NCST Technical Investigation of Hurricane Maria (Puerto Rico)

Characterization of Morbidity and Mortality

Project Leader: Judith Mitrani-Reiser

Objective: To complete a quantitative morbidity and mortality assessment of Puerto Rico, to better understand how damaged buildings and supporting infrastructure played a role in the injuries and deaths associated with Hurricane Maria. The study results will provide guidance to improve codes, standards and inform future approaches to accurately attribute and predict life loss due to building failure(s) caused by windstorms.

Background (1/2)

Analysis of Daily Excess Deaths*

- New York Times (NYT) analysis compares the number of deaths for each day in 2017 with the average of the number of deaths for the same days in 2015 and 2016.
- NYT and other news organizations estimate that the actual death toll could be over 1,000, based on analysis of daily mortality data from Puerto Rico's Vital Statistics Record Office.
- Deadliest day was September 25, 2017.
- Possible reasons for additional deaths may be related to delayed medical treatment or poor conditions in homes and hospitals, and oxygen tanks that ran out.

Analysis of Monthly Excess Deaths**

- Researchers compare 2017 monthly death counts in Puerto Rico after Hurricane Maria to mean monthly death counts estimated from vital records from 2010 through 2016.
- Researchers estimate 1,139 (95% CI 1006-1272) excess deaths through December 2017, using death counts from Puerto Rico's Vital Statistics Record Office.
- Greatest monthly excess death occurred in October 2017.
- Estimate is likely 'conservative' because of mean death counts used the upper 95% CI and did not adjust for the population that left the island.

* Robles, F., Davis, K., Fink, S, Almukhtar, S., 2017. "Official Toll in Puerto Rico: 64. Actual Deaths May Be 1,052." *The New York Times*. December 9, 2017.
** Santos-Lozada AR, Howard JT. Use of Death Counts from Vital Statistics to Calculate Excess Deaths in Puerto Rico Following Hurricane Maria. JAMA; Aug. 2, 2018: doi:10.1001/jama.2018.10929.

Background (2/2)

Population-Based Survey of Deaths***

- Harvard Chan School of Public Health led a community-based study that includes a representative stratified population-based sample of 3,299 households (of an estimated 1,135,507 total households), using a remoteness index based on travel time to nearest city.
- Researchers estimate a median excess of 4,645 deaths (95% CI range – 793 to 8,498), and a 62% increase in mortality rate between September 20 and December 31 in 2017.
- One third of the deaths surveyed are related to delayed or interrupted health care.
- On average, persons in the survey were older and households were larger than ACS 2016 baseline.

Statistical Analysis of Death Certificates****

- George Washington University analyzed past mortality patterns using mortality registration and population census data from 2010 to 2017, predicting mortality if Hurricane Maria had not occurred, and a comparing actual deaths to predicted deaths.
- Researchers estimate a total excess mortality post-hurricane to be 2,975 (95% CI: 2,658-3,290).
- Study accounts for trends in population size and distribution over this period in terms of age, sex, seasonality, residence by municipal level of socioeconomic development, and emigration during the prior decade and dramatic population displacement after the hurricane.

