CHIA.
center for health information and analysis

Non-Governmental Application for Massachusetts Case Mix and Charge Data [Exhibit A]

I. INSTRUCTIONS

This form is required for all Applicants, except Government Agencies as defined in 957 CMR 5.02, requesting protected health information. *All Applicants must also complete the Data Management Plan, attached to this Application. The Application and the Data Management Plan must be signed by an authorized signatory of the Organization. This Application and the Data Management Plan will be used by CHIA to determine whether the request meets the criteria for data release, pursuant to 957 CMR 5.00. Please complete the Application documents fully and accurately. Prior to receiving CHIA Data, the Organization must execute CHIA's Data Use Agreement. Applicants may wish to review that document prior to submitting this Application.*

Before completing this Application, please review the data request information on CHIA's website:

- Data Availability
- Fee Schedule
- Data Request Process

After reviewing the information on the website and this Application, please contact CHIA at casemix.data@state.ma.us if you have additional questions about how to complete 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. If you are requesting a fee waiver, a copy of the Fee Remittance Form and any supporting documentation must be uploaded to IRBNet.

II. FEE INFORMATION

1. Consult the most current Fee Schedule for Case Mix and Charge Data.

2. After reviewing the Fee Schedule, if you have any questions about the application or data fees, contact casemix.data@state.ma.us.

3. If you believe that you qualify for a fee waiver, complete and submit the Fee Remittance Form and attach it and all required supporting documentation with your application. Refer to the Fee Schedule (effective Feb 1, 2017) for fee waiver criteria.

4. Applications will not be reviewed until the application fee is received.

5. Data for approved Applications will not be released until the payment for the Data is received.

III. ORGANIZATION AND INVESTIGATOR INFORMATION

Project Title:	Effect of severe weather events on hospitals operations
IRBNet Number:	1554451-1
Organization Requesting Data (Recipient):	Northeastern University
Organization Website:	https://www.northeastern.edu/
Authorized Signatory for Organization:	Eva Pasadas
Title:	*Director, Grants and Contracts*
E-Mail Address:	e.pasadas@northeastern.edu
Address, City/Town, State, Zip Code:	360 Huntington ave, Boston, MA, 02115
Data Custodian: **(individual responsible for ogranizing, storing, and archiving Data)**	Raphael Schroter
Title:	Assistant Director, Research Computing, Information Technology Services (ITS)
E-Mail Address:	R.Schroter@Northeastern.edu
Telephone Number:	(617) 943-0549
Address, City/Town, State, Zip Code:	360 Huntington Avenue, 302-216, Boston, MA 02115
Primary Investigator: **(individual responsible for the research team using the Data)**	Ozlem Ergun
Title:	Professor of Mechanical and Industrial Engineering
E-Mail Address:	o.ergun@northeastern.edu,
Telephone Number:	6173736254
Names of Co-Investigators:	Md Noor E Alam, Mahsa Ghanbarpourmamaghani, MD Young Gary, MD Mahmudul Hassan
E-Mail Addresses of Co-Investigators:	md.alam@northeastern.edu, ghanbarpourmamagh.m@husky.neu.edu ga.young@northeastern.edu, hasan.mdm@husky.neu.edu,

IV. PROJECT INFORMATION

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

☐ Epidemiological	☒ Health planning/resource allocation	☐ Cost trends
☐ Longitudinal Research	☒ Quality of care assessment	☐ Rate setting
☐ Reference tool	☒ Research studies	☐ Severity index tool
☐ Surveillance	☒ Student research	☐ Utilization review of resources
☐ Inclusion in a product	☐ Other (describe in box below)	

2. Provide an abstract or brief summary of the specific purpose and objectives of your Project. This description should include the research questions and/or hypotheses the project will attempt to address, or describe the intended product or report that will be derived from the requested data and how this product will be used. Include a brief summary of the pertinent literature with citations, if applicable.

Weather-related emergencies can cause substantial disruption to the delivery of healthcare services that also present threats to patient care. Disruption to the delivery of healthcare services includes cancelling outpatients admissions, cancelling elective surgeries and evacuation in extreme cases. As an example, when the super-storm Sandy hit NewYork City in 2012, it caused major disruptions in the health care infrastructure, forcing many hospitals to evacuate their patients [1]. Preparedness and response planning are necessary to reduce the adverse impacts of extreme weather events on healthcare, and also to enable effective and quick recovery. For planning and making the right decisions during storms we need to analyze the impacts of weather emergencies on the healthcare and the real cause for the effects during storms.

