

# PATTERNS OF CHRONIC CO-MORBID MEDICAL CONDITIONS IN OLDER RESIDENTS OF U.S. NURSING HOMES: DIFFERENCES BETWEEN THE SEXES AND ACROSS THE AGESPAN

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**Abstract:** *Objective:* There are limited data on combinations of co-morbid conditions to guide efforts to improve therapeutic strategies in patients with multiple co-morbid conditions. To some extent, this may be due to limited data on combinations of co-morbid conditions in patient groups. Our goal was to determine the most common co-morbid medical conditions in older residents of U. S. nursing homes and identify sex differences in prevalences and changes across the agespan of nursing residents. *Design:* Cross sectional analysis of National Nursing Home Survey (NNHS) –a nationally representative sample with comprehensive medical data on nursing home residents. *Setting:* 1174 nursing homes. *Participants:* Long term stay residents of U.S. Nursing Homes aged 65 years and older (11,734 :8745 women, 2989 men). *Measurements:* Determination of the prevalences of the most frequent two and three disease combinations identified using Clinical Classifications Software (CCS) for ICD-9-CM and a composite vascular disease diagnosis (atherosclerosis and/or coronary artery disease, and/or peripheral arterial disease, and/or cerebrovascular disease or stroke) from the most recent and only NNHS survey with comprehensive medical diagnosis information. *Results:* Frequent 2-disease combinations were: hypertension (HTN) + dementia (DEM) in 27%, HTN + any Vascular (Vasc) disease (26%), HTN + depression (DEP) 21%, HTN + arthritis (ARTH) 20%, DEM + Vasc (21%), DEM+Depression 19%, Arthritis + DEM 17%, DEP + Vasc (16%), ARTH + Vasc (15%), followed by HTN + GERD (14%) and ARTH + DEP (14%). Frequent 3-disease combinations: HTN +VASC+ DEP in 13%, HTN +DEM +DEP (11%), and HTN+Arthritis+DEM (10%). HTN was in 80% of the top 3-disease combinations, Vasc in 50%, HTN+VASC in 35%, DEM or DEP in 40%, ARTH in 25% and GERD in 20%. Combinations with anemia, arthritis, dementia, heart failure, osteoporosis, thyroid disease were higher in women, COPD combinations higher in men. As age increased, dementia, depression, arthritis, and anemia with hypertension were common co-morbid combinations, diabetes and heart failure were not. *Conclusions:* Hypertension, vascular disease, dementia, arthritis, depression, and gastro-esophageal reflux disease were part of the most prevalent co-morbid conditions. Multimorbidity patterns can be identified in nursing home residents and vary with age and by sex.

**Key words:** Nursing home, disease prevalence, multi-morbidity, elderly, National Nursing Home Survey.

## Introduction

Aging is often accompanied by increasing numbers of health-related diagnoses (multi-morbidity) (1, 2). There are no established algorithms or universally accepted approaches to optimizing therapeutic strategies in patients with multiple co-morbid conditions. To some extent, this may be due to the limited data on combinations of co-morbid conditions approaches to optimizing therapeutic strategies in patients with multiple co-morbid conditions. The prevalence of common individual conditions and common co-morbid conditions in community-dwelling elderly people receiving care through the Department of Veterans Affairs medical care (VAMC) system has been reported (3). Hypertension, hyperlipidemia and coronary artery disease dominated the chronic medical conditions in the men. Hypertension, hyperlipidemia and arthritis dominated in the smaller group of community-dwelling older women receiving care in the VAMC system. In men and women, the prevalence of diabetes and hyperlipidemia was lower in patients over age 85 compared to those aged 65-74 and 75-84 years of age.

The nursing home population differs from community dwelling elderly in being comprised of the oldest patients with greater functional limitations and higher disease burden than community-dwelling elderly. Similar to older populations in the community but unlike the VAMC system, there are higher numbers of women than men residing in nursing homes. A series of National nursing home surveys have been performed by the National Center for Health Statistics between 1973 and 2000 (<http://www.cdc.gov/nchs/nnhs.htm>) with diagnostic data limited to no more than four medical diagnoses (4). Investigators have primarily examined characteristics and treatment of single disease states or use of single drug classes in both U.S. (5-9). and European studies of aggregate nursing home data (10-12). The most recent National Nursing Home Survey collected comprehensive medical data including up to sixteen current diagnoses and provides the data necessary to investigate patterns of co-morbid conditions in a nationally representative sample of U.S. nursing home residents (13).

The goal of the current work was to determine patterns of co-morbid conditions in the U. S. nursing home population of

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older patients. We hypothesized that we could identify the most prevalent co-morbid diseases we term “morbidotypes”, that these would differ between women and men and across the agespan of nursing home residents, and that co-morbid disease combinations in nursing home residents might differ from those previously reported for community-dwelling elderly cared for in the outpatient setting.

