

CHIA Non-Governmental Application for Re-Use Massachusetts Case Mix Data [Exhibit A: Data Application]

I. INSTRUCTIONS

This form is required for all Applicants, except Government Agencies as defined in [957 CMR 5.02](#), who wish to re-use Data received pursuant to a previously approved Data Application ("Extract"). **If the applicant requires data not presently held by its Organization the applicant should not use this form.**

All attachments must be uploaded to IRBNet with your Application. All Application documents can be found on the [CHIA website](#) in Word and in PDF format or on [IRBNet](#) in Word format. If you submit a PDF document, please also include a Word version in order to facilitate edits that may be needed.

Applications will not be reviewed until the Application and all supporting documents are complete and the required application fee is submitted. A [Fee Remittance Form](#) with instructions for submitting the application fee is available on the CHIA website and IRBNet. A copy of the Fee Remittance Form and any supporting documentation must be uploaded to IRBNet.

II. CASE MIX DATABASE EXTRACT TO BE RE-USED

Project Title:	Frailty, Aging, and Risk of Adverse Outcomes in Mitral Valve Prolapse (The FAR-OUT-MVP Study)
Extract Number:	BIDMC_Strom
IRBNet Number:	2111579-1
Date of Data Use Agreement	April 2, 2024

III. ORGANIZATION AND INVESTIGATOR INFORMATION

Project Title:	Cardiac Disease and Enhancing Non-invasive Correlations with Echocardiography (CADENCE)
IRBNet Number:	2316593-1
Organization Name:	Beth Israel Deaconess Medical Center, Inc
Organization Website:	www.bidmc.org/smithcenter
Authorized Signatory for Organization	Marlena D. Konieczynska, PhD
Title:	Sr. Research Contract Associate, Sponsored Programs Contracting
E-mail Address:	mkoniecz@bidmc.harvard.edu
Address, City/Town, State, Zip Code	Beth Israel Deaconess Medical Center, 330 Brookline Ave., Masco 4 - Smith Center, Boston, MA 02215
Primary Investigator:	Jordan Strom, MD, MSc
Title:	Director of the Echocardiography Laboratory and Section Head of Imaging Research at the Smith Center, BIDMC
E-mail Address:	jstrom@bidmc.harvard.edu
Telephone Number:	617-632-7672
Names of Co-Investigators:	N/A
E-mail Address of Co-Investigators:	N/A

IV. FEE INFORMATION

1. Consult the [Fee Schedule](#) for Case Mix and Charge Data and select one of the following options:

- ☒ Researcher
☐ Other
☐ Reseller

2. Are you requesting a fee waiver?

- ☐ Yes
☒ No

3. Complete and submit the [Fee Remittance Form](#). If requesting a fee waiver, submit a letter stating the basis for your request (if required). Please refer to the [Fee Schedule](#) (effective Feb 1, 2017) for fee waiver criteria. (Please note that fee must be paid in order to re-use the Data, even if no new extract is required upon application.)

V. PROJECT INFORMATION

1. What will be the use of the CHIA Data requested? [Check all that apply]

- | | | |
|---|--|--|
| <input checked="" type="checkbox"/> Epidemiological | <input type="checkbox"/> Health planning/resource allocation | <input type="checkbox"/> Cost trends |
| <input checked="" type="checkbox"/> Longitudinal Research | <input type="checkbox"/> Quality of care assessment | <input type="checkbox"/> Rate setting |
| <input type="checkbox"/> Reference tool | <input checked="" type="checkbox"/> Research studies | <input type="checkbox"/> Severity index tool |
| <input type="checkbox"/> Surveillance | <input type="checkbox"/> Student research | <input type="checkbox"/> Utilization review of resources |
| <input type="checkbox"/> Inclusion in a product | <input type="checkbox"/> Other (describe in box below) | |

N/A

2. Provide a summary of the specific purpose and objectives of your Project. This may include research questions and/or business use Projects.