Recently severe snowstorms are more frequent due to global climate change[2] ; for example in the eastern two-thirds of the contiguous U.S., the number of major snowstorms in the second half of the twentieth century was approximately twice of the first half [3]. Also, studies and reports expresse snowstorms and cold weather are associated with an increase in the rate of mortality [3]. On the other hand, as National Weather services reports snowstorms and blizzards can disrupt emergency and medical services [4]. This means snowstorms can potentially have negative effects on the quality of patient care. Therefore, As a first weather emergency and based on the most frequent type of weather emergencies in Massachusetts, we are trying to identify the adverse effects of severe snowstorms on the hospitals' operations in terms of the number of admissions, and discharges. The aim of this study is to quantify, test, and predict the impact of snowstorms with different intensity and levels of snow to identify and characterize the significant impacts on healthcare systems due to snowstorms. We are also interested in the effect of other types of weather emergencies on the hospitals and healthcare services.

The evidence generated by this research project will be useful to determine the adverse impact of severe weather events (snowstorms as the first case study) on healthcare systems; prepare for emergency weather events ; adapt hospital procedures during weather events, to improve outcomes for patients and service providers.

1. Uppal, Amit, Laura Evans, Nishay Chitkara, Paru Patrawalla, M. Ann Mooney, Doreen Addrizzo-Harris, Eric Leibert et al. "In search of the silver lining. The impact of Superstorm Sandy on Bellevue Hospital." Annals of the American Thoracic Society 10, no. 2 (2013): 135-142.
2. Gasparrini, Antonio, Yuming Guo, Masahiro Hashizume, Eric Lavigne, Antonella Zanobetti, Joel Schwartz, Aurelio Tobias et al. "Mortality risk attributable to high and low ambient temperature: a multicountry observational study." The Lancet 386, no. 9991 (2015): 369-375.
3. Kunkel, Kenneth E., Thomas R. Karl, Harold Brooks, James Kossin, Jay H. Lawrimore, Derek Arndt, Lance Bosart et al. "Monitoring and understanding trends in extreme storms: State of knowledge." Bulletin of the American Meteorological Society 94, no. 4 (2013): 499-514.
4. Weather Forecast Office, Winter Weather Awareness - Impacts On Society, . Available from: https://www.weather.gov/mkx/wwa-impacts

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.

V. PUBLIC INTEREST

1. Briefly explain why completing your Project is in the public interest. Use quantitative indicators of public health importance where possible, for example, numbers of deaths or incident cases; age-adjusted, age-specific, or crude rates; or years of potential life lost. *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.*

Extreme weather events especially cold events like blizzards and snowstorms have become public health concerns [1]. The United States experienced several major winter storms in recent years and more frequent heavy snows are expected [2, 3]. Numerous epidemiological studies have demonstrated snowstorms and blizzards cause many injuries and deaths and as studies show emergency admissions increase during cold-related weather events [4,5,6,7]. National Weather services reports during the period from 1988 thru 1995, winter storms caused 9% of all weather-related deaths and 20% of injuries[8]. On the other hand, as National Weather services reports snowstorms and blizzards can disrupt emergency and medical services [9]. This means many patients who need care and are scheduled for may face substantial delays when hospitals limit admissions in anticipation of a storm or have difficulties in getting to hospitals due to weather conditions. This can translate into delays for care that negatively affect the health status of patients. At the same time, some patients may remain in hospitals longer than required by their clinical condition (due to having difficulties in getting to their homes on heavy-snow days) increasing their exposure to hospital-based infections and medical errors.
Therefore, we will analyze the effect of snowstorms as our first case and its intensity (accumulated snow on the ground in this case) to investigate and identify the impact of snowstorms on different group of patients, hospitals, and different healthcare services. Result of this study can lead to plan proactively for healthcare services based on weather forecasts and reduce the adverse predicted impact of the weather event.

