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Whole Brain Radiation Therapy With Stereotactic Radiosurgery Boost Versus Stereotactic Radiosurgery Alone for Brain Metastases: A Cost-Effectiveness Analysis

C. Min,¹ H.T. Gold,¹ A. Narayana,² and S.C. Formenti¹; ¹New York University Medical Center, New York, NY, ²Yale University School of Medicine, New Haven, CT

Purpose/Objective(s): Stereotactic radiosurgery (SRS) with or without whole brain radiation therapy (WBRT) is currently a widely accepted method of treatment for brain metastases. Studies on WBRT in combination with SRS have shown conflicting results. To aid in evidence synthesis and interpretation, we created a decision model to estimate the incremental cost-effectiveness of adding WBRT to SRS.

Materials/Methods: We created a decision tree informed by three randomized trials of patients with brain metastases. WBRT + SRS vs SRS alone was the decision modeled (i.e., the decision node), followed by potentially occurring events (i.e., chance nodes) that included outcomes such as cognitive decline, recurrence, and salvage. The model had a one year time horizon. We produced summary estimates weighting the result from each trial by the inverse of its variance, in accord with standard methods. Costs used were from the healthcare perspective and were determined from Medicare 2012 reimbursement rates. Utilities and utility decrements (preference-weighted measures of health-related quality of life scaled from 0 to 1) were derived from published EQ-5D scores for chronic conditions. One-way sensitivity analyses were conducted to determine robustness of the decision analysis model.

Results: Compared to SRS alone, WBRT + SRS had a higher average cost (\$28,050 vs \$29,550) and a lower average health-related quality of life (utility 0.50 vs 0.41), yielding an incremental cost-effectiveness ratio of \$15,970 per quality-adjusted life year. Therefore, SRS alone dominated the WBRT + SRS strategy because it was both cheaper and delivered a higher quality of life. Sensitivity analyses revealed that altering assumptions regarding the following inputs could change the preferred decision: utility decrement after WBRT and utility decrement after recurrence. As the utility decrement from treatment with WBRT decreased (below 0.016), WBRT + SRS became the dominant strategy. Similarly, as the utility decrement from recurrence increased (above 0.440), WBRT + SRS became the dominant strategy.

Conclusions: Our preliminary results demonstrate that SRS alone may be a more cost-effective method of treatment for brain metastases, likely due to smaller utility decrements. This should be further explored with multi-way sensitivity analyses, threshold analyses, and larger randomized trials. Recommendations to patients should be on a case by case basis, taking into account patient preferences and ability to follow-up after treatment. For patients who decline WBRT, SRS alone may be a reasonable treatment modality for brain metastases.

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Cost-Effectiveness Analysis of Stereotactic Ablative Radiation Therapy Versus Single-Fraction External Beam Radiation in Painful Vertebral Body Metastases

J.C. Hodges,¹ J. Sheu,¹ D.N. Kim,¹ R. Abdulrahman,¹ L. Nedzi,¹ K.S. Choe,¹ J.E. O'Toole,² R.D. Timmerman,¹ and D.J. Sher²; ¹University of Texas Southwestern Dallas, Dallas, TX, ²Rush University Medical Center, Chicago, IL

Purpose/Objective(s): Single fraction external beam radiation therapy (SF-EBRT) for palliation of painful vertebral body metastases (PVB) is convenient but associated with suboptimal pain relief and high retreatment rates. Single-institution studies suggest that stereotactic ablative radiation therapy (SABR) significantly improves the magnitude and durability of

pain response, but this treatment is more costly. The purpose of this study is to compare the cost-effectiveness of SF-EBRT and SABR and determine disease, patient, and treatment parameters that influence the result.

Materials/Methods: A Markov decision model was designed with the various disease states for the base case of a 60-year-old patient with solid tumor PVB treated with SF-EBRT or single-fraction SABR. Health states included the degree of response (complete, partial, stable), progression, vertebral body fracture (VF), cord compression, and response/progression after salvage SABR. Efficacy, utility values, VF risk, and costs were adapted from the literature and varied in deterministic and probabilistic sensitivity analyses (SA).

Results: In the base case, mean costs and quality adjusted life expectancy in months (QALMs) for SABR and SF-EBRT were \$24,085 (7.00) and \$23,438 (6.42), respectively, resulting in an incremental cost-effectiveness ratio (ICER) of \$13,365/quality-adjusted life-year (QALY). Deterministic SA revealed that overall response rate (ORR), response durability, expected 1-year survival, and VF risk were the key parameters affecting the ICER. If SABR experienced just an 11% relative increase in ORR (70% to 78%), SABR would dominate SF-EBRT. Similarly, if one assumed a favorable 1-year survival (70%) consistent with metastatic breast or prostate cancer, the ICER of SABR was \$8,000/QALY or less. Conversely, for patients with an unfavorable 1-year survival (30%), SF-EBRT was cost-effective (SABR ICER >\$90,000/QALY). When SABR led to a 34% risk of VF at 2 years, the ICER of SABR exceeded \$50,000/QALY and was greater than \$100,000/QALY with a VF risk of 45% at 2 years. Prophylactic vertebroplasty in this high VF risk population again made SABR cost-effective. Probabilistic SA drawing on distributions for ORR, response durability, and VF risk found that SABR was cost-effective 62%, 70%, and 73% at willingness-to-pay thresholds of \$50,000, \$100,000, and \$150,000 per QALY.