Cardiovascular imaging (CVI) is essential to the diagnosis and management of cardiac and non-cardiac diseases with 6.8% of Medicare beneficiaries receiving an imaging test annually. Across a number of conditions, cardiovascular imaging often informs etiology, therapeutic intervention, response to treatment, risk stratification and prognosis. Despite the importance that CVI plays in public health and cascade testing as well as the extensive phenotypic data on cardiac structure and function that is derived from CVI testing, little is known about the relationship of these phenotypic findings and relevant health outcomes including adverse cardiovascular outcomes, hospitalizations, and resource utilization (e.g. cost, etc.) due in part to few imaging databases being linked to comprehensive claims. As part of the NHLBI-funded FAR-OUT-MVP project, we have previously linked clinical cardiac MRI and echocardiogram reports at Beth Israel Deaconess Medical Center (BIDMC) across 20 years of acquisition to CHIA Case Mix data to evaluate how outcomes in mitral valve prolapse vary across age and frailty. As this represents one of the first clinical datasets in the country to be linked to comprehensive claims, we hope to leverage this unique dataset to address ongoing knowledge gaps to better understand how cardiac structural and functional abnormalities identified on CVI relate to adverse cardiovascular outcomes, hospitalizations, and resource utilization. Examples of possible studies include: 1) the relationship of aortic regurgitation severity, receipt of aortic valve replacement, and health utilization, 2)

the comparison of cardiac MRI and echocardiography for prognostication in patients with severe mitral regurgitation, 3) the validity of ICD-10 claims to identify findings on CVI (e.g. late gadolinium enhancement), 4) whether deep learning algorithms applied to echocardiogram or cardiac MRI images can identify patients at risk for hospital readmission. Such questions are not feasible to answer outside of a unique data resource such as the one that currently created as part of the FAR-OUT-MVP study. As such, we request to reuse the CHIA claims data to broadly address these important questions facing the field of cardiovascular imaging.

3. Has an Institutional Review Board (IRB) reviewed your Project?

☒ Yes [If yes, a copy of the approval letter and protocol must be included with the Application package on IRBNet.]

☐ No, this Project is not human subject research and does not require IRB review.

4. **Research Methodology:** Applicants must provide either the IRB protocol or a written description of the Project methodology (typically 1-2 pages), which should state the Project objectives and/or identify relevant research questions. This document must be included with the Application package on IRBNet and must provide sufficient detail to allow CHIA to understand how the Data will be used to meet objectives or address research questions.

VI. PUBLIC INTEREST

1. Briefly explain why completing your Project is in the public interest. *Uses that serve the public interest under CHIA regulations include, but are not limited to: health cost and utilization analysis to formulate public policy; studies that promote improvement in population health, health care quality or access; and health planning tied to evaluation or improvement of Massachusetts state government initiatives.*

As stated earlier (section V.2), reuse of the Case Mix data for this purpose will benefit the public through the creation of important and generalizable insights to address existing gaps in knowledge that may inform patient management. Such information could 1) inform clinical practice as to the use of phenotypic features on CVI to guide clinical management and prognostication, 2) provide insights into the impact of public policies that may affect patients receiving CVI or the type of patients who receive CVI, 3) generate insights about unequal access to care that could be addressed through policy initiatives, 4) help identify critical trends in the health of the Commonwealth as viewed from CVI (e.g. trends in left ventricular hypertrophy and their association with resulting hospitalizations for heart failure), 5) assist in the development and validation of deep learning models applied to CVI images for use in improving clinical practice.

VII. DATASETS REQUESTED

The Recipient will use Data included in the Extract referenced above for use in this Project; no new Data will be released under this Application.

1. Specify below the dataset(s) and year(s) of data requested for this Project, and your justification for requesting each dataset.

