BIOGRAPHICAL SKETCH

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NAME: Narayan, Sanjiv M.

eRA COMMONS USER NAME (credential, e.g., agency login): S_NARAYAN

POSITION TITLE: Professor of Medicine, Medical Center Line

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Birmingham, England	MBCHB	08/1987	Medical Degree
Royal College of Physicians of London	MRCP, FRCP	11/90, 07/05	Internal Medicine
University of Birmingham, England	MSc	12/1990	Software Engineering
University of Birmingham (research at UCLA)	MD	12/1994	Doctorate (Neuroscience)
Harvard / Mt. Auburn Hosp, Cambridge, MA	Residency	06/1996	Internal Medicine
Washington University, St. Louis	T32 Postdoc	06/1998	Computational EP
Washington University, St. Louis	Clinical Fellow	06/2001	Clinical Cardiology, EP
University of California, Berkeley	Master of Data Science	05/2025	Information and Data Science (GPA 3.98)

A. Personal Statement

I am a practicing cardiac electrophysiologist and Co-Director of the Arrhythmia Center at Stanford. I direct the NIH T32 Computational Medicine in the Heart Program (CHIP), and I have held societal roles in these domains including past Chair of the Digital Health Committee and of the Research Committee of the Heart Rhythm Society, and past Chair of the Data Science Study Section of the AHA Institute on Precision Medicine.

The Computational Arrhythmia Research Lab that I direct has, since 2001, had a mission to apply state-of-the-art computational and data approaches to bridge disease mechanisms to patient care. Our work casts a broad net of physiological and engineering studies. In addition to my formal training in cardiology, I recently completed an additional MS in computational data science and machine learning from the University of California Berkeley, to enhance our engineering-clinical mission. I am a trained software engineer (1990), and hold a neuroscience doctorate (1994) for which I built an optical mapping system to study rodent neurophysiology. Our talented team members and collaborators continually enrich our work, with expertise in natural language processing and computational image processing. I am dedicated to mentoring, and an average of >2 trainees in our lab have won an award or grant each year since 2003. Some recent studies are below. Our lab routinely shares code and data (https://github.com/narayanlab).

1. Armoundas AA, **Narayan SM (Vice-Chair)**, Arnett DK, Spector-Bagdady K, Bennett DA, Celi LA, Friedman PA, Gollob MH, Hall JL, Kwitek AE, Lett E, Menon BK, Sheehan KA, Al-Zaiti SS; Use of AI in Improving Heart Disease Outcomes: AHA Scientific Statement. Circulation. 2024 PMID: 38415358
2. Feng R, Brennan KA, Azizi Z, Goyal J, Deb B, Chang HJ, Ganesan P, Clopton P, Pedron M, Ruiperez-Campillo S, Desai Y, De Larochellière H, Baykaner T, Perez M, Rodrigo M, Rogers AJ, **Narayan SM**. Engineering of Generative Artificial Intelligence and Natural Language Processing Models to Accurately Identify Arrhythmia Recurrence. Circ Arrhythm Electrophysiol. 2024 Dec 16:e013023. doi: 10.1161/CIRCEP.124.013023. PMID: 39676642
3. P. Ganesan, M. Pedron, …**Narayan SM**. Separating Mechanistic Phenotypes of AF Patients With Long-Term Vs Acute Success from Ablation by Machine learning. Circ EP 2025;18(2):e012860.
4. **Narayan SM**, Chung MK Adedinsewo D, Brant LCC, Yancy C, Armoundas AA et al. Personalized Framework to Increase Access to Digital Health Technologies. Nature Rev Cardiol 2025 (accepted)
5. **Narayan SM**, Kohli N, Martin MM. Addressing Contemporary Threats in Anonymised Healthcare Data Using Privacy Engineering. NPJ Digital Medicine 2025 Mar 6;8(1):145. doi: 10.1038/s41746-025-01520

Ongoing and recently completed projects that I would like to highlight include:

R01HL162260
Narayan (PI)
7/1/2023- 06/30/2027
Machine Learning for Ventricular Arrhythmias

