

Patterns of Risk Factors and Drug Treatments Among Hypertension Patients

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ABSTRACT

The most common comorbidities of hypertension are heart disease, kidney disease, diabetes, and hyperlipidemia. It is possible for two of these diseases to occur simultaneously. Monitoring the characteristics of hypertension patients is one way to prevent the co-occurrence of two diseases.

This paper compares the comorbidities of hypertension patients in two age groups. One group is under 65 years old and the other group is 65 years old and over. The paper shows that the younger group has diverse risk factors and comorbidities, while the older group has primarily heart- and kidney-related risk factors.

ACE inhibitors and beta blockers are commonly used to treat hypertension. This paper shows which order of taking these medications lowers cost and reduces either length of stay or heart disease events.

INTRODUCTION

Approximately 75 million adults have hypertension in the U.S., defined as a systolic blood pressure (BP) of greater than or equal to 130 and a diastolic BP of greater than or equal to 80. Hypertension is about twice as common in individuals who have one or two parents with hypertension. One in three American adults has hypertension. 17% prehypertension adults progress to stage 1 over 4 years. Hypertension was a primary or contributing cause of death for more than 410,000 in the US in 2014 [6]. Leading risk factors for cardiovascular death are heart attack, stroke, vascular disease, heart failure, and renal disease.

Hypertension that is present for an extended period can lead to a multitude of health consequences such as heart failure, hyperlipidemia, arteriosclerosis, stroke, and chronic kidney disease.

Medication classes for hypertension treatment are ACE inhibitors, beta blockers, and diuretics. ACE inhibitors are used to relax the blood vessels and prevent kidneys from becoming damaged. Beta Blockers are used to slow the heart rate, which in turn decreases blood pressure. Diuretics are used to remove salt and fluid in the blood vessels, which aids in lowering blood pressure.

There have been several recent efforts to study the comorbidities of hypertension (Liu et al. 2016; Zygmuntowicz et al. 2012). Liu's paper identified the top 20 comorbidities of hypertension and studied the gender and age-specific patterns of those comorbidities in China. They found that the age-specific detection rates of comorbidities showed five unique patterns and indicated that nephropathy, uremia, and anemia are significant risks for patients under 39 years of age. On the other hand, coronary heart disease, diabetes, arteriosclerosis, hyperlipidemia, and cerebral infarction are more likely to occur in older patients. The paper by Zygmuntowicz assessed the relationship between comorbidities and different health-related aspects of quality of life in a large unselected cohort of patients undergoing treatment for hypertension in Poland. They found that significantly lower health-related quality of life values are associated with coexisting diseases, especially obstructive respiratory disease, degenerative disc disease, radiculopathy, coronary artery disease, heart failure, stroke, diabetes, epilepsy, neurotic disorders, and mood disorders.

This paper uses CMS Synthetic PUF Medicare data [7] and de-identified commercial claims data. The de-identified commercial claims data will be called "COM" in this paper for convenience. Using SAS®

Health Analytics Framework, we create a separate hypertension cohort for each set of data and create 12 comorbidities: chronic kidney disease stage 1-2, chronic kidney disease stage 3-5, nephropathy, end-stage renal disease, uremia, congestive heart failure, depression, hyperlipidemia, arrhythmia, coronary heart disease, arteriosclerosis, and stroke. Among the 12 comorbidities, depression, congestive heart failure, and arrhythmia use the Elixhauser comorbidity index diagnosis codes. Others are created using SAS Health Analytics Framework predefined analysis variable codes or ICD-10-CM codes. In addition, ACE inhibitor and beta blocker indicators are created using SAS Health Analytics Framework predefined analysis variable codes.

This paper shows the difference in incidence rate of comorbidities in hypertension patients using two data sets (COM, CMS) and suggests the guideline of taking two medications switch from ACE inhibitors to Beta Blockers or reverse order to save medical costs and reduce the length of stay or risk of heart disease events.

METHODS

DATA SOURCE AND PATIENT POPULATION

The data used for this study came from the publicly available 2008-2011 CMS Synthetic PUF 50K Medicare data and 1984-2012 50K COM data. SAS Health Analytics Framework is used to create cohorts, which consist of patients with hypertension. The age group for the cohort that uses CMS data is 65 years old and over, and the age group for the cohort that uses COM data is under 65 years old. In the CMS data set, 30,858 (61.7%) members have hypertension disease. In the COM data, 7,900 (15.8%) members are hypertension patients.

COMORBIDITY RISK FACTORS AND DEMOGRAPHIC VARIABLES

Elixhauser comorbidity index diagnosis codes are used to capture the patient's comorbidity status after the start of hypertension. A value of 1 indicates that the risk factor is present, and a value of 0 indicates that it is not present. Demographic factors include the patient's age and gender.