☒ **Hospital Inpatient Discharge Data**

☒ 2004 ☒ 2005 ☒ 2006 ☒ 2007 ☒ 2008 ☒ 2009 ☒ 2010 ☒ 2011 ☒ 2012 ☒ 2013 ☒ 2014 ☒ 2015 ☒ 2016 ☒ 2017 ☒ 2018 ☒ 2019 ☒ 2020 ☒ 2021

Describe how your research objectives require Inpatient Discharge data:

Inpatient discharge data will be used to identify hospitalizations for cardiovascular outcomes of interest (e.g. myocardial infarction, cardiac arrest, heart failure) amongst people who have had cardiac imaging at BIDMC. Additionally, it can be used to construct clinical indicator variables based on validated claims-algorithms for use in multivariable adjustment.

☒ **Outpatient Observation Data**

☒2004 ☒2005 ☒2006 ☒2007 ☒2008 ☒2009 ☒2010 ☒2011 ☒2012 ☒2013 ☒2014 ☒2015 ☒2016 ☒2017 ☒2018 ☒2019 ☒2020 ☒2021

Describe how your research objectives require Outpatient Observation data:

Outpatient hospital observation data are necessary to provide a full picture of the clinical outcomes of individuals with diseases where cardiac imaging is involved as it may be used in studies of health utilization (e.g. cost, testing) and hospital revisits, which may not be adequately captured by readmission data alone.

☒ **Emergency Department Data**

☒2004 ☒2005 ☒2006 ☒2007 ☒2008 ☒2009 ☒2010 ☒2011 ☒2012 ☒2013 ☒2014 ☒2015 ☒2016 ☒2017 ☒2018 ☒2019 ☒2020 ☒2021

Describe how your research objectives require Emergency Department data:

Emergency department data are necessary, as for part of are studies we would be looking at the use of healthcare services which includes ED stays, which are frequent in cardiovascular medicine.

2. If there are datasets that are included in the Extract that **are not** required for this Project indicate below.

☐ Hospital Inpatient Discharge Data ☐ Outpatient Observation Data ☐ Emergency Department Data

3. If there are datasets included in the Extract that are not required for this Project, describe below how those datasets will be segregated and protected from use in this Project.

N/A

VIII. DATA ELEMENTS REQUESTED

State and federal privacy laws limit the release and use of Data to the minimum amount of data needed to accomplish a specific Project objective.

Case Mix and Charge Data are grouped into six “Levels” or Limited Data Sets (LDS) for release, depending on the fiscal year. Data for FY 2004 – 2014 are organized into Levels. Level 6 Data will be released to Government Applicants only. *CHIA staff will use the information provided in this section to determine the appropriate Level of Data justified for release.*

Data for FY 2015 and later are organized into LDS’s. All applicants receive the “Core” LDS, but may also request additional elements listed below for inclusion in their analyses. Requests for additional elements will be reviewed by CHIA to determine whether each represents the minimum data necessary to complete the specific Project objective.

For a full list of elements in the release (i.e., the “Core” elements and additional elements), please refer to [release layouts, data dictionaries](#) and similar documentation included on CHIA’s website.

1. Specify below which elements you are requesting in addition to the “Core” LDS. CHIA will use this information to determine what Level of data is needed for pre-FY 2015 data requests.

Geographic Data

The geographic sub-divisions listed below are available for CT, MA, ME, NH, RI, VT, and NY residents only for FY 2015 and after. Fiscal years 2004 – 2014 will contain the geographic sub-divisions listed below for all states. Choose one of the following geographic options.

<input type="checkbox"/> 3-Digit Zip Code (Standard)	<input type="checkbox"/> 3-Digit Zip Code & City/Town ***	<input type="checkbox"/> 5-Digit Zip Code ***	<input checked="" type="checkbox"/> 5-Digit Zip Code & City/Town ***
***If requested, provide justification for requesting 5-Digit Zip Code or City/Town. Refer to specifics in your methodology: Complete geographic information (5-digit zip code and city/town) will help in identifying issues of direct relevance to MA vs. other states and will be useful for geographic analyses evaluating differences or disparities across geographic regions within the New England area.			

