OMB No. 0925-0001 and 0925-0002 (Rev. 09/17 Approved Through 03/31/2020)

BIOGRAPHICAL SKETCH

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| NAME: Shah, Anish |
| eRA COMMONS USER NAME (credential, e.g., agency login): anishshah |
| POSITION TITLE: Postdoctoral Fellow |

EDUCATION:

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| INSTITUTION AND LOCATION | DEGREE | END DATE | FIELD OF STUDY |
| Brookhaven Community College  Farmers Branch, TX | OTH | 05/2007 | Emergency Medical Technician |
| Emory University College of Arts and Sciences  Atlanta, GA | BS | 05/2011 | Linguistics; Neuroscience & Behavioral Biology |
| Texas A&M University College of Medicine  College Station, TX | MD | 06/2016 | Medicine |
| Emory University School of Medicine  Atlanta, GA | Resident | 06/2019 | Internal Medicine |
| Emory University Laney Graduate School  Atlanta, Georgia | MS | 05/2020 | Clinical Research |
| Emory University Rollins School of Public Health | - | 05/2022 | Postdoctoral Fellow in Epidemiology |

### A. Personal Statement

My long-term goal is to become an independently funded clinical investigator in neurocardiology with a focus on computational techniques to understand the role of the autonomic nervous system in sudden cardiac death and arrhythmia, including from the perspective of neuropsychological pathology. I aim to leverage my clinical knowledge, background in computer programming and data science, and my current research studying autonomic dysfunction by noninvasive measures to better understand the neurocardiac axis. A NIH F32 award will provide me the critical training and mentorship to gain the fundamental skills in physiological signal processing and invasive measurements of autonomic tone to apply for future a NIH K award.

As a medical resident at Emory, under the mentorship of Amit J. Shah, MD, I began my work on heart rate variability (HRV) as a measure of autonomic function. I am now supported by the Georgia CTSA TL1 and am completing a Master of Science in Clinical Research, through which I am gaining additional skills in quantitative epidemiology, biostatistics, and grant writing. My current TL1 supported research, which will be my MSCR thesis, includes two aims: 1) identifying if abnormal HRV is predictive of coronary artery plaque burden by cardiac catherization, and 2) measuring how neuropsychological disease impacts autonomic function. Understanding how to measure disturbances of the neurocardiac axis is complex, and I will need a stepwise approach to gain the skills needed to be an independent investigator in this field.

With Dr. Shah’s guidance, I have assembled a multidisciplinary team of co-mentors for the NIH F32, including Alonso Alvaro, MD, PhD, Marc D. Thames, MD, Viola Vaccarino, MD, PhD, and Arshed Quyyumi, MD, who I have worked with extensively during my TL1 award. For the MSCR thesis project, I have prospectively enrolled 30 patients for the pilot study, with the intent of enrolling 200 patients by the summer of 2020, each with up to 24 hours of ECG data. My preliminary results show a strong signal that HRV markers are predictive of obstructive coronary artery disease and depression, and I will use the F32 to expand this analysis to identify the most important HRV features that may mediate this relationship. The multidisciplinary mentorship team I have established, my unique experience in both computer programming and clinical training, and the foundations from my current work will allow me to successfully carry out this research proposal and take full advantage of the F32 on my path towards becoming a physician-scientist.

### B. Positions and Honors

Positions and Employment

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| 2005 - 2007 | Learning Disability Tutor, Brainworks, Inc, Carrollton, TX |
| 2008 - 2009 | Research Fellow, College of Arts and Sciences, Emory University, Atlanta, GA |
| 2010 - 2010 | Cellular Biology Teaching Assistant, Emory University, Department of Biology, Atlanta, GA |
| 2011 - 2012 | Tutor, Northlake College, Department of Physics, Irving, TX |
| 2013 - 2013 | Research Assistant, Johns Hopkins University School of Medicine, Department of Pediatric Endocrinology, Baltimore, MD |
| 2016 - 2019 | Internal Medicine Resident, Emory University, School of Medicine, Atlanta, GA |
| 2019 - | Postdoctoral Fellow, Emory University, Rollins School of Public Health, Department of Epidemiology, Atlanta, GA |

Other Experience and Professional Memberships

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| 2012 - | Member, American Medical Association |
| 2012 - | Member, American College of Physicians |
| 2012 - 2016 | Member, Texas Medical Association |
| 2018 - | Member, American Heart Association |

