Nicole D. Muszynski, phd

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Multidisciplinary engineer with project management experience, 13 years. Experience working with Defense Advanced Research Projects Agency (DARPA). Pediatric and adult clinical research experience quantifying gastrointestinal motility disorders via magneto- and electrophysiology. Basic science work in fluid dynamics and big data analysis. Strong background in writing and communicating science effectively. Demonstrated technical skills and project leadership across projects in biology, medicine, and engineering. Consulting experience.

# Education

**PhD** Vanderbilt University, Biomedical Engineering (3.7)

*Progress towards bridging the gap between noninvasive electrophysiological and electromagnetic measurements and microphysiological systems to detect, characterize, and treat gastrointestinal disorders*

**BS** LipscombUniversity, Molecular Biology

Minors: Psychology and Chemistry

# Key Skills

**CAD Software:** Fusion 360 - AutoCAD – Solidworks

**Programming:** MATLAB - NI LabView - Canvas - Python - CorelDraw

**Technical Expertise:** Signal processing - Superconduction - Microfluidics - Fluid dynamics - Cryogenics - Thermoforming - Computational modeling

**Research & Development:**  Noninvasive diagnostics - Mathematical modeling - Advanced biomedical equipment calibration - Clinical trial coordination – Electrode design – Organ-on-a-Chip design

**Project Management:** Strategic planning - Timeline optimization - Resource negotiation - Team leadership

**Data Visualization:** Statistical analysis - Data visualization tools - Automated machine learning pipelines - Multi-omics/ big data analysis

**Communication/Teaching:** Technical writing - Scientific presentation - Public speaking - Curriculum development - Mentoring

**Regulatory Knowledge:** Proficient in IRB/IACUC protocols, AAALAC, and USDA regulations

# Engineering Experience

**Project 1:** **Gastrointestinal SQUID Technologies Laboratory** May 2011 – October 2024

*Biomedical Engineer, Project Manager, Clinical Research Coordinator*

Advisor: L. Alan Bradshaw, Vanderbilt University Medical Center

* Clinical Research in neonates, children, and adults
* Participated in the design and execution of bio-electro-magnetic methods as a noninvasive clinical screening tool for improving the care of patients suffering from gastrointestinal (GI) disorders
* Installed, tested, and calibrated various biomedical equipment, including a superconducting quantum interference device (SQUID) and helium cryocooler
* Developed digital signal processing methods to detect and classify GI electrical propagation patterns for diagnosing gastric dysrhythmias
* Utilized mathematical modeling of gastrointestinal electrophysiology to validate gastric dysrhythmias
* Wrote MATLAB code to analyze gastric dysrhythmias in LabView
* Negotiated institutional-wide helium contact
* Experience with IRB, IACUC, AAALAC, and USDA

**Project 2:** **DARPA Rapid Threat Assessment for Bioterrorism Defense**  June 2014 – April 2021

*Engineering Team Lead, Biomedical Engineer, Project Manager*

Advisor: John P. Wikswo, Richard Caprioli, Vanderbilt University

* Developed a system for rapidly heating and/or cooling cells+toxin to achieve metabolic cessation
* Fabricated a microfluidic system for rapidly mixing and exposing cells to toxin in the seconds to milliseconds range
* Validated microfluidic system using mathematical and computational modeling
* Built analytics reports using data extracted from fabricated systems to report to DARPA monthly
* Strategized timeline of goals and tactics to reach DARPA’s annual milestones

**Project 3: Organ-on-a-Chip, Micro-organ design and development**

* Developed openable gut-on-a-chip for multi-omic analyses of host-pathogen interactions
* Utilized human-derived intestinal stem cells from tissue explants to seed organ-on-a-chip
* Developed standard operating procedures for microfluidic platform

# Honors and Awards

**Young Investigator Award, International Gastrointestinal Electrophysiology Society** 2024

“Quantifying Pediatric Functional Nausea”

**Vanderbilt Sesquicentennial Scholarship Exhibition, Top 10** 2024

“Simple Flow: A method for cell exposure to drugs or toxins with precise metabolic

cessation on the millisecond timescale.”