### Methods

#### *National nursing home study (NNHS) design and sampling*

The 2004 NNHS was conducted between August 2004 and January 2005 and the methodology has been extensively described. (13) In brief, it was a weighted sample from 1,174 facilities and 13,507 residents that represented the 1.49 million residents in U.S. nursing homes at the time. Details on the study and sampling design are at <http://www.cdc.gov/nchs/nnhs.htm> (Accessed August 7, 2012) and [http://www.cdc.gov/nchs/data/series/sr\\_13/sr13\\_167.pdf](http://www.cdc.gov/nchs/data/series/sr_13/sr13_167.pdf) (accessed August 15, 2012) and in the on-line Appendix. Our analyses focused on chronic co-morbid conditions in those over the age of 65 years and were limited to “long-term stay” residents defined as not expected to return to home or the community but not actively dying and by excluding data from short stay residents currently housed in a Specialty Units” such as hospice or acute rehabilitation or sub-acute care and those admitted to a psychiatric ward with time-limited stays.

#### *Diagnoses Data*

A maximum of 16 current diagnoses in the resident’s medical record based on the ICD-9-CM (International Classification of Disease, 9th Revision, and Clinical Modification) were collected for each resident during the 2004 survey. Over 99% of residents sampled had fewer than 16 diagnoses. For the primary diagnosis, error estimates were calculated and the S.E. ranged from 0.1-0.6. ([http://www.cdc.gov/nchs/data/series/sr\\_13/sr13\\_167.pdf](http://www.cdc.gov/nchs/data/series/sr_13/sr13_167.pdf)). The most frequent chronic medical conditions were identified with Clinical Classifications Software (CCS) for ICD-9-CM developed as part of the Healthcare Cost and Utilization Project (HCUP) (<http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccsfactsheet.jsp>; described further in the Appendix). Single level CCS rankings (<http://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>) were used for initial aggregations of chronic medical conditions identified in over 5% of residents, with additional grouping into a single medical condition based on probable common physiologic basis as previously described (14). For example for “Hypertension”, any ICD-9 code that contained “Hypertension complications” resulted in the resident classified as having hypertension. Gastroesophageal reflux disease, heartburn and peptic ulcer disease were combined into a single chronic condition related to acid/peptic acid disease; and, diabetes with and without complications were combined into a single “diabetes”

condition. For combined ICD-9 diagnoses of delirium and dementia, ICD-9 diagnoses for delirium were excluded such that only dementia diagnoses were included in analyses. ICD-9 HCUPS classifies atherosclerotic vascular disease by individual organ systems (i.e. atherosclerosis, coronary or peripheral or central nervous system circulation) and by acuity of the disease). To appropriately capture the burden of atherosclerotic disease we created a composite diagnosis of vascular disease (“Vasc”) diagnosis that included any diagnostic codes for atherosclerotic disease of the heart, brain and peripheral arteries. We identified the twenty most common coded chronic medical conditions of atrial fibrillation, anemia, arthritis, atherosclerosis, congestive heart failure, constipation, chronic obstructive pulmonary disease, cerebrovascular disease, dementia, depression, diabetes, gastroesophageal reflux disease and heartburn and ulcer disease, hypertension, lipid disorder, osteoporosis, Parkinson’s disease, peripheral vascular disease, renal failure, thyroid disorders, benign prostatic hyperplasia We examined codes in CCS categories “Other” or “Unclassified” and included those related to the 20 most prevalent individual medical conditions or the vascular composite condition in our analyses. The complete list of ICD-9 codes that appeared in the NNHS dataset and the corresponding grouped chronic medical conditions are available upon request from the authors (14). The twenty most prevalent individual medical conditions plus the vascular composite diagnosis or 21 diagnoses comprise those analyzed for two and three co-morbid disease patterns.

#### *Medication Data*

The medications portion of the NNHS data lists up to 25 medications that a resident took the day before data collection, and up to 15 medications that a resident took regularly but not the day before data collection based on medical record reviews. The National Ambulatory Medical Care Survey (NAMCS) drug database was used to code and adjudicate medication names. The NAMCS drug database can be accessed at <http://www.cdc.gov/nchs/about/major/ahcd/ambulatory.htm> and further details about medication data collection and adjudication are available (15) Medication dosage, frequency, and route were not provided.

#### *Statistical Analysis*

Identifying Morbidotypes. Combinations of co-morbid conditions were determined by exhaustive data analysis of all possible combinations of two or three co-morbid conditions (of the 21 considered) representing the simplest of statistical methodology and used previously for analyses in community-dwelling elderly (3) as previously described (3). We identified the most prevalent combinations for the nursing home resident group overall, for men and for women, and by age groups defined as residents aged 65-74 years, 75-84 years, and >85 years of age. Due to the complex probability survey design, SAS survey procedures in SAS version 9.2 (SURVEYMEANS, SURVEYFREQ, SURVEYLOGISTIC) designed for analyzing

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survey data were used to account for design effects of stratification and clustering in all analyses to generate nationally representative estimates for nursing home residents ages ≥65. Percentages in this paper represent weight- and cluster-adjusted results. Comparisons of characteristics were made between women and men using t-tests for continuous variables using the Taylor series method to estimate sampling errors and Rao-Scott Chi-square tests for categorical variables. The standard errors of the prevalence estimates displayed were estimated with the Taylor series linearization method. The false discovery rate control method, which controls the expected proportion of incorrectly rejected null hypotheses, was used to correct for multiple comparisons (16) using the SAS MULTTEST procedure.