COMPLICATIONS OF HYPERTENSION

Hypertension can cause a multitude of health consequences such as heart failure, ischemic heart disease, and chronic kidney disease. Other health outcome comorbidities identified from diagnosis codes are used to capture the patient's comorbidity status after the start of hypertension. Heart failure, hyperlipidemia, arteriosclerosis, stroke, and chronic kidney disease comorbidities are derived as binary variables based on information. A value of 1 indicates that the risk factor is present, and a value of 0 indicates that it is not present.

MEDICATION CLASSES FOR TREATMENT OF HYPERTENSION

ACE inhibitors and beta blockers are the drug classes considered for this study.

STATISTICAL ANALYSES

The descriptive summary statistics that are used to describe the hypertension population are provided in Tables 1, 2, 3-1, and 3-2. Findings are reported for patients' demographic and comorbidity characteristics using frequency and percentage distribution. Odds ratios by gender and comorbidity characteristics are also reported. Tables 4-1 and 4-2 show the top five comorbidities for each age group. Tables 5-1 and 5-2 show how to cluster similar patterns of comorbidities using the TRAJ procedure.

Tables 6, 7-1, 7-2, 8-1, and 8-2 show patients that have taken more than one medication with overlapping time periods. COM population uses more ACE inhibitors than beta blockers.

Tables 9,10, and 11 show the number of patients who are taking two medications with no overlapping of time periods. All combinations of the order in which medications are taken are considered. This data can be used as a guideline for choosing the correct order for medications.

RESULTS

DISTRIBUTION OF HYPERTENSION PATIENTS BY DEMOGRAPHICS

The COM data has 10-year ranges in the age group under 65 years old, but the CMS data has 5-year ranges in the age group 65 years old and over. As a result, the 60-64 age group in the COM data might have a lower count than the age group 50-59. The COM table shows that 90% of hypertension patients are over 40 years old. The CMS table shows that about 65% hypertension patients are less than 80 years old. The COM data shows that hypertension patients have a slightly higher occurrence in males (54.45%) than females (47.55%). Reversely, the CMS data shows that hypertension patients are more often female (58.11%) than male (41.89%).

Variable	Variable Level	Count (%)
Total		N=7990
Age Group	0-9	8 (0.10)
Age Group	10-19	51 (0.64)
Age Group	20-29	220 (2.75)
Age Group	30-39	604 (7.56)
Age Group	40-49	1694 (21.20)
Age Group	50-59	3347 (41.89)
Age Group	60-64	2066 (25.86)
Gender	F	3799 (47.55)
Gender	M	4191 (52.45)

Variable	Variable Level	Count (%)
Total		N=30858
Age Group	65-69	8030 (26.02)
Age Group	70-74	7030 (22.78)
Age Group	75-79	5922 (19.19)
Age Group	80-84	4922 (15.95)
Age Group	85-89	3084 (9.99)
Age Group	90-	1870 (6.06)
Gender	F	17931 (58.11)
Gender	M	12927 (41.89)

Table 1. Distribution of hypertension patients by demographic (Left: COM, Right: CMS)

For the COM data, hyperlipidemia, depression, and coronary heart disease have high counts. For the CMS data, hyperlipidemia, heart failure, and coronary heart disease have high counts.

Variable	Count (%)	Variable	Count (%)
Total	N=7990	Total	N=30858
_IV1: CKD stage 3-5	147 (1.84)	_IV1: CKD stage 3-5	7827 (25.36)
_IV11: nephropathy	171 (2.14)	_IV11: nephropathy	5527 (17.91)
_IV12: ESRD	31 (0.39)	_IV12: ESRD	6229 (20.19)
_IV14: CKD stage 1-2	73 (0.91)	_IV14: CKD stage 1-2	1703 (5.52)
_IV2: stroke	68 (0.85)	_IV2: stroke	5223 (16.93)
_IV3: ELIX_CHF	459 (5.74)	_IV3: ELIX_CHF	14338 (46.46)
_IV4: ELIX_depression	1097 (13.73)	_IV4: ELIX_depression	10651 (34.52)
_IV5: hyperlipidemia	1437 (17.98)	_IV5: hyperlipidemia	26157 (84.77)
_IV6: uremia	48 (0.60)	_IV6: uremia	3234 (10.48)
_IV7: ELIX_arrythmia	144 (1.80)	_IV7: ELIX_arrythmia	7793 (25.25)
_IV8: arteriosclerosis	151 (1.89)	_IV8: arteriosclerosis	8578 (27.80)
_IV9: coronary heart disease	916 (11.46)	_IV9: coronary heart disease	24199 (78.42)

Table 2. Distribution of hypertension patients by comorbidity (Left: COM, Right: CMS)

Tables 3-1 and 3-2 show the count and odds ratio for each comorbidity by gender. For the COM data, most comorbidities have a higher occurrence in males. For example, stroke, coronary heart disease, and chronic kidney disease have a higher occurrence in males. For the CMS data, comorbidities do not display a large gender difference.

