# Examining the Impact of Healthcare Team Effectiveness on Mortality Outcomes of Heart Failure Patients Using EHR Note Social Network Analysis

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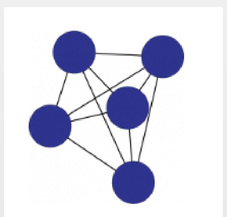
## Introduction

- Patients who receive care associated with poor teamwork are almost five times more likely to experience complications or death (odds ratio = 4.82).[1]
- Effective team collaboration has been established is a major contributor to patient safety. Teamwork failures are among the most frequent causes of adverse events in U.S. hospitals.[2]
- There is evidence that patient outcomes are a function of their clinical factors and treatments, and provider teamwork impacts outcomes including mortality.[3]
- Evidence-based methods for improving teamwork in healthcare, such as training, multidisciplinary rounds and huddles, structured communication protocols, and organizational redesign strategies, could be implemented more effectively with more extensive data availability on healthcare teamwork.
- Teamwork is most commonly measured using surveys, interviews, or direct observations. Electronic health record (EHR) data could reduce burden of these resource-intensive measurement, thus limiting barriers to sustained teamwork interventions and multisite research on healthcare teams.[4]

## Teamwork Definition and Framework

- A **team** is made of two or more individuals, who
  - Socially interact (face-to-face or virtually)
  - Have one or more common goals
  - Perform organizationally relevant tasks
  - Have interdependent workflows, goals, and outcomes
  - Have differentiated roles and responsibilities
  - Are embedded in an organizational system, linked to the broader context and task environment[5]



- Prior work in a Mid-Atlantic-based integrated health system established the use of clinical notes metadata to examine healthcare team dynamics in the inpatient setting and found a relationship between shared team experience and in-hospital mortality for patients with heart failure.[3]
- We sought to replicate this finding at a large academic medical center (AMC) in the Southeast, focusing on healthcare teams in inpatient settings.
- **We hypothesized patients cared for by healthcare teams with higher shared team experience will have lower odds of in-hospital mortality, after controlling for demographics and clinical factors.**

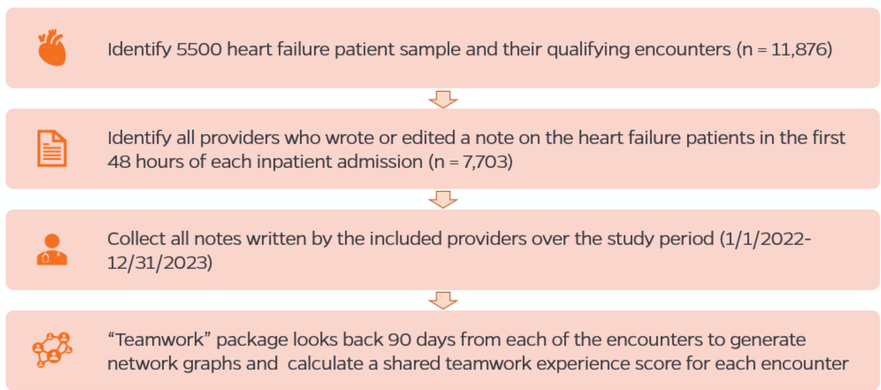
## Social Network Analysis

- Our analysis of team composition applies social network analysis concepts. Social network graphs are generated for each patient encounter.
- "Teamwork" is a Python library that aids in the study of medical care team collaboration by identifying the members of medical care teams for unique patient visits based on medical note meta-data.[6] It builds a network graph for each care team based on their common patients in the previous 90 days.
- Nodes of the generated network graphs are note authors, the healthcare team members.
- Edge weights are the number of days where the authors have both written a note on common patient.
- The following metrics are generated:
  - **Team size:** the number of unique healthcare professionals who wrote a note on a newly admitted heart failure patient during the first 48 hours of admission.
  - **Potential edges:** all possible dyads of providers within the encounter's team.
  - **Team edge size:** dyads of providers that wrote notes on a shared patient within a 24 hour period in the 90 days prior to the admission.
  - **Shared team experience:** final score of interest computed using the "teamwork" Python package's network graphs. It is the number of interactions (experience) minus the number of connected edge (team edge size) divided by the team size.
- Resulting care team network graphs are then used to compute the shared teamwork experience scores of the care team and other metrics (**Figure 1**).