Conclusions: In our base model, SABR is the cost-effective strategy for treating PVB, as the reduced need for costly salvage therapy ultimately reduces the initial cost difference. This result was consistent over a wide range of assumptions but sensitive to key treatment and disease variables, highlighting the value of SABR for palliation of PVB, particularly in favorable prognosis patients with stable or low risk of VF.

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Collaborative Quality Initiative in the Treatment of Breast and Lung Cancer: An Important Step Toward High Quality Cost-Effective Care

J.M. Vainshtein,¹ J.A. Hayman,¹ J.M. Moran,¹ K.A. Griffith,¹ R. Jagsi,¹ M.U. Feng,¹ I.S. Grills,² E.M. Walker,³ D. Heimburger,⁴ and L.J. Pierce¹; ¹University of Michigan, Ann Arbor, MI, ²Beaumont Health System, Royal Oak, MI, ³Henry Ford Hospital, Detroit, MI, ⁴Traverse Bay Radiation Oncology, Traverse City, MI

Purpose/Objective(s): Collaborative quality initiatives (CQIs) allow physicians and hospitals to partner with third-party payers to improve patient care and reduce healthcare costs. Multi-institutional CQI consortia can identify and disseminate best practices. The Michigan Radiation Oncology Quality Consortium (MROQC) is a radiation oncology-based statewide CQI, recently created with the support of Blue Cross Blue Shield of Michigan (BCBSM) to share data on practice patterns and radiation-related toxicity (RRT) in order to identify which breast cancer (BC) patients treated with whole breast radiation therapy (RT) and lung cancer patients treated with curative intent conventionally fractionated RT may benefit most from the use of intensity modulated RT. Herein we provide a summary of the CQI implementation process for BC patients.

Materials/Methods: Centers were approached for participation through BCBSM. Eligible centers treat at least 100 new cancer patients per year,

with identified clinical, physics, and administrative personnel agreeing to coordinate with MROQC. After IRB approval, patient-specific demographic, clinical, and toxicity data are prospectively collected for all eligible patients. Eligible BC patients include any stage newly diagnosed invasive ductal carcinoma or DCIS to be treated with breast conserving surgery and whole breast RT. Physician-reported RRT (required) and patient-reported quality of life outcomes (voluntary) are collected at baseline, weekly during RT, and at 1- and 3-month follow-up. Photographs to assess breast RRT are collected from consenting patients at the same time points. Following RT completion, simulation, plan, and delivery data are collected by survey, upload of dose-volume histogram (DVH) data, and DICOM-RT files.

Results: Of 65 centers providing RT services in Michigan, 28 to date have been approached to participate. Thus far, 14 of 22 eligible invited institutions have joined MROQC, with 11 having contributed cases. Eight hundred fifteen eligible cases of the 1,096 screened have been accrued to date. Seventy percent of cases have completed RT, of which 89% and 61% have all required weekly and follow-up physician assessment and patient-reported forms, respectively. Sixty-one percent of patients have consented for breast toxicity photographs. Simulation, plan, and delivery surveys, DVH data, and DICOM data have been received for 82%, 80%, and 83% of patients, respectively.

Conclusions: MROQC is ongoing to collect RT practice data throughout the entire state of Michigan and serves as a model for the development of registries that include data relevant for the evaluation of RT. Institutional and patient enthusiasm for participation has been high, supporting data collection to inform on best practices and to improve cost-effective care.

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Cost Analysis of Alternative Treatment Modalities Utilized in the Management of Early-Stage Testicular Seminoma

T. Lanni,¹ J.A. Cox,² S. Gajar,³ and T.A. Swanson²; ¹Beaumont Health System, Royal Oak, MI, ²University of Texas Medical Branch, Galveston, TX, ³University of Texas Medical Branch School of Medicine, Galveston, TX

Purpose/Objective(s): Testicular Seminoma is amongst the most common cancers in males age 15-35, with roughly 85% of patients diagnosed with stage I disease. Acceptable post-orchietomy management strategies for stage I patients include surveillance, para-aortic (PA)-radiation therapy (RT), dog-leg (DL)-RT or a single cycle of carboplatin (Carbo). The required follow-up recommendations for each treatment option were recently amended by the National Comprehensive Cancer Network (NCCN) in 2012. As such, surveillance imaging after treatment, a contributor to treatment costs, was significantly scaled back.