1. Gasparrini, Antonio, Yuming Guo, Masahiro Hashizume, Eric Lavigne, Antonella Zanobetti, Joel Schwartz, Aurelio Tobias et al. "Mortality risk attributable to high and low ambient temperature: a multicountry observational study." The Lancet 386, no. 9991 (2015): 369-375.
2. Hartmann, Dennis L., Albert MG Klein Tank, Matilde Rusticucci, Lisa V. Alexander, Stefan Brönnimann, Yassine Abdul Rahman Charabi, Frank J. Dentener et al. "Observations: atmosphere and surface." In Climate change 2013 the physical science basis: Working group I contribution to the fifth assessment report of the intergovernmental panel on climate change, pp. 159-254. Cambridge University Press, 2013.
3. Kunkel, Kenneth E., Thomas R. Karl, Harold Brooks, James Kossin, Jay H. Lawrimore, Derek Arndt, Lance Bosart et al. "Monitoring and understanding trends in extreme storms: State of knowledge." Bulletin of the American Meteorological Society 94, no. 4 (2013): 499-514.
4. Gooodwin, James. "A deadly harvest: the effects of cold weather on older people in the UK." British journal of community nursing 12, no. 1 (2007): 23-26.
5. Keatinge, W. R. "Winter mortality and its causes." (2002): 292-299.
6. Glass, RogerI, and MatthewM Zack JR. "Increase in deaths from ischaemic heart-disease after blizzards." The Lancet 313, no. 8114 (1979): 485-487.
7. Gorjanc, Michael L., W. Dana Flanders, James VanDerslice, Joel Hersh, and Josephine Malilay. "Effects of temperature and snowfall on mortality in Pennsylvania." American Journal of Epidemiology 149, no. 12 (1999): 1152-1160.
8. Kocin, P. J. "Some thoughts on the societal and economic impacts of winter storms." In Workshop of the Social and Economic Impacts of Weather, pp. 55-60. National Center for Atmospheric Research, 1997.
9. Weather Forecast Office, Winter Weather Awareness - Impacts On Society, . Available from: https://www.weather.gov/mkx/wwa-impacts

VI. DATASETS REQUESTED

The Massachusetts Case Mix and Charge Data are comprised of Hospital Inpatient Discharge, Emergency Department and Outpatient Hospital Observation Stay Data collected from Massachusetts' acute care hospitals, and satellite emergency facilities. Case Mix and Charge Data are updated each fiscal year (October 1 – September 30) and made available to approved data users. For more information about Case Mix and Charge Data, including a full list of available elements in the datasets please refer to release layouts, data dictionaries and similar documentation included on CHIA's website.

Data requests are typically fulfilled on a one time basis, however; certain Projects may require years of data not yet available. Applicants who anticipate a need for future years of data may request to be considered for a subscription. Approved subscriptions will receive, upon request, the same data files and data elements included in the initial release annually or as available. Please note that approved subscription request will be subject to the Data Use Agreement, will require payment of fees for additional Data, and subject to the limitation that the Data can be used only in support of the approved Project.

1. Please indicate below whether this is a one-time request, or if the described Project will require a subscription.

☒ One-Time Request **OR** ☐ Subscription

2. Specify below the dataset(s) and year(s) of data requested for this Project, and your justification for requesting *each* dataset. Data prior to 2004 is not available.

☒ Hospital Inpatient Discharge Data

☐2004 ☐2005 ☐2006 ☐2007 ☐2008 ☐2009 ☐2010 ☐2011 ☐2012 ☒2013 ☒2014 ☒2015 ☐ 2016 ☐ 2017

Describe how your research objectives require Inpatient Discharge data:

One of the main goals of our research is analyzing the effects of weather emergencies on different types of patients. We are interested in the impacts of snowstorms on admissions, discharges, length of stay of inpatients, and the operations like surgeries on different group of inpatients. Therefore this data is essential for us.

☒ Outpatient Hospital Observation Stay Data

☐2004 ☐2005 ☐2006 ☐2007 ☐2008 ☐2009 ☐2010 ☐2011 ☐2012 ☒2013 ☒2014 ☒2015 ☐ 2016 ☐ 2017

Describe how your research objectives require Outpatient Hospital Observation Stay data:

Another aim of the research is analyzing outpatients admission, no-show and discharge rates due to weather emergencies and compare the results with the result of the same measures for inpatients.

☒ Emergency Department Data

☐2004 ☐2005 ☐2006 ☐2007 ☐2008 ☐2009 ☐2010 ☐2011 ☐2012 ☒2013 ☒2014 ☒2015 ☐ 2016 ☐ 2017

Describe how your research objectives require Emergency Department data:

Another aim of the research is analyzing the effects of weather emergencies on emergency room visits due to injuries, accidents, heart strokes and other possible epidemiological concerns. This cannot be obtained unless we have access to emergency department data.