Variable	Male: Count (%)	Female: Count (%)	Chisq (p-value)	Odds Ratio (95% Confidence limit)
Total	N=4191	N=3799		
_IV1: CKD stage 3-5	87 (2.08)	60 (1.58)	2.72 (0.099)	1.32 (0.95, 1.84)
_IV11: nephropathy	96 (2.29)	75 (1.97)	0.95 (0.329)	1.16 (0.86, 1.58)
_IV12: ESRD	19 (0.45)	12 (0.32)	0.97 (0.324)	1.44 (0.70, 2.96)
_IV14: CKD stage 1-2	46 (1.10)	27 (0.71)	3.29 (0.070)	1.55 (0.96, 2.50)
_IV2: stroke	48 (1.15)	20 (0.53)	9.04 (0.003)	2.19 (1.30, 3.70)
_IV3: ELIX_CHF	238 (5.68)	221 (5.82)	0.07 (0.790)	0.97 (0.81, 1.18)
_IV4: ELIX_depression	394 (9.40)	703 (18.50)	139.43 (0.000)	0.46 (0.40, 0.52)
_IV5: hyperlipidemia	784 (18.71)	653 (17.19)	3.11 (0.078)	1.11 (0.99, 1.24)
_IV6: uremia	30 (0.72)	18 (0.47)	1.95 (0.162)	1.51 (0.84, 2.72)
_IV7: ELIX_arrythmia	96 (2.29)	48 (1.26)	11.88 (0.001)	1.83 (1.29, 2.60)
_IV8: arteriosclerosis	93 (2.22)	58 (1.53)	5.15 (0.023)	1.46 (1.05, 2.04)
_IV9: coronary heart disease	639 (15.25)	277 (7.29)	124.26 (0.000)	2.29 (1.97, 2.65)

Table 3-1. Distribution of hypertension patients by gender comorbidity (COM)

Variable	Male: Count (%)	Female: Count (%)	Chisq (p-value)	Odds Ratio (95% Confidence limit)
Total	N=12927	N=17931		
_IV1: CKD stage 3-5	3254 (25.17)	4573 (25.50)	0.44 (0.509)	0.98 (0.93, 1.04)
_IV11: nephropathy	2292 (17.73)	3235 (18.04)	0.49 (0.482)	0.98 (0.92, 1.04)
_IV12: ESRD	2513 (19.44)	3716 (20.72)	7.69 (0.006)	0.92 (0.87, 0.98)
_IV14: CKD stage 1-2	725 (5.61)	978 (5.45)	0.34 (0.558)	1.03 (0.93, 1.14)
_IV2: stroke	2168 (16.77)	3055 (17.04)	0.38 (0.538)	0.98 (0.92, 1.04)
_IV3: ELIX_CHF	5963 (46.13)	8375 (46.71)	1.01 (0.315)	0.98 (0.93, 1.02)
_IV4: ELIX_depression	4351 (33.66)	6300 (35.13)	7.24 (0.007)	0.94 (0.89, 0.98)
_IV5: hyperlipidemia	10882 (84.18)	15275 (85.19)	5.90 (0.015)	0.93 (0.87, 0.99)
_IV6: uremia	1315 (10.17)	1919 (10.70)	2.25 (0.134)	0.94 (0.88, 1.02)
_IV7: ELIX_arrythmia	3291 (25.46)	4502 (25.11)	0.49 (0.484)	1.02 (0.97, 1.07)
_IV8: arteriosclerosis	3509 (27.14)	5069 (28.27)	4.73 (0.030)	0.95 (0.90, 0.99)
_IV9: coronary heart disease	10065 (77.86)	14134 (78.82)	4.13 (0.042)	0.94 (0.89, 1.00)

Table 3-2. Distribution of hypertension patients by gender comorbidity (CMS)

Tables 4-1 and 4-2 show the top five comorbidities by age group for incidence rate. The incidence rate is calculated as the ratio of patient count for comorbidities happen after only hypertension to patient count for hypertension. Comparison of the age groups under 40 years old to the age groups over 40 years old indicates different top comorbidities. In the CMS population, mostly heart-related diseases dominate. In the CMS population, depression shows up as the fourth top comorbidity, but in the COM population, depression shows up as the number one comorbidity for the 20-39 age group.

