criteria. The median age was 63, and 36% of patients were female. The cohort comprised of: 26% Stage II, 54% Stage III, and 9% Stage IV patients. For RT treatment, 31 patients received 45Gy/25, 32 received 50.4/28, 16 received 25/5; 76% of patients received concurrent capecitabine with RT. For our primary outcome, 82/82 of patient specimens had a Cq<31, and thus all met the criteria of having a high amount of bacterial genetic material present. The mean Cq was 23.1 (interquartile range: 22.1 to 23.6). The maximum Cq was 28. The Cq by pathologic response was: 23.7 for complete, 23.0 for near-total, 23.2 for partial, and 22.0 for no response (p=0.6).

**Conclusions:** We have conducted a proof-of-concept study, showing the feasibility of total bacterial 16S rDNA extraction from pathologic rectal tissue specimens, following neoadjuvant treatment. Quantities of microbial 16S rDNA were similar, regardless of pathological response. This protocol allows for the possibility of further analysis of the rectal microbiota (including the study of microbial taxa diversity through 16S rDNA sequencing) and correlating this with rectal cancer outcomes.

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## IMPACT OF THE COVID-19 PANDEMIC ON CANADIAN RADIATION ONCOLOGY PRACTICES

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**Purpose:** To survey Canadian radiation oncology (RO) practice leaders to determine the impact of the COVID-19 pandemic on radiation services and patient and staff issues in the early phase of the pandemic and one year later.

**Materials and Methods:** The RO leader (Department or Division Head) from every Canadian cancer centre with radiation services was identified. Two surveys were circulated to the identified leader via email from the CARO central office, utilizing the SurveyMonkey® survey tool: the first closed in June 2020 and the second (expanded) survey in June 2021, representing two points in time of the COVID-19 pandemic. Questions included patient volume, service interruptions and delays, changes in scheduling and virtual/telemedicine utilization, and relevant policies and procedures adopted. Additional questions were included in the follow-up survey to determine further impacts on disease presentation, volume, vaccination and access, and personnel issues.

**Results:** Multiple safety and infection-control processes were developed and implemented, which continued one year later. Virtual/telemedicine was widely adopted early in the pandemic, and continued to be a common technique to communicate/connect with patients. Although many centres were deferring/delaying certain disease sites early on in the pandemic, this was not as prevalent one year later. Reduced cancer screening and patients presenting with more advanced disease were concerns documented in the 2021 survey. A high level of concern regarding stress amongst health care professionals was identified.

**Conclusions:** Canadian RO centres have faced numerous challenges during the COVID-19 pandemic, but continued to provide timely and essential cancer care for patients with cancer. Future evaluation of RO centre practices will be important to continue to document and address the impact of the COVID-19 pandemic on issues relevant to RO leaders, patients and staff.

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## OPTIMIZING RADIATION THERAPY DATA SUBMISSIONS THROUGH CARE PLANS: IMPLICATIONS FOR FUNDING

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**Purpose:** Radiation therapy in Ontario is transitioning to quality-based procedure funding beginning April 2022. Each patient must be associated with an evidenced-informed treatment protocol to trigger funding. This initiative reports the use of electronic care plans to link patients with the appropriate radiation therapy quality-based procedure (RT-QBP) protocols.

**Materials and Methods:** Radiation oncology care plans are utilized in the MosaiQ oncology information system and include all the activities for a patient's radiation treatment. From April to September 2020, existing care plans were compared to the list of evidence-informed RT-QBP protocols. Care plans were then adjusted or created to match the RT-QBP data elements, such as intent, disease site, dose, and fractionation schedule. Care plan nomenclature was modified to match the RT-QBP protocols and was selected from an approved Ontario Health (Cancer Care Ontario) list. Radiation Oncologists approve a care plan for each patient to prompt a cascade of activities and move the radiotherapy process forward. Additional care plans can be applied if patients have multiple distinct disease sites. Care plans are extracted during data reporting and associated with each patient. Data quality was evaluated April 1 – Sept 30, 2021 and discrepancies identified were reviewed and investigated.

**Results:** A total of 147 care plans were implemented to represent the RT-QBP protocols used locally. Evaluation found that 96% of cases were correctly associated with RT-QBP protocols upfront. The remaining 4% were investigated and processes were revised to avoid similar mismatches in the future.

**Conclusions:** Applying care plans to represent RT-QBP protocols was a robust strategy to link patients with the correct protocol. Strategies to manage care plans when treatment plans are discontinued or modified will further support data quality for accurate data submissions to ensure accurate radiotherapy funding.

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## ASSESSMENT OF THE USAGE OF HYPOFRACTIONATION FOR PROSTATE CANCER IN AN LMIC BEFORE AND AFTER THE COVID-19 PANDEMIC

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**Purpose:** One of the recommendations to minimize the number of visits to the hospital during the COVID-19 pandemic was to use safe hypofractionated radiotherapy (HFx) regimens whenever possible. For patients with prostate cancer, this meant to decrease the number of visits from 37-39 to 20 or, in some cases, to 5. However, in low and middle-income countries (LMIC), this could be a challenge due to several factors. The objective is to investigate the practice and the limitations on the use of HFx for patients undergoing curative radiotherapy (RT) for prostate cancer (PCa) in an LMIC before and after the COVID-19 pandemic.

**Materials and Methods:** Two questionnaires were sent to Brazilian radiation oncologists through the Sociedade Brasileira de Radioterapia: the first questionnaire was answered in 2018 when the survey was created in preparation for the Brazilian Annual Scientific Meeting. The same questionnaire was resent to the same audience in 2021, with some adaptations regarding changes in practice related to the COVID-19 pandemic. The questionnaires queried technical aspects, clinical indications, and impediments to implementing HFx. The results were analyzed by descriptive statistics methods.

**Results:** A total of 135 and 173 radiation oncologists answered the surveys in 2018 and 2021, respectively. Before the pandemic, 40% of the respondents routinely used HFx for PCa. This number increased to 69% in 2021. Among the 51 participants who started HFx in the last two years, only three justified the change in practice due to COVID-19 pandemic. The most used regimen of moderate HFx was 60Gy in 20 fractions in both surveys: 77.8% in 2018 and 72.5% in 2021. Daily image-Guided Radiation Therapy (IGRT) for patients undergoing HFx was utilized in 66.7% in 2018 and 71.6% in 2021. Analyzing the two surveys, 47 radio-oncologists answered both questionnaires, which 21 of them changed for HFx, and none identified the pandemic as the cause for change in practice. The main reasons listed for starting HFx were improved confidence in the maturing clinical evidence and the acquisition of new technology. Overall, the change to HFx happened mostly in centres caring for private/private health insurance (46%) or those composed of a mix of private and public health care (47%).

**Conclusions:** The use of HFx for PCa increased in Brazil between 2018 and 2021; however, the reasons for its implementation were not related to the COVID-19 pandemic. Most departments that started HFx during this period are private or linked to private health insurance. The lack of technology continues to be an obstacle for centres treating patients treated in the public health system.

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## IMAGE-BASED MACHINE LEARNING CLASSIFIER TO PREDICT LUNG METASTASES TREATMENT: A FEASIBILITY STUDY

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**Purpose:** In our institution, the management of patients with lung metastases is reviewed at a dedicated weekly multidisciplinary tumour board (MDT). In a previous phase of this project, a Machine Learning (ML) classifier trained on clinical parameters was developed and successfully reproduced management decisions for local treatment versus other options. We aim to expand upon this initial model and incorporate image-derived parameters from patient CT image data to improve the specificity of the ML classifier's recommendations. The preliminary results of classifying Surgery and Stereotactic Body Radiotherapy (SBRT) treatment decisions is presented.

**Materials and Methods:** Semi-automated segmentation on lungs, mediastinum and proximal airways was performed on thoracic CT datasets using an atlas-based algorithm. Lung lesions and lung fissures were manually segmented. Scripts were developed to parameterize lesion and normal tissue contours and extract geometric parameters from the segmented datasets. Parameters of interest included: minimum distances from lesion to mediastinum, pleural surface, chest wall, closest fissure, lesion volume and density (mean Hounsfield unit). The preliminary modeling included only patients with Surgery and SBRT decisions to test the ability of the image-based model to classify between the two local treatment modalities. Due to the limited size of the dataset, 3-fold cross validation was performed to evaluate the performance of a range of ML models (ridge regression, support vector machine, naïve Bayes, random forest). Feature selection was performed to remove highly correlated features.

**Results:** The preliminary phase of testing included modelling decisions on a dataset of parameterized features for 40 lesions across 32 patients, consisting of 22 surgery and 18 SBRT treatment decisions. Feature selection resulted in the identification of four features of interest: minimum distances from lesions to closest fissure and pleural surface, lesion volume and density. The best performing model was a random forest classifier which classified Surgery versus SBRT treatment decisions, with a mean Area under the Receiver operating characteristic Curve (AUC) of 0.780 and standard deviation, (SD) of 0.071 and mean accuracy of 0.761(SD = 0.073).

**Conclusions:** This initial modeling demonstrated the feasibility of using image-derived geometric parameters and ML classifier to predict local treatment decision (surgery versus SBRT) for patients with lung metastases. Next steps will include completing the manual segmentation of lesions and fissures for additional patients and testing the ML classifier on a larger dataset. Clinical information will also be incorporated into the classifier input parameters, which may improve the performance of the model.

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## CLINICAL IMPLEMENTATION OF HYPERARC FOR STEREOTACTIC RADIOSURGERY AT TRILLIUM HEALTH PARTNERS - CREDIT VALLEY HOSPITAL

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**Purpose:** Stereotactic Radiosurgery (SRS) is being increasingly used in the management of patients with multiple brain metastases. The SRS program at Trillium Health Partners was implemented in 2014 using a cone-based system for treating distinct brain metastases individually. With increased radiation utilization in the region and limited number of linear accelerators we implemented HyperArc for treatment of multiple brain metastases.

**Materials and Methods:** HyperArc is a dedicated hardware and software solution that delivers SRS (or fractionated SRS (SRT)) to multiple brain metastases using a single isocenter. HyperArc uses built-in automation and frameless immobilization (QFix-Encompass, QFix, Avondale, PA) in combination with image-guidance to provide precise patient localization. We evaluated the benefit of HyperArc in terms number of metastases treated per session and the reduction in overall treatment times per session. Plan quality was also assessed using the RTOG (RTOGCI) and Paddick (PCI) conformity indices.

**Results:** A total of 9 patients have been treated with HyperArc. The median patient age was 57.5 (39-76) years. Tumour histology included lung (n=8), renal (n=1) and adrenal (n=1). None of the patients had previous cranial radiation. For these patients, a total of 80 targets were treated in 9 treatment sessions using HyperArc. The average cumulative intracranial tumour volume was 10.2 cc. The cumulative treatment time (patient setup, image matching and beam on time) was 6 hours (40 minutes per session; 4.5 minutes per metastases). For 80 lesions treated individually using the cone-based single-metastasis approach, the cumulative treatment time is 60 hours (45 minutes per metastasis). Both RTOGCI and PCI were superior for HyperArc (1.09) compared to cones (1.21).

**Conclusions:** HyperArc dramatically reduces treatment time for linac based SRS, thus benefiting patients by reducing time spent in hospital and improving throughput in a busy community radiation program. Our study also demostrates that plan quality is superior compared to cone-based SRS.

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## DAILY ASSESSMENT OF ON-TREATMENT TUMOUR REGRESSION BY CONE BEAM CT REVEALS PROGNOSTIC DYNAMIC BIOMARKERS IN NASOPHARYNGEAL CANCER

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**Purpose:** Despite advancements in radiotherapy, approximately 30% of nasopharyngeal cancer (NPC) patients develop treatment failure. Dynamic on-treatment biomarkers may provide early evidence of response and improve risk stratification and treatment selection. Using daily cone beam computed tomography (CBCT) scans, we measure air volume recovery, an automated surrogate of tumour regression, and report its association with outcomes. We hypothesize that faster rate and greater total magnitude of air volume recovery predicts improved failure-free survival (FFS).

**Materials and Methods:** Thirty-nine consecutive NPC patients (two Stage II, 26 Stage III, 11 Stage IVA-B), ECOG 0-1, underwent radical radiotherapy (n=5) or chemoradiotherapy (CRT) (n=34) to a planned dose of 70 Gy in 35 fractions (Fx). Primary gross target volume (GTVp) was propagated from planning CTs to daily CBCTs by rigid registration and a density threshold was applied to measure the air volume in a 5 mm uniform expansion of the GTVp. Air volume was expressed as percent of planning GTVp volume. Missing values were interpolated, air volume trajectories were smoothed by sliding window averaging, and area under the curve (AUC) was calculated to provide a summary metric capturing both magnitude and rapidity of air volume recovery. Primary endpoint was FFS.

**Results:** Median AUC of the air volume recovery curve was 2.8 (Range: 0.05-7.4). Patients with above-median AUC had longer FFS (HR=0.28, log-rank p=0.045, median follow-up: 83 months). Exploration of clinical factors associated with air recovery showed that AUC was higher in CRT than RT alone (OR: 1.74±1.60, p=0.04), lower in large tumours with high GTVp volume (OR: -0.037±0.18, p<0.001), and was not correlated with disease stage. Current smokers had 26% lower median AUC than never/former smokers (p=0.132). AUC was lower in patients with detectable end-of-treatment Epstein-Barr virus (EBV) circulating tumour DNA (median AUC 0.99 versus 2.8 in undetectable EBV, p=0.021). We performed exploratory post-hoc analysis on air volume velocity (slope of air volume curve) and identified two independent putative positive prognostic biomarkers: high mid-treatment slope and negative end-treatment slope. Patients without failure had higher mid-treatment air recovery velocity (Fx 15-22), with Fx 18 velocity yielding the maximal FFS difference (HR: 0.12, p=0.007). Negative velocity at the end of treatment was associated with improved regional (p=0.033) and distant metastatic (p=0.013) control.

**Conclusions:** Greater and more rapid tumour regression, inferred by the CBCT surrogate measure of air volume recovery, was associated with improved FFS. This discovery cohort also allowed us to identify promising dynamic biomarkers which might guide treatment adaptation. Specifically, we observed strong clinical outcome associations with mid- and end-treatment air recovery velocities. Validation of these biomarkers is ongoing in a large cohort of NPC patients with mature follow-up.

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## A PROSPECTIVE COST COMPARISON BETWEEN HIGH-DOSE-RATE AND LOW-DOSE-RATE PROSTATE BRACHYTHERAPY

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**Purpose:** To determine the overall costs of equipment and personnel used during low-dose-rate (LDR-BT) and high-dose-rate (HDR-BT) prostate brachytherapy procedures.

**Materials and Methods:** Forty intra-operatively planned HDR-BT and 33 intra-operatively planned LDR-BT procedures performed at a single academic centre were prospectively observed by an individual independent from the operating room. All patient interactions with each member of the care team on the day of the procedure were monitored and the time taken was recorded.

Furthermore, all equipment used was tracked and capital costs per procedure, with the exception of the operating room itself, recorded. Means and standard deviations (SD) were then compared using the student's t-test.

**Results:** Mean personnel cost per HDR-BT procedure was $2097 (SD: $310). Mean equipment cost was $1549 ($61). This generated a mean total cost of $3647 ($319) per HDR-BT procedure. For LDR-BT, mean personnel cost was $1387 ($92) per procedure. Mean equipment costs was $2334 ($267). This generated a mean total cost of $3721 ($295) per LDR-BT procedure.
The difference in cost for personnel ($p<0.001$) and equipment ($p<0.001$) between procedures was statistically significant. The difference in overall cost between LDR-BT and HDR-BT was not significant ($p=0.303$).

**Conclusions:** Overall, prostate HDR-BT and LDR-BT have a similar cost per procedure. However, total costs are distributed differently with HDR-BT utilizing more personnel and less equipment related resources than LDR-B

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**RADIATION-INDUCED SARCOMAS OF THE BREAST: A REVIEW OF A 20-YEAR SINGLE-CENTRE EXPERIENCE**

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**Purpose:** Radiation-induced sarcomas (RIS) comprise only 2.5-5.5% of all sarcomas. Diagnosis requires histologically proven sarcoma within or around a previously irradiated site per Cahan's criteria. After a prolonged latency period, breast cancer patients have a higher incidence of RIS compared to other primary solid cancers. While the mechanism of RIS development is unclear, prognosis remains poor given often limited treatment options. This study aimed to review incidence, risk factors, management, and subsequent oncologic outcomes of breast RIS using 20-year experience at a large tertiary care centre.

**Materials and Methods:** Using our institutional cancer registry database, patients with histologically proven sarcomas of the breast diagnosed between the years 2000 to 2020 were identified. Patients meeting Cahan's criteria were included. Patient demographics, oncologic treatment of primary breast cancer and subsequent sarcoma, and oncologic outcomes were collected from our electronic medical record systems. Descriptive statistics were used to describe demographic data. Oncologic outcomes were assessed using the Kaplan Meier method.

**Results:** Nineteen patients with breast RIS were identified: 11 angiosarcomas, three osteosarcomas, two carcinosarcomas, two undifferentiated pleomorphic sarcomas and one high-grade leiomyosarcoma. The median age at RIS diagnosis was 72 years (range 39-82, mean 67) and median latency period for development of RIS was 112 months (range 53-300, mean 120). All patients underwent total or partial mastectomy (n=14 and n=5, respectively), three patients received systemic therapy, and six patients received re-irradiation as salvage treatment. The median follow-up time was 31 months (range 6-172, mean 48) from diagnosis of RIS. Overall, five patients had local recurrence and one patient developed distant metastases. The median time to progression was seven months (range 4-14). The progression-free survival (95% CI) at two years was 56.1% (37.4-84.4%). At two years follow-up after sarcoma diagnosis, two patients were deceased, resulting in an overall survival (95% CI) of 88.9% (75.5-100%).

**Conclusions:** While RIS of the breast remains rare, when managed in a high patient-volume centre, overall survival outcomes appear favourable. A significant proportion of patients recur locally after maximal treatment, confirming the aggressive nature of this disease. Salvage is of utmost importance to improve outcome. Given the rarity of this disease in the context of limited treatment options, patients with RIS should be managed in high-volume centres where multidisciplinary expertise is available.

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**SEMINAL VESICLE TREATMENT FOR LOCALIZED PROSTATE CANCER TREATED WITH EXTERNAL BEAM RADIOTHERAPY**

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**Purpose:** This study retrospectively reviewed men with localized prostate cancer treated with external beam radiotherapy (EBRT) at the Cross Cancer Institute to assess the seminal vesicle (SV) contours by radiation oncologists. We hypothesized that radiation oncologists are more likely to contour the proximal SVs in men with > 15% risk of SV involvement.

**Materials and Methods:** We identified 298 men with localized prostate cancer treated with curative EBRT at the Cross Cancer Institute between 2010 – 2011. The volume of SVs treated and doses for different parts (base, proximal and total) were extracted. These volumes were compared to gold standard contours from contouring guidelines that were drawn by a trained expert. At the same time, patient and tumour characteristics were extracted for these patients, including date of birth, Gleason score, PSA, T stage, and radiation details. The Memorial Sloan Kettering prostate cancer nomogram was used to assign a predicted risk of SV involvement for each patient based on baseline tumour characteristics.

