NCST Technical Investigation of Hurricane María (Puerto Rico)

Characterization of Morbidity and Mortality

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Background

• Death certificates often misclassify deaths caused by disasters because of a lack of attribution standards and consistent data collection/reporting.*

• Previous studies(^,^^,†,††) attempted to characterize the extent of mortality in Puerto Rico after Hurricane María using available data and/or collecting primary data.

• The GW study†† concluded that the lack of appropriate death certification practice after the hurricane and the local lack of communication about death certificate reporting prior to the storm limited the count of deaths that were reported as related to Hurricane María.

• The NIST mortality project will not produce another death count. Instead, NIST will use rigorous, scientific methods to understand the distribution of causes of death and the injury mechanisms of those that perished due to the storm, within the greater context of the hazards and the building and infrastructure system failures experienced by those individuals.


Updates on Mortality Contract

Contract Modified: Contract awarded to the George Washington University Milken Institute School of Public Health on July 27, 2020 was modified on May 23, 2022 to explore new methods in finding next-of-kin and key informants for VA’SÉ surveys.

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Geographic Mapping Technologies, Corp., San Juan, PR:
GIS and Remote Sensing
Project Plans (1/4): Verbal Autopsy (VA) + Social Environmental (S’E) Survey

Foundation for survey with next-of-kin and key informants

- VA+S’E survey marks the beginning of the development of a disaster-centric verbal autopsy, when including the social vulnerability and environmental conditions before, during, and after the event.
- The VA+S’E survey builds on the Institute for Health Metrics and Evaluation (IHME) VA questionnaire
- SmartVA-Analyze is an analysis program used to determine the cause of death and is an open application developed by IHME, University of Washington
- SmartVA-Analyze uses the Tariff method to provide most likely underlying cause of death, and the next two or three most likely ones.
- Suggested mode was originally face-to-face; survey mode was adapted to phone due to COVID-19.

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Project Plans (2/4): Medical Records and Hospital Functions Review

Hospital Medical Records Abstraction

• Retrieve additional data (e.g., medical records, hospital functions data) of the selected hospital deaths to augment key elements required to inform causal path of death and for final determination of the death disease category
• Integrate secondary data to expand the explanatory variables used in analysis
• Confirmation of individual information to help support VA+S'E survey effort

Hospital Management and Clinical Staff Interviews

• Develop structured interview to identify potential operational changes due to storm
• Selection of expert panel with local and national experts

MEDICAL RECORD ABSTRACTION

<table>
<thead>
<tr>
<th>Q1</th>
<th>Sociodemographic data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q3</td>
<td>Pre-triage (reason for ambulance call, patient status, medications, vitals, prognosis, etc.)</td>
</tr>
<tr>
<td>Q4</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q5</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q6</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q7</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q8</td>
<td>Accident Information, ER Notes, Ward Admission Notes, Daily Progress, ICU Notes, Transfer, Death Certificate</td>
</tr>
<tr>
<td>Q9</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q10</td>
<td>□ ______</td>
</tr>
<tr>
<td>Q11</td>
<td>□ ______</td>
</tr>
</tbody>
</table>
Develop Integrated Database of Deaths in Puerto Rico

- Collect and merge geocoded data on the deaths occurring in the first 15 days and up to six months after Hurricane María made landfall in Puerto Rico.
- Data sources include the Puerto Rico Vital Registration System with available datasets from the Bureau of Forensic Sciences, including DMORT E-Cases records, pathology registry records, case identification, case review, and cremation and institutional death databases.
- Additional data from other projects in the investigation, NWIRP study, and other products from the project.

Integrated Database

- Puerto Rico Demographic Registry
  - e.g., death certificates
- Puerto Rico Institute of Forensic Sciences
  - e.g., DMORT records, pathology records, etc.
- NCST + NWIRP
  - e.g., wind speeds, damage assessments, etc.
- Puerto Rico Bureau of Police
  - e.g., 911 emergency call records
- FEMA and/or American Red Cross
  - e.g., funeral and burial assistance
- VA'SE + Hospital
  - e.g., SmartVA output, medical records, etc.
Project Plans (4/4): Spatial & Temporal Analysis

Spatial and Temporal Clustering of Deaths

• Analyze the integrated database to calculate cause-specific mortality rates adjusted for age and gender and compare these to the prior seven years to obtain cause-specific excess mortality.