**Best Abstract, Digestive Disease Week, America Gastroenterological Association** 2023

“Noninvasive Bioelectric Signatures to Quantify Nausea Severity in Pediatric Functional Nausea*”*

**Young Investigator Award, American Gastroenterological Association**  2016

“High-density electrogastrogram identifies spatial dysrhythmias in adolescent patients

with chronic idiopathic nausea: a preliminary study”

**Benjamin Franklin Fellowship (declined)** 2016

US Department of State, Washington DC, USA

**Robert Stern Award, International Gastrointestinal Electrophysiology Society** 2015

“Experimental Recording and Analysis of Mucosal and Serosal Slow Wave Activity in Porcine Colon”

**98th Percentile, American Chemical Society** 2010

National Organic Chemistry Exam

# Teaching Experience

**ECE 5358 Control Systems II, Vanderbilt** Spring 2024

State-Space Modelling, Digital Control, Fuzzy Control, Nonlinear Control

**BME 3900 Biomedical Engineering Lab II, Vanderbilt**  Fall 2023

Scientific Writing and Adaptive Technology

**BME 2900 Biomedical Engineering Lab I, Vanderbilt** Spring 2023

Scientific Writing and Adaptive Technology

**ES 1401 Introduction to Engineering** Fall 2022

Microfluidic Design and Development

**Scientist in the Classroom Partnership** July 2022 - May 2023

Collaboration with NIH and Metro Nashville Public Schools 5-8

**Scientist in the Classroom Partnership** July 2021 - May 2022

Collaboration with NIH and Metro Nashville Public Schools 5-8

# Patents

1. Caprioli, Richard, John Wikswo, John McLean, Eric Skaar, Jeremy L. Norris, Dana Borden Lacy, Stacy Sherrod, James Pino, Danielle Gutierrez, **Nicole D. Muszynski**, Melissa Farrow. 2020. “High-throughput, multi-omics approach to determine and validate de novo global mechanisms of action for drugs and toxins.” United States US10607721B2, filed September 22, 2016, and issued March 31, 2020. <https://patents.google.com/patent/US10607721B2/en>.

# Presentations and Invited Lectures

1. “Simple Flow: A method for cell exposure to drugs or toxins with precise metabolic cessation on the millisecond timescale.” **Vanderbilt Sesquicentennial Scholarship Exhibition, February 16, 2024**

“DARPA Rapid Threat Assessment to assess and mitigate potential current and emerging threats by determining biological mechanism of action of incapacitating warfare agents.” **Warsaw, Poland, October 24, 2022**

**NATO, 50th meeting of the COMEDS BIOMEDICAL Expert Panel**

1. “Knowledge Graphs for COVID-19 Long Hauler and Other Post-Infection Syndromes: Contemporary Challenges in Systems Biology and Regulatory Plasticity.” **Institute for Systems Biology, May 18, 2021**
2. “COVID-19 Long Hauler and Other Post-Infection Syndromes as Problems in Systems Biology and Regulatory Plasticity.” **MIT Lincoln Laboratory, May 10, 2021**
3. “COVID-19 Long Hauler and Other Post-Infection Syndromes as Problems in Systems Biology and Regulatory Plasticity.” **Bioscience Division, Los Alamos National Laboratory, May 4, 2021**
4. “COVID Long Hauler & Other Post-Infection Syndromes as Problems in Systems Biology & Regulatory Plasticity”

**DTRA DOMANE Long Hauler Syndrome / Long COVID Workshop, April 13, 2021**

1. “Noninvasive measurement of small bowel slow wave activity in neonates – a pilot study.”

**American Gastroenterological Association - 2020**

1. “Bridging the Gap Between Organs-on-Chips and Multi-Omic Analysis for In Vitro Investigation of Incapacitating Agents and Medical Countermeasures.”