Honors

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| 2007 | EMT National Competition - 1st Place, Health Occupation Students of America |
| 2008 | Scholarly Inquiry and Research at Emory - Research Fellow, Emory University |
| 2009 | Delores B. Aldridge Excellence in Service to a Diverse Community Award, Emory University |
| 2009 | Speaker to His Holiness the XIV Dalai Lama, Emory-Tibet Partnership – *selected to represent Emory students in a meeting with the Dalai Lama in MacLeod Gange, India* |
| 2013 | Medical Student Research Program in Diabetes, National Institute of Diabetes and Digestive and Kidney Diseases |
| 2015 | Research Symposium - 1st Place Oral Presentation, Texas A&M University College of Medicine |
| 2017 | Doctor's Dilemma (Medical Jeopardy) Emory Resident Team, Georgia ACP |
| 2018 | AHA Scientific Sessions Top Donors Meeting, American Heart Association – *special invitation to discuss research with AHA leadership and top philanthropists* |
| 2019 | Georgia Clinical and Translational Science Alliance TL1 Postdoctoral Research Training Award (TL1TR002382, PI: Blumberg; and UL1TR002378, PIs: Garcia, Ofili, Phillips, Taylor), NIH/NCATS |

### C. Contribution to Science

1. **Quantification of autonomic tone in cardiovascular disease during graduate and postgraduate medical training:** Autonomic dysfunction leads to increased risk and mortality in patients with coronary artery disease but occurs in both systemic illness (e.g. diabetes) and psychological disorders. Under the guidance of Dr. Shah, I researched the relationship of heart rate variability (HRV) to ischemic heart disease and psychological stressors. I demonstrated that a novel, non-linear HRV index, *Dyx*, was strongly predictive of abnormal myocardial perfusion imaging (e.g., stress test) during early morning hours, which became a national poster and a first-author first author manuscript under review. Subsequently, I wrote a manuscript proposal to study HRV and psychological stress in the Atherosclerotic Risk in Communities study under the guidance of Dr. Shah and Dr. Alonso. I found that somatic depressive symptoms (vital exhaustion) was strongly associated with abnormal HRV with persistent HRV changes found on repeat exam 6-8 years later, submitted as a first-author manuscript. These studies introduced me to methods in epidemiology, approaches to confounding and interaction, and biostatistical analytical techniques. With the TL1 award, I currently study continuous HRV changes in patients undergoing cardiac catherization, completing a pilot study as described in this research proposal. This data allows us to assess the relationship of autonomic dysfunction with both obstructive coronary artery disease and depression through non-invasive tools. I have learned how to amend IRB protocols, directly enroll patients, retrieve raw ECG data, and analyze digital signals. My preliminary analyses suggest that early ECG markers add increased likelihood of obstructive disease. I am solidifying my expertise in this area with two invited review articles on brain-heart interactions in stress-related disorders, under Paul Marvar, PhD (George Washington University), and a clinically oriented review paper on cardiac sympathetic innervation, under Dr. Thames.
2. **Shah, Anish, S**, Alonso, Alvaro, Whitsel, Eric, A, Soliman, Elsayed, Z, Vaccarino, Viola, Shah, Amit, J. The Association of Psychosocial Factors with Heart Rate Variability: The Atherosclerosis Risk in Communities Study. American Heart Association Epidemiology/Lifestyle 2020 Scientific Sessions; 2020 March 5; Phoenix, AZ, USA. American Heart Association.
   1. **Shah, Anish, S**, Lampert, Rachel, Goldberg, Jack, Bremner, J Douglas,, Vaccarino, Viola,, Shah, Amit, J. Abstract 15216: Circadian Autonomic Inflexibility: A Marker of Ischemic Heart Disease. American Heart Association Scientific Sessions; 2018 November 12; Chicago, IL, USA. Chicago, IL: American Heart Association; c2018.
   2. **Shah, Anish, S**, Shah, Amit, J. Association of Ischemia with Heart Rate Variability. 2018 Georgia Chapter Scientific Meeting; 2018 October 12; Pine Mountain, GA, USA. American College of Physicians.
3. **Computational approach to pediatric diseases (necrotizing enterocolitis and cystic fibrosis-related diabetes) during undergraduate medical training:** Cystic fibrosis related diabetes (CFRD) portends a poor prognosis in patients with CF, and identifying which genotypes have a higher prevalence of this disease can help with early intervention. Under Scott Blackman, MD, PhD (Johns Hopkins), I utilized GWAS-based linkage analysis to identify novel SNP loci using computational techniques (e.g. Merlin, Plink) and we identified a specific SNP locus on chromosome 7 that was strongly associated with CFRD, which become a published abstract at a meeting for the NIDDK. By working on genetic linkage analyses, I further developed computational techniques using Perl, C++, and R, and learned biostatistical and data visualization skills. In a separate project under the mentorship of Lena Perger, MD (Texas A&M), I studied necrotizing enterocolitis (NEC) in a longitudinal retrospective cohort. NEC is a highly morbid condition with poor long-term prognosis. I was responsible for data collection through chart review and the statistical analyses, supported by our biostatistician. We showed for the first time that only severe NEC leads to children with significant long-term morbidities, and won the best oral presentation for this work at a local symposium, and accepted as an oral presentation at an international meeting.
   1. **Shah, Anish, S**, Blackman, Scott. Genetic Linkage Analysis for Cystic Fibrosis Related Diabetes. National Institute of Diabetes and Digestive and Kidney Diseases Medical Student Research Symposium; 2013; Nashville, TN, USA. National Institute of Diabetes and Digestive and Kidney Diseases.
   2. Mrdutt, Mary, **Shah, Anish, S**, Sanders, Emily, Mallett, Lea, Perger, Lena. Long-Term Outcomes of Newborns with Necrotizing Enterocolitis: a retrospective matched cohort study. 48th Annual Meeting of the Canadian Association of Pediatric Surgeons; 2017 September; Vancouver, British Columbia, Canada. Canadian Academy of Pediatric Surgeons.
   3. Mrdutt, Mary, **Shah, Anish, S**, Sanders, Emily, Perger, Lena. Long-Term Outcomes of Newborns with Necrotizing Enterocolitis: a retrospective matched cohort study. Texas A&M University College of Medicine Research Symposium; 2016 April; Temple, TX, USA. Texas A&M University.
4. **Introduction to study design and data collection methods during undergraduate training:** In the lab of Mar Sanchez, PhD, I helped to study cortisol levels in a model of chronic stress. I gained skills in the care of lab animals (rhesus monkeys), the creation of a salivary cortisol collection protocol, and imaging data analysis by assisting with MRI measurements of subject brain volumes. We found that salivary cortisol showed a strong correlation with serum cortisol in these subjects. We were able to start using salivary cortisol instead of serum cortisol to test stress responses. I learned to present, display, and communicate our findings through poster prese. Separately, under Yu Li, PhD, I designed a study to evaluate the effect of emotional valence on pitch changes in words. I learned how to write an IRB protocol, consent and enroll subjects, and collect data in the form of pitch recordings. We identified that a higher pitch associated with novel emotional information, and our findings were accepted as a regional poster. I developed skills in extracting signal tracings from recordings, analyzing data through basic programming and statistics with the R language.
   1. **Shah, Anish, S**, Sanchez, Mar. Cortisol Levels in Rhesus Monkeys with Maternal Separation Over Longitudinal Cohorts. Scholarly Inquiry and Research at Emory Research Partners Symposium; 2009; Altanta, GA, USA. Emory University.
   2. **Shah, Anish, S**, Li, Yu, Influence of the Acoustic Parameter of Pitch on Emotion and Focus Location in Statements using Ditransitive Verb Manipulations. Great Lakes Expo for Experimental and Formal Undergraduate Linguistics; 2011; East Lansing, MI, USA. Michigan State University.