**Institutional Review**

This research was approved by the Committee on Human Research at the University of California, San Francisco.

**Results**

Data were collected for 11,788 long-term care residents of nursing homes aged > 65 years. Data for residents without ICD9 data were excluded (n=54), resulting in data on 11,734 residents for analysis: 2989 men and 8745 women, representative of 325,919 men and 960,282 women after applying sampling weights. Table 1 provides demographic and clinical characteristics. Most were white (87%; 11% African), mean age was 84 years with 52% aged 85 and older. As previously reported, (14) women were on average older than men and required more assistance with activities of daily living (bathing, dressing, toileting, transfers, continence, eating). Mean number of diagnoses did not differ between women and

men or across the agespan of nursing home residents but prevalence of individual diseases differed between the sexes and across the agespan of nursing home residents (14). Notably, only one percent of nursing home residents had a single diagnosis and only six per cent had only two diagnoses. The frequency of 3, 4, 5, 6, 7, or 8 diagnoses was fairly evenly distributed (9-14 % for each) but was much lower for 12-16 diagnoses (1-2% for each). The mean number of daily oral medications (excluding as needed medications) taken by a resident was 8.8 with women taking slightly more than men (8.9 vs. 8.6, p=0.02). The number of daily medications was positively associated with the total number of diagnoses (p<.0001).

**Combinations of Co-morbid Conditions**

A. Two co-morbid conditions. Data on combinations of two co-morbid conditions present in over 10% of female or male nursing home residents are presented in Table 2 (data on less frequent combinations are available upon request). In the left hand column, the results of considering all combinations of the 20 most common conditions (excluding the composite for vascular disease) are presented and in the right hand column, all possible combinations for the 20 conditions and the vascular composite are presented (excluding consideration of individual vascular disease diagnoses). The two most frequent chronic co-morbid disease combinations in both men and women were hypertension (HTN) + dementia (DEM) in 27% with or without the composite Vasc category included in analyses. In analyses without the composite Vasc disease classification, it was followed by hypertension + depression in 21%. In women, these were followed by hypertension + arthritis (21%), dementia + depression (21%), arthritis + dementia (19%), arthritis + depression (15%), hypertension + diabetes (15%),

**Table 1**  
 Characteristics of Nursing Home Residents Aged 65 and Older

Characteristic	All Participants (N=11,734, nw= 1,286,201)	Women (n=8745, nw=960,282)	Men (n=2989, nw=325,919)	Sex Effect
Age	84±8 *	85±8	81±8	p<.001a
Age (y), nw (%)§				
65-69	66102 (5.1)	37594 (3.9)	28508 (8.7)	
70-74	102338 (8)	59062 (6.2)	43276 (13.3)	
75-79	183399 (14.3)	118043 (12.3)	65356 (20.1)	
80-84	273646 (21.3)	202236 (21.1)	71410 (21.9)	
85-89	308822 (24)	242786 (25.3)	66036 (20.3)	
90-94	241214 (18.8)	201316 (21.1)	39898 (12.2)	
≥95	110680 (8.6)	99245 (10.3)	11435 (3.5)	
Diagnoses, (n)				
Age 65-74	6.3±3.1	6.3±3.1	6.3±3.1	
75-84	6.5±3.2	6.4±3.2	6.3±3.1	
85+	6.4±3.1	6.4±3.1	6.5±3.1	
Number of medications,				
Age 65-74	8.7±3.9	9.0±4.1	8.3±3.6	
75-84	8.4±3.8	8.5±3.9	8.0±3.6	
85+	7.6±3.6	7.6±3.6	7.3±3.5	

nw=weighted frequency; Data are mean ± standard deviation. Numbers in parentheses indicate % of group indicated by column header. aSex comparison p-values based on Rao-Scott chi-square test.

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**Table 2**  
 Prevalence of combinations of two-co-morbid chronic diseases in nursing home residents

