Environmental Impact of Prostate Radiation Therapy: Modeling Emissions and Reduction Through Hypofractionation

J. L. Karten[1], A. Asaro[2], J. Starner[1], A. Narayana[1], and K. Lichter[3];

1.Northwell, New Hyde Park, NY,
2.Department of Internal Medicine, Ocean University Medical Center Hackensack Meridian Health, Brick, NJ,
3.Department of Radiation Oncology & Applied Sciences, The Dartmouth Institute for Health Policy & Clinical Practice, Geisel School of Medicine at Dartmouth, Dartmouth Cancer Center, Lebanon, NH

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INTRODUCTION

Radiation oncology contributes to healthcare's carbon footprint through energy-intensive equipment and patient transportation. A prior national Life Cycle Assessment (LCA) established EBRT emissions baselines- equaled **3.3 million metric tonnes of CO_2 equivalents in 2019**. 37,000 GU patents were treated with EBRT in 2019, contributing nearly **500,000 metric tonnes of CO2 equivalents** alone[1]
Further action is needed to reduce the GHG emissions from radiation treatment as our climate crisis only continues to worsen.

AIM

To model prostate-specific greenhouse gas emissions from external beam radiation therapy and evaluate the emissions-reduction potential of converting patients to guideline-concordant hypofractionated and stereotactic body radiotherapy (SBRT) regimens.

METHOD

Applied validated LCA methodology to 2019 NCDB and SEER data to estimate prostate EBRT volumes- 70% of curative GU EBRT cases; 65% low–intermediate risk

- Using previously established LCA[1] ,emissions were modeled from number simulation imaging, linac energy use, on-treatment visits, and transportation then multiplied by the number of patients treated
- Conventional fractionation (39 fx) modeled for conversion to moderate hypofractionation (28 fx; RTOG 0415/PROFIT) or SBRT (5 fx; PACE-B/C).
- Emissions were calculated both in metric tonnes equivalents and in Disability-Adjusted Life Years (DALY)

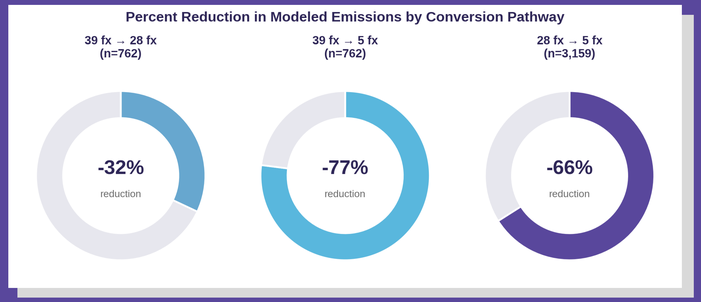
RESULTS

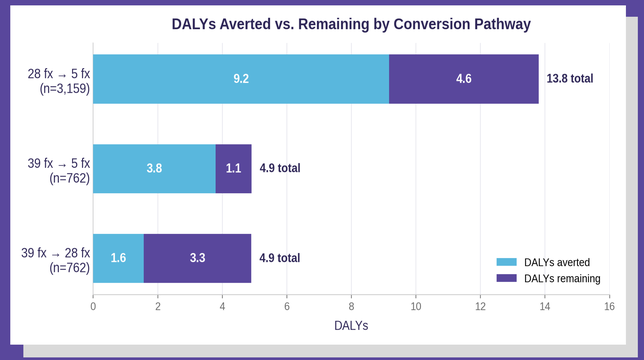
Among low–intermediate risk patients treated with 39 fractions (n=762) and 28 fx (n=3159, total modeled emissions were almost 16,000 metric tonnes CO_2e (4.9 DALYs) and 45,000 metric tonnes CO_2e (13.8 DALYs), respectively.

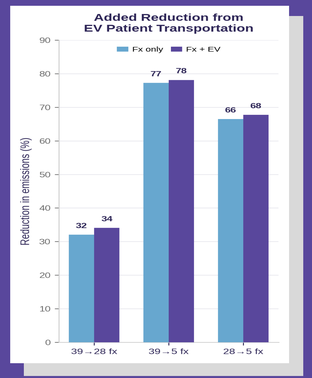
Conversion to moderately hypofractionated and SBRT significantly reduces the Greenhouse Gas emissions from treatment

Use of an Electric Vehicle (EV) further reduced emissions by an average of an additional 2%

Scenario	Emissions (t CO_2e)
Conventional (39 fx) (n=762)	15,972
Moderate hypofx (28 fx) (n=3159)	44,952
All 39 fx pts treated with 28 fx	10,851
All 39 fx pts treated with 5 fx	3,636
SBRT (5 fx)	15,080







CONCLUSIONS

Guideline-concordant hypofractionation reduces modeled emissions from prostate EBRT while aligning with efforts to minimize treatment-related burden.

Broader SBRT adoption among eligible patients may reduce emissions by up to 77% relative to conventional schedules.

These findings underscore the environmental co-benefits of evidence-based fractionation strategies.

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CONTACT INFORMATION

Jessie L Karten, DO
Resident, Northwell Health
jkarten1@northwell.edu