T32HL166155
Narayan (PI), Marsden (Co-PI)
1/1/2023 – 12/31/2027
Computational Medicine in the Heart, Integrated Training Program

R01HL149134
Narayan (PI)
4/1/2020 – 3/31/2026 (NCE)
Machine Learning in Atrial Fibrillation

R01HL083359
Narayan (PI)
7/1/2008 – 6/30/2025 (NCE)
The Dynamics of Human Atrial Fibrillation

R01HL122384-01 to -09
Rappel (PI), Role: PI Subaward
4/1/2014 - 3/31/2025 (with NCE)
Patient-Directed Computational Analysis of Atrial Fibrillation

B. Positions, Scientific Appointments, and Honors

Academic and Professional Appointments

2014 – present	Professor of Medicine, Dir. AF Program, Dir. EP Research; Stanford University, CA
2017 – 2024	Section Editor, Journal of the American College of Cardiology
2014 – 2020	Associate Editor, JACC: Clinical Electrophysiology Journal
2014	Section Editor, Heart Rhythm Journal
2006 – 2017	Associate Editor, Journal of the American College of Cardiology
2001 – 2014	Assistant, Associate and Full Professor of Medicine, University of California, San Diego, CA
1996 – 2001	Clinical, Research Fellow in Cardiology and Electrophysiology, Washington Univ., St. Louis
1996	Faculty, Harvard-MIT HST, Massachussetts Institute of Technology, Cambridge, MA
1994 – 1996	Clinical Fellow in Medicine, Harvard Medical School, Boston, MA
1991 – 1994	Postdoctoral Fellow, Neuro-Electrophysiology, UCLA, Los Angeles, CA

Mentorship: Honors and Prizes by Trainees of Dr. Narayan

2025	Mentor to Michael Liu, MD, Recipient AHA Fellowship Grant 2025
2025	Mentor to Sabya Bandyopadhyay, PhD, Recipient AHA Fellowship Grant 2025
2024	Mentor to Brototo Deb, MD, Cardiac Electrophysiology Society YIA Finalist 2024
2023	Mentor to Brototo Deb, MD, HRS Young Investigator Finalist 2023
2023	Mentor to A.J. Rogers, MD, 2023-2027 AHA Career Development Awardee
2023	Mentor to A.J. Rogers, MD, 2023-2028 NIH K23 HL166977
2023	Mentor to Prasanthan Ganesan, PhD, 1st Place, Western AF Fellows Competition
2022	Mentor to Sunil Vasireddi, MD; Young Investigator, Cardiac Electrophysiology Society, 2022
2022	Mentor to Sunil Vasireddi, MD; Young Investigator Finalist, HRS 2022.
2022	Mentor to Sunil Vasireddi, MD; Eric Prystowski Fellows Clinical Abstract Award, HRS,
2022	Mentor, Stanford Deans List Scholar. Brototo Deb, MD (fellow)
2022	Mentor, Forbes 30 Under 30 Asia in Healthcare & Science. Prash Ganesan, PhD
2021	Mentor, Asia-Pacific HRS 2021 Young Investigator Finalist, Prash Ganesan, PhD (fellow)
2021	Mentor, Atrial Signals 2021 (Karlsruhe) Top Poster Award, Prash Ganesan, PhD (fellow)
2021	Mentor, ACC Young Investigator Finalist. Miguel Rodrigo, PhD
2020	Mentor, HRS Young Investigator Finalist. AJ Rogers, MD (see paper in Circulation Research)
2019-24	Mentor, NIH K24 HL145017 Recipient, Tina Baykaner, MD (faculty)
2019	Mentor, Eur Heart Rhythm Assoc Young Investigator Finalist, Mahmood Alhusseini, MS (fellow)
2019	Mentor, HRS Eric Prystowsky Abstract Award Winner, Miguel Rodrigo, PhD (fellow)
2019	Mentor, Eur Heart Rhythm Assoc, Highest Scoring Abstract, Neal Bhatia, MD (fellow)
2018-21	Mentor, NIH F32 HL144101 Recipient, Albert J Rogers, MD (fellow)
2018	Mentor, 1st prize: American College of Physicians Meeting, Rachita Navara, MD (resident)

