Marcus Badgeley MEng, PhD

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA — May 2019 - present
Massachusetts General Hospital, Boston, MA
Postdoctoral Fellowship in Anesthesia and Brain and Cognitive Sciences

Verily (Google) Life Sciences, San Francisco, CA — June 2013 - May 2019
Icahn School of Medicine at Mount Sinai New York, NY
Doctor of Philosophy in Biomedical Sciences
Dissertation: Multimodal Deep Learning to Enhance the Practice of Radiology

The Ohio State University Columbus, OH — September 2009 - May 2013
Master of Science in Biomedical Engineering with Biomedical Imaging specialization — GPA 3.97/4.00
Bachelor of Science in Biomedical Engineering — GPA 3.91/4.00

RESEARCH

Massachusetts General Hospital, Emery Brown Lab *Post-doctoral Fellow* — 2019-present
- Develop closed-loop anesthesia control algorithm with deep reinforcement learning

Verily Life Sciences, Computational Biology — 2016-2018
- Use deep learning algorithms for computer-aided triage and diagnosis of radiographic images

Mount Sinai Hospital, Genetics and Multiscale Biology (Joel Dudley Lab) — 2014-2019
- Integrate electronic health records and genetics to investigate susceptibility and comorbidity patterns

Mount Sinai Hospital, Digital Health (Yvonne Chen Lab) — 2015-2016
- Evaluate feasibility of conducting iPhone-based asthma clinical trials for disease surveillance

Mount Sinai Hospital, Digital Pathology (Gerardo Fernandez Lab) — 2014-2015
- Use deep learning algorithms for computer-aided cancer grading of histologic images

The Ohio State University, Heart and Lung Research Institute — 2009-2013
- Investigate therapeutic and diagnostic (MRI) nanoparticles targeted to atherosclerotic plaques
- Optimize biomimetic nanoparticle synthesis for cholesterol trafficking assays

Nationwide Children's Hospital, Center for Injury Research and Policy — 2009-2010
- Use epidemiology techniques to investigate football injury patterns

Nationwide Children's Hospital, Center for Molecular and Human Genetics — 2009
- Use molecular genetics techniques to investigate Alzheimer's disease mechanisms

STARTUP

Nference *Clinical Science Partnerships Lead* — 2019-present
- Build strategic alliances with pharmaceutical partners and manage imaging projects
- Co-create the medical imaging program which raised 1.7M from pharmaceutical partners
- Coordinate engineering support from 4 engineers in Bangalore
- Advise CEO on digitizing analog hospital system pathology slides and a related acquisition opportunity

M&M Abodes LLC *Co-founder and COO* — 2013-2018

- Manage internal operations including valuation, maintenance, and legal (with contractors)

Myowareness *Co-founder, early stage startup* 2014-2015
- Funded to engineer a wearable biosensor, phone app, and event detection algorithm for epilepsy

CONSULTING

Whiteboard Coordinator *Software Engineer* 2018
- Develop image recognition solutions to automatically assess operating room workflows

MetaMed *Case Manager* 2013-2015
- Perform case based personalized medical research for patients with complex disease
- Develop Bayesian networks to quantify the probability of various diagnoses and treatment efficacies

Nationwide Children's Hospital *Business Process Improvement Intern* 2009-2010
- Implement process improvements for diverse departments with six sigma methods
- Lead hospital-wide project to improve the availability of transport carriers: failures reduced $> 90\%$

TEACHING

The Ohio State University *Graduate Teaching Associate* 2012-2013
- Develop curriculum and lead laboratory for nanotechnology design honors engineering course

TECHNICAL SKILLS

Scripting languages
- python
- R
- shell

Development Tools
- git
- docker
- GNU make

Reinforcement Learning
- gym (py)

Deep Learning (py)
- tensorflow
- torch
- keras

Machine Learning
- scikit-learn (py)
- caret (R)

Image analysis
- opencv (py)
- EBImage (R)

Databases
- SQL
- MongoDB
- elasticsearch

Markup Languages
- LaTeX
- markdown
- ReStructured Text

PATENTS

S Rajagopalan, **MA Badgeley**, A Maiseyeu. Cholesterol Efflux Assay Probe Formulations, Methods of Making and Using, U.S. Patent Application 13/861832, April 12, 2013

GRANTS AND AWARDS

National Collegiate Inventors and Innovators Alliance E-Team Grant 2014-2015
WebMD Hackathon 36 hour design contest winner (1^{st} of 25 teams) 2014
American Heart Association Summer Undergraduate Fellowship 2012
Biomedical Engineering Research Achievement Award (1^{st} of 75 students) 2012
Kettering Biomedical Engineering Scholarship 2011-2013