Demographic Data

Choose one of the following demographic options:

<input type="checkbox"/> Not Requested (Standard)	<input checked="" type="checkbox"/> Race & Ethnicity***
** If requested, provide justification for requesting Race and Ethnicity. Refer to specifics in your methodology: We will examine differences in outcomes of cardiovascular diseases, as well as rates of SCD between different racial and ethnic groups to understand race-based disparities and inequities in cardiovascular care.	

Dates

Choose one option from the following options for dates of admissions, discharges, and significant procedures:

<input type="checkbox"/> Year (YYYY)(Standard)	<input type="checkbox"/> Month (YYYYMM) ***	<input checked="" type="checkbox"/> Day (YYYYMMDD)***
***If requested, provide justification for requesting Month or Day. Refer to specifics in your methodology: To derive time-to-event outcomes for use in survival analyses, we need complete date information including year, month, and day.		

Practitioner Identifiers (UPN)

Please choose one of the following options for Practitioner Identifier(s):

<input checked="" type="checkbox"/> Not Requested (Standard)	<input type="checkbox"/> Hashed ID ***	<input type="checkbox"/> Board of Registration in Medicine Number(BORIM) ***
***If requested, provide justification for requesting Hashed ID or BORIM Number. Refer to specifics in your methodology:		

Unique Health Information Number (UHIN)

Please choose one of the following:

<input type="checkbox"/> Not Requested (Standard)	<input checked="" type="checkbox"/> UHIN Requested ***
*** If requested, provide justification for requesting UHIN. Refer to specifics in your methodology: The UHIN will be used to identify unique individuals across different admissions to different institutions which is necessary to inform readmission rates and strategies to prevent them.	

Hashed Mother's Social Security Number

Please choose one of the following:

<input checked="" type="checkbox"/> Not Requested (Standard)	<input type="checkbox"/> Hashed Mother's SSN Requested ***
*** If requested, provide justification for requesting Hashed Mother's SSN. Refer to specifics in your methodology:	

2. If there are data elements that are included in the Extract that **are not** required for this Project indicate below.

- | | | | |
|---|--|--|---|
| <input type="checkbox"/> 5-Digit Zip Code | <input type="checkbox"/> UHIN | <input type="checkbox"/> Hashed Physician ID | <input type="checkbox"/> Month (YYYYMM) |
| <input type="checkbox"/> City/Town | <input type="checkbox"/> Hashed Mother's SSN | <input type="checkbox"/> BORIM Number | <input type="checkbox"/> Day (YYYYMMDD) |
| <input type="checkbox"/> Race & Ethnicity | | | |

3. If there are data elements included in the Extract that are not required for this Project, describe below how the data elements will be segregated and protected from use in this Project.

N/A

IX. DATA LINKAGE

Data linkage involves combining CHIA Data with other data to create a more extensive database for analysis. Data linkage is typically used to link multiple events or characteristics within one database that refer to a single person within CHIA Data.

1. Do you intend to link or merge CHIA Data to other data?

- ☐ Yes
☒ No linkage or merger with any other data will occur

2. If yes, please indicate below the types of data to which CHIA Data will be linked. [Check all that apply]

- ☐ Individual Patient Level Data (e.g. disease registries, death data)
☐ Individual Provider Level Data (e.g., American Medical Association Physician Masterfile)
☐ Individual Facility Level Data (e.g., American Hospital Association data)
☐ Aggregate Data (e.g., Census data)
☐ Other (please describe):

3. If yes, describe the data base(s) to which the CHIA Data will be linked, indicate which CHIA Data elements will be linked and the purpose for each linkage.

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4. If yes, for each proposed linkage above, please describe your method or selected algorithm (e.g., deterministic or probabilistic) for linking each dataset. If you intend to develop a unique algorithm, please describe how it will link each dataset.

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5. If yes, please identify the specific steps you will take to prevent the identification of individual patients in the linked dataset.