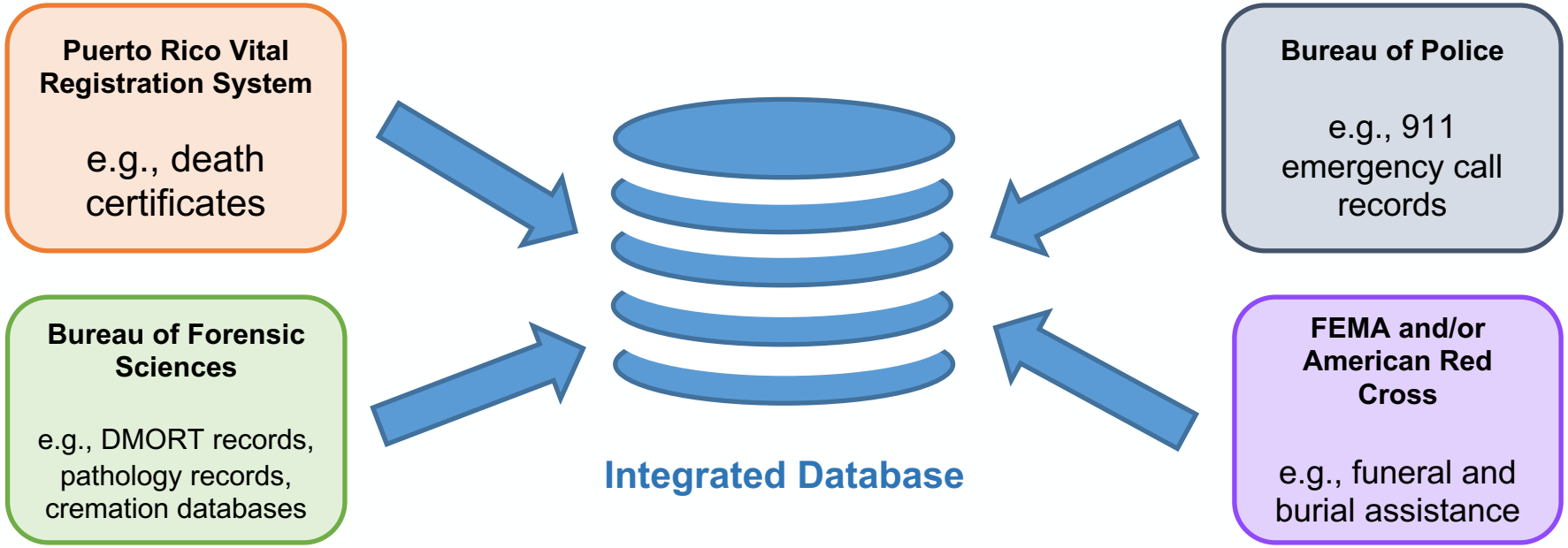
*** Kishore N, Marques D, et al. *Mortality in Puerto Rico after Hurricane Maria*. NEJM 2018; 379:162-170

**** George Washington University , in collaboration with the University of Puerto Rico Graduate School of Puerto Rico, 2018. “Ascertainment of the Estimated Excess Mortality from Hurricane Maria in Puerto Rico,” a Project Report for the Governor of Puerto Rico, August 28, 2018.

Project Plans (1/4)

Develop Integrated Database of Deaths in Puerto Rico

- Collect and merge geocoded data on the deaths occurring up to six months after Hurricane Maria 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 to consider are 911 emergency calls obtained from the Bureau of Police, and funeral and burial assistance data from FEMA and the American Red Cross.



Project Plans (2/4)

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 years.
- Examine each broad cause of death (i.e. ICD-10 codes) and specific causes of death typically attributed to hurricanes (e.g., drowning, death from a fallen object, etc.) and compare them to previous years.
- Identify significant increases in death rates from particular causes between the period after the storm and years prior; 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.