Co-morbid Conditions	Prevalence(%)			Co -morbid conditions with Vascular Composite	Prevalence (%)		
	All	Women	Men		All	Women	Men
HTN+DEM	27	28**	24	HTN+DEM	27	28**	24
HTN+DEP	21	22***	17	HTN+Vasc	26	25	29*
HTN+ARTH	20	21*****	16	Vasc+DEM	21	21	21
DEM+DEP	19	21**	16	HTN+DEP	21	22***	17
ARTH+DEM	17	19**	13	HTN+ARTH	20	21*****	16
HTN+DM	15	15	16	DEM+DEP	19	21**	16
HTN+GERD	14	14	14	ARTH+DEM	17	19**	13
ARTH+DEP	14	15*****	9	Vasc+DEP	16	16	16
HTN+ATHERO	13	13	14	HTN+DM	15	15	16
HTN+CVD	13	12	15*	Vasc+ARTH	15	15	14
HTN+CHF	12	13+	10	HTN+GERD	14	14	14
HTN+ANEM	12	12*	9	ARTH+DEP	14	15*****	9
DEM+GERD	11	11	10	HTN+CHF	12	13+	10
ANEM+DEM	10	11	8	Vasc+DM	12	11	15*
DEP+GERD	10	10	10	HTN+ANEM	12	12*	9
DEM+DM	10	10	10	DEM+OSTEO	12	12*****	2
ATHERO+DEM	10	10	10	Vasc+GERD	11	11	12
HTN+THYR	10	11*****	5	DEM+GERD	11	11	10
HTN+OSTEO	10	12*****	2	Vasc+CHF	10	10	10
CVD+DEM	9	9	11	DEP+GERD	10	10	10
DEM+OSTEO	12	12*****	2	DEM+DM	10	10	10
HTN+COPD	7	7	10+	HTN+THYR	10	11*****	5
				HTN+OSTEO	10	12*****	2
				ANEM+DEM	10	11	8
				DEM+THY	9	11	4
				HTN+COPD	7	7	10+

Data represent all combinations present in over 10% of either men or women. HTN=hypertension, ANEM=anemia, ARTH=Arthritis, ATHERO=atherosclerosis, CHF= congestive heart failure, COPD=chronic obstructive pulmonary disease, CVD=cerebrovascular disease, DEM=dementia, DEP= depression, DM=diabetes mellitus, GERD=gastroesophageal reflux and acid peptic disorders, OSTEO=osteoporosis, THYR=thyroid disease, Vasc= composite of vascular diseases (atherosclerosis, cerebrovascular disease, coronary artery disease, peripheral artery disease). Symbols indicate significant sex difference in prevalence of the combination as follows: +p<.01, \*p<.001, \*\*p<.0001, \*\*\*p<.00001, \*\*\*\*p<.000001, \*\*\*\*\*p<.0000001.

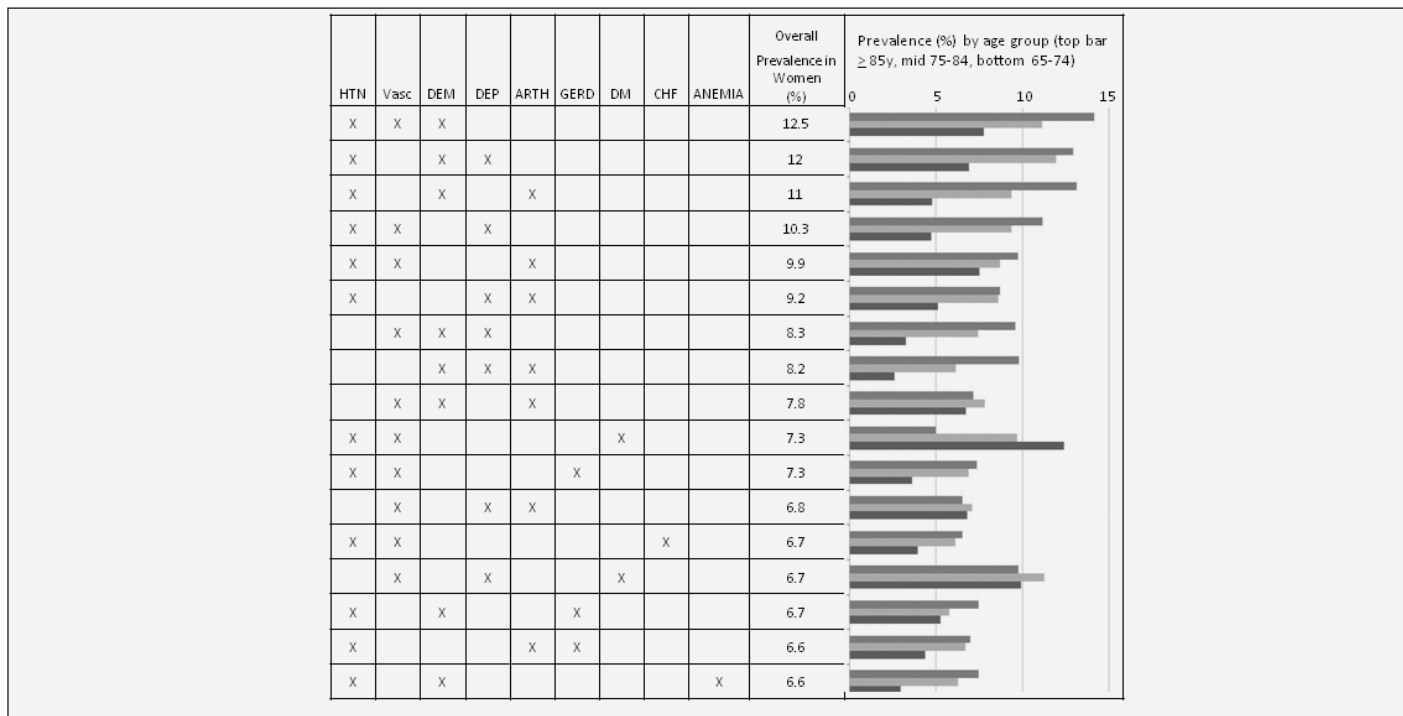
hypertension + gastroesophageal reflux (GERD) (14%), hypertension + heart failure (13%) and hypertension + atherosclerosis (13%). In men, the third most common combinations were hypertension + diabetes, dementia + depression, or hypertension + arthritis in 16%, followed by hypertension + cerebrovascular disease (15%), hypertension + atherosclerosis (14%), hypertension + GERD (14%), arthritis + dementia (13%), and cerebrovascular disease + dementia (11%). Using ICD-9 HCUPS classifications of atherosclerotic disease by individual organ systems or the separate general “atherosclerosis” classification, atherosclerotic diseases appeared in only 4 of the top 22 most common 2-disease combinations. When data were analyzed using the composite Vasc category (see Table 2), vascular disease was present in combination with hypertension in 26% of residents, second only to the combination of hypertension and dementia present in 27% overall, and appeared in 7 of the top 22 two-disease combinations (hypertension appeared in nine). For the most common 2-disease combinations, sex differences were consistently detected for combinations containing arthritis, osteoporosis, and thyroid disease that were more common in women, and those with chronic obstructive pulmonary disease