**Results:** In patients with a predicted risk of SV involvement greater than 15% (n=134), 85.6% (range= 0–100%, SD=19.7) of the base of the SVs were treated with EBRT, compared to 61.7% (range= 0-100%, SD= 34.6) for patients with a predicted risk of SV involvement less than 15% (n=164, $p<0.0001$). Similarly, the mean percentage of proximal and total SV volumes treated with EBRT were 75.0% (range= 0–100%, SD= 22.8) and 66.6% (range= 0–100%, SD= 24.9), compared to 46.4% (range= 0–100%, SD= 32.3, $p<0.0001$) and 37.8% (range= 0–98.4%, SD= 28.9, $p<0.0001$) for patients with a predicted risk of SV involvement of less than 15%.

**Conclusions:** The results indicate that all parts of the SVs are more likely to be contoured in men with > 15% risk of SV involvement than those with < 15% risk. However, radiation oncologists still contour a high percentage of SVs in men with < 15% risk of SV involvement, suggesting that there may be over-treatment of SVs that increases the risk of rectal or bladder toxicity.

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**THE EFFECTS OF A CURRICULUM CHANGE ON PEER MENTORSHIP AMONG RADIATION ONCOLOGY RESIDENTS**

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**Purpose:** Peer mentorship is the educational, professional, and personal support provided amongst trainees within a similar level of training. While peer mentorship has shown to benefit academic success and professional growth, little data has examined contextual factors, such as curricular change, that may affect the accessibility, content, and quality of these relationships. This study aims to explore peer mentorship among Radiation Oncology

(RO) resident physicians following the implementation of a new nationwide, competence-based RO residency curriculum, known as Competency by Design (CBD).

**Materials and Methods:** Two cohorts of Canadian RO residents in English programs were invited to participate - one being the final academic year before CBD implementation (non-CBD cohort entering training in July 2018), and the other being the inaugural CBD academic year (CBD cohort entering training in July 2019). Residents participated via convenience sampling and engaged in semi-structured interviews to elicit their thoughts and perceptions on the impact of curriculum change on peer mentorship. Interviews were conducted until data saturation, meaning that no new ideas or themes were emerging from the data. Interviews were audio-taped, transcribed, and de-identified. Iterative data collection was conducted in parallel with thematic analysis methods, using both deductive and inductive analysis, to generate themes to describe findings.

**Results:** Between April and December 2021, 14 interviews were conducted with 6 non-CBD (32% response rate) and 8 CBD (53% response rate) residents, at which point thematic saturation was achieved. Participants represented 8 out of 10 eligible English RO training programs across Canada. Three major themes were identified: (i) the CBD-cohort identified fewer opportunities for peer mentorship in navigating formal evaluation processes, and in discussing uncertainties about the later stages of residency training; (ii) peer mentorship tended to thrive when able to occur as spontaneous in-person interactions; and (iii) there was minimal impact on specialty-specific learning.

**Conclusions:** Findings from this study identified that inaugural RO residents of a new curriculum experienced uncertainty and fewer opportunities for peer mentorship around curriculum-specific objectives and evaluations. Peer mentorship was most impactful as informal and in-person interactions. Our findings suggest that the unintended consequences of curriculum change on resident peer mentorship may be mitigated with improved orientation and communication about stage-specific training objectives, and to provide increased opportunities for informal activities amongst residents to foster peer mentorship.

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## ENGAGING ONCOLOGISTS TO ADVANCE CANCER CARE: EVALUATION OF PROVINCIAL ENGAGEMENT INITIATIVE

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**Purpose:** Physician engagement contributes to health system efficiency, cost reductions, improved health outcomes and decreased errors as well as improved physician satisfaction and patient satisfaction. Facility Engagement (FE) is a provincial initiative to improve physician engagement with leadership. With FE support, in 2016 oncologists at a provincial Cancer centre formed a Medical Staff Engagement Society (MSES) to advance physician engagement within a province. MSES funded engagement projects were conducted from 2017-2019. As a first measure of evaluation, we undertook a process to describe the initiatives and map them to existing engagement frameworks.

**Materials and Methods:** All engagement projects conducted by MSES from 2017-2019 were collated and reviewed. Sources of data included initial applications, progress and final reports. Projects were excluded if no progress or final report was available. Data with respect to participants, initiative location/description was extracted. Recognizing no gold standard to classify engagement, three frameworks were used to describe initiatives and possible impacts on the cancer care system; Institute for Healthcare Improvement (IHI) Quadruple Aim, International Association for Public Participation (IAP2) Levels of Engagement and the Provincial Safety and Quality Council Dimensions of Quality (SQCDQ). A single research assistant coded the projects, with iterative discussion with the PI to ensure consistency. A third coder helped resolve discrepancies and assurance in coding consistency.

**Results:** Thirty-nine oncology related projects were included in the evaluation (10 in 2017, 20 in 2018 and nine in 2019). All projects took place in six regional cancer centres. The projects spanned multiple oncology disciplines; Radiation/Medical/Surgical/Gynecological/Oral Oncology, Psychiatry, Pathology, Functional/Diagnostic Imaging, Medical Genetics, Diagnostic Imaging, Palliative Care, and Hereditary Cancer. The total funding distributed was $758,825 with an average project cost of $17,000. With respect to the IHI framework 30 were related to Improving Provider Satisfaction, 22 Enhancing Patient Experience, 14 Improving Population Health and two Reducing Cost of Care. With respect to the IAP2 framework; 16 projects were Inform, seven Consult, eight Involve, 25 Collaborate and 11 were Empower. When projects were classified according to SQCDQ there were eight related to Respect, seven Safety, four Accessibility, 16 Appropriateness, 26 Effectiveness, one Equity, and 22 Efficiency.

**Conclusions:** The FE initiative is a unique opportunity for medical staff to engage with leadership to have a positive impact on the health care system. Over a three-year period MSES funded a wide variety of engagement activities with the potential to enhance both oncology provider and patient experience. This project identified areas for potential growth in this initiative. Longitudinal evaluation will be required to understand the lasting effects of this on cancer care delivery.

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## FORECASTING INSTITUTIONAL LINAC UTILIZATION IN RESPONSE TO VARYING WORKLOAD

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**Purpose:** Institutional radiotherapy (RT) utilization is generally not subject to significantly weekly or monthly fluctuations, allowing adequate time for equipment and workforce capacity adjustment. However unforeseen circumstances such as pandemics and natural disasters can cause short-term variation in RT utilization. We aim to develop a model to forecast linear accelerator utilization (LU) during periods of varying workload.

**Materials and Methods:** Using CT simulation data and the rate of new bookings in the preceding week as input parameters, a multiple linear regression model to forecast LU over a 20-working day horizon was developed and tested on institutional data. The performance of the model was assessed by comparing the actual and predicted LU over the entire data period, from January 1st to September 23rd, 2020. In addition to testing the numerical differences between the actual and predicted LU, the ability of the model to predict significant variations in LU (>5% absolute change) was investigated. If >5% change was forecasted in the specified horizon, this was "flagged" as a significant increase or decrease in LU.

**Results:** In total, 4448 unique courses of LINAC-based RT corresponding to 56,484 fractions were delivered during the analyzed period. Future LU was estimated in our dataset with a forecasting error of 3.3%, 5.9%, 7.2% and 9.0% at days 5, 10, 15 and 20, respectively. The model identified significant variations

(>5% absolute change) in LU with an accuracy of 69%, 62%, 60% and 52% at days 5, 10, 15 and 20, respectively.

**Conclusions:** The developed linear regression model was able to accurately forecast future LU based on booking rate and CT simulation data, and has been incorporated into our institutional dashboard for broad distribution. This model or variations of this approach could be used for resource planning during periods of varying LINAC workload.

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**SALVAGE INTERSTITIAL BRACHYTHERAPY FOR TREATMENT OF RECURRENT ENDOMETRIAL CANCERS IN THE VAGINA: SEVEN-YEAR SINGLE INSTITUTION EXPERIENCE**

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**Purpose:** Interstitial brachytherapy (ISBT) is an effective, accepted treatment for vaginal recurrence of endometrial cancer (EC). This study reviews a large tertiary institution's experience and presents outcomes for recurrent EC in the vagina treated with ISBT.

**Materials and Methods:** Patients who underwent salvage ISBT for vaginal recurrence of EC from January 1, 2014 - August 31, 2021, were included. Patients with second primaries or distant metastases at diagnoses were excluded. Initial disease factors, treatment details, recurrence and salvage treatment details were recorded. Actuarial outcomes calculated include overall survival (OS), local (LF), nodal (NF), and distant failure (DF).

**Results:** Forty-two patients were included; median age was 67, most initial cancers were adenocarcinoma (81%; 34/42), grade 1 (43%; 16/37), and stage IA (62%; 24/39). Initial treatment included adjuvant external beam radiation (EBRT) (17%), vaginal vault BT (19%), EBRT and vaginal vault BT (7%) and chemotherapy (12%). Median time from surgery to recurrence was 14 months. At recurrence, 19% (8/42) had lymph node involvement and 7% (3/42) distant metastases. For salvage, 26% (11/42) of patients received BT alone, 74% (31/42) EBRT and BT and 29% (12/42) sequential chemotherapy. Thirty-nine cases used interstitial technique while 3 had interstitial technique then multi-channel cylinder for remaining fractions. The most common prescription for salvage BT alone was 42Gray in 6 fractions while in combination with EBRT was 21Gray in 3 fractions. Mean BT HRCTV90 was 5397cGy, mean dose to Rectum D2cc 2938cGy and Bladder D2cc4237cGy. Mean BT and EBRT HRCTV90 was 7686cGy, mean dose to Rectum D2cc 6249cGy and Bladder D2cc 6735cGy. Median follow-up after salvage BT was 20 months (0-84). For patients undergoing salvage EBRT and BT, 2-year overall survival was 85.6%, local failure at 2 years 24% and distant failure at 2 years 37.6%. With salvage BT alone, 2-year overall survival was 83.3%, local failure at 2 years 16.7% and distant failure 54.3%. Four patients received repeat BT for second vaginal recurrence. One patient experienced grade 3/4 late toxicity with radiation proctitis and small bowel obstruction.

**Conclusions:** ISBT is an effective treatment for recurrent EC of the vagina, with acceptable toxicities. Salvage BT alone is an option for patients with previous or contraindication to pelvic radiation.

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**INTERVENTIONS TO SUPPORT NUTRITION IN PATIENTS UNDERGOING CONCURRENT CHEMORADIATION FOR ESOPHAGEAL CANCER: A SYSTEMATIC REVIEW OF RANDOMIZED TRIALS**

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**Purpose:** Chemoradiation for esophageal cancer can lead to substantial nutritional challenges for patients due to treatment effects coupled with primary tumour symptoms. Malnutrition can impact recovery, quality of life, and disease outcomes but nutritional supports vary widely. We conducted a systematic review of randomized trials to evaluate interventions supporting nutrition in patients undergoing concurrent chemoradiation for esophageal cancer.

**Materials and Methods:** A systematic review was performed to PRISMA guidelines. Medline and Embase were queried from inception to June 2021. Included trials were English randomized trials comparing nutrition-focused interventions, in non-metastatic esophageal primary cancers undergoing concurrent chemoradiation with neoadjuvant or radical intent. Post-operative treatments, lung or head-and-neck primaries, and abstracts were excluded. Independent reviewers screened abstracts, full texts and performed risk of bias assessment, with independent audit. Relevant data were abstracted, grouped and synthesized in narratively.

**Results:** Of 3,603 records evaluated, eight met inclusion criteria including 529 patients in studies completed between 2013 and 2020, and all in Asia. Studies were of moderate to high risk of bias. In six studies reporting histology, 95% of tumours were squamous cell carcinomas. Patients had Stage 2B+ disease, and performance status of ECOG-2 or better. Feeding tube use varied. Three studies utilized chemoradiation in a neoadjuvant setting, and five radically. Neoadjuvant doses were between 40-50.4Gy, and radical from 50-65Gy. Concurrent chemotherapy regimens were platinum-based regimens, paired with paclitaxel, 5-FU, or cisplatin alone. Common endpoints included weight loss, biochemical nutritional status, and acute toxicity.

Three trials studied interdisciplinary counselling and assessment with customized dietary interventions during the course of therapy, compared with standard care, two of which were in inpatient setting. All intervention arms showed significant improvement in toxicity rates, and reduced weight loss.
Two trials investigated enteral immune-nutrient fortified supplements (arginine, glutamine, omega-3) administered via percutaneous gastrostomy tubes compared to standard feeds. Both failed to show significant differences. Two others investigated oral supplements and regular dietitian assessment with routine physician assessment alone. While overall differences were minimal, one demonstrated improved lean body mass, and the other decreased Grade 3+ hematologic toxicity.

A walk-and-eat intervention was piloted in one study, demonstrating significantly better weight and lean muscle maintenance than standard care.

**Conclusions:** Various nutrition-focused interventions have demonstrated benefit for esophageal cancer patients undergoing chemoradiotherapy. Quality randomized data are limited, and significant heterogeneity precluded metanalysis. There is no clear evidence to recommend a specific approach and more RCTs are needed.

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**THE RADIATION INCIDENT SAFETY COMMITTEE: SUPPORTING CANCER PROGRAMS IN THE DELIVERY OF HIGH QUALITY RADIATION TREATMENT**

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**Purpose:** The Radiation Treatment Program (RTP) at Ontario Health Cancer Care Ontario (OH-CCO), established the Radiation Incident Safety Committee (RISC) responsible for promoting incident learning, safety and quality improvement. The committee uses a provincial approach, discussing regularly reported safety events, to operationalize quality improvement initiatives intended to support integrated cancer programs (ICP)s. A retrospective review of actual incident event types reported identified variation in the number of submitted incidents within a portion of ICPs. In response to this observed variation, RISC sought to identify areas of success and opportunities for improvement in supporting ICPs in effective incident reporting and learning.

**Materials and Methods:** RISC distributed a three-part survey to ascertain the current state of the quality and incident reporting practices across the province. The survey explored program quality and incident reporting practices across the following three domains. 1. Compliance with the Canadian Partnership for Quality Radiotherapy's (CPQR) "Quality Assurance Guidelines for Canadian Radiation Treatment Programs" guidance document. Specifically exploring the document's key quality indicators relevant to incident reporting. 2. Local incident reporting culture and practices, and 3. The programmatic impact of RISC initiatives.

**Results:** 73% of programs (n=15) identified that they regularly review compliance to the CPQR indicators, with 67% of programs reviewing compliance within the last year. 100% of programs had procedures to identify critical radiation treatment incidents and report incidents as per requirements of local, provincial, and/or national organizations. 87% of responding programs identified that they had written policies and procedures regarding the reporting, investigation, action, documentation, and monitoring of treatment. Finally, with respect to incident learning processes, 80% of programs perform root cause analyses for severe events or those at risk for programmatic impact.

With respect to RISC Initiatives, responding ICPs described they had established mechanisms to share RISC deliverables and incident alerts with the inter-professional team and radiation department. Programs also identified that RISC initiatives had a positive impact, providing guidance and improving reporting consistency. Finally, ICPs identified that there were opportunities for further support, specifically in the interpretation of dosimetric impact and the classification of complex events.

**Conclusions:** The RISC survey identified a number of successes and opportunities for improvement. Programs have implemented policies and procedures surrounding incident reporting and learning, however, there are opportunities to improve aspects of incident reporting at a local and provincial level. RISC plans to establish novel solutions to support programmatic learning as the committee continues to expand its mandate, improving the quality and safety of radiation treatment in Ontario.

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## VIRAL DISEASE GOES VIRAL: CHARACTERIZING HOW CANCER PATIENTS USE INTERNET RESOURCES FOR COVID-19 INFORMATION

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**Purpose:** Patients are increasingly using the Internet for health information. This study aims to evaluate the usage of Internet resources for COVID-19 information amongst cancer patients. Specifically, to understand where patients are seeking information, what topics are most frequently searched, and how physicians and web developers can improve clinical conversations and digital resources, respectively, to support cancer patients' needs.

**Materials and Methods:** From May to June 2021, cancer patients who were attending follow-up at a tertiary cancer centre completed a survey consisting of 28 closed and open-ended questions. This survey has been iteratively developed and validated through a process of design-based research. Quantitative results were evaluated using descriptive statistics and qualitative responses were evaluated using a grounded-theory approach.

**Results:** Fifty-seven surveys were distributed, and fifty-two surveys were received (91% response rate). The majority of respondents (96%) were Internet users. 70% used the Internet as a source of information about COVID-19 and cancer personally, with another 15% reporting that friends and family accessed online information on their behalf. The vast majority used Google as their choice of search engine, with COVID-19 rates and vaccine information being the most frequently searched topics. Three quarters (74%) considered Internet information easy to understand, and 90% stated that the Internet increased their understanding of COVID-19 and cancer. Only 15% of patients had been recommended online resource(s) by a physician, yet 100% of those patients found the physician-recommended sites useful.

**Conclusions:** Most cancer patients in this study use the Internet to search for COVID-19 information. Healthcare professionals (HCPs) should help guide patients towards credible online sources and address knowledge gaps to improve physician-patient communication and support educational needs.

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## CANADIAN ONCOLOGY RESIDENTS' KNOWLEDGE OF AND ATTITUDES TOWARDS ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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**Purpose:** The use of artificial intelligence (AI) and machine learning is becoming more common and is expected to expand further in order to meet the needs of our ever-evolving healthcare system. In oncology, AI and machine learning are already being explored in various applications. Despite AI's importance, there is sparse formal teaching on AI incorporated into medical schools' curricula and residency training programs. In this study, we examined the perceptions and knowledge of Canadian oncology residents and fellows with respect to AI technologies.

**Materials and Methods:** An electronic, anonymous, questionnaire-based survey was distributed to residents and fellows in medical and radiation oncology programs across Canada. Survey questions spanned areas of demographics, familiarity with AI, personal attitudes towards AI, and perspectives regarding AI use in different specialties. Approval was obtained from the Queen's Research Ethics Board prior to conducting this study. Mixed-methods statistical analysis is ongoing. Qualitative data
will be analyzed using thematic analysis. Univariable and multivariable regressions will be conducted to identify any correlation between perception or knowledge of AI and demographic factors.

**Results:** Fifty-seven participants responded in total. Most residents (67%) agreed or strongly agreed that it was important they learn about AI. Seventy percent indicated that, if given the chance, they would like to learn more about AI, yet the majority of participants (88%) indicated they had not received formalized teaching. Disciplines that were felt to be most associated with AI were radiology (98%), radiation oncology (84%), and pathology (58%). With respect to the field of radiation oncology, 98% of respondents

felt that AI had the potential to replace some, most, or all medical activities. A perceived barrier to understanding AI was a lack of knowledge of mathematics and programming (63%). Respondents indicated that their preferred formats for learning about AI would be workshops (78%), lectures (60%), and collaborative activities with other departments (46%).

**Conclusions:** Our results show that Canadian oncology residents' sense that AI is important and relevant to their area of training. Despite this, they have not received education on these topics. Thus, formalized teaching, such as lectures and workshops, would be perceived as beneficial by most Canadian oncology residents.

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**PEDIATRIC THYROID CANCER. CURRENT MANAGEMENT AND OUTCOMES. CROSS CANCER INSTITUTE ALBERTA CANADA**

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**Purpose:** Thyroid cancer is a rare pediatric malignancy. Literature is limited with respect to treatment and outcomes. Our treatment regimen has been refined over time. We review presentation, disease extent, treatment and outcomes for our patient cohort.