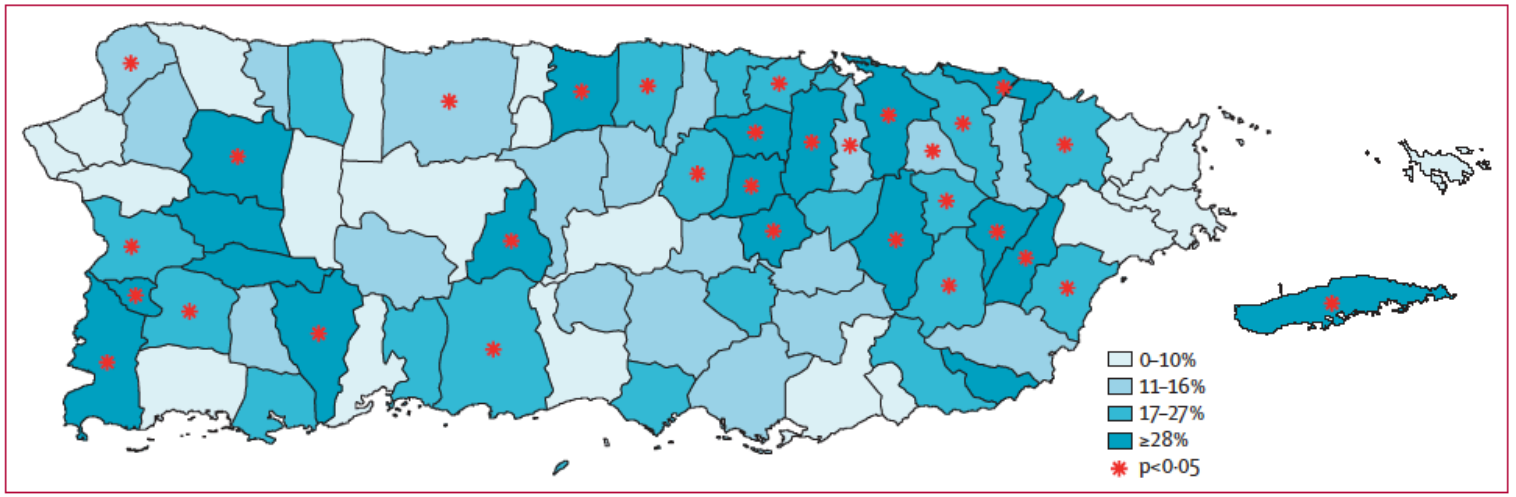


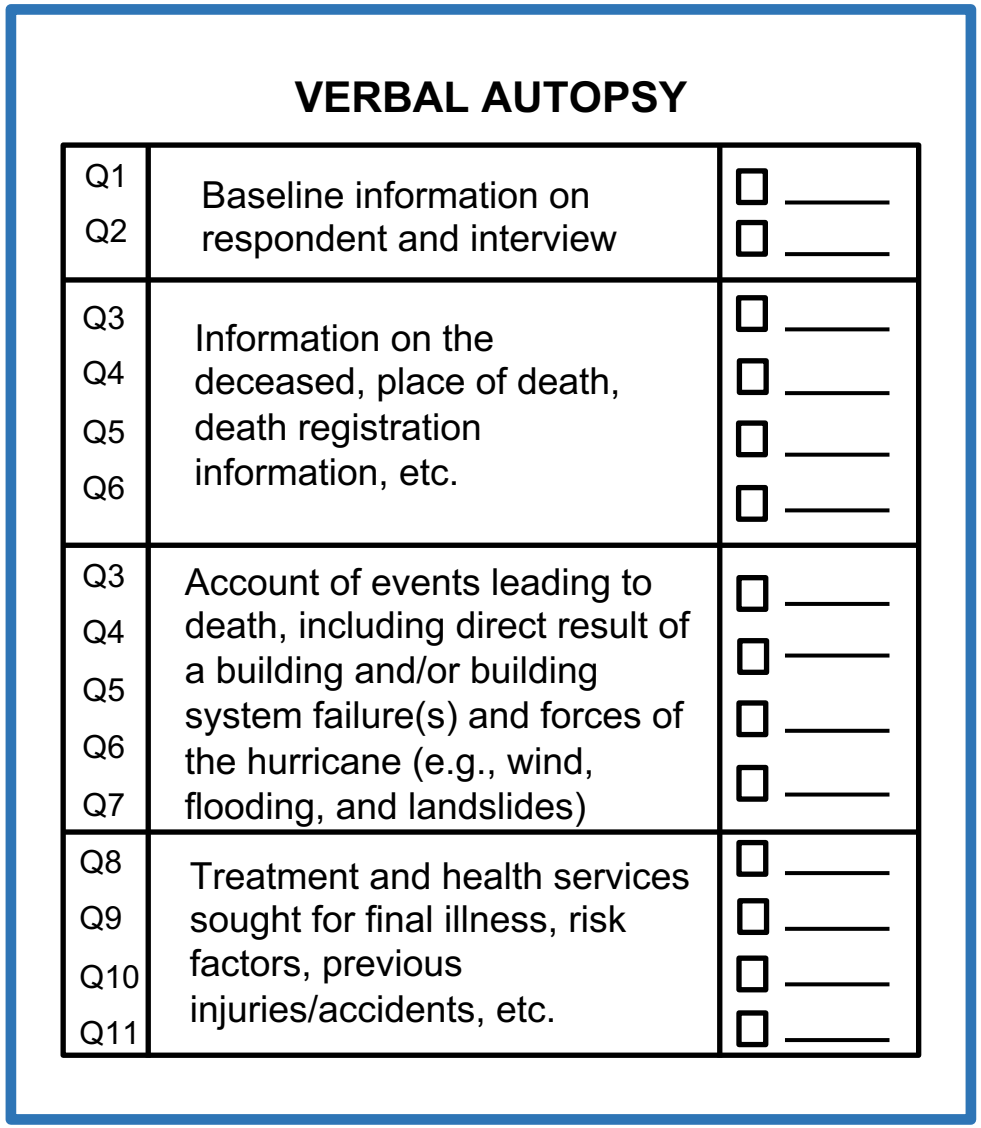
Figure 3: **Percentage increase in crude mortality by municipality in Puerto Rico**
Estimated increase in crude mortality from September, 2017, to February, 2018, relative to mean mortality in the same period in 2015–16 and 2016–17 under the displacement scenario.