(COPD) more common in men (see Table 2 for statistics). Dementia and depression were more common in women when combined with hypertension but not when combined with diabetes, atherosclerotic diseases or GERD. Diabetes (DM) in combination with vascular disease was more common in men.

B. Three co-morbid conditions. The prevalences of of the same three co-morbid conditions were less common than combinations of the two same diseases yet for women, 34% of 65-74 year olds, 40% of 75-84 year olds and 44% of those 85 years of age and older had at least one of the ten most prevalent morbidotypes. For men, 34% of 65-74 year olds, 39% of 75-84 year olds and 34% of those 85 years of age and older had at least one of the ten most prevalent three-disease morbidotypes. Table 3 provides data on the prevalence of frequent combinations of three co-morbid conditions occurring in over 5% of men or women. Figure 1 provides data for women by age subgroup and Figure 2 provides data for men by age subgroups. Hypertension +Vasc was found in combination with dementia in 12.5% of nursing home residents, with depression in 10%, and in combination with arthritis in 9.6%. Sex differences in prevalences were similar to those for two-disease combinations, i.e. those with osteoporosis, arthritis and thyroid

**Figure 1**

Prevalence of three co-morbid conditions in older women in nursing homes. ARTH=Arthritis, CHF= congestive heart failure, COPD= chronic obstructive pulmonary disease, DEM=dementia, DEP= depression, DM=diabetes mellitus, GERD=gastroesophageal reflux and acid peptic disorders, HTN=hypertension, Vasc= composite of vascular diseases



disease were more common in women and COPD combinations more common in men. Hypertension in combination with vascular disease and diabetes was also more common in men. Combinations that included dementia increased with age in both women and men, although this was most striking in the women. Arthritis also was part of disease combinations that increased with age. The only combinations that decreased over the agespan of nursing home residents were those that included diabetes. Depression and GERD appeared to have a less marked relationship with age.

Looking at the composition of disease in the three co-morbid disease combinations, hypertension was included in 80% of the top 20 and vascular disease was included in 50%. Hypertension and vascular disease occurred in combination in 35% of three co-morbid disease combinations. Dementia and depression were part of 40%, followed by arthritis (in 25%) and GERD (20%). Diabetes and heart failure were part of three disease combinations less frequently as were COPD in men and anemia in women.

**Discussion**

There is current dialogue on how the understanding of multi-morbidity should inform our health system design, care guidelines, and quality measures (2). Clinicians have limited guidance on how to approach health care decisions and medications for patients with multiple co-morbid conditions.

We have attempted to define commonly occurring co-morbid conditions in very elderly functionally dependent people as a first step in developing a multi-morbidity approach to care (17).

We analyzed data for chronic stay nursing home residents over the age of 65 years collected from 2004-2005 and made publicly available in 2009 (13). The data are the most currently available for U.S. nursing home residents, and the only nursing home survey to date to collect comprehensive diagnostic information. The results expand upon previous studies of multimorbidity in older adults by the focus across the agespan of residents of nursing homes that have higher proportions of women than men (3, 18-23). We have previously reported the prevalence of individual diagnoses by sex and across the agespan of this nursing home population (14). The twenty most frequent individual chronic medical conditions coded were hypertension, dementia, depression, arthritis, diabetes mellitus, gastrointestinal reflux and peptic ulcer disease, atherosclerosis, congestive heart failure -CHF, cerebrovascular disease, anemia, osteoporosis, thyroid disease, chronic obstructive pulmonary disease, atrial fibrillation, peripheral vascular disease, constipation, lipid disorders, Parkinsons disease, renal failure, and benign prostatic hypertrophy.