**Chemical and Biological Defense Science & Technology (CBD S&T), Cincinnati, OH, November 18-21, 2019**

1. “Distinguishing spatiotemporal functional abnormalities in pediatric chronic nausea using high density electrogastrography.” **BioEngineering Society Annual Conference. Philadelphia, PA, October 2019**
2. “Bridging the gap between multi-omic network analysis and Organ-in-a-Puck to elucidate the comprehensive mechanisms of host-pathogen interactions.” **BioEngineering Society. Philadelphia, PA, October 2019**
3. “Multichannel electrogastrography distinguishes gastric slow wave spatiotemporal parameter differences in pediatric chronic nausea.” **American Neurogastroenterology and Motility. Chicago, IL, August 2019**
4. “The convergence of multi-omic network analysis and Gut-on-a-Chip to elucidate the comprehensive mechanisms of incapacitating agents.” **Epimilitaris: International Bioterrorism Conference. Ryn, Poland, April 2019**
5. “The convergence of multi-omic network analysis and Gut-on-a-Chip to elucidate the comprehensive mechanisms of incapacitating agents.” **Military Institute of Technology. Warsaw, Poland, April 2019**
6. “Openable Organ-in-a-Puck and Multi-Omics for In Vitro Investigation of Host-Pathogen Interactions in the Gut and Brain.” **DTRA Tech Watch Seminar, Fort Belvoir, Springfield, VA, USA. July 2018**
7. “Rapid Threat Assessment: to detect, identify, and characterize the effects of chemical and biological warfare agents.” **American Society for Microbiology. Biothreats Conference, Washington DC, USA. February 2017**
8. “Rapid Threat Assessment: Bridging the gap between multi-omic network analysis and biological mechanism of action of drugs and toxins.” **Gordon Research Conference: Drug Safety. Easton, MA, June 2016**
9. “Rapid Threat Assessment: Bridging the gap between multi-omic network analysis and biological mechanism of action of drugs and toxins.” **Gordon Research Seminar: Drug Safety. Easton, MA, June 2016**
10. “Data-driven construction of global drug mechanisms enabled by an integrated high-throughput multi-omics platform.” **64th American Society of Mass Spectrometry, San Antonio, Texas, June 2016**
11. “High-density electrogastrogram identifies spatial dysrhythmias in adolescent patients with chronic idiopathic nausea: a preliminary study.” **International GI Electrophysiology Society. San Diego, CA, May 2016**
12. “High-density electrogastrogram identifies spatial dysrhythmias in adolescent patients with chronic idiopathic nausea: a preliminary study.” **Digestive Disease Week, San Diego, CA, May 2016**
13. “Spatiotemporal and Morphological Differences in Serosal and Mucosal Electrical Recording of Porcine Colonic Slow Wave.” **Digestive Disease Week, San Diego, CA, May 2016**
14. “Rapid Threat Assessment: Bridging the gap between multi-omic network analysis and biological mechanism of action of drugs and toxins.” **Campora san Giovanni, Calabria, Italy, April 2016**

**NATO ASI: Molecular Technologies for Detection of Chemical and Biological Agents.**

1. “A Lesson on Biomagnetism.” Long Island, New York, September 2015

**New York Institute of Technology, Department of Electrical and Computer Engineering.**

1. Professional Skill Development Workshop for Cancer Biologists

**Cold Spring Harbor National Laboratory. Long Island, New York, September 2015**

1. “Experimental recording and analysis of mucosal and serosal slow wave activity in porcine colon.”

**International Gastrointestinal Electrophysiology Society, Washington DC, May 2015**

1. “Noninvasive biomagnetic assessment of the effects of erythromycin on the gastric slow wave.”

**Digestive Disease Week, American Gastroenterological Association, Washington DC, May 2015**

1. “MENG reveals slow wave dysrhythmia in diabetic gastroparesis.”

**Digestive Disease Week, American Gastroenterological Association, Washington DC, May 2015**

1. “Rapid threat assessment year one.”

**Defense Advanced Research Projects Agency, Department of Defense, Washington DC, February 2015**

1. “Cholecystokinin alters serosal EMG but not MGG in porcine subjects.”

**International Gastrointestinal Electrophysiology Society, Chicago, IL, May 2014**

1. “Noninvasive measurement of gastric slow wave dysrhythmia in porcine.”

**Digestive Disease Week, American Gastroenterological Association, Chicago, IL, May 2014**

1. “Cholecystokinin alters serosal EMG but not MGG in porcine subjects.”