**Materials and Methods:** Thirty three pediatric thyroid cancer patients were treated at the our institution since 2002. All patients received total thyroidectomy. Twenty nine patients received thyroid ablation with radioactive I131. All patients were placed on a suppression regimen with Levothyroxine. Patients are followed with physical examinations, thyroid function testing and thyroglobulin levels. Other clinical investigations are requested as indicated.

**Results:** Thirty three (26F) patients presented with thyroid cancer between 2002-2022. Age range is 5 to 17 years old. Median follow-up period is 9.92 years, range 0.23 to 19.32 years. Most patients presented with a neck mass. Fifteen of 33 presented with disease limited to the thyroid gland, 17/33 presented with thyroid gland disease and metastatic to regional lymph nodes, and one of 33 patients presented with thyroid disease, regional nodes and lung mets. Twenty-seven cases were papillary, five follicular and one medullary carcinoma. Tumour in 19 cases was confined to one lobe. Extra capsular disease was noted in seven cases. Twenty-five patients had nodal evaluation. Positive nodes ranged from 0-45. Risk factors include thyroiditis, family or personal history of thyroid disease, radiation exposure and family history of MEN IIA. 28/29 patients ablated with radioactive I131, had residual uptake on post therapy imaging.

Thirty-one patients have no recurrence and are disease free. Two of 33 patients with neck recurrence at one and 10 years were treated with further surgery are currently disease-free.

**Conclusions:** Total thyroidectomy with lymph node evaluation followed by I131 thyroid ablation and subsequent thyroid suppression is a highly successful treatment approach for children with thyroid cancer. Long-term disease-free survival is seen.

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**UNILATERAL VERSUS BILATERAL RADIOTHERAPY FOR OROPHARYNGEAL CARCINOMA: IMPACT ON LONG TERM SYMPTOM BURDEN**

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**Purpose:** Bilateral neck radiotherapy (RT) is often required for oropharyngeal carcinoma (OPC) patients while unilateral neck RT is used for selected small well-lateralized primary tonsillar tumours with no/minimal ipsilateral nodal disease. Our purpose is to compare long-term symptom burden following unilateral versus bilateral RT in patients with oropharyngeal carcinoma (OPC).

**Materials and Methods:** A retrospective review was conducted for patients with T1-3 N0-2b (AJCC 7th edition) tonsillar cancer treated with IMRT from 2011 to 2017. Patient-reported symptom burden was collected in routine practice using the MD Anderson Symptom Inventory (MDASI) at baseline, RT-end (three weeks pre or post final RT fraction), 3 weeks – 3 months, 3 – 6 months, 6 – 12 months, 12 - 24 months, and 24 - 36 months post RT. Within each period, the latest record was chosen if there were multiple records for one patient. MDASI symptom scores (from 0 = "not present" to 10 = "as bad as you can imagine") were compared between unilateral versus bilateral RT groups using Wilcoxon Rank-Sum tests and linear mixed effect model.

**Results:** A total of 256 patients were eligible, of whom MDASI scores were available in 125 including 22 (18%) with unilateral and 103 (82%) with bilateral neck RT. Median age was 59 years, and 95 (76%) were male. The differences in "Dry Mouth" scores from baseline to six months and from baseline to 36 months were significantly better (lower) in the unilateral RT group on mixed effect model analysis [mean 2.11 (95% CI: 1.056 – 3.17) versus 3.72 (95% CI: 3.15 – 4.29), p=0.004] and [mean 1.43 (95% CI: 0.44 - 2.42) versus 2.62 (95% CI: 2.1 - 3.13), p=0.04] respectively; these differences meet a conventional threshold for clinical importance. MDASI change scores in other domains were similar between the two groups (all p>0.05). Mean MDASI raw scores were highest at RT-end for all domains with improvement by 2 years for most symptoms. The unilateral RT group had significantly better (lower) raw MDASI scores in "Dry Mouth" at baseline (mean 0.3 versus 1.4, p=0.045) and six months post RT (mean 2.6 versus 5.4, p<0.001). "Swallowing" raw scores were statistically significantly better (lower) in the unilateral RT group at six months post-RT (mean 2.1 versus 3.5, p=0.047).

**Conclusions:** Patients receiving unilateral RT fare better with "dry mouth" by six months and 36 months and possibly with "swallowing" by six months post-RT compared to patients receiving bilateral RT.

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**RADIOTHERAPY DOSE, FDG-PET UTILIZATION AND SURVIVAL OUTCOMES OF UNRESECTED LOCALLY ADVANCED NON-SMALL CELL LUNG CANCER (LA-NSCLC). ONTARIO POPULATION OUTCOMES OF CONTEMPORARY RADIOTHERAPY ALONE AND STANDARD OF CARE CHEMO-RADIOTHERAPY**

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**Purpose:** Standard of care (SOC) therapy for unresected locally advanced non-small cell lung cancer (LA-NSCLC) involves concurrent chemo-radiotherapy (cCRT) followed by consolidative immunotherapy. Radiotherapy (RT) is utilized as monotherapy in a substantial proportion of unresected LA-NSCLC patients, but outcomes in those patients are not well-described. In this population-based study we analyzed LA-NSCLC outcomes of RT alone in Ontario Canada and contrasted them against those of cCRT.

**Materials and Methods:** Ontario provincial databases were searched through the Institute of Clinical Evaluative Sciences (IC/ES) to find Stage III NSCLC patients diagnosed between 2007 and 2017. Surgical patients were excluded, and all patients that received RT without or with chemotherapy were selected. Patients

were divided in groups of RT dose received (<40Gy, 40-55.9Gy, and ≥56Gy) and whether they underwent diagnostic FDG-PET.

**Results:** Between January 2007 and March 2017, 110,690 individuals were diagnosed with NSCLC in Ontario. Of these, 5577 were Stage III patients were treated with chest RT and no surgery. Within this group, 39.9% (2,225) received RT alone, 47.4% (2,645) received cCRT, and 12.7% (707) received sequential chemoradiation. Median OS (mOS) with RT alone in the three dose groups (<40/40-55.9/≥56 Gy) was 7.2, 8.5 and 13.3 months compared to 16.5, 15.8 and 22 months for cCRT patients. Higher RT dose and PET utilization were independently associated with improved survival in multivariate analysis.

**Conclusions:** RT is used frequently as monotherapy in LA-NSCLC. Higher dose RT and utilization of FDG-PET imaging are associated with improved survival. These findings can help improve patient education, clinical decision making and serve as basis for future clinical trials

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**PATIENT AND PROVIDER EXPERIENCE WITH A 7-DAY/WEEK RADIATION ONCOLOGY CARE MODEL DURING COVID-19**

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**Purpose:** To maintain capacity during sequential replacement of 2/6 LINACs Trillium Health Partners extended its radiation treatment service from 5 to 7 days/week from January to December 2020. To gain insight into whether a 7-day treatment model is feasible and appropriate it is critical to understand the experiences and perceptions of patients as well as health care providers and staff. This report describes how the 7-day radiation model affected the patient and provider experience receiving or providing radiation therapy during the COVID-19 pandemic.

**Materials and Methods:** Patients with breast cancer (n=5) or prostate cancer (n=5) who received radiation treatment on both weekdays as well as weekends were interviewed and asked to describe their radiation oncology care journey. In addition, health care providers and staff (n=11) from different roles (e.g. RT, physics, clerks) within the radiation oncology department were interviewed and asked to describe their overall experience providing care during the 7-day model and the COVID-19 pandemic. These open narratives were followed by a semi-structured interview surveying their specific experience with receiving or providing care within the 7-day model and during the COVID-19 pandemic. In this study we applied a qualitative descriptive approach and thematic analysis.

**Results:** Benefits and challenges related to the 7-day radiation treatment model were identified within the following topics: receiving or providing treatment in the weekend; transportation; continuity of care; teamwork; communication; scheduling; staffing; and support. Additional topics were identified related to the COVID-19 pandemic: the impact of COVID-19 prevention measures – i.e. physical distancing; working from home; visitor policy; and concerns about getting infected or spreading COVID-19.

**Conclusions:** The 7-day treatment model was overall positively received by patients, however, from the providers' perspective the 7-day model was very challenging to execute. Both the patient and provider experiences should be interpreted in the context of the COVID-19 pandemic.

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**BRAIN METASTASIS HYPOFRACTIONATED STEREOTACTIC RADIOTHERAPY OUTCOME IN A SINGLE INSTITUTION**

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**Purpose:** The development of brain metastases heralds a dismal prognosis and remains a substantial contributor of high mortality in patients with advanced-stage cancer. Historically, craniotomy and whole-brain irradiation (WBI) have been standard of care for patients with brain metastases, with median survival only 3 to 4 months. However, long-term neurotoxicity and associated complications from WBI encouraged the use of a more localized radiation modality. This study reviews our single-institution experience with brain metastasis patients' outcomes during two years since adopting hypofractionated stereotactic radiotherapy (HSRT).

**Materials and Methods:** This retrospective study was approved by our institution's Research Ethics Board. All charts of patients with brain metastases between November 2018 and April 2021 were reviewed. A total of 51 patients and 75 lesions were treated with HSRT to a median prescribed dose of 30 Gy (range 20-30 Gy) in 5 fractions every other day; nine of them also received WBI with dose of 20 Gy in 5 fractions every day. Patients underwent follow-up with MRI, generally every three months after HSRT.

**Results:** The cohort's mean age was 66 years (37-90), 55% were female, and 55% had two or more major comorbidities. Of the 51 patients analyzed, most primary sites were from lung (67%), breast (12%), colorectal (6%), gastric (6%), melanoma (4%), head and neck (2%), and unknown primary (2%). The longest dimension of the brain metastases ranged from 4 mm to 39 mm (median 12 mm) on diagnostic MRI. Sixty-nine percent patients presented with solitary lesion and 31% with two to four oligo brain metastases. The most common tumour locations were the frontal lobe 36%, parietal lobe 17% and cerebellum 17%. According to the Kaplan-Meier curve, the overall survival at three, six, and 12 months were 72.7%, 45.5%, and 30.8%, respectively. The median survival after HSRT was six months. Using Response Evaluation Criteria in Solid Tumours (RECIST) guideline, local control rates at three, six, and 12 months were 91.8%, 77.4%, and 66.3%, respectively. Radionecrosis emerged in only four of 75 lesions (5.3%).

**Conclusions:** HSRT achieved good local control and survival in patients with brain metastases, with acceptable low rate of radionecrosis. Our findings suggest that it is safe and well-tolerated. HSRT could be a good alternative for solitary or oligo brain metastases if craniotomy and WBI are not desired. Further randomized controlled trials with larger cohorts and longer follow-up are warranted.

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**ASSESSMENT OF INTRAFRACTION MOTION FOR SPINE AND NON-SPINE BONE METASTASES TREATED WITH IMAGE-GUIDED STEREOTACTIC ABLATIVE RADIOTHERAPY WITHOUT 6 DEGREES-OF-FREEDOM COUCH CORRECTION**

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**Purpose:** Stereotactic ablative radiotherapy (SABR) allows the precise delivery of large radiation doses with smaller planning target volume (PTV) margins than conventional radiotherapy. PTV margins are influenced by uncertainties with immobilization, image-guidance, and intrafraction motion among other factors. There is limited data on the assessment of intrafraction motion in bone SABR, particularly for non-spine lesions. This study assessed our institutional data on intrafraction motion in patients

with spine and non-spine bone metastases treated with SABR on a standard treatment couch without 6 degrees-of-freedom (6-DOF) correction.

**Materials and Methods:** Patients who received extracranial bone metastasis-directed SABR between January 2017 and July 2021 were identified and classified based on location of metastasis (spine or non-spine). Targets superior to and including T4 were immobilized with a thermoplastic mask of the head and shoulders, while targets inferior to T4 were immobilized using a commercial SABR immobilization system. Spinal metastases were treated with a 2 mm PTV margin and non-spine metastases were treated with a 5 mm PTV margin per institutional policy. Patients were treated on a standard treatment couch where pitch and roll rotational corrections could not be applied. All patients were treated with volumetric modulated arc therapy using 2 arcs and targets were localized using daily cone-beam computed tomography (CBCT) prior to each arc with a radiation oncologist present at each fraction to verify the match in real-time. Alignments between the first and second CBCT images yielded intrafraction positional shift values in the medial-lateral (x), superior-inferior (y), and anterior-posterior (z) axes. The absolute values of these shifts were recorded and the translational 3-dimensional vector value was computed.

**Results:** A total of 125 SABR fractions from 43 patients were reviewed. This included 57 fractions from 19 patients with spine metastases and 68 fractions from 24 patients with non-spine metastases. The median number of fractions evaluated per patient was 2 (range 2-5). After the intrafraction CBCT, the median vector shift for all SABR fractions was 0.7 mm (range 0-6.6 mm). Spine targets had a median vector shift of 0.7 mm (range 0-2.3 mm), while non-spine targets had a median vector shift of 0.9 mm (range 0-6.6 mm). For spine targets, a 1.8 mm PTV margin would cover 90% of intrafraction shifts. For non-spine targets, a 3.4 mm margin would cover 90% of intrafraction shifts.

**Conclusions:** Intrafraction motion is small for patients with bone metastases treated with SABR using stereotactic immobilization systems and daily CBCT on a standard couch without 6-DOF correction capabilities. Intrafraction motion was slightly larger for non-spine sites and may require treatment with larger PTV margins than spine cases. High quality SABR for bone metastases is feasible in centres with less advanced treatment equipment provided an appropriate PTV margin is used.

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## RETROSPECTIVE CHART REVIEW OF CADIAC DOSE FOR EARLY-STAGE BREAST CANCER PATIENTS: AN ANALYSIS OF MEAN HEART DOSE AND TREATMENT VOLUME

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**Purpose:** Appropriately selected patients with low-risk, early-stage, node-negative breast cancer can be treated using multicatheter interstitial brachytherapy accelerated partial breast irradiation (MIB-APBI), with the benefit of reduced treatment volumes and favourable toxicity. For left-sided patients, MIB-APBI has variable dose delivery to the heart depending on the location of the treated volume. We report retrospective data of mean heart dose (MHD) for patients with left-sided breast cancer treated using MIB-APBI at our institution since 2014.

**Materials and Methods:** Patients treated with 3400 cGy in 10 fractions or 3200 cGy in 8 fractions (BID) or 3010 cGy in 7 fractions over 5 days who did not withdraw consent for inclusion in clinical studies were included. The MHD was calculated using the Oncentra 3.2 planning system. The minimum distance between the planning target volume (PTVeval) and heart contour was measured manually.

**Results:** 81 patients were included in this study. The upper outer quadrant was the most common cavity site for implantation. The MHD was 97.8 cGy ($EQD2_{a/b=2}$) (range 22-229 cGy). Median distance between PTVeval and heart contour was 2.8 cm (IQR 2.6-3.95 cm). MHD significantly correlated with the distance between PTVeval and heart contour (correlation coefficient -0.76). Size of PTVeval (cc) and quadrant did not correlate with MHD.

**Conclusions:** Appropriately selected patients with low-risk, early-stage, node-negative left-sided breast cancer who received MIB-APBI had MHDs well within institutionally acceptable dose constraint (<300 cGy) and below recommendations (<200cGy) published by Darby et al. (1). There was a strong correlation between the distance of PTVeval and MHD. These findings contribute to the growing evidence of the utility of MIB-APBI as a safe treatment option for appropriately selected patients, with acceptable mean cardiac doses. Further research is ongoing comparing MHD with historical controls treated with external beam radiation therapy at our centre.

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## DOSIMETRIC EVALUATION OF A NEW RT TECHNIQUE COMBINING STEREOTACTIC BODY RADIOTHERAPY (SBRT) TO HDR INTERSTITIAL BRACHYTHERAPY (ISBT) AS BOOST FOR LOCALLY ADVANCED CERVICAL CANCERS

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**Purpose:** Brachytherapy (BT) as a boost to external beam radiotherapy (EBRT) has an undisputable role in the management of locally advanced cervical cancers. The addition of interstitial needles improves HR-CTV coverage and local control outcomes in larger tumours when compared to treatments using intra-cavitary options alone. Nevertheless, some post-EBRT lesions remain bulky and/or in tricky locations, compromising the ability to achieve optimal brachytherapy dosimetry despite use of multiple interstitial needles. In this setting, this study suggests a new technique that integrates SBRT boost to the ISBT (Combo-RT) and investigates the dosimetric performance of this treatment in comparison to plans delivered with ISBT alone. In this concept, the SBRT boost component would be delivered with the brachytherapy applicator still in place and using it as a surrogate during image verification.

**Materials and Methods:** Patients with large and/or anatomically challenging post-EBRT lesions treated with perineal based ISBT technique were retrospectively selected. The selection of the BT technique was at the discretion of the treating physician. The Combo-RT plan was developed for each patient by integrating a modified ISBT plan (with the same needle implantation used in the clinical ISBT plan) with a new SBRT plan. The SBRT boost volume was created by applying a 5 mm margin to the 100% isodose from the ISBT plan and then subtracting it from the HR-CTV. A 3 mm PTV expansion was applied to this volume for SBRT planning and dose evaluation. VMAT plans were created in Aria (Varian Inc, Palo Alto-USA) using 2 half arcs and with multiple iterations between ISBT and SBRT plans until the final Combo-RT plan was achieved. Target and organ-at-risk (OAR) dosimetry followed the well-established GEC-ESTRO guidelines (considering EBRT 45Gy in 25 Fxs and a total of 4 BT fractions with 700cGy each) and were compared between planning modalities using descriptive analysis.

**Results:** Four patients were included in this study with a mean HR-CTV of 88 $cm^3$ (SD 47). All patients had a well-placed intra-uterine tandem and a median of 8.5 (range: 5-14) interstitial needles implanted. The mean HR-CTV D90 improved from 679cGy

(SD 84) to 750cGy (SD 32) by using the Combo-RT plan. The IR-CTV aim of D90 ≥ 450cGy was achieved in all patients planned with the Combo-RT plan versus 3 in the ISBT plan. It was always achievable to create a Combo-RT plan that met both the target and OAR dosimetry goals of GEC-ESTRO, whereas there were two clinical ISBT plans that could not meet target coverage, and one clinical ISBT plan that also could not meet bowel and sigmoid D2cc constraints.

**Conclusions:** The addition of SBRT to ISBT for challenging locally advanced cervical cancer lesions seems to improve HR-CTV dosimetry while respecting OAR constraints. A more in-depth dosimetric investigation is currently in place.

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**RE-IRRIDIATION FOR RECURRENT BRAIN A RETROSPECTIVE STUDY FROM A TERTIARY HOSPITAL IN SAUDI ARABIA**

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**Purpose:** To analyze the post-re-RT progression-free survival (PFS) and incidence of radio-necrosis (BRN) in patients with recurrent primary brain tumours and to explore the associated factors.

**Materials and Methods:** A retrospective cohort study that included 15 pediatric and adult patients with primary brain tumours who were treated with re-RT between 2011 and 2020. The study endpoints included the post-re-RT PFS, which were analyzed using Kaplan-Meier survival analysis, and the incidence of radio-necrosis. Baseline demographic and clinical data, primary radiation therapy (RT1) parameters and outcomes, and re-RT parameters and outcomes, were analyzed as factors for the two outcomes.