Only one percent of nursing home residents had a single diagnosis and only six per cent had only two diagnoses. Nursing home residents of all ages had a mean of 6.3 diagnoses. Despite the presence of multiple diseases in most

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**Table 3**  
 Prevalence of combinations of three-co-morbid chronic diseases in nursing home residents

Co-morbid Conditions	Prevalence(%)			Co -morbid conditions with Vascular Composite	Prevalence (%)		
	All	Women	Men		All	Women	Men
HTN+DEM+DEP	11.2	12.*	9.1	HTN +Vasc+DEM	12.6	12.5	13
HTN+ARTH+DEM	10.2	11+	7.7	HTN +DEM+DEP	11.2	12*	9.1
HTN+ARTH+DEP	8.3	9.2**	5.6	HTN +ARTH+DEM	10.2	11+	7.7
ARTH+DEM+DEP	7.4	8.2*	5	HTN +Vasc+DEP	10.1	10.3	9.6
HTN+DEP +GERD	6.5	6.7	5.8	HTN +Vasc +ARTH	9.7	9.9*	8.9
HTN+GERD +DEM	6.4	6.7	5.7	Vasc +DEM+DEP	8.3	8.3	8.3
HTN+DEM+DM	6.4	6.5	6.1	HTN +ARTH+DEP	8.3	9.2**	5.6
HTN+ARTH+GERD	6.2	6.6+	4.9	HTN +Vasc+DM	7.9	7.3	9.6*
HTN+ATHERO+DEM	6.2	6.1	6.4	Vasc +ARTH+DEM	7.5	7.8	6.6
HTN+DEM+ANEMIA	6.1	6.6*	4.5	HTN+ Vasc+GERD	7.4	7.3	7.6
HTN+CVD+DEM	6	5.8	6.6	ARTH+DEM+DEP	7.4	8.2*	5
HTN+DEP+DM	5.4	5.5	5.3	HTN+ Vasc+CHF	6.6	6.7	6.2
HTN+ATHERO+DEP	5.3	5.3	5.3	HTN+DEP+GERD	6.5	6.7	5.8
HTN+DEM+CHF	5.2	5.6	4.2	HTN +GERD+DEM	6.4	6.7	5.7
HTN+DEM+OSTEO	5.1	6.5*****	1.3	HTN+DEM+DM	6.4	6.5	6.1
DEM+DEP+GERD	5.2	5.2	4.9	Vasc+ARTH+DEP	6.4	6.8+	5.2
HTN+ARTH+ATHERO	5	5.1	4.5	HTN +ARTH+GERD	6.2	6.6+	4.9
HTN+ARTH+DM	4.9	5	4.6	HTN+DEM+ANEMIA	6.1	6.6*	4.5
HTN+DEP+CVD	4.9	5.1	4.2	HTN+Vasc+ANEMIA	5.6	5.7	5.1
HTN+ARTH+CHF	4.7	5.2*****	3.3	HTN+DEP+DM	5.4	5.5	5.3
HTN+DEM+THY	4.8	5.7*****	2.1	Vasc+DEP+GERD	5.3	5.2	5.5
HTN+DEP+OSTEO	4.3	5.5*****	0.9	HTN+DEM+CHF	5.2	5.6^	4.2
HTN+ARTH+ANEMIA	4.7	5.4**	2.8	Vasc+DEM+GERD	5.2	5.1	5.4
DEM+DEP+OSTEO	4.2	5.3*****	0.8	HTN+DEM+OSTEO	5.1	6.5*****	1.3
HTN+DEP+ANEMIA	4.7	5.2*****	3.3	DEM+DEP+GERD	5.2	5.2	4.9
HTN+ARTH+OSTEO	4	5.1*	0.8	Vasc+DEM+DM	5	4.8	5.5
				HTN+Vasc+THY	4.8	5.7*****	2.2
				HTN+ARTH+CHF	4.7	5.2*****	3.3
				Vasc+ARTH+GERD	4.7	5.1*	3.5
				HTN+DEP+ANEMIA	4.7	5.2*****	3.3
				HTN+ARTH+ANEMIA	4.7	5.4*	2.8
				HTN+DEP+OSTEO	4.3	5.5*****	0.9
				DEM+DEP+OSTEO	4.2	5.3*****	0.8
				HTN+ARTH+OSTEO	4	5.1*****	0.8
				HTN+Vasc+COPD	4	3.5	5.5

Data represent combinations of 3 co-morbid chronic medical conditions present in over 5% of either men or women. ANEM=anemia, ARTH=Arthritis, AATHERO=atherosclerosis, CHF=congestive heart failure, COPD=chronic obstructive pulmonary disease, CVD=cerebrovascular disease, DEM=dementia, DEP= depression, DM=diabetes mellitus, GERD=gastroesophageal reflux and acid peptic disorders, HTN=hypertension, OSTEO=osteoporosis, THYR=thyroid disease, Vasc= composite of vascular diseases (atherosclerosis, cerebrovascular disease, coronary artery disease, peripheral artery disease). Symbols indicate significant sex difference in prevalence of the combination as follows: ^ indicates p=.02,+p<.01, \*p<.001, \*\*p<.0001, \*\*\*p<.00001, \*\*\*\*p<.000001, \*\*\*\*\*p<.0000001 \*\*\*\*\*p<.00000001.

