Doctoral Dissertation Defense Announcement

“Non-Invasive Tracking of Prostate Cancer Risk Assessment Using Radio-Pathomic Mapping”

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Committee in Charge:
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Adam Greenberg, PhD
William Hall, MD
Radka Stoyanova, PhD

Date: Tuesday, July 2, 2024
Time: 11:00 AM (CST)
Defense Location: HUB – A4520/A4628
Zoom: https://mcw-edu.zoom.us/j/97341910603?pwd=ji0n5OV3qUYSqcWvVk7hHQy1r292T.1
Meeting ID: 973 4191 0603 Passcode: Duenweg24
Graduate Studies:
Cognitive Neuroscience
Statistical Models & Methods I
Nuclear Magnetic Resonance
Functional MRI Contrast Mechanisms
Introduction to Statistical Machine Learning
Biomedical Applications & Consulting
Ethics & Integrity in Science
Research Ethics Discussion Series
Biophysics Journal Club
Biophysics Seminar Course
Reading and Reading
Doctoral Dissertation
Prostate cancer (PCa) is the most diagnosed cancer among men in the United States, representing 30% of all new male cancer cases. Concerns about PCa typically arise following abnormal digital rectal exam results or elevated prostate-specific antigen (PSA) levels during routine annual exams. If abnormalities are found, patients may undergo biopsies based on findings from multi-parametric magnetic resonance imaging (MP-MRI). For clinically significant cancer, treatment options include radical prostatectomy, which involves the complete removal of the prostate and seminal vesicles, as well as chemotherapy and/or radiation. Although the 5-year survival rate for PCa is nearly 100%, about 30% of men will experience biochemical recurrence, indicated by rising PSA levels after surgery. A significant issue with current treatments is the overtreatment of low-risk patients. PCa treatments can lead to complications such as impotence, incontinence, and infection, which can adversely affect patient quality of life. Therefore, it is essential to develop advanced imaging tools to accurately detect cancer and assess its metastatic potential, ensuring that patients receive the most appropriate treatment and avoid unnecessary procedures and their associated lifelong side effects.

This work uses tissue samples collected following radical prostatectomy aligned to MR imaging acquired prior to treatment to determine the relationships between radiological signatures and the underlying pathology of prostate cancer lesions. Specifically, we hypothesize that clinical MRI couples with machine learning-based predictive models can distinguish regions of aggressive tumors and patients with high metastatic potential by using surgical tissue coupled with pathological cancer annotations as ground truth. The studies involved in this project include validating radio-pathomic modelling potential by 1) comparing standard digital slide scanners to determine if scanner quality impacts pathological findings, 2) MR image normalization techniques to best normalize across a variety of clinical factors, and 3) creating “digital twins” to simulate the biopsy procedure. After validation, we 4) determined pathological features in histology space that can quantitatively characterize regions of cancer tissue and associate with biochemical recurrence risk, 5) correlate these features in MRI space, and 6) develop models that predict prostate cancer in MRI space. These studies have resulted in non-invasive maps of prostate pathology to improve clinical detection of aggressive cancers non-invasively. These maps have the potential to aid in clinical decision making and treatment planning in PCa, therefore improving patient outcomes. Additionally, these maps use quantitative pathomic features and MRI intensity values to mitigate interrater variability that is well known in pathological and radiological studies of Gleason patterns and PI-RADS scores, respectively.
EDUCATION
Milwaukee School of Engineering (Milwaukee, WI, Fall 2016–Spring 2020): Bachelor of Science
  Major: Biomedical Engineering
  Certificate/Minor: User Experience
  University Scholars Honor Program (2016)

Medical College of Wisconsin (Milwaukee, WI, Fall 2020–Current): PhD
  Department of Biophysics

RESEARCH EXPERIENCE
PhD Student, Medical College of Wisconsin (Fall 2020–Current)
Principal Investigator: Dr. Peter LaViolette
Thesis Title: *Non-invasive tracking of prostate cancer risk assessment using radio-pathomic mapping*

- Developed radio-pathomic machine learning models to detect prostate cancer pathology from MRI intensity values using aligned whole mount tissue samples as ground truth.
- Validated traditional imaging signatures and radiomic texture features using whole mount tissue samples, drawing comparisons across different diagnostic and treatment groups.
- Assessed MRI and histology image standardization methods for analysis generalization.
- Assisted in performing analogous brain cancer radio-pathomic mapping studies, including digital pathology pipeline development and statistical analyses.

Biomedical Research Intern, University of Wisconsin – Madison (Spring 2019–Fall 2019)
Principal Investigator: Dr. Ari Rosenberg

- Assisted in developing software to create an in-house graphical user interface (GUI) for real-time experimental control.
- Applied User Experience (UX) principles to design GUI with modular style.
- Created supporting documentation and tutorial guides for GUI use and applications.
PROFESSIONAL MEMBERSHIPS

- International Society for Magnetic Resonance in Medicine (ISMRM)
  - MR of Cancer Study Group (ISMRM-MRoC)
  - Body MR Study Group
- Society of Abdominal Radiology
- American Society of Neuroradiology
  - Artificial Intelligence Subgroup
- Society for Neuro-Oncology
- American Urological Association
- Society for Neuro-Oncology
- American Urological Association
- Alpha Eta Mu Beta Biomedical Engineering Honor Society
- Society of Women Engineers
- Biomedical Engineering Society
- Engineering World Health