Source: Santos-Burgoa et al., 2018 (with permission)

Project Plans (3/4)

Verbal Autopsies with Next of Kin and Key Informants

- Develop an inclusion and exclusion criteria for identifying deaths that occurred within 14 days of the storm's landfall, for in-depth study.
- Identify deaths from the integrated database that may have been caused by a building and/or building system failure(s).
- Complete verbal autopsies for this census of deaths with next of kin of decedents or key informants capable of identifying direct and indirect deaths associated with the disaster, and specifically those potentially related to building failures.
- Suggested mode is face-to-face, but currently considering other options.



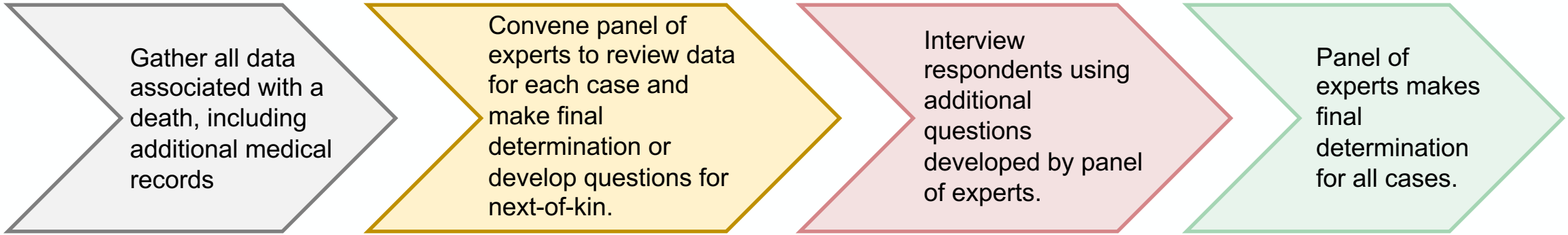
VERBAL AUTOPSY

Q1 Q2	Baseline information on respondent and interview	☐ ____ ☐ ____
Q3 Q4 Q5 Q6	Information on the deceased, place of death, death registration information, etc.	☐ ____ ☐ ____ ☐ ____ ☐ ____
Q3 Q4 Q5 Q6 Q7	Account of events leading to death, including direct result of a building and/or building system failure(s) and forces of the hurricane (e.g., wind, flooding, and landslides)	☐ ____ ☐ ____ ☐ ____ ☐ ____
Q8 Q9 Q10 Q11	Treatment and health services sought for final illness, risk factors, previous injuries/accidents, etc.	☐ ____ ☐ ____ ☐ ____ ☐ ____

Project Plans (4/4)

Clinical Panel (option that may be exercised during the award period)

- Retrieve additional data (e.g., medical records) of indeterminate cases and/or interview next of kin or key informants with specific questions generated by the panel. This data shall be reviewed by the panel again for final determination.
- Convene a panel of experts to review cases of deaths identified as potentially due to building failures. The expert panel shall include medical personnel from Puerto Rico, and other types of experts as identified by the Contractor in collaboration with NIST.



Recent Progress

- NCDMPH's Disasters and Health Workshop held in April 2019.
- Testified at the National Academies of Medicine's Study on Morbidity Attribution after a Major Disaster.
- Met with HHS to collect GIS Map Book with information on schools and hospitals.
- Completed full and open competition procurement package in May 2019; solicitation posted Nov 2019 and closed in Dec 2019; evaluation panel assessments in Jan 2020; consensus completed in Feb 2020; meeting with offerors in March/April/May 2020; NIST near decision on award.

Photo: Mitrani-Reiser (2019)

Key Next Steps

Award Contract:

- Host kick-off meeting with contractors and NIST staff
- Develop project work plan and align contractor's products with overall HM NCST project management plan

Integrated Database:

- Identify available data readily accessible to contractors and NIST staff
- Identify data gaps and develop MOUs to retrieve secondary data, as needed
- Work with other project leads to inform spatial and temporal analyses to complete

Verbal Autopsy:

- Finalize mode for surveying next of kin (face-to-face over phone interviews)
- Provide literature review completed by NCDMPH in 2019 (under IAA) to inform verbal autopsy (VA) instrument development
- Work with other project leads to inform final VA instrument
- Obtain required approvals for VA instrument and deploy with next of kin or key informants