**Results:** Of the 15 participants, 7 had glioblastoma and 5 had anaplastic ependymoma. The mean interval from first RT to re-RT was 24 months (range=2 – 60 months). The mean total cumulative dose after re-RT as per EQD2 (equivalent dose in 2 Gy) fractions was 101.97 Gy (max 135.6 Gy). The total mean (max) cumulative doses for organs at risk as per EQD2 after re-RT were 54.05 (92.93) Gy for brain stem, 41.19 (87.94) Gy for optic chiasma, and 28.79 (77.18) Gy and 28.6 (88.71) Gy for left and right optic nerves respectively. Disease progression occurred in 10/15 patients, and the median PFS was 4 months (95%CI=0 – 9.1). Although not statistically significant, PFS was likely to be prolonged in case of low-grade tumours, longer RT1–re-RT time. Radiation necrosis occurred in two patients.

**Conclusions:** The expected clinical benefits against the adverse effects should be contemplated for re-irradiation in primary brain tumours.

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**IMPACT OF TIMING OF ADJUVANT RADIOTHERAPY ON LOCO-REGIONAL CONTROL IN PATIENTS WITH HIGH-RISK ENDOMETRIAL CANCER**

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**Purpose:** High-risk endometrial cancer is characterized as having a higher risk of regional and distant recurrence rates. We sought to examine our institutional experience regarding the timing of adjuvant radiotherapy and local failure (LF) loco-regional failure (LRF), and distant failure (DF).

**Materials and Methods:** We retrospectively reviewed a database of patients with high-risk endometrial cancer treated with sequential chemotherapy (4-6 cycles) followed by adjuvant EBRT plus or minus brachytherapy from 2013 to 2018.

**Results:** One hundred and thirty-one patients were identified. Median age at diagnosis 59 (range 28-81) The most prevalent FIGO Stage were IIIB 28.2% (n=37), IIIC1 19.8 % (n=26), and IIIA 17.6 % (n=23). 29% (n=38) of patients had positive lymph nodes and 71% (n=93) negative lymph nodes. The most prevalent histology type was endometroid 71% (n=93), serous 12.2% (n=16), clear cell 9.2% (n=12), others 7.6% (n=10). 100% (n=131) of the patients completed EBRT. Mean EBRT dose 49.6 Gy(45-50.4). Median number of days between surgery to EBRT was 216 days (103-279). Mean Brachytherapy dose 14.7 Gy (12-30). Cumulative incidence of LF 10.7%, LRF 19% and DF 19%. For patients who completed EBRT 180 days after surgery LRF [HR 3.55 (1.23-10.2) (P= 0.013)], LF [HR 3.91 (0.9-17) (P= 0.054)] and DF [HR 0.91 (0.41-2) (P= 0.806)]

**Conclusions:** In our cohort of patients treated with sequential chemotherapy, delaying RT was associated with an increased risk of loco-regional failures.

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**STRATEGIES FOR INCREASING ACCESS TO PALLIATIVE RADIATION THERAPY USING A CLINICAL SPECIALIST RADIATION THERAPIST-MEDIATED MODEL OF CARE: A CAMRT WHITE PAPER REVIEW**

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**Purpose:** The role of the palliative Clinical Special Radiation Therapist (pCSRT) has been well-established in Ontario's cancer care framework. The purpose of this study was to summarize the work of nine pCSRTs to encourage wider implementation of a pCSRT-facilitated model of care for managing patients requiring palliative radiation therapy (pRT).

**Materials and Methods:** Mixed methods data, including time studies, survey results, and concordance studies, were collected from nine existing pCSRTs in Ontario demonstrating the positive effects of a pCSRT-mediated model of care. Evidence was categorized in four key areas: increased system capacity, improved quality of care, increased professional influence and systems influence. For each area, challenges identified by pCSRTs, actions taken, results and examples were provided.

**Results:** The pCSRT role in Ontario has demonstrated the ability to increase system capacity for pRT by expediting care, enhancing access to care, and enabling time savings by undertaking unscheduled activities. The pCSRT is also able to improve the quality of care for patients by contributing to system improvements and identifying gaps in existing models of care, enhancing the quality and safety of treatment, providing leadership in technical innovations/implementations, and improving overall patient satisfaction. The pCSRTs also demonstrate increased professional influence, evidenced by their academic contributions and overall system engagement in palliative radiation therapy initiatives.

**Conclusions:** After review of the evidence and experience summarized in this White Paper, the Canadian Association of Medical Radiation Technologists (CAMRT) has recognized the success of the palliative Clinical Specialist Radiation Therapist-mediated model of care and its ability to improve and address many challenges to increase access to care, improve the patient experience/quality of life, facilitate community outreach, and enhance pRT education. The pCSRT-mediated model of care is an important and innovative strategy to increase access to pRT, and should be considered for expansion to other jurisdictions.

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## CLINICAL OUTCOMES AFTER SALVAGE TREATMENT WITH EXTERNAL BEAM RADIOTHERAPY COMBINED WITH INTERSTITIAL BRACHYTHERAPY FOR RECURRENT ENDOMETRIAL CANCER

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**Purpose:** To document the efficacy and toxicity profile of salvage external beam radiation therapy (EBRT) followed by interstitial brachytherapy (ISBT) for patients with vaginal recurrence of endometrial cancer.

**Materials and Methods:** Twelve consecutive patients with biopsy-proven vaginal recurrence after surgically treated endometrial cancer (EC) who received salvage EBRT (45Gy in 25 daily fractions to microscopic disease and 55-57.5Gy to gross nodal disease) with ISBT (20-21Gy in 3 fractions over two days) at a single tertiary cancer care centre between June 2016 and June 2021 were retrospectively reviewed. Descriptive statistics were used to characterize the cohort. Toxicity was graded using the common criteria for adverse events reporting (CTCAE) v5.0. Cumulative incidence (CI) of recurrence was then calculated. All analyses were performed using the r programming language (www.r-project.org).

**Results:** Median (inter-quartile-range (IQR)) follow-up from diagnosis of recurrent disease was 22 (18-28) months. Median (IQR) tumour size of recurrent disease on magnetic resonance imaging (MRI) was 5 (3-6) cm. Three (25%) tumours involved bladder wall, three (25%) involved urethra and four (33%) extended to the pelvic sidewall. Four (25%) patients had gross nodal disease. Elective pelvic nodal radiation volumes included inguinal nodes in seven patients (58%), and para-aortic nodes in two patients (16%). At the time of ISBT, median (IQR) residual tumour size on repeat MRI was 3 (1-4) cm. On follow-up, no (0%) patient had local recurrence. One patient (8%) developed nodal recurrence outside of the radiotherapy treatment volume, and one patient (8%) developed distant metastasis 2.5 years post-treatment and subsequently died from disease. No (0%) other deaths were reported. At two years post-treatment, CI of regional failure was 8 (95% confidence interval: 0-23)%. No patient (0%) developed Grade 3+ bowel or bladder toxicity.

**Conclusions:** The current study supports a growing body of literature that shows salvage EBRT with ISBT for vaginal recurrences of endometrial cancer after primary surgery is both efficacious and safe.

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## REVIEW OF 20 YEARS OF ADULT MEDULLOBLASTOMA TREATMENT AT A HIGH-VOLUME CENTRE - CHEMOTHERAPY PRESCRIPTION TRENDS AND SURVIVAL

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**Purpose:** Medulloblastomas are WHO Grade 4 tumours, representing less than 1% of adult brain malignancies. Standard of care is maximal safe resection followed by craniospinal and primary site radiation – chemotherapy's role has been unclear. The objective of this study was to review 20-year chemotherapy prescribing trends in adult medulloblastoma patients at a high-volume centre, with secondary objectives assessing overall and progression free-survival.

**Materials and Methods:** A retrospective review was performed of adult medulloblastoma patients at a high-volume centre from 1999-01-01–2020-12-31. Eligible patients were 18 years and older with a pathologic diagnosis of medulloblastoma – supratentorial primitive neuroectodermal tumours were excluded. Descriptive statistics were used for population data and Kaplan–Meier estimators for survival.

**Results:** Forty-three patients were eligible; median age was 30 and male: female ratio was 2:1. Desmoplastic and classical histologies were the most common. Molecular subgroup was available for 6 patients, with SHH predominating. Of all patients, 47% (23/49) were classified as high risk –commonly due to large cell/anaplastic histology or large residual. Only 10 (20%) received primary chemotherapy (concurrent or adjuvant), 70% of which were high risk. Of those who received primary chemotherapy, 30% went on to receive chemotherapy for recurrence or metastases; of the entire population, this was only 39%. Primary regimens were mainly cisplatin/lomustine/vincristine, while recurrence regimens often cisplatin/etoposide. The majority who received primary chemotherapy were treated from 2010–2020. Median overall survival was 7.8 years (95% CI 5.7–∞), with 1-, 5-, and 10-year survival 95.8%, 67.5% and 42.2% respectively. Overall survival was marginally better for those who did not receive primary chemotherapy (8.5 years) versus those who did (7.4 years). The main chemotherapy toxicity was hematologic and neuropathy – 90% of primary chemotherapy patients experienced toxicity

**Conclusions:** This study reviewed 20 years of treatment for adult medulloblastoma patients. Only a small proportion of patients received chemotherapy as their primary treatment- these patients had marginally worse overall survival, perhaps due to baseline worse clinical status not captured by the definition of high risk disease. Despite calls for adjuvant chemotherapy for all adult medulloblastoma patients, there is clinical equipoise and future randomized trials needed.

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## IMPACT OF CLINICAL TRIAL PARTICIPATION ON BIOCHEMICAL RECURRENCE IN PROSTATE CANCER PATIENTS TREATED WITH EXTERNAL BEAM RADIATION THERAPY

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**Purpose:** There is a widespread belief that the outcomes of cancer patients treated within clinical trials might not be representative of the outcomes obtained within standard clinical settings. Most studies showing a benefit of trial participation on oncologic outcomes included patients receiving various systemic treatments, and very few data exist regarding this trial effect for patients treated with radiation therapy. We sought to investigate the effect of trial participation on biochemical recurrence (BCR) in prostate cancer patients treated with external beam radiation therapy (EBRT).

**Materials and Methods:** Patients treated with EBRT for non-metastatic D'Amico intermediate- or high-risk prostate cancer at the Centre hospitalier de l'Université de Montréal between January 2001 and January 2021 were included in this retrospective analysis and stratified according to trial enrollment. All data were collected from the prospectively maintained institutional database. Kaplan-Meier plots and multivariable Cox regression models tested five-year BCR-free survival and its association with trial participation after adjustment for age, cT-stage, PSA at diagnosis, Gleason score, ratio of positive biopsy cores, androgen deprivation therapy, and equivalent dose in 2-Gy fractions.

The analyses were refitted after inverse probability treatment weighting (IPTW) was performed for age, year of EBRT, Gleason score, cT-stage and time from biopsy to EBRT.

**Results:** Of 932 eligible patients, 635 (68%) and 297 (32%) had intermediate- and high-risk prostate cancer, respectively. Overall, 53% of patients were trial participants. BCR rates were 11 versus 5% (p=0.27) and 12 versus 14% (p=0.08) in trial participants versus non-participants for intermediate- and high-risk subgroups, respectively. Trial participation was not a predictor of BCR in multivariable Cox regression models in both intermediate- (hazard ratio [HR]: 1.34; 95% confidence interval [CI]: 0.72-2.49; p=0.36) and high-risk patients (HR: 1.03; 95% CI: 0.45-2.34; p=0.90). These results were unchanged in the IPTW cohorts.

**Conclusions:** Relying on a large prospectively maintained database, clinical trial participation does not affect biochemical recurrence in EBRT-treated intermediate- and high-risk prostate cancer patients after accounting for potential confounders.

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**CLINICAL INNOVATION: INTEGRATION OF PATIENT PARTNERS WITHIN THE MULTIDISCIPLINARY ONCOLOGY TEAM**

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**Purpose:** Inclusion of Patient Partners (PP) who have experienced an oncologic care trajectory to the oncology multidisciplinary healthcare team engages patients into their own care trajectory, improves patient care experience while improving the quality of care and thus, contributing to a more patient centered approach. The PPs, are selected and trained to support the patients as well as to contribute as an integral part of the oncology healthcare team. This project aimed for oncology patients to have an PP included into their healthcare team.

**Materials and Methods:** This is a mixed longitudinal observational and descriptive study carried out among patients, PPs and health professionals (radiation oncologists, oncologist, surgeons, nurses). Validated questionnaires measuring distress (K6) and ability to cope with cancer (CASE) were administered to the patients. Descriptive analysis and Chi2 analysis were performed. Qualitative analysis from interviews with PPs and professionals were carried out.

**Results:** Since December 2019, 501 patients were supported by 24 PPs following the referral of 20 professionals in 2 healthcare centres. Questionnaires highlighted that the PP intervention reduced patients anxiety by sharing their experiences (92,3%), helped them prepare for medical appointments (84,6%), were more proactive in decision-making (53,8%) and ultimately had a better quality of life (69,2%). The initial PP appointment (T1) allows a better patient comprehension and participation in care (59.2%) and allowed them to seek and obtain more information (59.2%). One month later (T2), the PP intervention gave patients a better comprehension and participation in their care (65.5%). There was no significant difference in stress level in patients between T1 and T2. For professionals, a questionnaire taken during the intervention and 2 years later showed that they were more willing to work with PPs (83.3%). PPs also contributed a unique and complementary perspective for patients while improving healthcare services (83.3%). For PPs, this gave meaning to their oncologic care trajectory (62,5%) while allowing them to give back to others (62,5%).

**Conclusions:** The integration of PPs into oncology healthcare teams benefits both patients, PPs as well as the care team. This constitutes an innovative model allowing a more patient-centered and humanistic approach in oncology.

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**A FRAMEWORK FOR REAL-WORLD CLINICAL IMPLEMENTATION OF TECHNICAL INNOVATIONS IN RADIATION ONCOLOGY**

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**Purpose:** To develop a standard implementation methodology for clinical implementation of technical innovations in radiation oncology.

**Materials and Methods:** A systematic clinical implementation framework was developed to compliment the R-IDEAL framework (1) for clinical evaluation of technical innovations in radiation oncology. The development of the clinical implementation framework was grounded in principles of process design, knowledge-to-action theory and models of sustainability, scale-up and spread. To understand and define the phases of development work required for successful clinical implementation, a prospective observational design was used with the MR-Linac as the test case. Disease site clinical leads collaborated with the interdisciplinary MR-Linac technical team to plan and deliver MR-guided adaptive radiotherapy (MRgART) on the MR-Linac. As new patient cohorts were introduced into the MR-Linac clinical workflow, an iterative process was leveraged to further refine the phases of work with feedback from operational team members.

**Results:** The knowledge required and activities involved, for simulation, treatment planning and adaptive treatment delivery, were identified and refined in order to safely and effectively deliver MRgART on the MR-Linac. The phases of the framework include (1) Process Identification, (2) Process Development, (3) Process Prototyping, (4) Implementation, Normalization and Evaluation and (5) Monitoring and Improvement. Each phase is executed consecutively with checkpoints and deliverables associated with the process, along with ongoing monitoring and evaluation of identified measures and key quality indicators. Observations during the implementation of 3 patient cohorts have highlighted the need for: building technical team expertise; actively creating opportunities for knowledge exchange and collaborative protocol development with the disease site leads and technical team; and clarity of roles and responsibilities of the interdisciplinary team. Additionally, observations demonstrated the need to have a robust process to efficiently refine clinical protocols and operational tools based on audit findings and feedback mechanism to ensure the operational team is appropriately supported during Phase 3 and 4.

**Conclusions:** A methodical, multi-phased implementation strategy is associated with successful clinical implementation of MRgART on the MR-Linac across patient cohorts. The development and execution of the phases within the framework suggests that a framework grounded in theory can be used to practically drive sustained clinical use and scale up of novel radiation technologies to improve patient access.

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**EVALUATING THE ONCOLOGY RESEARCH INTERNSHIP (ORION) DURING THE COVID-19 PANDEMIC: A COMPARISON OF VIRTUAL AND IN-PERSON ITERATIONS**

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**Purpose:** The Oncology Research Internship (ORIoN), a novel resident-supervised initiative for medical students (MS), was first established in 2018 and found to be mutually beneficial to both residents and MS. The COVID-19 pandemic halted many scholarly programs, including ORIoN, which relied heavily on mentorship through in-person interactions. We report results of

the first virtual program, adapted to the COVID-19 pandemic, and compare participant feedback to previous in-person iterations.

**Materials and Methods:** ORIoN application details were published online and emailed to first- and second-year MS. A panel of three physicians reviewed and scored applications independently. Successful MS applicants were paired with volunteer resident supervisors; each pair supervised by a staff oncologist. Compared to previous years, all meetings, correspondences and presentations between MS, residents, and supervising oncologists were conducted exclusively remotely. Only chart reviews were conducted on-site by MS. At the program's conclusion, each MS delivered a live virtual oral presentation of their completed case report, previously done in-person. Resident and MS participants completed questionnaires pre-/post program. Responses were collected on a 5-point Likert scale with open-ended free-text responses. Survey results from this virtual and the previous in-person programs were compared.

**Results:** Of 54 applications (previously 32 in 2018), 9 MS (three first-year, six second-year) were accepted and assigned to nine volunteer residents (six radiation oncology, two medical oncology, one pathology). To date, nine manuscripts have been completed with two submitted for publication (one published, one under review). Survey response rates were 100% (9/9) for residents and 89% (8/9) for MS. In the post-program surveys comparing the virtual and prior in-person programs, 87.5% (7/8) MS felt comfortable completing a clinical research project (22% strongly agree (SA), 62.5% agree (A), previously 25% and 75% respectively) and 100% (8/8) felt comfortable writing a case report (50% SA, 50% A, previously 75%, 25% respectively). All MS felt comfortable giving an oral research presentation (37.5% SA, 62.5% A) and teaching another MS to complete a case report (37.5% SA, 50% A). Similar to the in-person program, MS unanimously agreed that ORIoN was a beneficial experience (100%) and felt the program contributed to their career goals (100%, previously 88%). Post-program, all residents felt comfortable as a supervisor (67% SA, 22% A, previously 33%, 67% respectively), reviewing manuscripts (56% SA, 33% A, previously 33%, 50% respectively) and providing constructive feedback to trainees (67% SA, 33% A, previously 17%, 67% respectively).

**Conclusions:** Compared to the previous in-person program, the virtual ORIoN retained strongly favourable ratings from MS and residents alike. These findings support adapting similar scholarly and mentorship programs to a virtual setting when in-person interactions are not feasible.

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**THE ROLE OF CAPRA SCORE AS A PREDICTOR OF OUTCOMES IN HIGH-RISK PROSTATE CANCER PATIENTS TREATED WITH EBRT PLUS HDR BRACHYTHERAPY BOOST**

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**Purpose:** This study aims to report clinical outcomes of high-risk prostate cancer (PCa) patients treated with external beam radiation therapy (EBRT) and high dose-rate boost (HDRB) according to CAPRA score.

**Materials and Methods:** The study sample consisted of 361 high-risk PCa patients according to D'Amico classification and treated with EBRT and HDRB and antiandrogen therapy (ADT) between 1999 and 2016. We conducted retrospective competing-risk survival analyses to compare individuals with a CAPRA score lesser than or equal to five and greater than five on biochemical relapse (BCR) and metastasis incidence. Kaplan-Meier analysis was performed to assess overall survival (OS). Subsequently, we used ROC curves to compare the performance of the CAPRA model to an adapted form of the MSKCC stratification tool on BCR and metastasis incidence.

