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# Patterns of Complex Comorbidity in Older Patients with Heart Failure

Jane S. Saczynski
*University of Massachusetts Medical School*

*Et al.*

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Jane S. Saczynski, PhD[1,2]; Jerry H. Gurwitz, MD[1,2]; Sandhyasree Padmanabhan, MS [1,2]; Robert J. Goldberg, PhD [1,2]; David J. Magid, MD[3]; David H. Smith, PhD[4]; Sue Hee Sung, MPH[5]; Alan S. Go, MD[5].

[1]Meyers Primary Care Institute; [2]University of Massachusetts Medical School; [3] Kaiser Permanente Colorado

[4] Kaiser Permanente Northwest; [5] Kaiser Permanente Northern California

## BACKGROUND

Heart failure (HF) carries a high burden of comorbidity with approximately one half of patients with HF having at least one additional comorbid condition present. Rates of comorbidity in patients with HF have steadily increased over the past 2 decades.

## OBJECTIVE

To examine patterns of comorbidity among older patients with HF in the Cardiovascular Research Network PRESERVE cohort.

## METHODS

### PRESERVE Cohort

Data are from the CVRN PRESERVE cohort which is a multicenter cohort of 37,054 patients [mean age = 74 years (SD = 12.4 yrs); 46% female] with HF diagnosed between 2005 and 2008 currently being conducted at 4 CVRN sites: KPNC, KPCO, KPNW, and FCHP. The primary data source for the PRESERVE cohort was the HMO Research Network Virtual Data Warehouse.

### Identification of Coexisting Diseases

Coexisiting illnesses at the time of HF diagnosis were based on diagnoses and procedures mapped to relevant International Classification of Diseases, Ninth Edition (ICD-9) codes. For the purposes of characterizing clusters of comorbidities, we focused on coexisting conditions with a prevalence rate of ≥3%.

## STATISTICAL ANALYSIS

We used the Agglomerative Clustering technique to characterize patterns of comorbidity. Over multiple iterations, each condition is clustered with the condition with which it has the highest squared correlation. This process is repeated to determine whether assigning a condition to a different cluster increases the amount of explained variance [ranging from 1.0 (all variance explained) to 0.0 (no variance explained)]. The conditions in each cluster are as correlated as possible among themselves and as uncorrelated as possible with conditions in other clusters.

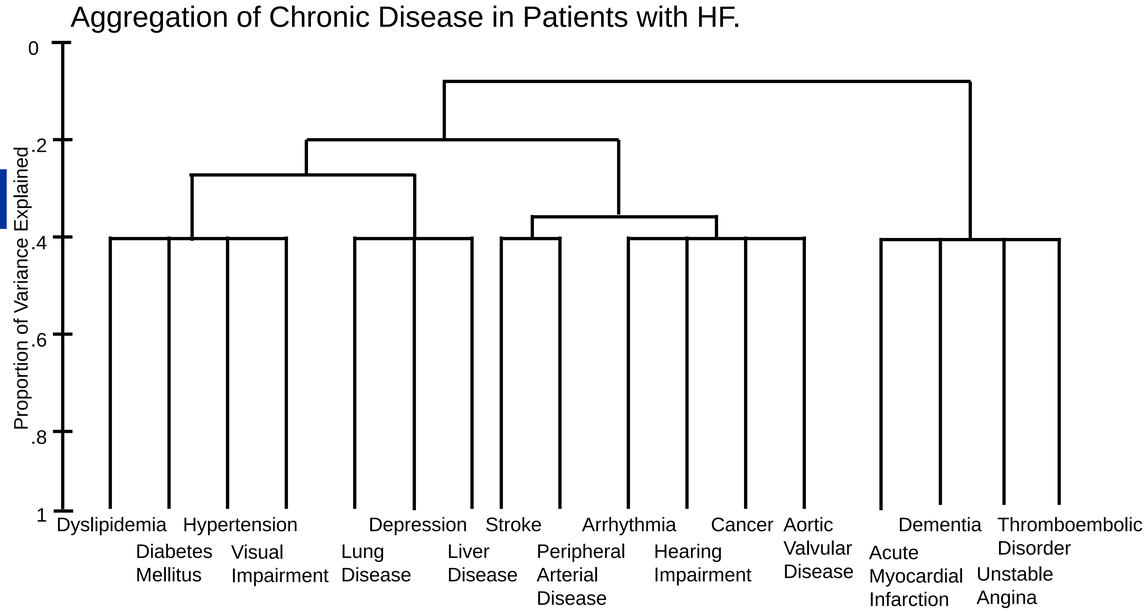
The dendogram (Figure 1) is a graphical display of cluster results.