2018 Mentor, Asia-Pacific HRS Young Investigator 1st Place Winner, George Leef, MD (fellow)
2018 Mentor, Top abstract: AAPI Annual Meeting, Rachita Navara, MD (resident)
2017 Mentor, European Society of Cardiology, Top Abstract Awardee, Junaid Zaman, MD (fellow)
2017-19 Mentor, AHA Postdoctoral Fellowship, David Vidmar, PhD
2017 Mentor, 1st Prize, Society of General Internal Medicine, Rachita Navara, MD (resident)
2016 Mentor, 1st Prize, Stanford-Karolinska Symposium, Christopher Kowalewski (pre-doc)
2016-17 Mentor, Stanford Medscholars Program grant to Mallika Tombolli, BS (MD class of 2019)
2015-16 Mentor, Stanford Society of Physician Scholars Grant to Rachita Navara, MD (resident)
2015-17 Mentor, Fulbright Foundation Scholar Junaid Zaman, MD (fellow, Stanford-Imperial College)
2015 Mentor, Heart Rhythm Society Josephson Fellowship to Tina Baykaner, MD (fellow)
2015 Mentor, AHA Postdoctoral Fellow, Tina Baykaner, MD (declined)
2014-16 Mentor, British Heart Foundation grantee Junaid Zaman, MD (fellow Stanford, Imperial College)
2014 Mentor to 2014 Schulman Fellow Prize, Tina Baykaner, MD; UCSD (fellow)
2014 Mentor to 2014 Schulman Fellow Prize, Gautam Lalani, MD; UCSD (fellow)
2013 Mentor to HRS Young Investigator Competition 1st place awardee, Amir Schricker, MD (fellow)
2013 Mentor, 2013 Schulman Fellow Prize, Amir Schricker, MD; UCSD (fellow)
2012 Mentor, 2012 Schulman Fellow Prize, Gautam Lalani, MD; UCSD (resident)
2012-13 Mentor, ACC Foundation / Merck Fellowship to Amir Schricker, MD, MS (fellow)
2012 Mentor, Heart Rhythm Society Max Schaldach Fellow Amir Schricker, MD, MS (declined)
2011 Mentor, 2011 Schulman Prize Winner, David Krummen, MD; UCSD (Assistant Prof)
2011 Mentor, AHA Young Investigator Award Finalist, David E. Krummen, MD (Assistant Prof)
2010 Mentor, Student Research Prize Awardee, Krishna Ravi, MD, UCSD (med student)
2010-12 Mentor, AHA Beginning Grant-In-Aid Awardee, David E. Krummen, MD (Assistant Prof)
2009 Mentor, 2009 Schulman Prize Winner, Dhruv Kazi, MD; UCSD (fellow)
2008 Mentor, ACC Young Investigator Award Finalist, David E. Krummen, MD (fellow)
2007 Mentor, 2007 Schulman Prize Winner, David E. Krummen, MD (fellow) (UCSD)
2006 Mentor, 2006 UCSD Thomas Carew Prize Winner, Ashwani Sastry, MD (Medical Student)
2005-06 Mentor, ACC Foundation / Merck Fellowship to Hanh Bui, MD (fellow)
2004 Mentor to 2004 Schulman Prize Winner, Bobbi Hoppe, MD; UCSD (fellow)
2003-04 Mentor, ACC Foundation / Merck Fellowship to David Krummen, MD (fellow)

Honors to Dr. Narayan (Selected list)