Lumley Engineering Foundation Fellowship	2011-2012
Six Sigma Process Improvement Greenbelt Qualification	2010
Battelle Memorial Institute Scholarship	2009-2013
Maximus Scholarship	2009-2013
Eagle Scout, Boy Scouts of America	2007

MEMBERSHIPS

American Society of Anesthesiologists	2017-present
Society for Technology in Anesthesia	2015-2016, 2018-present
American Physician Scientists Association	2014-2019
American Society of Human Genetics	2015-2016
International Society for Computational Biology	2014-2015
American Heart Association	2012-2013

PUBLISHED ARTICLES

JH Abel, **MA Badgeley**, TE Baum, S Chakravarty, PL Purdon, EN Brown. Constructing a control-ready model of EEG signal during general anesthesia in humans. *arxiv.org*. 2019 Dec; 1912.08144.

BS Glicksberg, L Amadori, NK Akers, K Sukhavasi, O Franzn, L Li, GM Belbin, KL Akers, K Shameer, **MA Badgeley**, KW Johnson, B Readhead, BJ Darrow, EE Kenny, C Betsholtz, R Ermel, J Skogsberg, A Ruusalepp, EE Schadt, JT Dudley, H Ren, JC Kovacic, C Giannarelli, SD Li, JLM Bjrkegren, R Chen. Integrative analysis of loss-of-function variants in clinical and genomic data reveals novel genes associated with cardiovascular traits. *BMC Med Genomics*. 2019 July; 12:108. PMID: 31345219

BS Glicksberg, B Oskotsky, PM Thangaraj, N Giangreco, **MA Badgeley**, KW Johnson, D Datta, V Rudrapatna, N Rappoport, MM Shervey, R Miotto, TC Goldstein, E Rutenberg, R Frazier, N Lee, S Irani, R Larsen, B Percha, L Li, JT Dudley, NP Tatonetti, AJ Butte. PatientExploreR: an extensible application for dynamic visualization of patient clinical history from Electronic Health Records in the OMOP Common Data Model Title. *Bioinformatics*. 2019 Jun; epub. PMID: 31214700

MA Badgeley, BS Glicksberg, M Liu, M Shervey, J Zech, S Khader, N Knudson, A Costa, J Titano, J Schefflein, A Su, MV McConnell, J Lehar, EK Oermann. TM Snyder, JT Dudley. CANDI: an R package and Shiny app for Annotating Radiographs and Evaluating Computer-Aided Diagnosis. *Bioinformatics*. 2019 May; 35(9):1610-1612. PMID: 30304439

MA Badgeley, JR Zech, L Oakden-Rayner, BS Glicksberg, M Liu, W Gale, MV McConnell, B Percha, TM Snyder, JT Dudley. Deep Learning Predicts Hip Fracture using Confounding Patient and Healthcare Variables. *NPJ Digital Medicine*. 2019 April; epub. PMID: 31304378

J Zech*, **MA Badgeley***, M Liu, A Costa, J Titano, EK Oermann. Variable generalization performance of a deep learning model to detect pneumonia in chest radiographs: A cross-sectional study. *PLOS Medicine*. 2018 Nov; 15(11):e1002683. PMID: 30399157

J Titano*, **MA Badgeley***, J Schefflein, A Costa, M Pain, A Su, M Cai, N Swinburne, J Zech, J Kim, J Bederson, J Mocco, B Drayer, J Lehar, S Cho, EK Oermann. Automated Surveillance of Head CTs for Acute Neurologic Events with Deep Neural Networks. *Nature Medicine*. 2018 Sep; 24(9):1337-1341. PMID: 30104767

R Feng, **MA Badgeley**, J Mocco, EK Oermann. Deep learning guided stroke management: a review of clinical applications. *J Neurointerv Surg*. 2018 Apr; 10(4):358-362. doi:10.1136/neurintsurg-2017-013355.

PMID: 28954825.

J Zech, M Pain, J Titano, **MA Badgeley**, J Schefflein, A Su, A Costa, J Bederson, J Lehar, EK Oermann. Natural Language-based Machine Learning Models for the Annotation of Clinical Radiology Reports. *Radiology.* 2018 Jan 30:171093. doi: 10.1148/radiol.2018171093. PMID: 29381109

YY Chan, P Wang, L Rogers, N Tignor, N Genes, SG Hershman, ER Scott, M Zweig, **MA Badgeley**, S Violante, E Krock, R Edgar, R Wright, C Powell, J Dudley, EE Schadt. The Asthma Mobile Health Study, a Large Scale ClinicalStudy Using ResearchKit. *Nature Biotechnology.* 2017 Apr; 35(4):354-362. PMID: 28288104.