**Results:** The mean age of the patients at treatment time was 69.6±7.3 years. The median follow-up was 55.5 months. Of the 361 individuals, 52,4 % (n=189) had a CAPRA score above five. In comparison to individuals with a CAPRA score lesser than or equal to five, individuals with a CAPRA score above five were deemed at higher risk of BCR (sHR = 2.74, 95% CI: 1.12-6.66, p=0.027) and demonstrated a tendency towards significance in their metastasis incidence (sHR 2.33 95% CI: 0.89-6.12, p=0.085). For 10-year OS, there was a HR for mortality of 1.89 (95% CI: 1.04-3.43, p=0.036) for individuals with a CAPRA score above five. There was no significant difference between either risk stratification strategy in ROC curves analysis.

**Conclusions:** The data suggest that patients' tumours classified as high-risk using the CAPRA score correlated with a higher risk of BCR, metastasis, and mortality when compared to lower-risk tumours. Further studies are needed to validate the use of the CAPRA score to predict cancer-specific mortality (CSM) as an additional risk stratification tool.

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**CALCIFICATION AND IMAGE GUIDED RADIOTHERAPY FOR LOCALIZED HIGH-RISK PROSTATE CANCER**

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**Purpose:** Fiducial markers have been used in hypofractionated image-guided radiotherapy (HIGRT) of prostate cancer to improve localization of the target and accuracy of treatment delivery. However, their insertion is an invasive procedure with some associated risks and increased costs. Calcification inside the PTV (CIP) may be a natural fiducial marker. We reviewed CT scan images of prostate cancer patients treated with HIGRT without fiducial markers, to determine the frequency of CIP and to compare potential differences in toxicity between patients with and without CIP.

**Materials and Methods:** We retrospectively reviewed planning CT and CBCT scans of high-risk prostate cancer patients treated in our institution with moderate HIGRT (60Gy/20 fractions in 4 weeks), all without fiducial markers. CT slice thickness measured 3 mm. The PTV margin was 7mm from prostate. The presence of CIP should be visible in both the planning CT and CBCT scans. GU and GI toxicity were prospectively scored according to the CTCAE.v3.

**Results:** Between November 2012 and August 2015, 100 consecutive cases that had CBCTs were reviewed. We observed 16 cases (16%) without and 84 (84%) with CIP in both the planning CT and CBCT images. In two-thirds of patients, two or more CIP were seen on the imaging studies. Median follow-up was 64 months.

Acute Grade 2 or greater toxicity in patients with or without CIP was as follows: GI 10% and 11%, and GU 2% and 20%, respectively. Similarly, late Grade 2 or greater toxicity was as follows: GI 4% and 2%, and GU 4% and 3%, respectively.

**Conclusions:** In patients undergoing radiotherapy for prostate cancer, the presence of CIP was high (84%). This observation is consistent with other publications. Acute and late GU or GI toxicity were similar in patients with or without CIP. Maybe routine insertion of fiducial markers can be avoided in HIGRT.

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## POPULATION-BASED TREATMENT AND OUTCOMES FOR SQUAMOUS CELL CARCINOMA OF THE NASAL CAVITY

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**Purpose:** The optimal treatment for patients with squamous cell carcinoma (SCC) of the nasal cavity is unknown. This study evaluates population-based outcomes of patients treated in our province.

**Materials and Methods:** Patient characteristics, treatments, and outcomes were retrospectively evaluated for patients with nasal cavity SCC treated in our province from 1980 to 2014. Patients who had metastatic disease or who were treated with palliative intent were excluded. Completing risk analysis was used to assess loco-regional recurrence (LRR) and the Kaplan-Meier method was used to assess overall survival (OS). Multivariable competing risk analysis was used for LRR and Cox regression analysis for OS.

**Results:** There were 159 patients. Median follow-up was 7.8 years. The median age at diagnosis was 68 years (Interquartile Range 56-77 years) and 56% of patients were male. Most were current (38%) or former (38%) smokers. The majority (87%) were ECOG status 0-1 at diagnosis. The stage breakdown was as follows: 46% Stage I, 24% Stage II, 11% Stage III, and 15% Stage IV.
Primary treatment was as follows: 57% had upfront surgery to the nasal cavity and 3% had neck dissection. Radiotherapy was delivered for 79%, of these 71% the volumes were nasal cavity alone and 29% were nasal cavity and neck. Only 7% received concurrent cisplatin chemotherapy. Three-year LRR was 28% for RT alone, 28% for surgery alone and 23% for surgery + RT (p=0.21). Three-year OS was 62% for RT alone, 67% for surgery alone and 65% for surgery + RT (p=0.16). On MVA, larger primary tumour size was associated with higher LRR (HR 1.27, p=0.05). Surgery + RT relative to surgery alone was associated with lower risk of LRR (HR 0.36, p=0.03). Poor ECOG status (HR 2.26, p=0.02), node positive (HR 3.49, p=0.01), orbital invasion (HR 3.63, p=0.008), smoking (HR 2.18, p=0.01), and advanced age HR 1.04, p<0.001) were associated with worse OS.

**Conclusions:** In this population-based analysis, dual modality treatment with surgery and adjuvant RT was associated with improved LRC for squamous cell carcinoma of the nasal cavity.

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## RADIATION ONCOLOGY RESIDENT PREFERENCES FOR VIRTUAL OR IN-PERSON TREATMENT PLANNING REVIEW AND TEACHING FORMAT

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**Purpose:** The project aimed to determine if radiation oncology residents prefer in-person or virtual treatment planning review and teaching formats, and the reasons contributing to these preferences.

**Materials and Methods:** Email questionnaires were distributed to current PGY1-PGY5 residents in Canadian radiation oncology programs, examining level of training, typical teaching format, preferred teaching format, and reasons for format preference. Chi-square tests compared differences in teaching format preference and reasons for preference.

**Results:** Analysis excluded PGY1s due to insufficient treatment planning exposure during first year. Study response rate was 54.7%, with representation across training level (PGY2=25%; PGY3=33%; PGY4=21%; PGY5=21%). Most respondents typically review radiation plans with both virtual and in-person formats (76.9%). Some typically review only in-person (17.3%). Fewest typically review only virtually (5.8%). When asked which format they prefer, Virtual (V) platforms were most preferred (44.2%), followed by In-Person (IP) (36.5%), and Both (V&IP) (19.2%). The difference between preference for V versus IP was not significant (p=0.424), but was significant for V versus V&IP (p=0.006), and IP versus V&IP (p=0.049). Examined by year, PGY2 and PGY3 most preferred V, while PGY4 and PGY5 most preferred IP, though the trend was not significant (p=0.211). Reasons for preferences varied across preferred teaching formats, with significant differences between V and IP. Most common reasons for preferring V compared to IP were location flexibility (96% versus 11%; p<0.0001), time flexibility (87% versus 11%; p< 0.0001), and timeliness of feedback (74% versus 47%; p=0.078). Most common reasons for preferring IP over V were quality of teaching (74% versus 65%; p=0.739) and greater acquisition of planning skills (63% versus 61%; p=0.879). Quality of communication was high for respondents preferring V&IP (60% versus 61% (V), 58% (IP); p=0.981).

**Conclusions:** Analysis showed no statistically significant difference in terms of preference for one format over the other. In analyzing reasons why residents may prefer one format over the other, amongst those who indicated a preference, a statistically significant difference was found between the specific reasons they indicated, which we believe reflects the perceived advantages of either format. As such, with different formats having different advantages, staff and residents should be flexible in selecting the format that best meets residents' educational needs. Future research should explore staff preferences and perspectives upon teaching and review format for treatment planning.

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## USE OF RADIOTHERAPY, POST-OP CALCITONIN AND OUTCOME IN MEDULLARY THYROID CANCER AT A TERTIARY CARE CENTRE IN ATLANTIC CANADA

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**Purpose:** Medullary thyroid carcinoma (MTC) constitutes around 1-2% of all thyroid cancer with a paucity of published data. Distinctively, MTC has a strong genetic component with oncogene mutations. For AJCC Stages I, II, III, and IV, 5-year overall survival (OS) rates are 100, 90, 86.5 and 55.5 %. The aims of this study are to report use of radiotherapy and outcomes of the MTC patient cohort managed at a single tertiary cancer centre. Specifically, the incidence, demographics, stage, genetic mutation status, dynamic risk stratification (DRS), use of external beam radiotherapy (EBRT) and OS rate will be reported. The outcome of MTC patients found to have low detectable post-op calcitonin (POC) levels (10-200 pg/ml=Grp B)) will be compared to those who have undetectable (< 10 pg/ml=Grp A) and significantly high-level POC levels (>200 pg/ml=Grp C).

**Materials and Methods:** Patients with MTC were identified from the Interdisciplinary Thyroid Oncology Clinic (ITOC) prospective database. Data was extracted and completed with a chart review.

**Results:** Thirty-five cases with MTC were identified from 1570 cases. Twenty-one of 35 were males. The diagnosis was made between 1988 and 2019 with a median age at diagnosis of 50 years (range=15 to 77) and a median follow-up of eight years. Distribution (and five-year OS, p=0.515) across Stages I, II, III, IV were 23% (100%), 14% (100%), 17% (100%) and 32% (90%) respectively with 14% unknown. 10 (29%) tested positive for RET gene mutations. Post-operative DRS response to initial treatment for 29 cases found 48%, 35% and 17 % were classified into excellent (E=undetectable calcitonin), biochemical incomplete (B=only

detectable calcitonin), or structural incomplete (S=structural disease present) respectively. The 29 cases with available POC and DRS were divided into Groups A, B, and C based on POC levels as above. The final status at last follow-up for Grp A was 13/14 (93%) with E and 1 (7%) with S, for Grp B 6/9 (67%) with B, 3/9 (33%) with S, and for Grp C 6/6 (100%) with S. The DRS for Grp A, B and C was 100% E, 89% B and 11% S, and 33% B and 67% S. 13/35 (37%) received EBRT to the neck (n=11) and bone/mediastinum (n=2) with all showing detectable calcitonin at last follow-up and a final status of S in bone, lung and liver in 8/13 cases (61%). The five-year OS for Grp A, B, C was 100%, 89%, 100% (p=0.223) respectively.

**Conclusions:** This cohort of MTC cases failed to show significant differences in OS by stage and POC levels but did exhibit a higher rate of genetic mutations (29%) than those from other regions of Canada. Additionally, a biochemically incomplete response with a POC level above 200 pg/ml was highly suggestive of progressive structural disease as final outcome. About a third of cases required EBRT mostly to the neck. This study will provide the template for a national survey of MTC in Canada facilitating analysis of a larger dataset.

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## THE TRANSITION TO PRACTICE STAGE IN RADIATION ONCOLOGY: A PROPOSED CURRICULUM TO ADDRESS THE ADVANCED REQUIREMENTS FOR COMPETENCE

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**Purpose:** With the launch of The Royal College Competence By Design (CBD) medical education framework in Radiation Oncology training programs across Canada in 2019, the first cohort of CBD residents are expected to enter the Transition to Practice (TTP) stage of training in late 2023. During TTP, residents are expected to attain specific entrustable professional activities (EPAs) and milestones that will prepare them for autonomous practice. Since this is a novel program design, we sought to develop a curriculum which would allow residents to meet these advanced training requirements to successfully complete their training.

**Materials and Methods:** A curriculum mapping exercise was done to identify potential learning activities to meet Royal College-specific learning objectives. TTP-specific EPAs and milestones were used to align these teaching and learning activities to learner assessment to create a comprehensive curriculum of approximately six to nine months in duration. A condensed version of this TTP curriculum was then piloted in June 2021 during a 1-month rotation for our past graduating resident cohort (non-CBD).

**Results:** There are three main EPAs and associated milestones that must be completed during the TTP stage. These objectives focus on longitudinal management of patients undergoing radiotherapy, interdisciplinary teamwork, administrative and professional development, and conducting a scholarly project. To address longitudinal patient care, our residents select 4 areas of personal interest or self-identified knowledge gaps and are responsible for providing treatment and follow-up care to a limited number of patients during half-day clinics. A resident-led longitudinal clinic was piloted with the non-CBD PGY5s and found to be feasible. Furthermore, through assuming a leadership role in preparing tumour board presentations, leading quality assurance rounds, and coordinating grand rounds residents are able to meet objectives pertaining to teamwork and administrative practice. Other elements include protected time to complete a variety of online continuous professional development courses, wellness activities, faculty development exercises, and their scholarly project. They are also provided the opportunity to mentor a junior trainee in a scholarly work.

**Conclusions:** A curriculum mapping exercise has allowed the development of a proposed curriculum for the TTP stage of CBD residency training in radiation oncology. This proposed curriculum addresses all EPAs and milestones required during this stage, and a condensed version was successfully piloted on a non-CBD cohort. As the first CBD cohort is soon approaching the TTP stage, there is potential to share this curriculum nationally, with the allowance for adapting it to meet the local program context.

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## SINGLE INSTITUTION EXPERIENCE WITH STEREOTACTIC ARRHYTHMIA RADIOABLATION FOR VENTRICULAR TACHYCARDIA

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**Purpose:** Ventricular tachycardia (VT) is characterized by electrical re-entry within patches of heterogeneous myocardial fibrosis leading to sustained consecutive ventricular beats at a rate > 100 per minute. Catheter ablation is the standard of care adjunctive therapy for patients who are refractory to medical therapy to destroy the pathways responsible for these arrhythmias. Recently, a novel treatment approach using ablative radiation with stereotactic body radiation therapy (SBRT) to the arrhythmogenic scar regions defined by noninvasive cardiac mapping has been described for patients refractory to standard-of-care therapies. We describe our experience with 6 patients treated with this technique in our institution.

**Materials and Methods:** All six patients had refractory VT with previously failed ablations and at least one anti-arrhythmic drug. Patients were simulated with 4D computed tomography (4D-CT) and targets were defined using the combined information from cardiac mapping, diagnostic and simulation imaging with cardiologists, medical physicists, and radiation oncologists for each patient. An internal target volume was created based on the cardiac and respiratory motion. An isotropic margin of 3 mm was added to create the planning target volume (PTV). The PTVs were prescribed 25 Gy in 1 fraction normalized so 95% of the PTV was covered by the 25 Gy isodose. Radiation was delivered using volumetric modulated arc therapy. Patients were evaluated immediately following treatment for acute side effects, and then at six weeks, three months, six months, and then yearly. Implantable cardioverter defibrillator (ICD) interrogation was performed regularly by the treating cardiologist to assess the number of VT and ICD events.

**Results:** All six patients tolerated treatment with no immediate acute side effects. One patient experienced mild esophagitis in the first three weeks following treatment which resolved. Four of six patients had immediate significant reduction in the number of VT and ICD events in the first six months after treatment (>90%), however, one patient did not respond and required an extracorporeal membrane oxygenation assisted ablation three months later. The first two patients treated have had longer follow-up and one remains VT-free and has stopped anti-arrhythmic drugs, however, another has relapsed two years following radiotherapy in an area of the arrhythmogenic substrate that was intentionally not irradiated due to organ at risk safety concerns.

**Conclusions:** Despite increasing reports in the literature, there are no established criteria to predict success for this treatment, making it difficult to identify optimal patients. Current limited evidence suggests that this technique may be a relatively safe approach that provides an acute reduction in VT burden for those that have run out of conventional treatment options.

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## ORGAN PERFORATION AND CLINICAL, DOSIMETRIC, AND TREATMENT OUTCOMES DURING IMAGE GUIDED CERVIX BRACHYTHERAPY

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**Purpose:** Research in cervical brachytherapy has shown suboptimal implants to be associated with worse local control in the two-dimensional planning era. This study evaluates the dosimetric and local control outcomes in patients with cervical cancer treated with modern image guided cervical brachytherapy who have a suboptimal insertion because of organ perforation.

**Materials and Methods:** A retrospective analysis was performed for patients with invasive cervical carcinoma treated at BC Cancer between 2015 to 2018 who received radical intent radiotherapy (with IMRT/VMAT technique) and ultrasound guided HDR Ir-192 brachytherapy boost. Patient demographics, tumour and treatment characteristics were compared between implants with versus without perforation using Fisher's exact test. Overall survival (OS), cancer specific survival (CSS) and local regional recurrence (LRR) were evaluated with Kaplan-Meier estimates.

**Results:** Our cohort includes 167 patients with 718 implants performed, of which 20 (2.8%) had an associated perforation. Within the perforation group, 11 (55%) implants were associated with a perforation at the fundus, one (5%) anteriorly, 1 (5%) at the cervical-vaginal junction, two (10%) into the parametrium, two (10%) posteriorly and three (15%) into a separate organ including bladder and sigmoid. Of the 20 implants associated with perforation, 17 were treated despite the perforation and three had the apparatus removed and re-inserted on a separate day. Patient and treatment characteristics were similar between groups including age, smoking status, FIGO stage, pathology, vaginal stenosis, prior LEEP, prior gynecologic surgery, chemotherapy, applicator used, and use of interstitial needles (all $p>0.05$). There was a non-significant higher rate of cervical stenosis in the perforated group (20% versus 9%, $p=0.09$). There was a significant difference in complication rates with the perforation group having higher rates of hematuria (5%) and hospitalization (5%) ($p=0.04$). The rectum D2cc was significantly higher in perforated implants (3.1 Gy versus 2.3 Gy, $p=0.04$). The bowel bag, sigmoid, bladder D2ccs were similar, as were the CTV volumes and HR-CTV D90 (all $p>0.05$). Overall treatment duration of external beam radiation and brachytherapy was similar between both groups ($p>0.05$). The median follow-up was 3.4 years. Five-year LRR free survival was 69% versus 85% ($p=0.32$), CSS 56% versus 81% ($p=0.04$) and OS 47% versus 77% ($p=0.003$) in the perforated versus non-perforated groups respectively. On multivariate analysis, lower stage (HR 0.21, $p=0.002$) and higher D90 (HR 0.95, $p=0.015$) predicted for improved CSS. Lower stage (HR 0.21, $p=0.0007$) and higher D90 (HR 0.95, $p=0.0028$) predicted for improved OS. Perforation predicted for worse OS (HR 2.8, $p=0.017$).

**Conclusions:** The rates of perforation in 3D image guided brachytherapy are low. Organ perforation was associated with poorer OS and CSS. Although LRR free survival was not statistically significantly worse for patients with perforation, the low numbers limit drawing firm conclusions.

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## OUTCOME OF LOCALLY ADVANCED HEAD AND NECK SQUAMOUS CELL CARCINOMA TREATED IN THE NEW ERA OF IMRT AND VMAT: A SINGLE INSTITUTION EXPERIENCE

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**Purpose:** Due to the higher smoking rates and alcohol consumption than the provincial average and the low human papillomavirus (HPV) vaccination rates, our region had experienced a higher incidence and poorer prognosis of head and neck squamous cell carcinoma (HNSCC) in the past. We started intensity-modulated radiotherapy (IMRT) in 2009 and then volumetric modulated arc therapy (VMAT) in 2012 as standard radiation modality for definitive treatment of locally advanced HNSCC. This study aims to review our experience with Stage III, IVA and IVB HNSCC outcomes since the adoption of IMRT, VMAT and image-guided radiation therapy (IGRT) for more than a decade.