| visit_id | team_size | potential_edges | team_edge_size | experience | cumulative_experience | avg_cumulative_experience |
|---|---|---|---|---|---|---|
| 7189434899 | 6 | 15 | 15 | 230 | 215 | 14.333 |
| 7202529620 | 7 | 21 | 15 | 82 | 67 | 3.190 |
| 7202755152 | 16 | 120 | 105 | 1097 | 992 | 8.267 |
| 7203101942 | 13 | 78 | 62 | 420 | 358 | 4.590 |
| 7203124199 | 14 | 91 | 62 | 314 | 252 | 2.769 |
| 7204143923 | 12 | 66 | 56 | 333 | 277 | 4.197 |

Figure 1. Example of resulting output after applying the "Teamwork" Python library

## Data Collection




All data was collected from a HIPAA-compliant clinical data warehouse aggregating data from various clinical and administrative information systems, including Epic.

- We sampled 5,500 individuals who were adults, with heart failure ICD-10 code diagnoses, inpatients only, and admitted to select units at our Southeastern AMC between January 1, 2022 to December 31, 2023.

## Results

- We examined 5,500 patients admitted to the Southeastern AMC for heart failure over 11,878 unique inpatient encounters during the timeframe of 2022-2023 (**Figure 2**).
- We found a mean team size of **12.41(SD=4.22)** at our Southeastern AMC, smaller than the mean team size at the previous Mid-Atlantic site, **18.30(SD=5.96)**.
- Mean shared team experience scores between the institutions were similar, with **6.65 (SD=3.16)** at our Southeastern AMC compared to **7.46(SD=4.34) at** the Mid-Atlantic site.
- Higher shared team experience was associated with a significant reduction of in-hospital mortality for heart failure patients, for our Southeastern AMC cohort (OR=0.960 [95% CI = 0.92, 0.99), p =.03). This was similar to the findings at the Mid-Atlantic site which found a significant reduction of in-hospital mortality for heart failure patients for all levels of care (OR=0.922, p<.001).

| Characteristic | 11,878 heart failure patient encounters |
|---|---|
| Sex | Male: n = 6368 (53.6%) |
| | Female: n = 5508 (46.4%) |
| Race | White: n = 7795 (66.1%) |
| | Asian: n = 77 (0.7%) |
| | Black; n = 3509 (29.8%) |
| | Multiracial: n = 96 (0.8%) |
| | American Indian: n = 17 (0.1%) |
| | Other: n = 300 (2.5%) |
| Ethnicity | Hispanic: n = 477 (4.0%) |
| | Non-Hispanic: n = 11291 (95.9%) |
| Age | Mean 65.02; SD 13.87 |
| Payer Type | Private: n = 1418 (11.9%) |
| | Medicaid: n = 1600 (13.5%) |
| | Medicare: n = 8299 (69.9%) |
| | Self Pay: n = 358 (3.0%) |
| | Other: n = 201 (1.7%) |
| Accommodation Type | Med/Surg: n = 9492 (79.9%) |
| | Step Down: n = 1629 (13.7%) |
| | ICU: n = 755 (6.4%) |
| DNR/DNI Orders | n = 1060 (8.9%) |
| Mortality | n = 513 (4.3%) |
| Intermountain Risk Score | Mean 15.96; SD 3.82 |

Figure 2. Characteristics of adult inpatient heart failure patient encounters included from the Southeastern AMC sample

## Discussion and Conclusion

- Higher shared team experience at two sites, after controlling for patient and clinical characteristics was associated with a significant reduction of in-hospital mortality for heart failure patients in the ICU (**OR 0.938, 95% CI 0.881-0.998**), but was not significant (**OR 0.982, 95% CI 0.947-1.019**) for all accommodation levels combined.
- Shared experience has a small impact on mortality for heart failure patients, even after controlling for clinical and demographic characteristics.
- Using EHR data to study inpatient teams requires:
  - access to the necessary clinical notes metadata in a defined structure with time relationships included
  - programming expertise and sufficient computational power.

## References

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