X. PUBLICATION / DISSEMINATION / RE-RELEASE

1. Describe your plans to publish or otherwise disclose CHIA Data, or any data derived or extracted from CHIA Data, in any paper, report, website, statistical tabulation, seminar, conference, or other setting. Any and all publication of CHIA Data must comply with CHIA's cell size suppression policy, as set forth in the Data Use Agreement. Please explain how you will ensure that any publications will not disclose a cell less than 11, and percentages or other mathematical formulas that result in the display of a cell less than 11.

We anticipate that reuse of this linked datasets will be used to produce manuscripts with relevant findings, intended for publication in peer-reviewed journals, and preliminary data for subsequent grant submissions. The results will also be presented at national and international conferences.

We have an existing DUA with CHIA that details the previously linkage of Case Mix data to BIDMC echocardiogram and cardiac MRI reports. Thus, all re-analysis of this data under this reuse agreement will be done in accordance with the approved CHIA DUA. All output containing individually identifiable information will be treated as confidential data. Such information will never be transferred electronically via e-mail or other protocols. This includes complying with CHIA's policy to suppress cell sizes less than 11.

2. Do you anticipate that the results of your analysis will be published and/or made publically available? If yes, describe how an interested party will obtain your analysis and, if applicable, the amount of the fee, that the third party must pay.

The results of research resulting from the linked dataset will be presented at academic conferences and published in peer-reviewed journal articles.

3. Will you use CHIA Data for consulting purposes?

- ☐ Yes
☒ No

4. Will you be selling standard report products using CHIA Data?

- ☐ Yes
☒ No

5. Will you be selling a software product using CHIA Data?

- ☐ Yes
☒ No

6. Will you be reselling CHIA Data in any format?

- ☐ Yes
☒ No

If yes, in what format will you be reselling CHIA Data (e.g., as a standalone product, incorporated with a software product, by a subscription, etc.)?

N/A

7. If you have answered “yes” to questions 4, 5 or 6, please describe the types of products, services or studies.

N/A

8. If you have answered “yes” to questions 4, 5, or 6, what is the fee you will charge for such products, services or studies?

N/A

XI. APPLICANT QUALIFICATIONS

1. Describe your previous experience using hospital data. This question should be answered by the primary investigator and any co-investigators who will be using the Data.

Investigators at the Smith Center for Outcomes Research in Cardiology at BIDMC have successfully used claims data from the Centers of Medicare and Medicaid Services, as well as, CHIA (case mix and APCD) in prior publications across a variety of research projects. The Smith Center investigators are supported by skilled biostatisticians with years of experience in analyzing Medicare, Medicaid, and HCUP claims data.

In particular, Dr. Jordan Strom, MD, MSc (PI) has extensive expertise in the use of imaging registries and linkage to claims. He is Associate Professor at Harvard Medical School, Director of the Echocardiography Laboratory and Director of Echocardiographic Research at BIDMC, and Section Head for Cardiovascular Imaging Research at the Smith Center. His research which has been funded by the NIH (including a current NHLBI R01) and American Heart Association focuses on three main areas: 1) the relationship of cardiac structure and function to health outcomes, 2) the optimal use and timing of cardiac imaging in practice, and 3) the clinical role of emerging technologies (e.g. AI and ultrasound contrast) in cardiac imaging. He has published more than 110 papers in peer-reviewed journals, is a member of the Editorial Board of the Journal of the American Society of Echocardiography, and serves as Guest Editor for the Journal of the American Society of Echocardiography and the Journal of Cardiovascular Magnetic Resonance. He additionally was the inaugural American Society of Echocardiography (ASE) leadership academy member elected to the Board of Directors of the ASE and previously served on the American College of Cardiology Imaging Council Leadership Committee. He currently serves as Secretary of the Board of Directors of the International Contrast Ultrasound Society, and is representative to the Board of Directors of the Joint Review Committee on Education in Diagnostic Medical Sonography, which accredits sonography training programs in the United States. Additionally, he was the American College of Cardiology Commissioner to CAAHEP, the largest accreditor of allied health professions in the United States. He was named the 2025 Kalmanson Lecturer at the American Society of Echocardiography which honors worthy investigators promoting research and education in cardiovascular Doppler ultrasound.