**Materials and Methods:** This retrospective study was approved by our institution's Research Ethics Board. All electronic medical records of patients with head and neck malignancies seen at our regional cancer program between August 2009 and March 2019 were reviewed. A total of 296 patients had locally advanced HNSCC (Stage III, IVA and IVB - AJCC 7th Edition). Patient demographics, treatment modalities, survival and toxicity data were recorded. Kaplan-Meier survival curves and life tables using GraphPad Prism software were generated to compare outcomes of patients that received VMAT versus IMRT starting from the end of radiation therapy, i.e. not from date of tissue diagnosis or date of randomization as some other studies in the literature.

**Results:** The cohort's median age was 63 years (26-96), 80% were male, 32% were positive for P16, and 53% had two or more significant comorbidities. The median follow-up for patients that are still alive was 42 months. The most common primary tumour sites were the oropharynx (52%), larynx (15%) and hypopharynx (6.4%). Furthermore, 97% received radiotherapy, including 23% IMRT and 74% VMAT, 89% received 50 Gy or higher radiation dose, 30% had surgery, and 61% had chemotherapy. Using Kaplan-Meier Curves, the loco-regional control (LC) and overall survival (OS) were 80% and 53% at 5 years, respectively. Further analysis demonstrated treatment modality significantly impacted both 5-year LC (VMAT 82% versus IMRT 72%, $p=0.0365$) and 5-year OS (VMAT 61% versus IMRT 40%, $p=0.0017$). There was no treatment-related death, and 22% had Grade 3-4 acute toxicity (RTOG Acute Radiation Morbidity Scoring Criteria).

**Conclusions:** IMRT and VMAT demonstrated excellent LC of the locally advanced HNSCC despite the significant comorbidities in our patient population. Interestingly, there is significant LC and OS benefit in patients treated with VMAT versus IMRT. Both LC and OS are better than published historical data. This might indicate that the introduction of new VMAT technology leads to improved measurable patient outcomes, although further studies with large randomized controlled trials are needed to confirm this. We will continue to do subgroup analysis to compare the difference between VMAT and IMRT.

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## THE ROLE OF VAGINAL VAULT BRACHYTHERAPY BOOST IN STAGE II ENDOMETRIAL CANCER

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**Purpose:** The standard of care for Stage II endometrial cancer is total hysterectomy and bilateral salpingo-oophorectomy followed by adjuvant radiotherapy. External beam radiotherapy (EBRT) is often delivered to reduce the risk of disease recurrence in the

pelvis, but the role of vaginal vault brachytherapy (VBT) boost remains less clear, while there exists a variation in practice pattern among different centres. We aimed to investigate the use of VBT boost in Stage II endometrial cancer and its role in the local disease control.

**Materials and Methods:** A single-centre retrospective study was conducted on patients with FIGO Stage II endometrioid-type endometrial cancer who have undergone total hysterectomy and bilateral salpingo-oophorectomy at our institution between 2005 and 2018. Data on the surgery and radiation treatments were analyzed 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 136 patients were identified from our institution database. Median age at diagnosis was 63 years (range 31-88 years) and median follow-up was 8.3 years. Pelvic lymph nodes were surgically assessed in 68% of patients and 32% of patients had positive lymphovascular invasion. The majority of patients (70%) received EBRT followed by VBT boost, while 14%, 10% and 7% received EBRT alone, VBT alone and no adjuvant radiotherapy, respectively. Disease recurred in 18 patients (13%), among which 5 patients (3.7%) recurred locally at the vaginal vault and 7 patients (5.1%) recurred within the pelvis, translating into 5-year local disease control rate of 96.2%, 5-year pelvic disease control rate of 94.6% and 5-year overall survival rate of 73.8%. On multivariate analysis, VBT boost was not associated with disease recurrence (p=0.54) or overall survival (p=0.74).

**Conclusions:** Adjuvant radiotherapy with pelvic EBRT with or without VBT boost resulted in a high rate of disease control in Stage II endometrioid-type endometrial cancer. VBT boost following pelvic EBRT is likely not indicated and can safely be omitted in Stage II patients with favourable features.

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**INTERRUPTION OF CARE: AN IMPORTANT QUALITY METRIC IN CHEMO-RADIATION FOR LOCALLY ADVANCED HEAD AND NECK SQUAMOUS CELL CANCERS (LASCCHN) IN SUB-SAHARAN AFRICA**

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**Purpose:** Implementation of evidence-based, guideline recommended treatment such as concurrent chemoradiotherapy (CRT) for LASCCHN does not always equate to timely completion of care for patients in LMIC**.** The objective of this report is to identify reasons for treatment interruption and its effect.

**Materials and Methods:** A prospective study to document patient reported outcomes during treatment for patients with LASCCHN recommended to receive concurrent CRT was open to accrual. Our institutional treatment protocol is 0-3 courses of iCT (Paclitaxel 175mg/m$^2$,Cisplatin 100mg/m$^2$ q3w) followed by CRT (60Gy in 30fr, IV Cisplatin 40mg/m$^2$ wkly). Study inclusion criteria were: LASCCHN, ECOG 0-1, recommended for radical CRT. A phone administered questionnaire, designed to enquire about treatment delays and patient impact was implemented as part of our follow-up. The outcome measures were duration of concurrent chemo-radiation treatment, disease progression; need to transfer care and patient perception on delay.

**Results:** Between November 2020 and November 2021, 30 patients were enrolled and attempt was made to contact all. Seven patients (35%) have died and 13 patients (or their caregivers) participated in the follow-up interviews and formed the basis for the current report. All patients received iCT. In 11/13 (85%) patients, there was a 2-4 week delay in commencing CRT. Reasons were: financial constraints (three), social (one), CT-related delays (two) and RT machine downtime (five). The mean duration of CRT was 9.8 weeks (SD2.4). While all patients completed 60 Gy, none completed this in 6w. The duration of CRT was >6to≤8w: 3; 8to≤10w: 5; and >10w: 5. The reasons for CRT interruptions were machine breakdown (seven), financial (five), toxicity (one). No patient transferred care to other institutions. Eight patients developed new symptoms during treatment interruption. Eleven of 13 recalled being dissatisfied (anger, disappointment, worry) with the delay.

**Conclusions:** Despite availability of CRT for treating locally advanced SCCHN, there are systemic challenges in timely treatment completion. Solutions to mitigate these are urgently needed.

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**UNANTICIPATED RADIATION REPLANNING FOR STAGE III NON SMALL CELL LUNG CANCER**

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**Purpose:** Technological advancements in the planning process have facilitated more efficient complex radiotherapy (RT) adaptation in cancers where changes in motion and anatomy during treatment may occur, such as in Stage III non-small cell lung cancer (NSCLC). The primary objective of this study was to identify factors associated with unanticipated RT re-planning in Stage III NSCLC. Secondary objectives were to examine survival and cumulative incidence of local, regional and distant recurrence.

**Materials and Methods:** In this single-institution ethics-board approved study, all Stage III NSCLC patients from January 1, 2016, to December 31, 2019, treated with radical intent RT were analyzed. Descriptive statistics were performed, including the frequency of RT re-planning and reason for re-planning. Logistic regression analysis was used to identify predictive factors associated with re-planning. Variables significant on univariate modelling, with a P value < 0.05, were selected for multivariate modelling. Overall survival was determined using the Kaplan-Meier method. Cumulative incidence of local, regional, and distant recurrence was determined using the competing risk method.

**Results:** There were 144 patients with Stage III NSCLC meeting study criteria, of which 18% (n=26) required re-planning. The most common reason for re-planning was due to volume changes (target shift or enlargement) on cone beam computed tomography (CBCT) (n=20, 77%), followed by failure to meet planning constraints (n=6, 23%). On univariate analysis, patients with a larger superior -inferior (SI) dimension of the primary and nodal planning target volume (PTV) was associated with a higher incidence of re-planning [Odds ratio (OR) 1.17, 95% CI 1.03-1.35 p=0.02). Larger PTV (primary and nodal) was also associated with higher incidence of re-planning on univariate analysis [(OR) 2.48, 95% CI 1.21-5.38, p= 0.02). On multivariable analysis, only larger PTV (primary and nodal) were statistically predictive of re-planning.

The actuarial median OS was 36.3 months (95% CI 27.7-66.5).

The cumulative incidence for local, regional, and distant recurrence at 2 years were 18% (95% CI 12-25%), 19% (95% CI 13-26%), and 38% (95% CI 30-46%), respectively.

**Conclusions:** A larger SI dimension of the PTV, as well as larger PTV are associated with a higher odds ratio of re-planning. Survival and recurrence outcomes for this group of patients are similar to the outcomes reported in the literature.

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## OPERATION OF INCIDENT LEARNING DURING THE COVID-19 PANDEMIC: A SINGLE CENTRE EXPERIENCE

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**Purpose:** The Ottawa Hospital's Radiation Oncology program maintains the Incident Learning System (ILS) -- a quality assurance program that consists of report submissions of errors and near misses arising from all major domains of radiation. In March 2020, the department adopted workflow changes to optimize patient and provider safety during the Covid-19 pandemic. In this study, we analyzed ILS submissions pre- and post-pandemic precautions to assess the number and type of ILS reports following implementation of pandemic precautions.

**Materials and Methods:** ILS data was collected over three one-year time periods: March 13th 2020 to March 12th 2021, March 13th 2019 to March 12th 2020, and March 13th 2018 to March 12th 2019. In addition, ILS data was collected from the most recent six months, from March 13th 2021 to September 12th 2021. For all time periods the number of ILS submissions were counted. Each ILS submission was analyzed for the specific treatment domain from which it arose and its root cause explaining the impetus for the error or near miss.

**Results:** There were 20% fewer ILS submissions during the first pandemic year, and 25% fewer ILS submissions per number of treatment courses compared to prior years. There was also a significant increase in the proportion of "treatment planning" ILS submissions and a 50% reduction in the proportion of "decision to treat" ILS submissions compared to previous years. Root cause analysis revealed there were significantly more incidents attributable to "poor, incomplete, or unclear documentation" during the pandemic year.

**Conclusions:** Covid-19 workflow changes were associated with fewer ILS submissions, but a relative increase in submissions stemming from poor documentation and communication. It is imperative to analyze ILS submission data, particularly in a changing work environment, as it highlights the potential and realized mistakes that impact patient and staff safety.

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## A RANDOMIZED CONTROLLED TRIAL OF PRE-OPERATIVE VERSUS POST-OPERATIVE STEREOTACTIC RADIOSURGERY FOR PATIENTS WITH SURGICALLY RESECTABLE BRAIN METASTASES

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**Purpose:** Postoperative stereotactic radiosurgery (SRS) to the resection cavity is a standard management option for patients with resected brain metastases. Preoperative SRS may have certain advantages compared to postoperative SRS, including less uncertainty in delineation of the intact tumour compared to the postoperative resection cavity, reduced rate of leptomeningeal dissemination/recurrence postoperatively, and lower risk of radionecrosis. The recently published ASCO-SNO-ASTRO consensus statement provides no recommendation for the preferred sequencing of radiotherapy and surgery for patients receiving both treatments for their brain metastases.

**Materials and Methods:** This multicentre, randomized controlled trial aims to recruit 88 patients with operable brain metastases over an estimated three-year period. Patients with ≤10 brain metastases in number with at least one resectable, fulfilling inclusion criteria will be randomized to postoperative SRS (control arm) or preoperative SRS (investigational arm) in 1:1 ratio. Randomization will be stratified by age (<60 versus ≥60 years), histology (melanoma/renal cell carcinoma/sarcoma versus other), number of metastases (one versus 2-10). In the control arm, postoperative SRS will be delivered within three weeks of surgery, and all unresected metastases will receive primary SRS. In the investigational arm, enrolled patient will receive SRS of all brain metastases followed by surgery of resectable metastases within one week of SRS. In either arm, single fraction or hypofractionated SRS in three or five fractions is permitted. The primary endpoint is to assess local control at 12 months in both arms. Secondary endpoints include local control at other time points, regional/distant brain recurrence rates, leptomeningeal recurrence rates, overall survival, neurocognitive outcomes, and adverse events including radionecrosis rates in both arms.

**Discussion:** This trial addresses the unanswered question of the optimal sequencing of surgery and SRS in the management of patients with operable brain metastases. No randomized data on this topic has been published or presented to date.

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## IDENTIFICATION OF FACTORS ASSOCIATED WITH PROLONGED SURVIVAL IN PROSTATE CANCER PATIENTS POST-RECEIPT OF PALLIATIVE RADIOTHERAPY TO A BONE METASTASIS: A RETROSPECTIVE, POPULATION-BASED STUDY

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**Purpose:** There is a paucity of data regarding factors impacting the survival of prostate cancer patients after receipt of palliative radiotherapy (RT) to bone metastases in the setting of contemporary staging and systemic treatment paradigms including Androgen Receptor Antagonists (ARATs) or Abiraterone. We conducted a retrospective, population-based, cohort study aiming to quantify survival durations of prostate cancer patients post receipt of palliative RT and identify factors associated with survivorship.

**Materials and Methods:** All prostate cancer patients treated with palliative RT to a bone metastasis from 1 January 2018 to 31 December 2019 were identified using the CancerCare Manitoba (CCMB) electronic RT database. The post-RT Survival interval was defined as date of first fraction of RT to date of death or last follow-up. Patient, disease and treatment characteristics at the time of RT were extracted from the electronic medical record and were stratified by the median survival interval of the cohort to define short-term and long-term survivors. Differences in the distributions of baseline characteristics by survival group was assessed by student t-test or the chi-square test. Metastatic burden at the time of RT was defined using the CHAARTED criteria (high if ≥4 bone metastases with ≥1 outside the vertebral bodies/pelvis &/or visceral metastases). Multivariable Cox hazard regression was conducted to assess associations of patient, disease and treatment factors to Post-RT survival.

**Results:** During 2018-19, 545 palliative RT courses for bone metastases were delivered to 274 prostate cancer patients of which 63.3% had no prior treatment to their prostate primary. Median age was 76 (IQR 69-83) and median post-RT survival was 10.5 (IQR 3.5- 24) months. Short and long-term survival groups had median survivals of 3.5 (IQR 1.8-6.3) and 25 (IQR 17.5-32) months. First line palliative systemic therapy was androgen depravation (75.8%), taxanes (14%), or abiraterone/ARAT (6.2%). The proportion of patients with high metastatic burden was greater in the short-term survival group (90.5% vs 83.9%). Single fraction RT (8Gy/1#) was delivered in 78.2% of cases. Multivariable Cox Hazard regression found ECOG of ≥3 (HR-1.4, p=0.02), high volume

disease (HR-1.71, p=0.02) to be associated with worse survival, irrespective of the treatment offered in the first or second line. Non-receipt of palliative systemic treatment (HR-3.6, p=0.006) was associated with a significantly increased hazard of death. Receipt of abiraterone/ARAT in the first line setting trended towards but did not reach statistical significance (HR-0.63, p=0.1).

**Conclusions:** Amongst a contemporary cohort of prostate cancer patients undergoing palliative RT for bone metastasis, high metastatic burden and ECOG best predicted survival, irrespective of the treatment offered in the first line. The type of palliative systemic therapies received in the first line setting were not associated with post-RT survival with the exception of those who did not receive any palliative systemic therapy.

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## EFFECT OF SCAR BOOST ON LOCAL CONTROL OF LOCALLY ADVANCED BREAST CANCER PATIENTS RECEIVING POSTMASTECTOMY RADIOTHERAPY

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**Purpose:** Clinical evidence regarding utility of a scar boost during postmastectomy radiotherapy for locally advanced breast cancer remains unknown. Given the uncertainty of any benefit from this common practice, this study hopes to determine whether the addition of a scar boost contributes to local control.

**Materials and Methods:** We performed a retrospective study comparing patients who received a scar boost and those without. Primary outcome was local recurrence rates. Additional outcomes were LRFS, DMFS and OS.

**Results:** One-hundred forty-five (145) patients were included in the study (scar boost, n = 118; no scar boost, n=27). Median follow-up time was 31.5 months (range, 5 to 96 months). Local failure rate for the entire cohort was 3.52% (5 out of 145), and all local failures occurred in the scar boost group. Of the five local failures, 4 (80%) were in the chest wall, and 1 (20%) was in the supraclavicular fossa.

There is a significant association between treatment with scar boost and high-grade (p=0.048), use of hormonal therapy (p-value=0.047), T3 and T4 tumours (p=0.014) and Stage III disease (p =0.027). Two-year LRFS was 96.2% while two-year DMFS was 83.6%. There was no significant association between treatment with scar boost and LRFS, DMFS or OS.

**Conclusions:** The scar boost group performed no worse than the no scar boost group with regard to local control and survival. Our evidence highlighted the variability of practice patterns for using a scar boost, which in our institution is more often used for Stage III, T3/T4 tumours, high grade disease and patients undergoing hormonal therapy. Despite the small sample size, limited follow-up and retrospective nature of the study, our findings show limited benefit with use of a scar boost in locally advanced breast cancer. Prospective studies on the topic are warranted.

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## LONG-TERM OUTCOMES OF PRIMARY AND SECONDARY ANGIOSARCOMAS OF THE BREAST: A 20-YEAR SINGLE-CENTER EXPERIENCE

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**Purpose:** Radiation-associated angiosarcomas (RAA) account for 0.05 - 0.2% of breast malignancies. Primary angiosarcomas are mostly diagnosed in younger women, while RAA occur after a prolonged latency following radiation therapy. This study sought to evaluate the management and subsequent outcomes of breast angiosarcomas (BAS) at a large tertiary care centre from 2000 to 2020.

**Materials and Methods:** We identified patients with histologically confirmed BAS diagnosed between 2000 and 2020. Demographics, treatment, and oncologic outcome data were collected retrospectively. Descriptive statistics were used to summarize the characteristics of the study population. Kaplan Meier curves were used to describe progression-free survival probability, overall survival, and corresponding 95% confidence intervals.

**Results:** Fourteen patients were identified, including three with primary BAS and eleven with RAA. The median age at presentation for RAA was 71.4 years (range 59-82), compared to 44 years (range 28-53) in primary BAS. The mean latency period for the development of RAA was 8.0 years (range 4.4-13.3). Treatment of primary angiosarcomas included surgery in all patients, radiotherapy (RT) in two, and chemotherapy in one. Treatment of RAA included surgery (100%), radiotherapy (18%), and chemotherapy (9%). At a median follow-up of 32.5 months (range 0-172) following initial treatment, five patients (35.7%) experienced local recurrence. Among primary angiosarcoma patients, after accounting for one patient lost to follow-up, none experienced recurrence or death. Overall survival probability in the entire study population was 100% at 36 months. The PFS at 24 months was 51.3% (95% CI: 29.6-88.8%) for the whole study population and 41.6% (95% CI: 19.9-86.8%) in the RAA group. Among the five RAA patients that recurred locally, one patient developed a third unrelated malignancy, and three patients were alive at the time of analysis.

**Conclusions:** Our 20-year single-centre experience confirms the rarity of BAS. Despite a favourable overall survival rate, local recurrence remains a significant challenge. Our results underscore the importance of optimal salvage therapies such as wide surgical excisions, RT, and chemotherapy that in our series lead to better-than-expected overall survival. Patients should be managed in large tertiary care centres where multidisciplinary management and clinical expertise can guide salvage approaches.