K Shameer, BS Glicksberg, R Hodos, K Johnson, **MA Badgeley**, B Redhead, M Tomlinson, R Miotto, B Kidd, R Chen, JT Dudley. Systematic analysis of drugs and disease indications in RepurposeDB reveal chemical, biological, and epidemiological factors influencing drug repositioning. *Briefings in Bioinformatics.* 2017 Feb 15. doi: 10.1093/bib/bbw136. PMID: 2820013.

BS Glicksberg, L Li, **MA Badgeley**, K Shameer, R Kosoy, ND Beckmann, N Pho, J Hakenberg, M Ma, KL Ayers, GE Hoffman, SD Li, EE Schadt, CJ Patel, R Chen, JT Dudley. Comparative Analyses of Population-scale Phenomic Data in Electronic Medical Records Reveal Race-specific Disease Networks. *Bioinformatics.* 2016 Jun 32(12):i101-i110. PMID: 27307606.

MA Badgeley, K Shameer, BS Glicksberg, MS Tomlinson, MA Levin, PJ McCormick, A Kasarskis, DL Reich, JT Dudley. EHDViz: Clinical Dashboard Using Open-Source Technologies. *BMJ Open.* 2016 Mar; 24:6(3):e010579. PMID: 27013597.

K Shameer*, **MA Badgeley***, R Miotto, BS Glicksberg, JW Morgan, JT Dudley. Translational Bioinformatics in the era or Real-Time Biomedical, Health Care and Wellness Data Streams. *Briefings in Bioinformatics.* 2016 Feb; Epub ahead of print. PMID: 26876889.

V Bagalkot, **MA Badgeley**, T Kampfrath, JA Deiuliis, S Rajagopalan, A Maiseyeu. Hybrid nanoparticles improve targeting to inflammatory macrophages throughout phagocytic signals. *J Control Release.* 2015 Sep; 217: 243-255. PMID: 26386437.

MA Badgeley, SC Sealfon, MD Chikina. Hybrid Bayesian-rank integration approach improves the predictive power of genomic dataset aggregation. *Bioinformatics.* 2015 Jan; 31(2):209-15. PMID: 25266226.

A Maiseyeu, HY Yang, G Ramanathan, F Yin, RL Bard, M Morishita, JT Dvonch, L Wang, C Spino, B Mukherjee, **MA Badgeley**, A Barajas-Espinosa, Q Sun, J Harkema, S Rajagopalan, JA Araujo, RD Brook. No effect of acute exposure to coarse particulate matter air pollution in a rural location on high density lipoprotein function. *Inhal Toxicol.* 2014 Jan; 26(1):23-9. PMID: 24417404

MA Badgeley, E Yard, H McIlvain, S Fields, D Comstock. Epidemiology of 10,000 High School Football Injuries: Patterns of Injury by Position Played. *Journal of Physical Activity and Health.* 2013 Feb; 10(2): 160-169. PMID: 22821941.

A Maiseyeu, **MA Badgeley**, T Kampfrath, G Mihai, Q Sun, S Parthasarathy, DI Simon, K Croce, S Rajagopalan. In Vivo Targeting of Inflammation Associated Myeloid-Related Protein 8/14 Gadolinium Immunoparticles. *Arteriosclerosis, Thrombosis, and Vascular Biology.* 2012 April; 32(4): 962-U258. PMID: 22308043

INVITED PRESENTATIONS

MA Badgeley, J Abel, G Schamberg, B Meschede-Krasa, EN Brown. Deep Reinforcement Learning.

Austin, TX. Society for Technology in Anesthesia (January 2020)

MA Badgeley. Applying Convolutional Neural Networks to Real World Evidence. Cambridge, MA. Computation, Representations, and Inferential Statistics Group Meeting (October 2019)

PUBLISHED ABSTRACTS

B Stannard, **MA Badgeley**, M Weiner, MA Levin. Analysis of Cerebral Oximetry Changes During Cardiopulmonary Bypass: A Machine Learning Approach. Orlando, FL. American Society of Anesthesiology (October 2019)

MA Badgeley, JT Dudley, MA Levin. Agreement between Depth of Anesthesia Monitors Depends on the Patient and Procedure. Scottsdale, AZ. Society for Technology in Anesthesia (January 2019)