As part of previous projects, Dr. Strom has linked Medicare claims data to echocardiogram reports at BIDMC and has validated claims for aortic stenosis and aortic regurgitation against echocardiographic definitions. He additionally has linked Medicare claims to clinical trial data to validate frailty indices as well as a number of claims-algorithms to identify relevant covariates and outcomes against trial-adjudicated outcomes. He currently serves as the Chair of the ImageGuideEcho Registry for the ASE which is the only nationwide, multicenter registry of echocardiographic report and image data.

2. **Resumes/CVs:** When submitting your Application package on IRBNet, include résumés or curricula vitae of the principal investigator and co-investigators. (These attachments will not be posted on the internet.)

XII. USE OF AGENTS AND/OR CONTRACTORS

Please note: By signing this Application, the Organization assumes all responsibility for the use, security and maintenance of the CHIA Data by its agents, including but not limited to contractors.

Provide the following information for all agents and contractors who will work with the CHIA Data. *[Add agents or contractors as needed.]*

AGENT/CONTRACTOR #1 INFORMATION	
Company Name:	
Company Website:	
Contact Person:	
Title:	
E-mail Address:	
Address, City/Town, State, Zip Code	
Telephone Number:	
Term of Contract:	

1. Describe the tasks and products assigned to the agent or contractor for this Project and their qualifications for completing the tasks.

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2. Describe the Organization's oversight and monitoring of the activities and actions of the agent or contractor for this Project, including how the Organization will ensure the security of the CHIA Data to which the agent or contractor has access.

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3. Will the agent or contractor have access to or store the CHIA Data at a location other than the Organization's location, off-site server and/or database?

- ☐ Yes
☐ No

4. If yes and a Data Management Plan for this agent or contractor is not part of the Data Use Agreement, a separate Data Management Plan **must** be completed by the agent or contractor.

AGENT/CONTRACTOR #2 INFORMATION	
Company Name:	
Company Website:	
Contact Person:	
Title:	
E-mail Address:	
Address, City/Town, Zip Code	
Telephone Number:	
Term of Contract:	

1. Describe the tasks and products assigned to the agent or contractor for this Project and their qualifications for completing the tasks.

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2. Describe the Organization's oversight and monitoring of the activities and actions of the agent or contractor for this Project, including how the Organization will ensure the security of the CHIA Data to which the agent or contractor has access.

--

3. Will the agent or contractor have access to or store the CHIA Data at a location other than the Organization's location, off-site server and/or database?

- ☐ Yes
☐ No

4. If yes and a Data Management Plan for this agent or contractor is not part of the Data Use Agreement, a separate Data Management Plan **must** be completed by the agent or contractor.

XIII. ATTESTATION

By submitting this Application, the Organization attests that it is aware of its data use, privacy and security obligations imposed by state and federal law *and* confirms that it is compliant with such use, privacy and security standards. The Organization further agrees and understands that it is solely responsible for any breaches or unauthorized access, disclosure or use of CHIA Data including, but not limited to, any breach or unauthorized access, disclosure or use by its agents.

The Organization's use of the Data for this Project will be governed by the executed Data Management Plan(s), Data Use Agreement, and any Amendment thereto.

By my signature below, I attest: (1) to the accuracy of the information provided herein; (2) that the requested Data is the minimum necessary to accomplish the purposes described herein; (3) that the Organization will meet the data privacy and security requirements described in this Application and supporting documents, and will ensure that any third party with access to the Data meets the data use, privacy and security requirements; and (4) to my authority to bind the Organization.