Materials/Methods: NCCN guidelines were used to design treatment plans for each of the acceptable adjuvant treatments strategies: single agent Carbo (AUC = 7), PA-RT (20 Gy), DL-RT (20 Gy) and salvage chemotherapy (Bleomycin, Etoposide and Cisplatin x 3 cycles). NCCN guidelines for growth factor support and anti-emetic use were incorporated into the treatments. Follow-up charges were also generated for 10 years based on both the 2012 (version 1.2012) and the 2011 NCCN (version 2.2011) surveillance recommendations. According to published literature, the anticipated failure rate for surveillance only, either RT adjuvant strategy, or adjuvant Carbo was 18%, 5%, and 4% respectively. The 2012 Medicare fee schedule was used to calculate the reimbursement for each treatment strategy. Cost-effectiveness analyses were performed using incremental cost effectiveness ratios (ICER) to compare treatment options.

Results: Under the current 2012 NCCN recommendations, the total reimbursement generated over 10 years for observation, PA- RT, DL-RT, and Carbo were \$10,643, \$11,678, \$9,662, and \$10,405 respectively. This is compared to the required follow-up under the 2011 and earlier versions

of the guidelines for which the costs (based on 2012 reimbursements) for the observation, PA- RT, DL-RT, and Carboplatin were \$20,986, \$11,517, \$9,394, and \$20,365 respectively. ICERs for each group were calculated using the 2012 Medicare reimbursement and 5-year Relapse Free Survival Rate. At five years, without factoring salvage therapy as defined in our model of patient outcomes, observation in the setting of the 2012 guidelines was found to be less costly than adjuvant RT or Carbo. Factoring the rates of relapse into a salvage model, observation was found to be more costly and less effective compared to PA-RT, DL-RT and Carbo (\$1,831, \$7,318, \$7,010) in the adjuvant management of stage I seminoma patients.

Conclusions: Based on ICER, PA-RT, DL-RT and Carboplatin are a cost effective option for the treatment of stage I seminoma compared to observation; however, further studies are required to validate these findings. Such cost and reimbursement analyses are becoming increasingly relevant, however, not meant to usurp sound clinical judgment.

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Total Societal Cost of Care: Analysis of Partial Breast With APBI or IORT Versus Conventional Versus Accelerated External Beam Regimens for Breast Conservation

V. Arterbery; *Crittendon Cancer Center, Rochester Hills, MI*

Purpose/Objective(s): To compare cost to payers and physicians and to evaluate whether there are cost savings associated with alternate breast radiation techniques such as intraoperative radiation (IORT), whole breast accelerated radiation similar to Canadian regimens, accelerated partial breast irradiation (APBI) when compared with the conventional external beam-based whole-breast RT with a boost (WBRT-B). Randomized and single institution studies in the US and Europe have shown equivalent local control with these radiation techniques used for breast conservation.

Materials/Methods: Medicare reimbursement and treatment planning and delivery utilization data were modeled for 4 different breast RT techniques: (1) WBRT-B: 61.20 Gy in 34 fractions; (2) WBRT-accelerated (AC): 42.5 Gy in 16 fractions (3) (APBI) balloon based techniques: 34 Gy in 10 twice-daily fractions (4) (IORT) - intraoperative radiation at the time of breast surgery as only treatment. Costs incurred by payer (i.e., direct medical costs; 2012 Medicare Fee Schedule-MI) and patient (i.e., direct nonmedical costs; time and travel) were estimated. Total societal costs were then calculated for each treatment approach.

Results: Reduction in overall treatment time does not guarantee a reduction in total cost savings to payers. The least expensive external beam radiation approach was the (AC) regimen using 16 fractions. Any reduced cost to patients for the HDR brachytherapy-based APBI regimens were overshadowed by substantial increases in cost to payers, resulting in higher total societal costs; the cost of HDR treatment delivery was primarily responsible for the increased direct medical cost. Overall, IORT was the least costly of all the regimens, in terms of costs to society and payers. The traditional APBI approach has the highest reimbursement to physicians over all other techniques. Physician reimbursement and direct medical cost was greatest to least for APBI, then WBRT-B, AC and IORT respectively. Direct non medical costs to patient were ranked highest to lowest for WBRT-B, AC, WBRT-B and IORT in that order.

Conclusions: Current reimbursement does not reflect societal cost considerations. If one were to pursue a partial-breast regimen to minimize patient and payer costs, it would be more advantageous from a societal perspective to pursue IORT. The current reimbursement does not fairly represent the physician work involved to deliver these accelerated treatments. These large discrepancies in physician payments discourage the use of more cost effective breast treatments. Given the equivalent outcomes of some of the accelerated regimens either APBI or IORT or accelerated fractionation (AC), consideration should be given to restructuring or bundling radiation payments for early stage breast cancer.

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