**Digestive Disease Week, American Gastroenterological Association, Chicago, IL, May 2014**

1. “Noninvasive biomagnetic detection of isolated ischemic bowel segments.”

**Surgery and Engineering Symposium, Vanderbilt University, Nashville, TN, December 2012**

1. “Correlation of noninvasive magnetic and electric measurement of the gastric slow wave.”

**Student Scholar Symposium, Lipscomb University, Nashville, TN, 2012**

# Peer-reviewed Publications

1. Chad E. Drake, Leo K. Cheng, **Nicole D. Muszynski**, Suseela Somarajan, Niranchan Paskaranandavadivel, Timothy Angeli-Gordon, Peng Du, Leonard A. Bradshaw, Recep Avci. Electroanatomical mapping of the stomach with simultaneous biomagnetic measurements. *Computers in Biology and Medicine*.
2. Somarajan, S.; **Muszynski, N. D**.; Olson, J. D.; Russell, A. C.; Walker, L. S.; Acra, S. A.; Bradshaw, L. A. Multichannel Magnetogastrogram: A Clinical Marker for Pediatric Chronic Nausea*. American Journal of Physiology-Gastrointestinal and Liver Physiology.* 2022, 323 (6), G562–G570.
3. Pino, J. C.; Lubbock, A. L. R.; Harris, L. A.; Gutierrez, D. B.; Farrow, M. A.; **Muszynski, N**.; Tsui, T.; Sherrod, S. D.; Norris, J. L.; McLean, J. A.; Caprioli, R. M.; Wikswo, J. P.; Lopez, C. F. *Processes in DNA Damage Response from a Whole-Cell Multi-Omics Perspective*. iScience 2022, 25 (11), 105341. https://doi.org/10.1016/j.isci.2022.105341.
4. J. D. Olson, S. Somarajan, **N. D. Muszynski**, A. C. Russell, L. S. Walker, S. A. Acra, and L. A. Bradshaw, “Automated machine learning pipeline approach for classification of pediatric chronic nausea using high resolution electrogastrogram,” *IEEE Transactions on Biomedical Engineering*. Nov, 2021.
5. Pino, James C., Alexander L. R. Lubbock, Leonard A. Harris, Danielle B. Gutierrez, Melissa A. Farrow, **Nicole Muszynski**, Tina Tsui, et al. 2020. “A Computational Framework to Explore Cellular Response Mechanisms from Multi-Omics Datasets.” *BioRxiv*, March, 2020.03.02.974121.
6. S. Somarajan, **N. D. Muszynski**, J. D. Olson, A. Comstock, A. C. Russell, L. S. Walker, S. A. Acra, and L. A. Bradshaw, “The effect of chronic nausea on gastric slow wave spatiotemporal dynamics in children,” *Neurogastroenterology and Motility*, Nov 20, 2020.
7. S. Somarajan, **N. D. Muszynski**, J. D. Olson, A. Comstock, A. C. Russell, L. S. Walker, S. A. Acra, and L. A. Bradshaw, “Response to "retrograde slow wave activation: A missing link in gastric dysfunction?",” *Neurogastroenterology and Motility,* vol. 33, no. 4, Apr, 2021
8. S. Somarajan, **N. D. Muszynski**, D. Hawrami, J. D. Olson, L. K. Cheng, and L. A. Bradshaw, “Noninvasive Magnetogastrography Detects Erythromycin-Induced Effects on the Gastric Slow Wave,” *Ieee Transactions on Biomedical Engineering,* vol. 66, no. 2, pp. 327-334, Feb, 2019.
9. S. Somarajan, **N. D. Muszynski**, J. D. Olson, L. A. Bradshaw, and W. O. Richards, “Magnetoenterography for the Detection of Partial Mesenteric Ischemia,” *Journal of Surgical Research,* vol. 239, pp. 31-37, Jul, 2019.
10. Norris, Jeremy L., Melissa A. Farrow, Danielle B. Gutierrez, Lauren D. Palmer, **Nicole Muszynski**, Stacy D. Sherrod, James C. Pino, et al. 2017. “Integrated, High-Throughput, Multiomics Platform Enables Data-Driven Construction of Cellular Responses and Reveals Global Drug Mechanisms of Action.” *Journal of Proteome Research* 16 (3): 1364–75. **Co-first author.**
11. Somarajan S, **Muszynski ND**, Cheng LK, Bradshaw LA, Naslund TC, and Richards WO. “Noninvasive biomagnetic detection of intestinal slow wave dysrhythmias in chronic mesenteric ischemia”. *Am J Physiol-Gastr L* 309: G52-G58, 2015.
12. Somarajan S, **Muszynski ND**, Obioha C, Richards WO, and Bradshaw LA. “Biomagnetic and bioelectric detection of gastric slow wave activity in normal human subjects-a correlation study.” *Physiol Meas* 33: 1171-1179, 2012.