VII. DATA ENHANCEMENTS 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 the data enhancements listed below for inclusion in their analyses. Requests for enhancements 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 enhancements), please refer to release layouts, data dictionaries and similar documentation included on CHIA's website.

1. Specify below which enhancements 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 Subdivisions

State, five-digit zip code, and 3-digit code are available for patients residing in CT, MA, ME, NH, RI, VT, and NY. City or Town of residence is available for residents of MA only. States outside of this region will be coded as XX ("Other").

Select *one* of the following options:

☐ 3-Digit Zip Code (Standard)	☐ 3-Digit Zip Code & City/Town ***	☐ 5-Digit Zip Code ***	☒ 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:**

In our study, we will investigate and test the effect of weather events and the severity of them on the hospitals' operations like admission and discharge numbers. Therefore, the weather condition like the amount of snow in the place of the service provider is the key element. Without zip codes, we can not connect the admissions or discharges or other operational metrics in any service provider to the weather data and realize the impact of severity of weather event (the amount of snow in the snowstorm case) on the hospital operations. Also, we will investigate the association between the intensity of storms and weather events in the path between patients and service provider. To reach this aim, we need information regarding patients and service providers location.

Demographic Data

Selcect *one* of the following options:

☐ Not Requested (Standard)	☒ Race & Ethnicity***

**** If requested, provide justification for requesting Race and Ethnicity. Refer to specifics in your methodology:**

Understanding the impact of weather emergencies on different patients groups in terms of age, sex, race and ethnicity will help us to prepare and plan for future events. As an example if a snowstorm affects on a specific group of patients more than others, healthcare planner can focus more on that specific group and reduce the adverse impact of a weather

event on that group dramatically and this will help the total system and society.

Date Resolution

Select *one* of the following options for dates of admissions, discharges, and significant procedures.

☐ Year (YYYY)(Standard)	☐ Month (YYYYMM) ***	☒ Day (YYYYMMDD)***

*****If requested, provide justification for requesting Month or Day. Refer to specifics in your methodology:**

We require the day dates because weather events have daily impacts and their effect may reduce after a couple of days. We need to find the difference between snowy days and normal days in the same period and having only months as dates can not provide this information for us.

Practioner Identifiers (UPN)

Select *one* of the following options.

☒ Not Requested (Standard)	☐ Hashed ID ***	☐ 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)

Select *one* of the following options.

☒ Not Requested (Standard)	☐ UHIN Requested ***

***** If requested, provide justification for requesting UHIN. Refer to specifics in your methodology:**

Hashed Mother's Social Security Number

Select *one* of the following options:

☒ Not Requested (Standard)	☐ Hashed Mother's SSN Requested ***

***** If requested, provide justification for requesting Hashed Mother's SSN. Refer to specifics in your methodology:**

VIII. 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.

For analyzing the impact of weather events on hospitals' daily operations, we will link Case Mix data set with historical weather data collected from the National Weather and Atmospheric Administrator (NOAA). Without this linkage we cannot understand the weather condition during admission, discharge or any other procedure on patients. The weather condition includes: Snow fall, snow depth, Maximum temperature, Minimum temperature, average temperature, and wind speed

The CHIA Data elements for linkage: Admission date, Discharge date
The NOAA Data elements for linkage: date and the station location (Name (city), Longitude, Lattitude)

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.

The linkage will be a deterministic one:
After filtering data based on the different features, we will add weather condition features like snow level or percipition during the admission date and discharge date for group of patients who are admitted or discharged in the location of service provider.
The linkage is based on the geographical area (service provider zip code and/or member zip code) and date (admission date and discharge date). This means we will merge NOAA data which includes Snow fall, snow depth, Maximum temperature, Minimum temperature, average temperature, and wind speed with the filtered, aggregated case mix data

based on the similarity of on the geographical area and date. The variables we will use for the linkage will be date and the station location in NOAA side and service provider zip code or member zip code and admission date and discharge date of patients in the case-mix data side.

5. If yes, attach complete listing of the variables from all sources to be included in the final linked analytic file.

NOAA data: Station name, Date,Name (city), Longitude, Lattitude, Precipitation, Snow fall, snow depth, Maximum temperature, Minimum temperature, average temperature, wind speed

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

The datasets that will be link to the Case Mix data do not increase the likelihood of the identification of individual patients. The data that we are linking is weather data and do not include any information about service providers, member and indivduals. Hence no additional steps will be needed to prevent the identification of individual patients. Also, we do not plan to report any results by zip codes. For reporting purpose, the unit of geographical area will be the city.