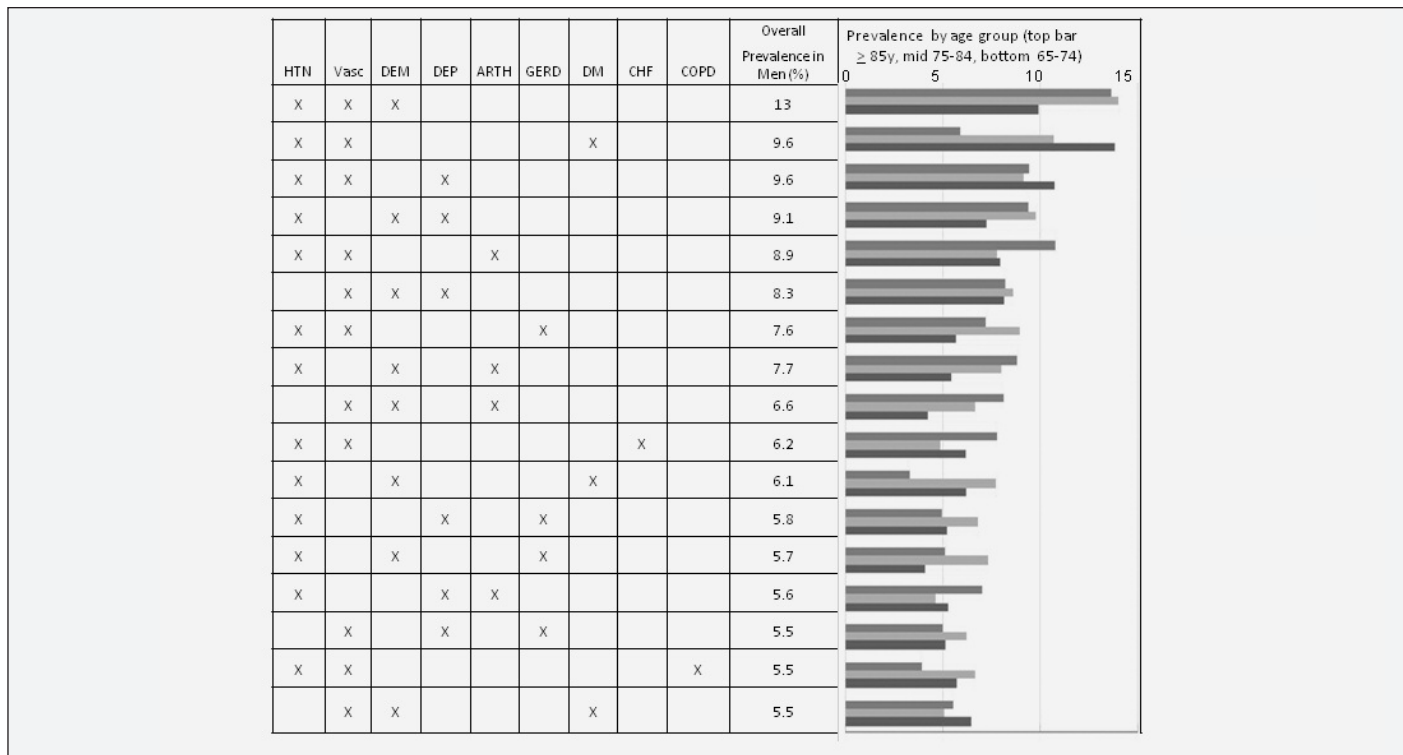
residents, there was a wide range of diseases such that combinations that occurred in over 10% of residents were limited to combinations of two and three diseases. Hypertension was the most frequent recurring diagnosis in common combinations of chronic diseases similar to results in community-dwelling elderly VAMC patients and reflecting its overall prevalence in older populations (3, 14). In contrast, in nursing home residents, the next most common co-morbid diagnosis was dementia with 28% of female nursing home residents and 24% of male nursing home residents having hypertension and dementia in combination. Depression was the next most frequent contributor to common two or three disease combinations. These prevalences differ from the VA community-dwelling elderly data where a diagnosis of lipid

disorder was second only to hypertension in prevalence and frequency in three co-morbid conditions.