Signature: (Authorized Signatory for Organization)	
Printed Name :	

Attachments

A completed Application must have the following documents attached to the Application:

- ☒ 1. IRB approval letter and protocol (if applicable)
- ☒ 2. Research Methodology (if protocol is not attached)
- ☒ 3. CVs of Investigators
- ☒ 4. Data Management Plan (including one for each agent or contractor that will have access to or store the CHIA Data at a location other than the Organization's location, off-site server and/or database)

Applications will not be reviewed until they are complete, including all attachments. Applicant may not use the Extract for this Project until CHIA approval and the execution of an amendment to the Recipient's Data Use Agreement.

TRACKING TABLE (to be completed by CHIA staff only)	
Complete Application Received	
Application Fee Received	
Data Privacy Committee Review	
Data Release Committee Review	
Linkages Approved (as described)	
Approved for additional years of data	
Executive Director Approval	
Data Fee Received	
Date of First Audit	
IT Extract #	

Attachment #1 – Research Methodology

Cardiac Disease and Enhancing Non-invasive Correlations with Echocardiography (CADENCE): Project Methodology

Background and Aims

Cardiovascular imaging (CVI) is essential to the diagnosis and management of cardiac and non-cardiac diseases with 6.8% of Medicare beneficiaries receiving an imaging test annually. Across a number of conditions, cardiovascular imaging often informs etiology, therapeutic intervention, response to treatment, risk stratification and prognosis. Despite the importance that CVI plays in public health and cascade testing as well as the extensive phenotypic data on cardiac structure and function that is derived from CVI testing, little is known about the relationship of these phenotypic findings and relevant health outcomes including adverse cardiovascular outcomes, hospitalizations, and resource utilization (e.g. cost, etc.) due in part to few imaging databases being linked to comprehensive claims. As part of the NHLBI-funded FAR-OUT-MVP project, we have previously linked clinical cardiac MRI and echocardiogram reports at Beth Israel Deaconess Medical Center (BIDMC) across 20 years of acquisition to CHIA Case Mix data to evaluate how outcomes in mitral valve prolapse vary across age and frailty. As this represents one of the first clinical datasets in the country to be linked to comprehensive claims, we hope to leverage this unique dataset to address ongoing knowledge gaps to better understand how cardiac structural and functional abnormalities identified on CVI relate to adverse cardiovascular outcomes, hospitalizations, and resource utilization through the following aims:

- 1) To understand the relationship of cardiac structure and function as identified through CVI on cardiovascular health outcomes, hospitalizations, and resource utilization.
- 2) To evaluate the impact of public policies that may affect patients receiving CVI or the type of patients receiving CVI.
- 3) To identify the presence and contributors to unequal access to care and the role of CVI in mitigating these inequalities.
- 4) To understand health changes in the population using trends in phenotypic changes apparent on CVI.
- 5) To assist in the development and validation of statistical and artificial intelligence models applied to CVI images or reports for use in improving clinical practice.

Proposed Methodologies

To address these aims, we will use a broad range of biostatistical and data science methods including (but not limited to): 1) univariate descriptive statistics, 2) epidemiologic study designs (e.g. retrospective cohort studies, case control studies), 3) generalized linear models, 4) longitudinal models (i.e. mixed models and hierarchical model designs), 5) survival techniques, 6) causal inference techniques (e.g. instrumental variable analysis etc.), 7) penalized regression, 8) ensemble methods (e.g. random forest, boosted tree), 9) clustering techniques (e.g. K-means clustering, hierarchical clustering, factor analysis, principal components analysis), 10) artificial neural networks and deep learning models (e.g. convolutional neural networks, generalized adversarial networks, etc.), and 11) econometric techniques for evaluating health policy (e.g. difference in differences analyses, interrupted time series, etc.). These methods will be applied to the linked dataset by skilled biostatistical analyses at the Smith Center with extensive methodological experience and familiarity with analysis of large claims datasets using the highest standards of rigor. All analyses will be carried out under the data use restrictions set about through the existing data use agreement between Dr. Strom/BIDMC and CHIA.