IX. PUBLICATION / DISSEMINAITON / RE-RELEASE

1. Do you anticipate that the results of your analysis will be published or made publically available? If so, how do you intend to disseminate the results of the study (e.g.; publication in professional journal, poster presentation, newsletter, web page, seminar, conference, statistical tabulation)? 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.

The aim of this study is to help and provide information for healthcare planners. To reach this goal, we will publish the results of the project in the peer-reviewed academic journals. Also, unpublished results may be shared in seminars or conferences.

Our reported outcomes will not contain cell sizes of less than 11 observations. We will be characterizing patients based on broad classes of diagnoses, such as cardiological patients, orthopaedic, and etc. Demographic data will similarly be characterized in broad categories to support statistical analyses as well. We are interested in the behaviour of the healthcare system in the presence of snowstorms in a large geographical area with a large population. Therefore the lowest geographical level of analysis of data will be the city level. We do not intend to present any map in our outcomes.

2. Describe your plans to use or otherwise disclose CHIA Data, or any data derived or extracted from such data, in any paper, report, website, statistical tabulation, seminar, or other setting that is not disseminated to the public.

The results will be presented in a PhD-level dissertation, academic journal publications and scientific conferences. This research will be part of Mahsa Ghanbarpourmamaghani's PhD dissertation. Only aggregate level information and results from bivariate and multivariate analyses will be presented.

Also, as discussed in the previous part, we will report, aggregated data; then, no disclose outcome will use cell sizes of less than 11 observations.

3. What will be the lowest geographical level of analysis of data you expect to present for publication or presentation (e.g., state level, city/town level, zip code level, etc.)? Will maps be presented? If so, what methods will be used to ensure that individuals cannot be identified?

We are interested in the behaviour of the healthcare system in the presence of snowstorms in a large geographical area with a large population. Therefore the lowest geographical level of analysis of data will be the city level. We do not intend to present any map in our outcomes.

4. Will you be using CHIA Data for consulting purposes?

☐ Yes
☒ No

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

☐ Yes
☒ No

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

☐ Yes
☒ No

7. Will you be using CHIA Data as in input to develop a product (i.e., severity index took, risk adjustment tool, reference tool, etc.)

☐ Yes
☒ No

8. Will you be reselling CHIA Data in any format not noted above?

☐ Yes
☒ No

If yes, in what format will you be reselling CHIA Data?

9. If you have answered "yes" to questions 5, 6, 7 or 8, provide the name and a description of the products, software, services, or tools.

10. If you have answered "yes" to questions 5, 6, 7 or 8, what is the fee you will charge for such products, software, services or tools?

XI. INVESTIGATOR 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.

Dr. Ergun has worked with data sets relevant to public health and health systems for more than a decade in order to identify system level and operational efficiencies and improve service delivery in a variety of health and humanitarian relief contexts. Data sets Dr. Ergun works with include logistics, beneficiary demand, and human resources related data from United Nations World Food Program and High Commissioner for Refugees, and USAID, and domestic health systems order data for antibiotics and oncology drugs available from IQVIA.

Dr. Alam's research in healthcare analytics focuses to investigate how advanced data analytics can be used to investigate patterns and determinants of unplanned readmission, and evaluate healthcare policies to recommend intervention for improving healthcare service and patient outcome. In one project, his team used a nationally representative sample (HCUP Nationwide Readmission Database) of adult readmissions and found that the unplanned 30-day readmission rates are nearly two times greater for patients with serious mental illness (SMI). He also used state of California hospital discharge database to investigate the patterns and predictors of 30-day unplanned non-index readmission rate followed by the adoption of HRRP. He is also using data mining and statistical methods to analyze patients' adherence to Suboxone treatment and investigate the patient level and prescriber level factors that affect treatment non-adherence (for a CDC funded project in partnership with MDPH) by using MA APCD data.

Mahsa Ghanbarpour is a PhD candidate in the Departement of Mechanical and Industrial Engineering at Northeastern University. Previously she worked on varous healthcare projects. Her master thesis was about operating room scheduling and during that project she worked on hospital data in Iran. Also she worked as a data science intern at Liberty Mutual Insurance and used confidential data to classify opportunities. She applied her statistical knowledge on insurance data to cluster missing opportunities and find the most valuable cluster with the highest probability of binding.