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## IMPACT OF QUALITY ASSURANCE AND FEEDBACK ON RADIOTHERAPY PRESCRIBING PRACTICES: A RANDOMIZED CONTROLLED TRIAL

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**Purpose:** Clinical Audit and feedback (CA&F) is a demonstrated successful knowledge translation (KT) method that positively impacts change in practice in numerous clinical scenarios. However, there has been low implementation of CA&F in oncology, and specifically in radiotherapy (RT) prescribing practices. We sought to identify the impact of a simple CA&F intervention on prescribing practices across six BC Cancer Centres by investigating four clinical scenarios: (1) women <50 years old with invasive breast cancer post partial mastectomy who receive surgical cavity RT boost versus not; (2) patients with 1-3 positive lymph nodes receiving regional RT versus not; (3) women >70 years old with T1N0 breast cancer omitting whole breast RT versus not; (4) all women who received local or loco-regional radiotherapy who are prescribed 16 versus 25 fractions of RT.

**Materials and Methods:** Thirty-five radiation oncologists were randomized to receive CA&F intervention versus not and stratified by BC Cancer Centre. Patient data was obtained retrospectively for patients treated before and after intervention. The study measured one of two possible prescriptions per clinical scenario, with prescription 1 containing the most evidence in favour of its use. A logistic fixed effect regression model was used to measure odds ratio of prescription 1 before and after intervention. This model captured the difference in prescription use within and between control and intervention groups pre and post CA&F, while adjusting for the number of patients seen by each physician. Time as a potential confounding variable that could impact prescription rates from pre to post intervention was also adjusted for.

**Results:** A total of 5215 unique cases were identified. The change in odds of using prescription 1 after CA&F in cohorts 1, 2, 3 and 4 was 0.45 (p=0.12), 0.59 (p=0.34), 2.23 x $10^{-9}$ (p=0.98, unstable model), and 0.77 (p=0.11) respectively.

**Conclusions:** There was no significant change in odds of utilizing the more evidence-based prescription across any of the four clinical scenarios, suggesting our simple CA&F intervention was not effective in changing prescribing practices. A more complex CA&F intervention may be necessary in future quality assurance efforts to achieve a greater impact on radiotherapy prescribing practices.

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## CARDIAC MIGRATION OF AN IMPLANTED HEPATIC FIDUCIAL MARKER USED FOR STEREOTACTIC BODY RADIATION THERAPY

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**Purpose:** Stereotactic body radiation therapy (SBRT) delivers ablative doses of radiation to target primary and oligometastatic tumours. The Calypso 4-dimensional Localization System allows the delivery of high-dose of radiation to a target guided by the implanted markers. Here, we report on a case where a Calypso soft tissue marker migrated to the right ventricle shortly after implantation in liver.

**Materials and Methods:** A 65-year-old female with a squamous cell carcinoma of anal canal was treated with a course of radical chemoradiotherapy. She later developed liver metastasis that were confirmed on biopsy. After receiving palliative chemotherapy, the decision was made to proceed with SBRT for the liver metastases. Three calypso beacons were inserted in the liver under CT guidance.

**Results:** An immediate post-procedure CT confirmed the presence of the three transponders within the liver. However, the CT simulation images, 6 days post insertion, revealed a missing marker that had migrated to the right ventricle. An echocardiogram was done which failed to detect the beacon in the heart. Treatment was delivered with no complications.

**Conclusions:** Migration of fiducial markers after insertion in liver is a rare complication. Imaging techniques such as a doppler ultrasound prior to insertion could reduce the risk of migration by ensuring that the fiducial markers are at an appropriate distance from blood vessels to avoid potential complications. Anchored Calypso beacons could potentially be a consideration to reduce risk of migration.

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## FINAL RESULTS OF AN INTERNATIONAL DELPHI CONSENSUS STUDY REGARDING THE OPTIMAL MANAGEMENT OF RADIATION PNEUMONITIS

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**Purpose:** There is a lack of consensus around the diagnosis, management and follow-up of radiation pneumonitis (RP). A Delphi consensus process was conducted in this area.

**Materials and Methods:** In round 1, open questions were distributed to 31 clinicians treating thoracic malignancy. In round 2, participants rated agreement/disagreement with statements derived from round 1 answers using a 5-point Likert scale. Consensus was defined as ≥75% agreement. Statements which did not achieve consensus were modified and re-tested in round 3.

**Results:** Response rate was 74% in round 1 (n=23/31; 17 oncologists, 6 respirologists); 82% in round 2 (n=19/23; 15 oncologists, 4 respirologists); and 100% in round 3 (n=19/19). Thirty-eight of 64 round 2 statements achieved consensus; a further 11/26 statements achieved consensus in round 3. In round 2, there was agreement that risk stratification/mitigation should consider patient factors; the importance of minimizing RP risk through treatment planning; the basis for diagnosis of RP; and that oncologists and respirologists should be involved in treatment. Treatment should involve oral steroids with consideration of gastroprotection, starting with 60 mg PO prednisolone or equivalent, for a duration of 2 weeks, with a taper of 10 mg in the daily dose per week, or for severe pneumonitis, IV methylprednisolone for 3 days before PO. Key statements achieving consensus in round 3 were: "There is uncertainty about the clinical significance of whether pneumonitis is radiation- or drug-induced, and further research is needed to understand this area," and "Although there are guidelines for the review schedule of patients receiving immunotherapy, it is unclear how these could be modified for patients also receiving radiotherapy."

**Conclusions:** Consensus was achieved on many aspects of RP diagnosis and management. Further research is needed, particularly around pneumonitis in those receiving both radiotherapy and immunotherapy. These data will inform the development of final consensus statements providing practical guidance on diagnosis and management of RP.

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## INFLUENCE OF PALLIATIVE RADIOTHERAPY ON TOXICITY AND SURVIVAL IN PATIENTS TREATED WITH RADIUM-223 DICHLORIDE FOR METASTATIC CASTRATE-RESISTANT PROSTATE CANCER

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**Purpose:** It remains unclear if palliative external beam radiation therapy to the bone (EBRT) and radioactive radium ($^{223}$Ra) share a synergic effect on the immune system. We investigated whether concurrent EBRT could impact prognosis in this population.

**Materials and Methods:** Known and possible prognostic parameters including EBRT concurrent to $^{223}$Ra were tested. Log-rank test (Kaplan-Meier method) and Cox regression analysis were used to predict overall survival (OS).

**Results:** One hundred and thirty-three patients were treated with $^{223}$Ra. Median age was 72 years. By univariate analysis, baseline ECOG performance status (PS) 0-1 (p=0.001), ≥5 cycles of $^{223}$Ra

(p<0.001), baseline hemoglobin (Hb) ≥120 g/L (p<0.001), baseline total alkaline phosphatase (tALP) <110 U/L (p=0.001) and any prostate-specific antigen (PSA) decline at week 12 (p=0.013) were associated with increased OS. Patients who received EBRT during $^{223}$Ra [n=20 (15%)] did not have worse baseline characteristics. Age, Hb, tALP, PSA, LDH and white blood cells counts were not different from patients who did not receive EBRT (p>0.36). Toxicity as well as biochemical response to $^{223}$Ra, as measured by the change between baseline and the values for Hb, LDH, tALP before the 6$^{th}$ cycle of $^{223}$Ra, were not different whether patients received EBRT or not. Both groups received the same mean number of $^{223}$Ra cycles [4.8 (SD 2.0) versus 5.1 (SD 2.2), p=0.6]. EBRT concurrent to $^{223}$Ra showed a trend (p=0.051) towards inferior OS by univariate analysis, but not by multivariate analysis. Using baseline Hb, tALP and PS, patients were divided into three groups with a median OS of 23.0, 8.0, and 5.0 months for low, intermediate, and high risk, respectively (p<0.001).

**Conclusions:** Our findings that EBRT did not negatively affect OS in multivariate analysis are reassuring since pain relief should not be denied during treatment with $^{223}$Ra. $^{223}$Ra therapy can result in an OS of close to two years in carefully selected patients.

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## DEVELOPING A VIRTUAL REALITY SIMULATOR FOR CERVICAL CANCER BRACHYTHERAPY PROCEDURES: A STEP TOWARDS THE FUTURE OF HANDS-ON TRAINING

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**Purpose:** Cure of locally advanced cervical cancer (LACC) requires delivery of personalized adaptive brachytherapy (BT). The latter starts with a hands-on procedure that combines clinical knowledge and technical know-how, cultivated incrementally over years, for optimum execution. As in other procedural fields, Radiation Oncology residents face increasingly limited opportunities for proficiency training, even more problematic as BT for LACC grows in complexity to achieve better clinical outcomes. Virtual reality (VR), now emerging in postgraduate surgical education to enhance learner procedural skills, may be helpful. We report on the development of a novel interaction-enabled VR simulator 'BrachyCerv' designed to reflect the steps of a simple intracavitary/interstitial (IC/IS) BT applicator insertion procedure, within an immersive operating room (OR).

**Materials and Methods:** LACC BT-specific and procedure-oriented learning outcomes were crafted, after reviewing institutional practices and published guidelines. A case vignette was developed, typifying the usual LACC BT boost scenario after external radiation with chemotherapy. A process map was generated to assist in programming the procedural steps of IC/IS BT using the Venezia applicator (Elekta, Netherlands; with permission). Physical objects used in OR (e.g., applicator) were CT simulated and contoured (Varian, US), then further image-processed (Autodesk, US) before use (filmbox format) in simulator development. BrachyCerv was programmed on 'Unreal Engine' (v4.26), in iterative consultation with subject-matter experts, to closely mimic the actual BT procedure.

**Results:** A pilot single-player simulation was created, with estimated runtime of 20 minutes depending on user proficiency, optimized for Oculus Quest 2 (Meta Quest, US) but compatible with different VR headsets. It opens with the user in the OR, facing surgical instruments on a sterile table, and the computer-generated VR patient, draped and in lithotomy. The clinical vignette is then presented, followed by a series of user-triggered step-by-step instructions. To move through the procedure, each step (e.g., instrument selection, applicator assembly), must be executed by the user in the correct sequence. Vibration feedback in the controllers signals successful completion of each step. Integrated pop-up quizzes test and consolidate critical concepts in BT for LACC. The simulation can start/stop at user discretion, allows non-playing observers, and can be run repeatedly, permitting users to progress at their own pace.

**Conclusions:** An immersive and interaction-enabled VR simulator was developed for BT in LACC, piloting a simple procedure scenario of IC/IS BT applicator insertion. With promise to enhance resident learning of BT procedures, further technical development is planned to broaden the range and complexity of procedural scenarios, and level of user interaction. Validation work for this educational tool will be reported separately.

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## THE IMPACT OF ABDOMINAL COMPRESSION ON INTERNAL TARGET VOLUMES FOR PATIENTS UNDERGOING STEREOTACTIC ARRHYTHMIA RADIOABLATION FOR VENTRICULAR TACHYCARDIA

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**Purpose:** Ventricular tachycardia (VT) is characterized by electrical re-entry within patches of heterogeneous myocardial fibrosis leading to sustained consecutive ventricular beats at a rate > 100 per minute. Recently, a novel treatment approach using ablative radiation with stereotactic body radiation therapy (SBRT) to arrhythmogenic scar regions defined by noninvasive cardiac mapping has been described. The optimal strategy for patient simulation and target contouring is an area of active research. Abdominal compression has previously been described as a tool to decrease motion in thoracic SBRT, with most benefits seen for patients with targets close to the diaphragm. We evaluated the benefit of motion reduction and internal target volume definition for 4 patients undergoing stereotactic arrhythmia radioablation for VT (StAR-VT).

**Materials and Methods:** Four patients receiving StAR-VT at our institution underwent four-dimensional computed tomography simulation with and without abdominal compression as part of the planning for their radiation treatment. The clinical target volume (CTV) was contoured on both sets of images, and an internal target volume (ITV) was contoured as an expansion of the CTV in the maximum intensity projection of the four-dimensional computed tomography simulation. The volumes of the CTVs were compared before ITV creation to ensure the volume difference was less than 5%. The ITV volume expansions were compared as a percent-expansion of the CTVs with and without abdominal compression.

**Results:** Due to the highly comorbid, and poor cardiac and respiratory function of this patient population, only 3 of the 4 patients could tolerate abdominal compression and thus, evaluation was limited to these 3 patients. The CTV for these patients ranged from 38.3-43.1 $cm^3$ and the ITVs ranged from 58.9 – 81.0 $cm^3$. In all 3 patients, ITV gains from abdominal compression were minimal, ranging from 4.1% - 7.2% in favour of compression. All patients reported that abdominal compression negatively impacted their comfort during simulation and impeded tolerance of the procedure.

**Conclusions:** Abdominal compression is a computed tomography simulation technique often used to limit respiratory motion for thoracic SBRT, however, in the context of the highly respiratory and cardiac comorbid StAR-VT population, the gains in ITV from this technique provided limited benefit in a small sample of

patients compared to no abdominal compression. In addition, abdominal compression negatively affected patient comfort during simulation.

**177 Withdrawn**

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**ADJUVANT HYPOFRACTIONATED RADIOTHERAPY FOR HEAD AND NECK CANCER: A SYSTEMATIC REVIEW AND A SINGLE INSTITUTION EXPERIENCE**
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**Purpose:** Selected patients with mucosal head and neck squamous cell carcinoma (HNSCC) require adjuvant radiation treatment (RT). Standard treatment of 60 Gy over 6 weeks is not feasible for some patients due to medical frailty and/or post-operative complications. This study aims to assess adjuvant, hypofractionated RT through i) systematic review of the evidence and ii) single institution experience.

**Materials and Methods:** First, a systematic review of non-conventional postoperative radiation in HNSCC was performed. Adjuvant, hypofractionated radiotherapy (Hypo-RT) was defined as > 2.5 Gy per fraction for this study. The search was conducted from inception until February 2021 using Ovid MedLine and EMBASE data sources, then analyzed using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guideline.

Then, a single institution chart review was performed with IRB approval to report the outcomes of HNSCC patients treated between 2010-2020 using Hypo-RT. The primary endpoint was the incidence of CTCAE toxicity Grade ≥3. Secondary endpoints included local control and median disease-free survival.

**Results:** The systematic review yielded 1944 reports; after removing duplicates, 774 were screened for eligibility, 154 met eligibility and 19 met quality criteria. None of the included reports described Hypo-RT in previously un-irradiated patients. A single study reported on the use of adjuvant stereotactic re-irradiation following salvage surgery. The remaining 18 reports focused on adjuvant brachytherapy treatments.

The retrospective, single institution review identified five patients treated with Hypo-RT with a dose of 8 Gy x 3 fractions given once weekly; total dose 24 Gy. Mean age was 75 years (range 70-82). Primary disease sites were larynx and oral cavity. Median Charlson Co-morbidity Index score was 4 (range 3-7). Average hospital stay following surgery was 33 days (range 11-87). Interval between surgery and XRT was 69 days (range 54-82) Median follow-up time was 28 months (range 7-66).

All patients completed the planned Hypo-RT treatment. One patient experienced a Grade 3 late toxicity; esophageal narrowing requiring dilatation 36 months after RT. At last follow-up, none of the patient had loco-regional recurrence, two patients had developed solitary lung tumours and three patients had no evidence of disease.

**Conclusions:** A systematic review failed to identify relevant studies examining the use of hypo-fractionated, external beam, adjuvant RT for HNSCC. To our knowledge, this single-institution experience is the first report of Hypo-RT (8 Gy x 3 fractions) for patients deemed unfit for conventional adjuvant RT. Further investigation is required to establish the optimal adjuvant radiation schedule for medically frail HNSCC patients.

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**THE EVOLUTION OF TECHNOLOGY IN THE MANAGEMENT OF EARLY-STAGE (T1) CANCER OF THE LARYNX, AN INSTITUTIONAL REVIEW OF RADIATION THERAPY OUTCOMES**
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**Purpose:** This single institution, retrospective cohort study was undertaken to evaluate the impact of evolving radiation therapy (RT) treatment technology on the long-term outcomes and patterns of failure for patients with early-stage, T1, squamous cell cancer of the larynx.

**Materials and Methods:** All patients with T1N0 squamous cell cancer of the larynx that underwent radical RT from January 2008 to December 2018 were included. The planning and delivery of radiation, two-dimensional RT versus 3-D with IMRT or VMAT, as well as patient factors were reviewed in the context of local disease control.

**Results:** A total of 171 Patients with were eligible for inclusion in the analysis. The median age was 70 years (range of 38-91 years), and just over 90% (90.6%) of the cohort were male. While all patients were staged as having T1 disease, a smaller proportion had more detailed assignments of T1a (38 or 23.3%), or T1b (23 or 14.1%). The majority of patients were treated with 50-51 Gy in 20 daily fractions over four weeks. After a median follow-up of over five years, there were only 11 patients (6.4%) that had reported local regional failure, most occurring within the first two years of follow-up, and in a multivariate model, only age was a prognostic factor for local control (p=0.013), whereas RT technique specifically was not.

**Conclusions:** Single-modality RT provides an excellent and effective treatment for T1 glottic cancer. A shift to conformal 3-D planning and treatment delivery to minimize radiation dose to surrounding normal tissues, has not resulted in a significant change to rates of local failure. The majority of local failures have occurred within the first two years after RT. Prospective comparative measures of toxicity and functional preservation seem unlikely to be measured given the shift in the routine delivery of RT.

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**TRIMODALITY IMAGING AND PREDICTIVE FACTORS OF RETROPHARYNGEAL LYMPH NODE METASTASES IN OROPHARYNGEAL CANCERS**
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**Purpose:** The systematic combination of computed tomography (CT), magnetic resonance imaging (MRI), and fluorodeoxyglucose-positron emission tomography (FDG-PET) for the detection of retropharyngeal lymph nodes (RPLN) in patients with oropharyngeal cancer (OPC) planned for curative radiation therapy has never been reported. We aim to evaluate the incidence of RPLN metastases in OPC patients undergoing all three imaging modalities, and the predictive factors of RPLN involvement.

**Materials and Methods:** Consecutive patients with OPC treated with curative-intent radiation therapy at the Centre hospitalier de l'Université de Montréal from May 2017 to June 2019 were retrospectively analyzed. Treatment planning comprised contrast-enhanced CT, MRI and FDG-PET for all patients, unless

contraindicated. All imaging studies were interpreted by an expert head and neck radiologist and nuclear medicine specialist to review tumour extension and lymph node involvement, including RPLN. Cancer stages were recorded according to the 8th edition of the American Joint Committee on Cancer's staging system. Predictive factors of RPLN involvement were determined using univariate analysis.