### D. Additional Information: Research Support and/or Scholastic Performance

Scholastic Performance

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| YEAR | COURSE TITLE | GRADE |
| Brookhaven Community College | | |
| 2006 | Emergency Medical Technician | A |
| Texas A&M University College of Medicine | | |
| 2012 | Core Principles of Medicine I | A |
| 2012 | Core Principles of Medicine II | A |
| 2012 | Introduction to Disease | B |
| 2012 | Neuroscience | B |
| 2012 | Systems Based Practice | A |
| 2012 | Introduction to Clinical Skills I | B |
| 2012 | Introduction to Clinical Skills | B |
| 2012 | Interprofessional Healthcare Ethics | A |
| 2013 | Cardiovascular | B |
| 2013 | Becoming a Physician | B |
| 2013 | Hematology/Oncology | A |
| 2013 | Respiratory | B |
| 2013 | Renal/Genitourinary | A |
| 2013 | Metabolism, GI, Nutrition | B |
| 2013 | Endocrine/Reproductive Science, Human Sexuality | B |
| 2013 | Integumentary/Musculoskeletal | B |
| 2014 | Internal Medicine Clerkship | P |
| 2014 | Family Medicine Clerkship | P |
| 2014 | Pediatrics Clerkship | P |
| 2014 | Psychiatric Clerkship | P |
| 2014 | Radiology Clerkship | H |
| 2014 | Obstetrics & Gynecology Clerkship | P |
| 2014 | Surgery Clerkship | H |
| 2015 | Emergency Medicine | S |
| Emory University | | |

Medical school clerkship grades during M3 year are Pass (P) or High Honors (H). Satisfactory (S) is used for non-core clerkships and electives to document completion.

Ongoing Research Support

TL1TR002382, NIH/NCATS Blumberg (PI) 07/01/19-06/30/20

Georgia Clinical and Translational Science Alliance NSRA (TL1) Training Core

This grant provides scholarship and salary support for the completion of the Emory University Master of Science in Clinical Research (MSCR) degree program and a mentored clinical research project in the trainee’s area of clinical interest.

Role: Post-Doctoral Scholar