• Examine groups of causes of death (based on ICD-10 codes) and the causes usually attributed to hurricanes (e.g., drowning, death from a fallen object, etc.) and compare them to the 7 previous years.

• Identify significant increases in death rates from specific causes in the aftermath of the storm; flag all deaths from those causes in the first two weeks after the storm.

• Identify spatial and temporal clusters of deaths occurring up to six months after the storm (entire island), with a separate analysis for the first 14 days after the event.

Puerto Rico Hurricane Maria Mortality Study Population, by time-period, sex, age, and socioeconomic development index (SEI*).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Period</th>
<th>Landfall + 14 days¹</th>
<th>6 Months²</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Total sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>812</td>
<td>46%</td>
<td>7,597</td>
</tr>
<tr>
<td>Male</td>
<td>960</td>
<td>54%</td>
<td>9,060</td>
</tr>
<tr>
<td>age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young</td>
<td>74</td>
<td>4%</td>
<td>846</td>
</tr>
<tr>
<td>Mid</td>
<td>320</td>
<td>18%</td>
<td>2,988</td>
</tr>
<tr>
<td>Old</td>
<td>1,378</td>
<td>78%</td>
<td>12,823</td>
</tr>
<tr>
<td>SEI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>304</td>
<td>17%</td>
<td>2,988</td>
</tr>
<tr>
<td>Middle</td>
<td>537</td>
<td>30%</td>
<td>4,950</td>
</tr>
<tr>
<td>High</td>
<td>931</td>
<td>53%</td>
<td>8,719</td>
</tr>
</tbody>
</table>

*Junta de Planificación. Índice de desarrollo socioeconómico municipal. 2017.
Recent Progress: Verbal Autopsy and Socio-Environmental Survey

- VA+S’E instrument developed with the objectives to: (1) ascertain the cause of deaths within two weeks of the storm making landfall in Puerto Rico, and (2) identify socio-environmental contextual factors that could be related to the occurrence of those deaths.
- Pilot study conducted April - June 2021; instrument was revised and submitted for IRB and PRA approvals July - August 2021; final VA’SE instrument approved by OMB on September 3, 2021.
- Diverse outreach methods (e.g., > 950 letters mailed via USPS, study website, social media, etc.) were implemented to reach next-of-kin and key informants.
- UPR team completed 368 interviews as of May 31, 2022. Of the individuals contacted, 62% agreed to participate. More than 1500 informants remain unreachable.

**PHASE I: Pilot**
Apr – Ju 2021
- Train interviewers
- Conduct pilot study
- Report on prelim findings

**PHASE II: Study Prep**
Jul – Sep 2021
- IRB/OMB approvals
- Identify strategies to improve response rates
- Outreach to informants

**PHASE III: Full Study**
Oct 2021 – Mar 2022
- Initiate full study
- Call informants
- Evaluate data quality
- Assess biases

**PHASE IV: Next Steps**
Mar 2022 – present
- Identify strategies to locate additional informants
- Analyze data
- Draft final report
Recent Progress: Verbal Autopsy and Socio-Environmental Survey

- Non-response analysis completed to assess any biases introduced based on respondents.
- The team has been conducting quality control checks to make sure all informants had followed the 3-call protocol, including one call on the weekend.
- A modification was awarded on May 23, 2022 to GW-UPR to use a people finder service to contact more next of kin and key informants.

### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Interviewed</th>
<th>Non-Interviewed</th>
<th>P-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>171 (47.8%)</td>
<td>652 (45.1%)</td>
<td>0.36</td>
</tr>
<tr>
<td>Male</td>
<td>187 (52.2%)</td>
<td>794 (54.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-39 years</td>
<td>13 (3.6%)</td>
<td>63 (4.4%)</td>
<td></td>
</tr>
<tr>
<td>40-64 years</td>
<td>54 (15.1%)</td>
<td>274 (18.9%)</td>
<td></td>
</tr>
<tr>
<td>65+ years</td>
<td>291 (81.3%)</td>
<td>1105 (76.4%)</td>
<td></td>
</tr>
<tr>
<td>Not Available</td>
<td>0 (0.0%)</td>
<td>4 (0.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>41 (11.4%)</td>
<td>121 (8.4%)</td>
<td></td>
</tr>
<tr>
<td>Associate degree</td>
<td>33 (9.2%)</td>
<td>84 (5.8%)</td>
<td></td>
</tr>
<tr>
<td>High school diploma or GED</td>
<td>95 (26.5%)</td>
<td>328 (22.7%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Graduate school</td>
<td>15 (4.2%)</td>
<td>41 (2.8%)</td>
<td></td>
</tr>
<tr>
<td>No high school diploma</td>
<td>167 (46.7%)</td>
<td>783 (54.1%)</td>
<td></td>
</tr>
<tr>
<td>Not Available</td>
<td>7 (1.9%)</td>
<td>89 (6.2%)</td>
<td></td>
</tr>
<tr>
<td><strong>Marital status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>127 (35.5%)</td>
<td>444 (30.7%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Never married</td>
<td>50 (13.9%)</td>
<td>287 (19.8%)</td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>69 (19.3%)</td>
<td>217 (15.0%)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>108 (30.2%)</td>
<td>440 (30.4%)</td>
<td></td>
</tr>
<tr>
<td>Not Available</td>
<td>4 (1.2%)</td>
<td>58 (4.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Residence zone</strong></td>
<td></td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>Rural</td>
<td>164 (45.8%)</td>
<td>610 (42.2%)</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>182 (50.8%)</td>
<td>746 (51.6%)</td>
<td></td>
</tr>
<tr>
<td>Not Available</td>
<td>12 (3.4%)</td>
<td>90 (6.2%)</td>
<td></td>
</tr>
</tbody>
</table>

*Pearson Chi-Square
Recent Progress: Medical Records and Hospital Functions Review

• Implemented a non-random, stratified, and paired matched sampling method to select the sample of hospitals (6 hospitals total)
• Data will be extracted from the medical records of each of the deaths that occurred in the sample hospitals within 14 days of the impact of Hurricane María.
• Interviews with 5-6 members of the key administrative and medical-clinical staff who worked in the hospital at the time of Hurricane María's impact. The instrument will cover the following topics, among others:
  o Position (in the hospital) of the person being interviewed
  o Information on pre-existing problems in the hospital prior to Hurricane María
  o Hospital emergency plans and their implementation
  o Hospital operational status
  o Availability of utilities
  o Operation of the hospital's clinical units
  o Impact of these circumstances on hospital operations and patient care
Recent Progress: Medical Records and Hospital Functions Review

• Hospital survey instruments developed with input across HM Program projects, and submitted for OMB approval on May 19, 2022

• Hospital recruitment efforts underway, in collaboration with relevant HM Program projects

• Recruitment efforts include letters of support from the Puerto Rico Department of Health (PRDOH).

• For the medical records abstraction, an electronic form will be utilized to gather the following data:
  o Basic sociodemographic information
  o "Pre-triage" and "triage" information, such as the patient's status, vital signs, main complaints, etc.
  o Injuries information, if applicable
  o Emergency Room Admission Notes
  o Room Admission Notes
  o Daily progress notes for length of hospital stay
  o Patient transfers- last day; DNR order information
Recent Progress: Spatial and Temporal Analysis

• NIST HM and GWUPR’s GIS staff meet to discuss leveraging data across the HM Program’s projects, and support analyses and visualization of hurricane impacts; more than 10 layers of information for analysis.

• Cause-Specific Excess Mortality report submitted to NIST in April 2022 for review and feedback.
Next Steps

Verbal Autopsy and Socio-Environmental Survey:
• Continue survey data collection with additional methods to identify next of kin and key informants
• Employ finalized framework for attribution analysis, including risk factors associated with building failures

Medical Records and Hospital Functions Review:
• Collect medical records from deaths that occurred in the hospital sample
• Interview administrators and clinicians in sample hospitals
• Finalize clinical panel members
• Identify data required for attribution determination by clinical panel

Integrated Database:
• Continue to work with other projects to inform the cause-specific mortality assessment
• Finalize any required MOUs to retrieve secondary data, as needed

Spatial & Temporal Analysis:
• Continue to work with other projects to inform the cause-specific mortality assessment
• Continue adding new layers to dataset and work across projects on data analysis
• Complete analysis for spatial and temporal clustering of deaths
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Characterization of Morbidity and Mortality

Project Leader: Judith Mitrani-Reiser, PhD (NIST)
Project Team: Thomas D. Kirsch, MD, MPH (NCDPH), Emina Herovic, PhD (NIST), GW/UPR scientists

*A special thanks to Captain Rebecca Noe (CDC) for sharing her time and expertise so graciously with the Hurricane María NCST investigation, and specifically, with this project!

Questions?

Please ‘raise your hand’ using the Blue Jeans Participant window and unmute your audio and video