**Results:** Of the 300 included patients, 82% had p16-positive OPC. All patients but one had at least a dedicated MRI or an FDG-PET with the planning CT, and 246 (82%) had all modalities. Sixty-six patients (22%) had radiological evidence of RPLN involvement, of which three had no involved cervical nodes and nine had bilateral positive RPLN. On univariate analysis, RPLN involvement was associated with advanced T-stage (T4 versus T1: OR: 7.35; 95% CI: 2.34-23.12; p<0.001), N3 nodal stage (OR: 3.54; CI: 1.22-10.28; p=0.020), disease extension to the nasopharynx (OR: 4.64; CI: 1.65-12.07, p=0.003), soft palate (OR: 3.38; CI: 1.91-5.97; p<0.001), posterior pillar (OR: 3.25; CI: 1.58-6.67; p=0.001) or anterior pillar (OR: 2.55; CI: 1.44-4.52; p=0.001), intermediate-risk (OR: 3.14; CI: 1.33-8.75; p=0.011) or high-risk (OR: 4.46; CI: 1,74-11.48; p=0.002) prognostic subgroups as per the RTOG classification, presence of positive ipsilateral level II (OR: 3.82; CI: 1.14-12.82; p=0.03) or III (OR: 1.90; CI: 1.08-3.35; p=0.026) cervical lymph nodes, and involved contralateral cervical lymph nodes (OR: 2.67; CI: 1.51-4.75; p=0.001).

**Conclusions:** Trimodality imaging with CT, MRI and FDG-PET reveals a 22% rate of RPLN metastasis in patients with OPC. Patients with advanced diseases or tumours extending to the nasopharynx, soft palate or tonsil pillars, and patients in the intermediate- or high-risk groups as per the RTOG classification appear at higher risk of RPLN. Larger prospective trials are needed to better determine the patient subgroups at higher risk of RPLN involvement in order to guide treatment-related decisions.

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## A REVIEW OF A STRUCTURED APPLIED PHYSICS COURSE FOR RADIATION ONCOLOGY AND RADIATION PHYSICS TRAINEES

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**Purpose:** Radiation oncology and radiation physics residents learn physics principles through textbooks and clinical placements. We supplemented radiation physics teaching with structured case-based discussions, designed to foster collaborative interaction between radiation oncology and medical physics trainees. To our knowledge, this is the first report on a structured applied physics curriculum for radiation oncology and radiation physics trainees.

**Materials and Methods:** We reviewed the curriculum and teaching format for the yearly applied physics course given from 2016-2019 (inclusive). Due to the covid-19 pandemic, we also reviewed the changes to the applied physics course during the years 2020- 2021 (inclusive). This course was given to radiation oncology and radiation physics residents in a multi-hospital site (university affiliated) accredited training program. Teaching evaluation scores were assessed as an indicator on how well the course was received by our trainees.

**Results:** The number of applied physics students ranged from 7-14 per year (2-9 radiation oncology and 3-6 medical physics residents per year). Each session was taught by a pair of radiation oncology and radiation physics faculty members. Twenty-nine case based sessions were given yearly (2016 to 2019). Because of the COVID-19 pandemic restrictions, the course was shortened to 8 case based virtual sessions in 2020 and 2021. Out of a possible 1, 800 teaching evaluation forms, there were 366 teaching evaluation forms received. For the years 2016-2021, the mean and median teaching evaluation scores were 4.65 and 5 respectively (range 2-5), where 1 represents worse teaching quality and 5, the best teaching quality. For the year 2021, 2 questions relating to the video virtual format (implemented due to the covid-19 pandemic), revealed consistent high scores with the mean and median responses of 4.14 and 5, respectively (range 1-5).

**Conclusions:** The results from the teaching evaluation scores indicate that the teaching faculty demonstrated excellent teaching skills. Trainees highly valued the teaching sessions. During the pandemic, the case based applied physics course was successfully delivered virtually, with continued high teaching evaluation scores. A video virtual platform for a structured case-based applied physics course could be useful, especially for small programs without an existing applied physics case based curriculum.

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## STAFF STRESS AT A CANADIAN CANCER CENTRE

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**Purpose:** Oncology health care professionals (HCPs) generally find their work rewarding despite its demanding and stressful nature. Thus, it is important to ensure that staff have an environment where supports exist to reduce the risk of severe stress and burnout. This study investigated workplace stress amongst physicians, nurses, and radiation therapists at The Ottawa Hospital Cancer Centre.

**Materials and Methods:** A 61-item ethics approved staff satisfaction survey was developed at our cancer centre to evaluate factors contributing to workplace stress. The online survey was distributed to staff via email for self-completion in 2020 and descriptive statistics were used to evaluate the responses.

**Results:** A total of 478 individuals completed the online survey, out of which there were 89 resident and staff physicians, 102 nurses, and 95 radiation therapists. The majority were involved in direct patient care, with 71% of physicians, 56% of nurses and 62% of radiation therapists having a high level of interaction with patients. Approximately 28% of physicians, 20% of nurses, and 9% of radiation therapists found their work "very" stressful, and 10% of physicians, 35% of nurses, and 41% of radiation therapists admitted to calling in sick for work-related stress. Also, 19% of physicians, 24% of nurses, and 15% of radiation therapists stated that they were having burnout symptoms either "always" or "often". Only 6% of physicians, 30% of nurses, and 18% of radiation therapists felt there was enough support at the cancer centre to help staff deal with stress and burnout. In addition to this, 24% of physicians, 37% of nurses, and 48% of radiation therapists had considered changing careers. Common strategies to cope with stress included exercise, family support, and interaction with colleagues. Suggestions of ways to improve the workplace experience included acknowledgement and support from management, as well as increased teamwork.

**Conclusions:** Workplace stress is common amongst our oncology staff members and a concerning proportion admit to having high degrees of stress and/or symptoms of burnout. Strategies to support workers are required and should include more individualized acknowledgement for the work being done, better support from management, and efforts to create a more team-based work environment.

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**PATIENT REPORTED CHANGE IN PAIN OUTCOME AMONG STAGE IV CANCER PATIENTS WITH BONE METASTASES AFTER PALIATIVE RADIOTHERAPY AT TIKUR ANBESSA SPECIALIZED HOSPITAL**

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**Purpose:** To determine the patient reported change in pain status after palliative RT at two, four, and eight weeks (wks.), when compared to pretreatment pain status.

**Materials and Methods:** A total of forty-four cancer patients with bone metastasis were enrolled in the study. Uncontrolled before and after study was conducted to investigate the effectiveness of palliative RT with cobalt 60 radiotherapy machine towards alleviating pain due to bone metastases. Patient reported pain score was assessed at baseline and post radiotherapy at two, four and eight weeks. The baseline pretreatment pain score was compared to post palliative radiotherapy pain score at two, four and eight weeks.

**Results:** Forty-four patients enrolled to this study with six of them having two sites of bone metastases from February 10 2020 to September 20 2020. Half of patients initially presented with severe pain and the rest half had either moderate or mild pain. Patients who had severe pain were more likely to receive 8 Gy than 20 Gy. After patients receive palliative RT at week 2, 4 and 8, complete pain response was 32.61%, 45.24%, and 51.28% and overall response rate was 65%, 67%, 78% respectively.

**Conclusions:** Palliative RT administered to Stage IV cancer patients with painful bone metastases is effective in reducing pain severity in majority of patients in Ethiopia.

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**STAFF SATISFACTION AT A CANADIAN CANCER CENTRE**

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**Purpose:** Caring for cancer patients is generally considered very rewarding work but it can also be stressful and demanding. Therefore, it is important for oncology healthcare professionals to feel satisfied with their work environment in order to provide the best care possible.

**Materials and Methods:** An ethics approved 61-item staff satisfaction survey was developed in-house to gain insights regarding workplace satisfaction among all staff at our regional cancer centre. It was an online survey requiring approximately 15 minutes to complete. Descriptive statistics were used to analyze the responses.

**Results:** A total of 478 individuals completed the online survey, with 75.1% women, 23.2% men and 1.7% preferring not to say. This represented the vast majority (>75%) of cancer centre staff. The median age range was 41-50 years, with 76.8% either married or in common-law relationships. Over half (64.3%) had worked at the cancer centre for at least five years, with 47.1% having worked for 10 or more years. Many (93.3%) had some degree of patient interaction, with 74.9% describing it as moderate or high. The approximate breakdown according to healthcare professional type was as follows: 21% nurses, 20% radiation therapists, 18% physicians, 13% clerical staff, and 28% other types of staff. Almost all (97.4%) generally enjoyed their work, with 60% stating "very much" and 37.4% stating "a little bit", and 93.3% found working with cancer patients rewarding. Overall satisfaction level at work was high, with 30.1% reporting "very satisfied" and 54.2% "somewhat satisfied". Over two-thirds looked forward to coming to work; either "most days" (55.2%) or "every day" (12.6%). Approximately 80% of staff believed that they were able to provide either "Good" or "Excellent" care to patients. However, in terms of their work being stressful, 18.6% stated it was "very much" and 62.1% "a little bit". Also, in terms of their workload, 61.3% stated it was "very busy" and 10% stated it was "excessively busy". The most enjoyable aspects of work were listed as interactions with colleagues, interactions with patients and learning new things. The least enjoyable aspects of work were excessive workload, perceived unsupportive work environment and technology problems. Levels of satisfaction and stress at work varied according to role at the cancer centre.

**Conclusions:** Most cancer centre staff seem to enjoy their work and find it rewarding. However, the work environment can be challenging and stressful. Areas for improvement include managing workloads, ensuring staff feel supported and improving user-friendliness of technology.

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**STEREOTACTIC ARRHYTHMIA RADIOABLATION FOR VENTRICULAR TACHYCARDIA (STAR-VT): A SINGLE INSTITUTION, DOSE DE-ESCALATION, PHASE II TRIAL**

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**Purpose:** Ventricular tachycardia (VT) is characterized by electrical re-entry within patches of heterogeneous myocardial fibrosis leading to sustained consecutive ventricular beats at a rate > 100 per minute. Implantable cardioverter-defibrillators (ICD) are the main intervention for reducing mortality, however, they are exclusively a symptom-control therapy. Catheter ablation is the standard of care adjunctive therapy for patients refractory to medical therapy. A novel treatment approach using ablative radiation with a stereotactic body radiation therapy (SBRT) to arrhythmogenic scar regions defined by cardiac mapping has been described. Initial results, using a single 25 Gy fraction, suggest this technique may improve morbidity among this ablation-refractory population. The optimal dose for this therapy remains unclear and major adverse events with 25 Gy have been reported. This clinical trial will compare treatment with a single fraction of 20 Gy delivered with SBRT to historical controls treated with a single fraction of 25 Gy.

**Materials and Methods:** Inclusion criteria for participants are age > 18 years, cardiomyopathy, and recurrent episodes of monomorphic ventricular tachycardia failing standard treatment with at least 1 antiarrhythmic drug, and previous electrophysiologic ablation. Exclusion criteria are participants with previous thoracic radiation, connective tissue disease, interstitial pulmonary fibrosis, and pregnancy.

We anticipate an incidence rate of approximately five VT events per person-year in participants treated with 25 Gy as a historical comparator based on a previous Phase I/II trial. Based on a Poisson distribution, and using a non-inferiority margin of 8.5 events per-year (corresponding to an incident rate ratio of 1.7), recruitment of 9 participants will provide 80% power when using a one-sided type I error, set at 0.05. We will evaluate the non-inferiority of 20 Gy relative to 25 Gy by determining whether the upper bound of the one-sided 95% confidence interval for the incidence rate ratio will be below the pre-specified non-inferiority margin (incidence rate ratio=1.70). Descriptive statistics will be used to describe continuous variables and proportions will be used to describe binary variables.

**Results:** The Research Ethics Board at the institution has given ethics approval to this research study and is responsible for the ongoing ethics oversight of the study. Our primary efficacy endpoint is the reduction in arrhythmia burden measured by the total number of VT events and ICD treatments for VT comparing the 6 and 12-month periods after a single fraction of 20 Gy SBRT with a single fraction of 25 Gy in the published literature. Our primary safety endpoint is defined as the rate of severe treatment-related adverse events at ≤ 90 days. Secondary endpoints include overall survival, late adverse events, number and doses of antiarrhythmic drugs, and quality of life.

**Conclusions:** This study is currently recruiting participants.

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## DOSIMETRIC EVALUATION AND EFFICACY OF LINAC BASED STEREOTACTIC RADIOSURGERY IN BRAIN METASTASIS USING HYPERARC -VOLUMETRIC MODULATED ARC PLANNING EXPERIENCE OF A TERTIARY CARE CENTER OF PAKISTAN

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**Purpose:** The aim of this study is to evaluate dosimetric quality and delivery efficacy of LINAC based SRS, with single isocenter non-coplanar volumetric modulated arc therapy (VMAT) in brain metastasis using Hyper-arc technique.

**Materials and Methods:** From April 2020 till May 2021, data of 19 patients with a total of 33 brain metastasis treated with Hyperarc VMAT based stereotactic radiotherapy was evaluated. The volumes, planning parameters, doses to target volume and critical structures were evaluated retrospectively.
Data was evaluated using SPSS version 20

**Results:** Median age was 45(33-73).
Primary disease was breast Carcinoma (15) followed by lung 4.
11 patients had supratentorial lesion and 8 had infratentorial.
Median GTV volume was 11.9cc (1.4-34) and PTV volume 20.3(3.2-77cc).
7 patients were treated with single fraction while rest were treated with 3-5 fractions.
Median MUs were 3416 (897 - 11606) with dose rate of 1400.
Plan Quality index were also evaluated with median RTOG CI 1.03, Median Paddick CI 0.89 and median GI 2.34

**Conclusions:** This clinical data show that SFRT/SRS with HyperArc is safe and effective for brain Metastasis patients. The utilization of SFRT/SRS for brain Metastasis is promising and should be further explored in randomized trial.

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## USAGE OF REGULAR SAFETY SURVEYS TO EVALUATE AND STRENGTHEN SAFETY CULTURE IN THE RADIATION TREATMENT DEPARTMENT

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**Purpose:** The Radiation Treatment Quality Assurance Committee (RTQAC) is a multidisciplinary committee within the Radiation Treatment department. As a newly established committee in 2013, the RTQAC had a desire to obtain feedback from staff and to evaluate the existing safety culture. This practice has continued in subsequent years, with six surveys conducted over an 8-year period. The purpose of the safety culture surveys is to measure staff comfort with reporting incidents and the information-gathering process which follow an incident, to gather staff feedback on ways to improve the quality of treatment delivery, to measure and assess the current state of the safety culture in the department, and to identify themes from the results to drive quality improvement initiatives.

**Materials and Methods:** The safety culture surveys are developed in an electronic format and have been sent to all staff across various disciplines in the Radiation Treatment department, including radiation oncologists, medical physicists, physics associates, electronics engineers, radiation therapists, nurses, and clerical staff. The most recent survey was conducted in 2021.

The surveys have ranged from nine to fifteen questions in length. Many of the questions have remained the same across the years, while some have been modified with each survey as seen fit by the committee. Responses are collected in both a multiple-choice format as well as written responses.

Responses collected from each survey are analyzed, and when possible, compared against similar questions asked in previous years. The results are compiled into a report which is shared with the department.

**Results:** Safety culture is something that is dynamic, as it can change with the implementation of new procedures, updates to incident reporting systems, changes in staffing, and external challenges such as COVID-19. Regular collection of safety culture survey results have highlighted both successes and areas of improvement within the department and the RTQAC.
While in many areas, trends are positive, those areas which illustrate progressively negative responses have identified common issues which can be addressed. Feedback that has been collected has subsequently helped guide quality improvement initiatives.

**Conclusions:** The implementation of safety culture surveys in our department has proven invaluable. It has provided staff an opportunity to talk openly and anonymously about safety concerns. Through assessment of responses, quality improvement strategies can be undertaken, which in turn can advance the culture of safety in the program.

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## CHOROID PLEXUS PAPILLOMA IN A ADULT: CASE REPORT

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**Purpose:** Chroroid plexus tumours are a rare intraventricular neoplasm originating from choroid plexus that account for only 0.3-0.6% of all intracranial tumours. These tumours are seen more frequently in children, especially in first two years of life with an incidence of 1.5-4% in this age group. The mayority of the tumours are benign choroid plexus papilloma WHO Grade I. Here we report a case of choroid plexus papilloma in an adult patient and his treatment.

**Materials and Methods:** A 39-year-old man was admitted to the neurosurgery department of his hospital for a headache, gaze shift to the left, and disorientation. By computed tomography and magnetic resonance imaging in January / 2020, a tumour in the third ventricle directed to the mesencephalon with a cystic component was reported compatible with choroid plexus papilloma of 21x26x22mm. Due to the location and restriction of surgical treatments due to the COVID19 pandemic, he was sent for radiotherapy evaluation. Treatment with stereotactic radiosurgery was decided in our department 12 Gy in 1 fraction in a volume at PTV of 11.25cc with a prescription at 100% of the dose, coverage of 98.3% at GTV in 31th July 2020. Surveillance was maintained through imaging studies.

**Results**: By magnetic resonance imaging of July 23, 2021, 12 months after having indicated the treatment, no tumour data was reported, although clinically even with mild persistence of dizziness, achieving a complete answer.

**Conclusions:** Choroid plexus papillomas are rare, benign tumours originating from choroid plexus. Although its initial treatment has been established surgical resection, it cannot always be achieved due to the location, conditions of the patient, or in this case indirect reasons such as space limitation due to Pandemic. In this case, radiosurgery was indicated as initial treatment, achieving a complete response at 12 months, so we verified that radiosurgery can be used as initial treatment in early stages and in locations that are not susceptible to resection.

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**ASSESSING THE LANDSCAPE IN MEDICAL ONCOLOGY MEDICAL EDUCATION SCHOLARSHIP: A SCOPING STUDY**

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**Purpose:** Medical oncology and medical education have both expanded exponentially over the past 50 years; as such, it is important to understand the current status of postgraduate medical oncology education and develop ways to advance this field. This study undertakes a scoping review of medical education literature in medical oncology to inform future scholarship in this area.

**Materials and Methods:** MEDLINE (Ovid), Embase (Ovid), ERIC (EBSCO), and Web of Science (UBC Core Collection) were searched to find peer-reviewed English language articles on Postgraduate Medical Education in Medical Oncology published between 2009 and 2020. The review was designed in accordance with updated methodological guidance for the conduct of scoping review. Articles were classified by learning specialty, learner training level, region of authorship, single or multi-institution, year of publication, whether the journal was an education journal, quantitative versus qualitative design, study methodology, and category or topic. A modified Kerns framework for curriculum development was used to assess the type of curriculum intervention, Boyer's definition of scholarship was used to classify the type of scholarship, and the CanMEDS Framework was used to map the domains of physician competency each study aims to address. Results were interpreted using descriptive statistics and collated and summarized utilizing predetermined conceptual frameworks.

**Results:** 2959 references were initially found across the 4 databases. After title and abstract screening,
305 articles remained; after full text review, a total of 144 articles were included in our final analysis. These data showed that postgraduate medical oncology graduate medical education scholarship is increasing and most commonly observed in the United States. Quantitative studies were most common with surveys used as the most popular study approach. In terms of CanMEDS framework, Professional and Medical Expert comprised the large majority of education focuses, while very few articles addressed Leader or Health Advocate. Curriculum development, professional development, and attitudinal skills (communication skills, ethics) were the dominant research themes, while no articles discussed teacher training.

**Conclusions:** By investigating the body of current literature, this research identifies areas of highest priority in postgraduate medical oncology graduate medical education and opportunities for growth. Whereas areas like professionalism and attitudinal skills are well-studied, research is lacking in leadership, health advocacy and teaching training. This study provides guidance for future medical education scholarship in medical oncology and establishes a benchmark to examine changes in medical oncology educational scholarship over time.

***Correction to abstract 128 from 2021 VSM.***

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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 5-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.

**Conclusion:** 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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