Md Mahmudul Hasan is a PhD candidate at Mechanical and Industrial Engineering Department in Northeastern University. His research in healthcare analytics intends to leverage machine learning, predictive modeling and statistical

analysis, and operations research to solve assorted problems in the US health service (unplanned and preventable hospital readmission, treatment non-adherence etc.) and public health (opioid crisis) in order to improve the quality of healthcare service, patient satisfaction and community resilience against opioid overdose epidemic. In one project funded by CDC in partnership with MDPH, Md Mahmudul has analyzed the MA APCD to investigate buprenorphine/ naloxone treatment adherence for patients with opioid use disorder. Furthermore, using predictive analytics, he has examined patient and provider-level factors in an effort to determine their association with premature treatment discontinuation. In addition to that, he has also used state of California hospital discharge data to investigate the patterns and determinants of 30-day unplanned non-index readmissions among Medicare and non-Medicare population.

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

By signing this Application, the Agency assumes all responsibility for the use, security and maintenance of the CHIA Data by its agents, including but not limited to contractors. The Agency must have a written agreement with the agent of contractor limiting the use of CHIA Data to the use approved under this Application as well as the privacy and security standards set forth in the Data Use Agreement. CHIA Data may not be shared with any third party without prior written consent from CHIA, or an amendment to this Application. CHIA may audit any entity with access to CHIA Data.

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.

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, 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.

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, a separate Data Management Plan **must** be completed by the agent or contractor.

[INSERT A NEW SECTION FOR ADDITIONAL AGENTS/CONTRACTORS AS NEEDED]

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 any third party to which it grants access.

Applicants approved to receive CHIA Data will be provided with Data following the payment of applicable fees and upon the execution of a Data Use Agreement requiring the Organization to adhere to processes and procedures designed to prevent unauthorized access, disclosure or use of data.

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 :	Eva Pasadas
Title:	*Director, Grants and Contracts*

Attachments

A completed Application must have the following documents attached to the Application or uploaded separately to IRBNet:

☒ 1. IRB approval letter and protocol (if applicable), or research methodology (if protocol is not attached)
☒ 2. 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)
☒ 3. CVs of Investigators (upload to IRBnet)

APPLICATIONS WILL NOT BE REVIEWED UNTIL THEY ARE COMPLETE, INCLUDING ALL ATTACHMENTS.

[INSERT IRB approval letter and protocol, or research methodology]

Research Methodology:

Weather-related emergencies like hurricane, snowstorms, and blizzards are among significant public health problems in many parts of the world [1]. Hurricanes and significant snowstorms cause hazards for human health and disrupt many systems such as transportation, public services, and healthcare. As an example, when the superstorm Sandy hit New York City in 2012, it caused major disruptions in the health care infrastructure, forcing many hospitals to evacuate their patients. Before, during, and after Sandy, hospitals made different decisions at different times to manage the effects of the storm, including canceling elective admissions, suspending elective surgeries, and engaging in rapid patient discharges. These experiences led Uppal et al. [2] to conclude that a system should be developed to predict the impact of extreme weather events and assess the risk and benefits of preemptive evacuation.

With global climate change, the likelihood of having heavy snowstorms is increasing [3,4]. There are many studies that associated snowstorms and cold weather with an increase in the rate of mortality [1, 5, 6, 7, 8, 9]. Berko et al. [10], in their study estimated during 2006-2010, over 60% of weather-related deaths are attributable to cold weather. On the other hand, as National Weather Services reports snowstorms and blizzards can disrupt emergency and medical services [11]. This means many patients who need care and are scheduled for receiving services may face substantial delays when hospitals limit admissions in anticipation of a storm or have difficulties in getting to hospitals due to weather conditions. This can translate into delays for care that negatively affect the health status of patients. At the same time, some patients may remain in hospitals longer than required for their clinical condition (due to having difficulties in getting to their homes on heavy-snow days), which increases their exposure to hospital-based infections and medical errors. However, while many studies investigate the association between cold weather and mortality, there is a lack of study regarding the impact of winter storms on health care services such as hospital admissions or discharges. Thus, as the first case study in our research, we will focus on snowstorms. Also, the other types of weather emergencies like hurricanes, heavy precipitations, and extreme cold or hot temperatures will be considered in future studies.