# Abstract Publications

1. De, **Muszynski**, Somarajan, Wolf, Orsagh-Yentis, Acra, Bradshaw. “Detection of Gastric Slow Waves using High-resolution Electrogastrogram in a Critically Ill Child.” *Critical Care Medicine.* 2024, 52 (1), S165.
2. **Muszynski, N. D**.; Somarajan, S.; Olson, J. D.; Russell, A.; Walker, L.; Acra, S.; Bradshaw, L. A. Mo2005: “Noninvasive Bioelectric Signatures to Quantify Nausea Severity in Pediatric Functional Nausea.” *Gastroenterology.* 2023, 164 (6), S-950-951. **Best Abstract** **Award**
3. Somarajan S, **Muszynski ND**, Olson JD, Rashed H, Bradshaw LA, Acra SA, Vaezi M, Patel D. “High Resolution Electroesophagram: A Novel Means of Detecting Esophageal Function,” *Gastroenterology*, May, 2022.
4. S. Somarajan, **ND Muszynski**, JD Olson, AC Russell, SA Acra, and LA Bradshaw. “Pediatric Functional Nausea Alters Magnetogastrogram Propagration Patterns,” *Gastroenterology*, May, 2022.
5. S. Somarajan, **N. D. Muszynski**, A. S. Monk, J. D. Olson, A. Russell, S. Acra, L. A. Bradshaw, and H. Weitkamp, “Noninvasive Measurement of Small Bowel Slow Wave Activity in Neonates - a Pilot Study,” *Gastroenterology,* vol. 158, no. 6, pp. S364-S364, May, 2020.
6. S. Somarajan, **N. D. Muszynski**, J. D. Olson, A. C. Russell, S. A. Acra, and L. A. Bradshaw, “Multichannel electrogastrography distinguishes gastric slow wave spatiotemporal parameter differences in pediatric chronic nausea,” *Neurogastroenterology and Motility,* vol. 31, Aug, 2019.
7. Somarajan S, **Muszynski ND**, Russell A, Gorman BL, Acra S, Cheng LK, and Bradshaw LA. High-Density Electrogastrogram Identifies Spatial Dysrhythmias in Adolescent Patients With Chronic Idiopathic Nausea: A Preliminary Study. *Gastroenterology* 150: S356, 2016.
8. **Muszynski ND**, Paskaranandavadivel N, Togrye CT, Somarajan S, Williams P, Bradshaw LA, and Cheng LK. Spatiotemporal and Morphological Differences in Serosal and Mucosal Electrical Recording of Porcine Colonic Slow Wave. *Gastroenterology* 150: S350-S351, 2016.
9. Somarajan S, **Muszynski ND**, Richards WO, Cheng LK, and Bradshaw LA. Noninvasive Biomagnetic Assessment of the Effects of Erythromycin on the Gastric Slow Wave. *Gastroenterology* 148: S511-S511, 2015.
10. **Muszynski ND**, Somarajan S, Richards WO, and Bradshaw LA. Noninvasive Measurement of Gastric Slow Wave Dysrhythmia in Porcine. *Gastroenterology* 146: S616-S616, 2014.
11. **Muszynski ND**, Somarajan S, Richards WO, and Bradshaw LA. Cholecystokinin Alters Serosal EMG but Not MGG in Porcine Subjects. *Gastroenterology* 146: S616-S616, 2014.