2022 Distinguished Scientist Award; Heart Rhythm Society
2017-25 Top Doctor in US, Castle Connolly
2022-23 Chair, Digital Health Committee, Heart Rhythm Society.
2019-21 Chair, Data Science Study Section, AHA Institute for Precision Cardiovascular Medicine.
2019-20 Chair, Research Committee of the Heart Rhythm Society
2018-19 Member, Digital Health Task Force, Heart Rhythm Society.
2018 Invited Speaker, Pioneers Unplugged "Mapping AF", Heart Rhythm Society 2018 (05/11/18).
2017-20 NIH, Electrophysiology, Signaling, Ion Transport and Arrhythmias (ESTA) Charter Member
2015 Invited Plenary Speaker, Heart Rhythm Congress UK 2015, Birmingham UK (10/06/15).
2014 Invited Speaker, Mines Centenary Symposium, McGill University (11/07/14).
2012 Stephen Scheidt Professor 2012, Cornell University, New York, NY (12/18/12).
2012 Richard Lewar Lecturer, University of Toronto, CN; Toronto, Canada (04/19/12).

University/Public/National Committee Service

2016 – present Co-Director, Co-Founder, Stanford Arrhythmia Center
2012 – 2015 Program Committee, American College of Cardiology (ACC) Scientific Sessions
2011 – 2013 Planning Committee, Scientific Sessions, American Heart Association (AHA)
2008 – 2010 Heart Failure Society/America Research Committee.
Editorial Boards: Several Journals in Cardiovascular and arrhythmia medicine

C. Contribution to Science

1. **Combining clinical mapping with computational modeling of human electrophysiology. My interest in this field started nearly 30 years ago (first paper in 1993), and developed to model indices of human AF and VF to explain mechanisms, with the goal of defining phenotypes for personalized therapy.**

a. **Narayan SM**, Sensharma D, Santori E, Lee A, Sabherwal A, Toga AW. Animated Visualization Of A High Resolution Color Three Dimensional Digital Computer Model Of The Whole Human Head. International Journal of Biomedical Computing 1993; 32:7-17. PMID: 8425754

b. Aguado-Sierra J, Krishnamurthy A, Villongco C, Chuang J, Gonzales M, Krummen DE, **Narayan SM,** Kerckhoffs RCP, McCulloch AD. A Patient-Specific Computational Model Case Study of Heart Failure. Prog Biophys Mol Biol 2011 Oct;107(1):147-55. Epub 2011 Jul 7
c. Rappel W-J, **Narayan SM**. Theoretical Considerations for Mapping Activation in Human Cardiac Fibrillation. Chaos: An International Journal of Nonlinear Dynamics. 2013; 23(2): 023113.
d. Rappel, W-J, Zaman, ZAB, **Narayan SM**. Mechanisms For the Termination of Atrial Fibrillation by Localized Ablation: Computational and Clinical Studies, Circ Arrhyth Electrophysiol 2015; 8(6): 1325-33

2. Physiological mapping of human atria in patients with and without atrial fibrillation. This has yielded the largest reported series of human atrial monophasic action potentials. We reported bi-atrial action potential duration and rate response (restitution), conduction rate-response, in relation to anatomy. We combined these studies with drug intervention, ablation, imaging and computer modeling.

a. **Narayan SM**, Bode F, Karasik PL, Franz MR. Alternans of Atrial Action Potentials During Atrial Flutter as a Precursor of Atrial Fibrillation. Circulation 2002; 106: 1968-1973.
b. **Narayan SM,** Franz MR, Clopton P, Pruvot E, Krummen DE. Repolarization Alternans Indicates Vulnerability to Human Atrial Fibrillation. Circulation 2011; 123: 2922-2930
c. Tang S, Razeghi O, Kapoor R, … **Narayan SM**, Baykaner T. Machine Learning-Enabled Multimodal Fusion of Intra-atrial and Body Surface Signals in Prediction of AF Ablation Outcomes. Circ Arrhythm Electrophysiol. 2022 Aug;15(8):e010850. doi: 10.1161/CIRCEP.122.010850.
d. Ganesan P, Deb B, Feng R, Rodrigo M, Ruiperez S, …Schotten U, **Narayan S.M.,** "Quantifying a Spectrum of Response in Atrial Tachyarrhythmias", Europace, 2023, 25(5): euad055.