AWARDS

- Top Trainee Presentation, ISMRM MR of Cancer Workgroup, May 2024 (power pitch)
- ISMRM Educational Stipend, May 2024
- GSA Travel Award, November 2023
- Biophysics Scholar Award, MCW Department of Biophysics, June 2023
- The William G. Negendank First Place Award, International Society for Magnetic Resonance in Medicine MR of Cancer Workgroup, November 2022 (poster)
- Top Oral Presentation, MCW Graduate Student Symposium, April 2022 (oral)

VOLUNTEERISM & MENTORING

- MCW Summer Program for Undergraduate Research (SPUR) Mentor
  - Cassandra Naze, Summer 2021
  - Jeff Rodriguez, Summer 2021
  - Alicia Hoefs, Summer 2022
  - Jordyn Hamburger, Summer 2022
  - Sarah Rubenstein, Summer 2023
- MCW 500 Stars Mentor
  - Lily Kriegel, Summer 2023
- BrainExpo 2023, Volunteer

JOURNAL PEER REVIEWS

- The Prostate
- Cancer Epidemiology, Biomarkers & Prevention
- PLoS ONE
- Quantitative Imaging in Medicine and Surgery (QIMS)
PUBLICATIONS


PEER REVIEWED PRESENTATIONS

International


Increased cell density and heightened tumor probability, as defined by radio-pathomic models, outside the FLAIR hyperintensity is associated with worse overall survival in glioblastoma patients prior to gross total resection – Savannah R. Duenweg, Samuel A. Bobholz, Allison K. Lowman, Aleksandra Winiarz, Michael Flatley, Biprojit Nath, Jennifer Connelly, Dylan Coss, Max Krucoff, Wade M. Mueller, Anjishnu Banerjee, and Peter S. LaViolette. ASNR 2024 (oral)


Survival outcomes and glioblastoma locations: a voxelwise survival analysis of white matter tract intersections – Biprojit Nath, Aleksandra Winiarz, Samuel A. Bobholz, Allison K. Lowman, Savannah R. Duenweg, Michael Flatley, Fitzgerald Kyereme, Jennifer Connelly, Dylan Coss, Max Krucoff, Anjishnu Banerjee, and Peter S. LaViolette. ASNR 2024 (oral)


A comparison of radio-pathomic maps of cell density to rCBV for detecting infiltrative tumor outside contrast enhancement in de-novo glioblastoma - Samuel Bobholz, Allison K. Lowman, Savannah R. Duenweg, Aleksandra Winiarz, Fitzgerald Kyereme, Jennifer Connelly, Dylan Coss, Max Krucoff, Mohit Agarwal, Anjishnu Banerjee, Peter S. LaViolette. ASNR 2023 (oral)


Regional


Local


POSTERS


[13] Radiomic features of contrast enhanced T1 MRI sequences predict survival in primary glioblastoma patients who underwent adjuvant radiation therapy – Michael Flatley, **Savannah R. Duenweg**, Allison K. Lowman, Samuel Bobholz, Margaret Stebbins, Aleksandra Winiarz, Biprojit Nath,
SOX2 positive, presumed tumor invasion measured beyond contrast enhancement and FLAIR hyperintensity in both treated and untreated glioblastoma patients assessed at autopsy – Margaret Stebbins, Samuel Bobholz, Savannah R. Duenweg, Allison K. Lowman, Aleksandra Winiarz, Michael Flatley, Bijprojit Nath, Fitzgerald Kyereme, Jennifer Connelly, Dylan Coss, Max Krucoff, Anjishnu Banerjee and Peter S. LaViolette. SNO 2023 (poster)


Use of containers and microservices in supporting dynamic research environments – Michael Barrett, Samuel A. Bobholz, Allison K. Lowman, Savannah R. Duenweg, Aleksandra Winiarz, Bijprojit Nath, and Peter S. LaViolette. Olson Radiology Retreat 2023 (poster)


[26] Tumor probability maps derived from conventional MRI and machine learning predict the location of glioblastoma invasion beyond contrast enhancement confirmed with 5-ALA-guided resection – Aleksandra Winiarz, Samuel Bobholz, Allison K. Lowman, Savannah R. Duenweg, Fitzgerald Kyereme, Dylan Coss, Max Krucoff, Jennifer Connelly, and Peter S. LaViolette. ISMRM-MRoC 2022 (power pitch and poster)


Fitzgerald Kyereme, Elizabeth J. Cochran, Jennifer Connelly, Wade M. Mueller, Mohit Agarwal, Anjishnu Banerjee, Peter S. LaViolette. SNO 2022 (poster)


[34] Radio-pathomic associations between MRI and complex histomorphometric features of prostate cancer – Savannah R. Duenweg, Samuel A. Bobholz, Allison K. Lowman, Michael Brehler, Fitzgerald Kyereme, Kenneth A. Iczkowski, Peter S. LaViolette. ISMRM 2022 (power pitch)


[38] Pathological validation of contrast enhancement at autopsy between patients treated and untreated with chemotherapy and radiation – Allison Lowman, Samuel Bobholz, Jennifer Connelly, Elizabeth Cochran, Wade Mueller, Michael Brehler, Fitzgerald Kyreme, John Sherman, Savannah Duenweg, Peter LaViolette. SNO 2021 (poster)


[40] Histomorphometric features of prostate cancer identify patients who biochemically recur after prostatectomy - SR Duenweg, M Brehler, S Bobholz, AK Lowman, F Kyereme, K Iczkowski, and PS LaViolette. MCW Graduate School Poster Session 2021 (poster)

[41] Development of customized software for transferring pathologist annotations between high-resolution histology digitized on two different slide scanners – SR Duenweg, M Brehler, S Bobholz, AK Lowman, F Kyereme, K Iczkowski, and PS LaViolette. MCW Graduate School Poster Session 2020 (poster)