SK Belman, OK Mathew, MR Walther-Antonio, P Jerarldo, F Abdu, RD Vunikili, **MA Badgeley**, KW Johnson, BS Glicksberg, JS Hirsch, A Lee, R Saha, L Subramanian, K Bock, M Oppenheim, R Sowdhamini, IJ Kullo, PK Gregersen, J Chelico, JT Dudley, N Chia, K Shameer. MuPhenome: A Curated Catalog of Microbiome Correlates with Clinical Phenotypes. San Diego, CA. American Society of Human Genetics Meeting (October 2018)

F Richter, P Atteberry, **MA Badgeley**, L Rasberry, T Pour. Outcomes of teaching students to edit medical content on Wikipedia. New York City, NY. Mount Sinai Education Research Day (April 2017)

KK Yadav, K Shameer, SS Yadav, C Elaiho, L Li, J OConnor, B Glicksberg, K Johnson, **M Badgeley**, B Readhead, B Kidd, A Kasarskis, J Dudley, A Tewari. A Multiscale Survey of Inflammatory Diseases and Prostate Oncophenotypes. J Urol (2017)

MA Badgeley, P Wang, E Scott, N Tignor, S Hershman, L Rogers, JT Dudley, N Genes, Y Chan, E Schadt. The Asthma Mobile Health App - A Nationwide Longitudinal Study of Patient-Reported Asthma Symptoms, Triggers, and Pulmonary Function. New York City, NY. Mount Sinai Research Day (March 2016)

MA Badgeley, JT Dudley, MA Levin. Signal Processing Methods to Improve Concordance of Bispectral Index with End-Tidal Anesthetic Concentration. Palm Beach, FL. Society for Technology in Anesthesia (January 2016)

MA Badgeley, S Khader, B Kidd, BS Glicksberg, D Ruderfer, M Tomlinson, P Wang, R Chen, J Dudley. Pleiotropic Variability Score: Quantifying Phenomic Associations of Genetic Variants. Baltimore, MD. American Society of Human Genetics Meeting (October 2015)

MA Badgeley, S Khader, B Kidd, B Glicksberg, D Ruderfer, M Tomlinson, P Wang, R Chen, JT Dudley. A Genome-Wide Association Study of Multi-Comorbidities: Towards a Genomic-Decision Aid for Health and Wellness Forecasting. Baltimore, MD. American Society of Human Genetics Meeting (October 2015)

MA Badgeley, S Sealfon, M Chikina. Hybrid Bayesian-rank integration approach improves the predictive power of genomic dataset integration. Boston, MA. Intelligent Systems for Molecular Biology (June 2014)

MA Badgeley, A Maiseyeu. Nanoprobe Design for Cholesterol Transport Investigation. Columbus, OH, USA: Denman Undergraduate Research Forum (2012)

MA Badgeley, S Rajagopalan, A Maiseyeu. A Novel Nanotechnology Approach for Cholesterol Loading and Reverse Cholesterol Transport Assessment. Chicago: Scientific Sessions on Arteriosclerosis, Thrombosis and Vascular Biology. American Heart Association (Apr 2012)

MA Badgeley, A Maiseyeu. 2011. Cholesterol Trafficking Nanoprobe Design and Fabrication to Investigate Reverse Cholesterol Transport. Columbus, OH, USA: 5th Annual Biomedical Engineering Conference. (September 2011)

T Schneider, G Shak, **MA Badgeley**. Please Send All Available Tubes to the Pharmacy. Orlando, FL, USA: Society for Health Systems Conference and Expo 2011. (February 2011)

A Maiseyeu, G Mihai, **MA Badgeley**, OP Simonetti, JA Deiuliis, CK Sen, S Parthasarathy, S Rajagopalan. PEGylated Nano-Peaches: A Novel Multimodality Platform for Imaging of Atherosclerosis. Stockholm, Sweden: ISMRM 18th Scientific Meeting (2010)

A Maiseyeu; **MA Badgeley**; G Mihai; et al. Rosiglitazone-Loaded Theranostic Nanolatexes for Simultaneous Inflammation Imaging and Therapy. Chicago, IL, USA: The Best of AHA Specialty Conferences Poster Session at AHA Scientific Sessions. (November 2010)

A Maiseyeu; **MA Badgeley**; G Mihai; et al. Rosiglitazone-Loaded Theranostic Nanolatexes for Simultaneous Inflammation Imaging and Therapy. San Francisco, CA, USA: Scientific Sessions on Arteriosclerosis, Thrombosis and Vascular Biology. (April 2010)

MA Badgeley, A Maiseyeu. Evaluating Nanoparticles for Imaging and Treatment of Atherosclerosis. Columbus, OH, USA: Denman Undergraduate Research Forum (2010)