Snowstorms negatively impact the income of hospitals and other healthcare providers due to higher patient no show rate, hospital staff absences, cancelation of elective surgeries, and daycare closures. As a result, capacity for general admissions reduces, and this leads hospitals to under-utilize critical units such as operating rooms. Under-utilization means losing opportunities and possible profit for hospitals and healthcare. A Massachusetts Emergency Management Agency report stated that Brigham and Women's Hospital in Boston during 2015 winter lost $10M due to the cancelation of elective surgeries as well as reducing general admissions, outpatient services, and visitors [12]. Furthermore, some other units of hospitals, such as emergency rooms, may face increased utilization.

To reduce the adverse impact of weather emergencies, we need to anticipate these impacts and prevent or be prepared for them. Since snowstorms are slow onset events and can be predicted, if we are prepared and planned for them, we can reduce their impact on society, healthcare systems, and patients. Our aim in this research is to study healthcare data to identify the adverse effects of severe weather events on hospital operations. For understanding the impact of weather emergencies and their intensity (amount of snowfall in the snowstorm case) on hospital-related patterns of patient care, we will cross-map hospital case-mix data with historical weather data from the National Weather and Atmospheric Administrator (NOAA).

In this study, we will quantify, test, and predict the adverse effects on medical delivery and hospital operations before, during, and immediately after a major weather event. Also, we will investigate the possible association between the intensity of a weather event (accumulated snow on the ground will be considered as the intensity of snowstorms) with healthcare delivery. To achieve these research goals, we apply different methodologies. We will aggregate data based on date, patients' demographical features, and their principal diagnosis. Then a set of hypotheses tests will be designed and applied on aggregated

data to investigate the difference between admission numbers of inpatients and outpatient immediately before, during, and immediately after a weather event compared to regular days in the same season. Similar hypotheses tests will be designed for other types of hospital operations and metrics such as discharge numbers. We will compare the impact of different levels of snow on different patient groups and identify most affected patient groups. Also, we are interested in comparing the impact on admission numbers with discharge numbers during similar weather conditions to analyze if the weather event might cause clogging of the system.

Furthermore, we will investigate the difference between the length of stay for patient groups who are discharged before, during or after weather events with the length of stay of the same patient groups who are discharged during regular days in the same season. One other important scenario that we will examine is analyzing the existence of possible variations on emergency visits during or after any weather events. We will assess the possible increase in injuries and accidents during weather events and their effect on the capacity of various hospital units.

Furthermore, we will investigate possible factors that determine the alteration in hospital operations during weather events. These factors include patient's demographical characteristic, his/her health conditions, his/her residency area size, and its distance with admitted hospital or clinic. The weather condition in the living area, the hospital, and the distance between them can determine the possibility of no-show or delay.

Predicting the number of patients, the number of admissions, discharges, and possible reduction or growth in the admission or discharge rates will lead us to predict the hospital capacities during, before and after a weather emergency such as a snowstorm. Having weather forecasts and predicted admission and discharge numbers for different weather conditions will help healthcare decision-makers to act before the event and adjust hospital operations accordingly before a storm hits. Therefore, statistical and machine learning models will be applied to the aggregated data to predict admission numbers and discharge numbers of different patient categories during, before, and after events. The proper machine learning model(s) will be selected after analyzing the distribution and features of data. The selected model(s) will be trained and tuned on the part of the data (train set) and tested on the rest (test set) for validation and performance evaluation. The selected model will be used for predicting and planning for future events.

Also, the possible growth or reduction rate on the admission numbers and discharge numbers will be predicted and compared together for periods before, during, and after a storm. The comparison between these two measures can lead us to realize the main cause of healthcare service disruptions. Exploring this cause can lead decision-makers in healthcare to understand the system and develop a framework to eliminate the main cause and reduce its adverse impacts. The method that we use for comparing admission and discharge rates is comparing the value of variations from the monthly average for the same group of patients on the same day in the presence of extreme weather events.

In summary, this study focuses on the assessment of the relationship between weather emergencies and healthcare delivery. Access to Case-Mix data will provide a unique opportunity to examine the number of admissions, discharges, emergency room visits, and patient length of stays before, during and immediately after a major weather event. The outcome of this study will help in developing a framework to plan proactively for hospitals and healthcare services based on the forecasted intensity of impending weather events.

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