As the most common cause of death in both older men and women at the time of the NNHS survey in 2004-2005 was cardiovascular disease, we were puzzled that cardiovascular disease diagnoses did not initially appear to be very frequent in analyses using CCS for ICD-9-CM HCUP groupings. Vascular disease is likely underestimated by analyses of ICD-9-CM HCUPS classifications that group disorders by organ systems and acuity rather than the common underlying pathophysiologic process of atherosclerosis. When data were analyzed with a composite category for vascular diseases, vascular disease joined hypertension in dominating the commonly co-occurring conditions. Dementia followed closely, then arthritis,

**Figure 2**

Prevalence of three co-morbid conditions in older men in nursing homes. ARTH=Arthritis, CHF= congestive heart failure, COPD= chronic obstructive pulmonary disease, DEM=dementia, DEP= depression, DM=diabetes mellitus, GERD=gastroesophageal reflux and acid peptic disorders, HTN=hypertension, Vasc= composite of vascular diseases



depression and GERD. Of the 20 most frequent three disease co-morbid conditions, hypertension was included in 80%, vascular disease in 50%, and the combination of hypertension and vascular disease in 35%. Dementia and depression were part of 40%, followed by arthritis (in 25%) and GERD (20%).

Diabetes was only seen in combinations with vascular disease and hypertension in 7% of women and about 10% of men overall and was not seen in the more common co-morbid combinations as age increased in men and women. The prevalence of diabetes also decreased with increasing age of nursing home residents in earlier NHHS surveys analyzed by others despite the overall increased prevalence of diabetes in the community (24). This consistent finding suggests that the patients with diabetes may be dying at earlier ages. In contrast, common co-morbid combinations that included dementia increased with age. The increase in dementia prevalence with aging in the nursing home mirrors that seen in community-dwelling elderly.

The data demonstrate the high prevalence of multimorbidity in these older adults and identifies unique disease combinations. We believe the implications of this work are relevant to optimizing therapeutic regimens in nursing home residents and other older patients with multiple co-morbid conditions (2). Some progress has been made in considering medication choices for hypertension in the elderly with concomitant conditions such as coronary artery disease, heart

failure, diabetes mellitus, and renal insufficiency but not for hypertension in combination with other highly prevalent diagnoses in the nursing home population (25). Antihypertensive treatment guidelines do not consider hypertension in combination with dementia, depression, arthritis, or gastrointestinal reflux. Considering concomitant diseases during the selection of an antihypertensive medication from the wide range of effective agents available (26) could be a logical starting point for treatment regimens. For example, diuretics are effective therapy for hypertension in the elderly but may increase discomfort and/or contribute to incontinence and care burden by increasing urinary frequency in patients with dementia or limited mobility due to arthritis and may create the need for the addition of potassium replacement agents to the medication burden. Similarly, calcium channel blockers and beta blockers may aggravate or precipitate gastrointestinal reflux and lead to prescribing of additional medications for management. These are just two examples of considerations that are not often part of the decision-making related to the choice of an antihypertensive medication in the elderly patient but should play a role in the care of very older and functionally dependent people where quality of life is a primary consideration.

Our work has limitations. The data analyzed were collected from records used for clinical care and billing and laboratory data were not included. Diagnostic criteria were not

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standardized and may reflect variability in health care professional practices and biases. Estimates of the prevalence of hypertension, heart disease and diabetes were similar to estimates for the elderly in the community. ([www.aoa.gov/Aging\\_Statistics/Profile/2012/docs/2012profile.pdf](http://www.aoa.gov/Aging_Statistics/Profile/2012/docs/2012profile.pdf)). We report higher estimates for dementia that appear plausible but the prevalence of osteoporosis (even broadly defined) was lower than expected and likely represented undercoding resulting in lack of inclusion in the common comorbid disease combinations. In addition, diagnostic data did not focus on geriatric syndromes important to the health of older adult. We examined non-diagnosis portions of the survey for the presence of pain and found it reported as present in 20-24% of residents in the seven days prior to the survey in keeping with other reports of its presence in about one quarter of nursing home residents (<http://www.cdc.gov/nchs/data/databriefs/db30.htm>). The findings are also limited to U.S. nursing home residents during 2004-2005 and nursing home populations both then and now are not ethnically diverse and there are known differences in multimorbidity profiles over age between the races (27). A major limitation to the field is the lack of comprehensive data on multimorbidity in nursing home residents of other countries for comparisons. We used the simplest of statistical methods to identify the most prevalent combinations of co-morbid conditions. Alternative strategies were evaluated (latent class analysis, dendograms) but did not appear to offer any advantages. We also analyzed our data with a unique composite diagnosis category for any form of vascular disease that would encompass neurologic, cardiovascular, and peripheral vascular disorders often considered separately (stroke, heart attack, peripheral artery disease) that we believe could be a useful clinical construct as the underlying pathophysiology is similar as are therapeutic strategies.

In summary, our work identifies common combinations of two and three chronic co-morbid conditions or morbidotypes in residents of U.S. nursing homes. Hypertension, vascular disease, dementia, arthritis, depression, and (unexpectedly) gastro-esophageal reflux disease were diagnoses found in the most prevalent combinations of co-morbid conditions. We believe this information can serve as a foundation to develop strategies to optimize care and prescribing for elderly patients with co-morbid conditions residing in U.S. nursing homes and that similar comprehensive data from other countries are needed to guide international approaches to improving the care of the population of vulnerable nursing home residents.

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