Table 1. Patients with Heart Failure Affected by Each Chronic Disease and Degree of Multi-Morbidity (N = 37,054)

| Chronic Disease | All cases, n | Cases w/out multi-morbidity, % | Co-occurring conditions, Mean (± SD) |
|---|---|---|---|
| Acute Myocardial Infarction | 4,852 | 1.9 | 4.1 (2.0) |
| Unstable Angina | 2,467 | 0.0 | 5.2 (2.0) |
| Thromboembolic Disorder‡ | 2,467 | 0.0 | 5.2 (2.0) |
| Dementia | 4,363 | 3.6 | 3.9 (2.0) |
| Lung Disease* | 11,121 | 3.6 | 3.7 (1.9) |
| Liver Disease | 1,245 | 2.8 | 3.9 (2.0) |
| Dyslipidemia | 16,690 | 2.7 | 3.7 (1.8) |
| Hypertension | 21,121 | 4.8 | 3.5 (1.8) |
| Diabetes Mellitus | 7,741 | 1.5 | 4.2 (1.8) |
| Aortic Valvular Disease | 7,472 | 3.0 | 3.8 (1.9) |
| Peripheral Arterial Disease | 3,156 | 2.1 | 4.2 (2.0) |
| Depression | 6,605 | 2.6 | 4.1 (2.0) |
| Cancer | 2,536 | 3.6 | 3.8 (1.9) |
| Visual Impairments | 15,089 | 3.2 | 3.7 (1.8) |
| Hearing Impairment | 6,789 | 3.3 | 3.8 (1.9) |
| Stroke** | 7,469 | 1.9 | 4.2 (1.9) |
| Arrhythmia*** | 8,857 | 4.7 | 3.7 (1.9) |

‡ Based on inpatient primary discharge diagnoses: 440.0, 444.1, 444.21, 444.22, 444.81, 444.89, 557.0, 557.1, 557.9 ; * Based on inpatient primary discharge diagnosis or outpatient diagnosis 490-496; 518 * Includes ischemic stroke, transient ischemic attack, and cerebrovascular disease; *** Includes atrial fibrillation, atrial flutter, ventricular fibrillation, ventricular tachycardia

Figure 1. Dendogram Resulting from Cluster Analysis of the Distribution and Aggregation of Chronic Disease in Patients with HF.




## RESULTS

### Burden of Comorbidity

There was a high degree of comorbidity and multi-morbidity among patients with HF. (Table 1) Hypertension and arrhythmias were the comorbidities of HF that occurred most often in the absence of other chronic conditions (4.8% and 4.7%, respectively). The average number of comorbid conditions varied from 3.5 to 5.2. Patients with HF and unstable angina or other thromboembolic disorders had the highest multi-morbidity (mean = 5.2 conditions), whereas those with HF and hypertension had the lowest (mean = 3.5).

### Clustering of Comorbiditites

A five-cluster structure was derived. (Figure 1)

**Cluster 1:** Dyslipidemia, Hypertension, Diabetes Mellitus, Visual Impairment

**Cluster 2:** Acute Myocardial Infarction, Unstable Angina, Thromboembolic Disorder, Dementia

**Cluster 3:** Aortic Valvular Disease, Cancer, Hearing Impairment, Arrthythmia

**Cluster 4:** Peripheral Arterial Disease, Stroke

**Cluster 5:** Lung Disease, Liver Disease, Depression

## DISCUSSION & CONCLUSIONS

- Cluster analysis is an innovative approach to examining the co-occurrence of diseases and allows for identification of broad patterns of multi-morbidity beyond the pairings of diseases or disease counts.
- Patients with HF have a high rate of multi-morbidity, with an average of 4 co-occurring conditions. Intuitive and unintuitive patterns of clustering were identified.
- Randomized clinical trials in HF will need to include more diverse patient populations in order to adapt to the increasingly complex patient population.
- A cluster analysis approach to characterizing patterns of comorbidity may help indentify important patient subgroups.

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