3. Numerical and machine learning studies of atrial fibrillation as a physiological network. We reported that AF may be sustained by localized drivers (rotational and focal) rather than 'random' activity, where targeted ablation may improve outcome. We are comparing mapping approaches in human AF and have made mapping code and results freely available (http://narayanlab.stanford.edu)**.**

a. **Narayan SM**, Krummen DE, Shivkumar K, Clopton PS, Rappel WJ, Miller JM. Treatment of AF by the Ablation of Localized Sources: The CONventional Ablation For AF With and Without Focal Impulse and Rotor Modulation (CONFIRM) Trial. JACC 2012; 60(7):628-36. PMID: 22818076 PMCID: PMC3416917.
b. Mahmood I. Alhusseini, Firas Abuzaid, Albert J. Rogers, Junaid A. B. Zaman, Tina Baykaner, Paul Clopton, Peter Bailis, Matei Zaharia, …**Sanjiv M. Narayan.** Machine Learning to Classify Intracardiac Electrical Patterns During AF. Circ Arrhyth EP 2020; 13(8):e008160. PMID 32631100
c. Kowalewski CA, Meckler G, Alhusseini M, Shenasa F, Baykaner T, Zaman JAB, Park S, Zei P, Viswanathan M, Brachmann J, Sauer WM, Wang PJ, **Narayan SM**. Interaction of Localized Drivers and Disorganized Activation in Persistent Atrial Fibrillation: Reconciling Putative Mechanisms Using Multiple Mapping Techniques. Circulation: Arrhyth Electrophysiol 2018; 11(6):e005846
d. Krittanawong C, Johnson KW, Rosenson RS, Wang Z, Aydar M, Baber U, Tang WHW, Halperin JL, **Narayan SM**. Machine Learning for CV Medicine. Eur H J 2019; **40**(25): 2058-2073. PMID: 30815669

4. Mechanisms of ventricular arrhythmias. We recently used machine learning of human ventricular MAPs to predict sudden cardiac death (paper (a)). We have studied repolarization (via MAPs; paper (b)) and conduction dynamics (paper (c)) in patients and animal models, and showed that ventricular fibrillation (VF) in humans may be maintained by drivers amenable to local therapy (paper (d)).

a. **Narayan SM,** Bayer J, Lalani G, Trayanova NA. Action Potential Dynamics Explain Arrhythmic Vulnerability in Human Heart Failure: A Combined Clinical and Modeling Study Implicating Abnormal Calcium Handling. J Am Coll Cardiol, 2008; 52(22): 1782-1792.
b. Krummen DE, Hayase J, Vampola SP, Ho G, Schricker AA, Lalani GG, Baykaner T, Coe TM, Clopton P, Rappel WJ, Omens JH, **Narayan SM**. Modifying Ventricular Fibrillation by Targeted Rotor Substrate Ablation: Proof-of-Concept from Experimental Studies to Clinical VF. J Cardiovasc Electrophysiol. 2015; 26(10): 1117-26 Jul 14. doi: 10.1111/jce.12753. PMID: 26179310 PMCID: PMC4826737
c. Chengyi Tu, Arianne Caudal, Yu Liu, Nikoloz Gorgodze, Hao Zhang, Chi Keung Lam, Yuqin Dai, Angela Zhang, Alexa Wnorowski, Matthew Wu, Huaxiao Yang, Oscar Abilez, Xuchao Lyu, **Narayan S.M.**, Joseph Wu Tachycardia-induced metabolic rewiring as a driver of contractile dysfunction. Nature Biomedical Engineering 2023; doi: 10.1038/s41551-023-01134-x. PMID: 38012305
d. Rogers AJ, Bhatia NK, Bandyopadhyay S, Tooley J, … Clopton P, Sameni R, Clifford GD, Hughes JW, Ashley EA, Perez MV, Zaharia M, **Narayan SM.** Identification of cardiac wall motion …by deep learning of the ECG. NPJ Digit Med. 2025 Jan 11;8(1):21. doi: 10.1038/s41746-024-01407-y.PMID: 39799179

A full list of my published work can be found at: **https://www.ncbi.nlm.nih.gov/pubmed/?term=narayan+sm**