

The Reproducibility Roadblock:
Unmasking the Challenges of Reproducing Results from
“Differences in Out-of-Hospital Cardiac Arrest
Management and Outcomes across Urban,
Suburban, and Rural Settings”

Introduction

Reproducibility is the bedrock of scientific validity, allowing researchers to build upon existing knowledge with confidence. While our goal was to replicate the findings of the Prehospital Emergency Care paper, we encountered significant obstacles that hindered our ability to achieve true reproducibility. This paper outlines the key challenges encountered, highlighting the critical need for greater transparency and specificity in reporting research methodologies and suggests methods to overcome these obstacles.

Lack of Specificity in Filter Definitions: A Recurring Theme

A major roadblock to reproducibility stemmed from the lack of precise definitions for the filters used to create patient subgroups in the original study. While the paper provided general descriptions of the inclusion and exclusion criteria, it often lacked the granularity needed for accurate replication.

For example, one exclusion criterion was "Not a 911 scene response," based on the `eResponse_05` variable. The paper did not explicitly state which codes within this variable constituted a "911 scene response." This lack of clarity is further compounded by the fact that the code list for `eResponse_05` includes categories like "Intercept" and "Mutual Aid." We were given guidance that these categories were "often acceptable" to include

in this grouping. The ambiguity in filter definition was a recurring issue throughout our replication attempts. Without clear and unambiguous instructions on which tables to definitively use as the source for defining features and within those tables which fields to search for specific codes to include or exclude for each filter, it is impossible to ensure that we are working with the same filters that the patient populations of the original study were built from.

Consistency and Data Field Availability

Another hurdle we faced was the availability and consistency of data fields between the dataset used in the original study and the dataset accessible to us.

An answer was found in email correspondence with Rebecca Cash, an author of the paper at the center of our reproducibility efforts. Yue Huang received this reply when seeking an answer to why filters were producing such markedly different results on 2023 data vs 2018 data. Dr Cash stated that: “The NEMSIS TAC did cross-walk the 3.5 data to 3.4 variables, but in our own work, we’ve found that some of the key OHCA variables seem to be very different in 2023 than prior years.”

- The lack of consistency in how medical field personnel are reporting across years may render the findings of reproduction efforts on different years difficult to interpret

A prime example of this obstacle is found in the original paper's findings on advanced airway management. The study reported statistics on the use of "None," "Failed Attempts," "Supraglottic airways," and "Endotracheal intubation" within this field. However, the specific NEMSIS data elements required to define these airway management categories, in eAirway, are not part of the nationally tracked dataset and therefore not available to us in the NEMSIS Public Dataset. This absence has a profound impact:

- Impossible Replication: We are unable to construct the same patient cohorts as the original study for this section of their analysis because we lack the very data points used to differentiate these patient groups.
- Exploring Alternative Data: To address this limitation, we consulted with NEMESIS staff, who suggested an alternate table, eProcedure, contained within the public dataset *might* contain some or all of the desired information. This exploration highlights the complexity of working with NEMESIS data and the need for confirmation between research parties regarding what features should be reproduced and how they should be defined.

Impact on Reproducibility and Future Research

The lack of specificity in filter definitions, coupled with the challenges posed by data field discrepancies, raises significant concerns about the reproducibility of the original study's findings. Our attempts to replicate the analysis revealed that even slight variations in feature query definitions could lead to substantially different results, ranging from near-identical outcomes to significant deviations from the original paper. While we have endeavored to adhere to the spirit of the original research, the lack of methodological transparency makes it difficult to disentangle whether the observed discrepancies stem from genuine differences in patient populations or are artifacts of variations in data processing and filtering techniques.

Moving Forward: A Call for Enhanced Transparency

Our experience underscores the critical need for greater transparency and rigor in reporting research methodologies, particularly when dealing with complex datasets like NEMESIS Data. To set clear practices going forward and enhance reproducibility, we propose the following recommendations:

- Detailed Feature Documentation: Provide comprehensive documentation of all features used in the analysis, including:
 - The specific NEMSIS variable(s) and codes used for inclusion and exclusion.
 - Clear definitions and justifications for each code selection.
- Data Dictionary Accessibility: Make the data dictionary readily available, clearly outlining the meaning of each variable and code.
- Code Sharing: Share the code used for data processing by clearly linking the scripts saved in the project github source files directory to the features being defined to enable others to understand and replicate the implementation.

A Novel Tool for Enhanced Transparency: The Feature Definition Spreadsheet

To address the challenges of reproducibility and foster greater transparency in future research using NEMSIS data, we are developing a novel tool: The Feature Definition Spreadsheet. This spreadsheet serves as a central repository of information about each feature (variable) used in our analysis, ensuring that our methodology is clearly documented and easily replicable. We believe this will enable subsequent teams to precisely reproduce our findings and establish a method to create new features, track down open questions from prior findings with current stakeholders and original study authors and move forward with the research required to discover improvements in the treatment of cardiac patients across different urbanities.