Age Group	Count	Top 1	Top 2	Top 3	Top 4	Top 5
0-9	8	_IV3: ELIX_CHF (25%)	_IV4: ELIX_depression (12.5%)	_IV1: CKD stage 3-5 (0%)	_IV11: nephropathy (0%)	_IV12: ESRD (0%)
10-19	51	_IV3: ELIX_CHF (7.84%)	_IV4: ELIX_depression (7.84%)	_IV1: CKD stage 3-5 (3.92%)	_IV14: CKD stage 1-2 (3.92%)	_IV11: nephropathy (1.96%)
20-29	220	_IV4: ELIX_depression (14.09%)	_IV5: hyperlipidemia (5%)	_IV3: ELIX_CHF (4.09%)	_IV1: CKD stage 3-5 (1.36%)	_IV14: CKD stage 1-2 (1.36%)
30-39	604	_IV4: ELIX_depression (17.38%)	_IV5: hyperlipidemia (12.42%)	_IV3: ELIX_CHF (3.81%)	_IV9: coronary heart disease (2.98%)	_IV8: arteriosclerosis (1.16%)
40-49	1694	_IV5: hyperlipidemia (16%)	_IV4: ELIX_depression (13.75%)	_IV9: coronary heart disease (5.84%)	_IV3: ELIX_CHF (5.61%)	_IV7: ELIX_arrythmia (1.89%)
50-59	3347	_IV5: hyperlipidemia (19.27%)	_IV4: ELIX_depression (14.07%)	_IV9: coronary heart disease (12.37%)	_IV3: ELIX_CHF (5.35%)	_IV11: nephropathy (2.27%)
60-64	2066	_IV5: hyperlipidemia (21.01%)	_IV9: coronary heart disease (18.54%)	_IV4: ELIX_depression (12.2%)	_IV3: ELIX_CHF (7.12%)	_IV1: CKD stage 3-5 (3.15%)

Table 4-1. Top 5 comorbidities of hypertension by age group (COM, incidence rate (%) in parentheses)

Age Group	Count	Top 1	Top 2	Top 3	Top 4	Top 5
65-69	8030	_IV5: hyperlipidemia (83.41%)	_IV9: coronary heart disease (74.78%)	_IV3: ELIX_CHF (41.46%)	_IV4: ELIX_depression (31.61%)	_IV8: arteriosclerosis (24.71%)
70-74	7030	_IV5: hyperlipidemia (84.32%)	_IV9: coronary heart disease (77.07%)	_IV3: ELIX_CHF (45.15%)	_IV4: ELIX_depression (33.74%)	_IV8: arteriosclerosis (25.46%)
75-79	5922	_IV5: hyperlipidemia (84.8%)	_IV9: coronary heart disease (79.82%)	_IV3: ELIX_CHF (47.43%)	_IV4: ELIX_depression (35.29%)	_IV8: arteriosclerosis (28.23%)
80-84	4922	_IV5: hyperlipidemia (86.1%)	_IV9: coronary heart disease (81.53%)	_IV3: ELIX_CHF (49.78%)	_IV4: ELIX_depression (35.62%)	_IV8: arteriosclerosis (31%)
85-89	3084	_IV5: hyperlipidemia (86.61%)	_IV9: coronary heart disease (81.55%)	_IV3: ELIX_CHF (51.82%)	_IV4: ELIX_depression (37.81%)	_IV8: arteriosclerosis (32.78%)
90-	1870	_IV5: hyperlipidemia (85.56%)	_IV9: coronary heart disease (81.34%)	_IV3: ELIX_CHF (52.3%)	_IV4: ELIX_depression (39.14%)	_IV8: arteriosclerosis (31.82%)

Table 4-2. Top 5 comorbidities of hypertension by age group (CMS, incidence rate (%) in parentheses)

Table 5-1 and Figure 5-2 show how to cluster similar patterns of comorbidities in the COM and CMS populations. Group 1 from COM and Group 5 from CMS have hyperlipidemia and heart disease, but this indicates different patterns for each group. In COM, hyperlipidemia shows at Top2 in the age group 20-39 and at Top1 in the age group 40-64 and incidence rate is increased as the age is older. In CMS, hyperlipidemia shows at Top1 all age group, and the incidence rate is very high.

Group	Variable	Group	Variable
1	_IV5: hyperlipidemia	1	_IV3: ELIX_CHF
1	_IV9: coronary heart disease	1	_IV4: ELIX_depression
2	_IV11: nephropathy	2	_IV11: nephropathy
2	_IV12: ESRD	2	_IV12: ESRD
2	_IV14: CKD stage 1-2	2	_IV1: CKD stage 3-5
2	_IV1: CKD stage 3-5	2	_IV2: stroke
2	_IV2: stroke	2	_IV7: ELIX_arrythmia
2	_IV6: uremia	2	_IV8: arteriosclerosis
2	_IV7: ELIX_arrythmia	3	_IV14: CKD stage 1-2
2	_IV8: arteriosclerosis	3	_IV6: uremia
4	_IV4: ELIX_depression	5	_IV5: hyperlipidemia
5	_IV3: ELIX_CHF	5	_IV9: coronary heart disease

Table 5-1. Clustering groups of comorbidities (Left: COM, Right: CMS)

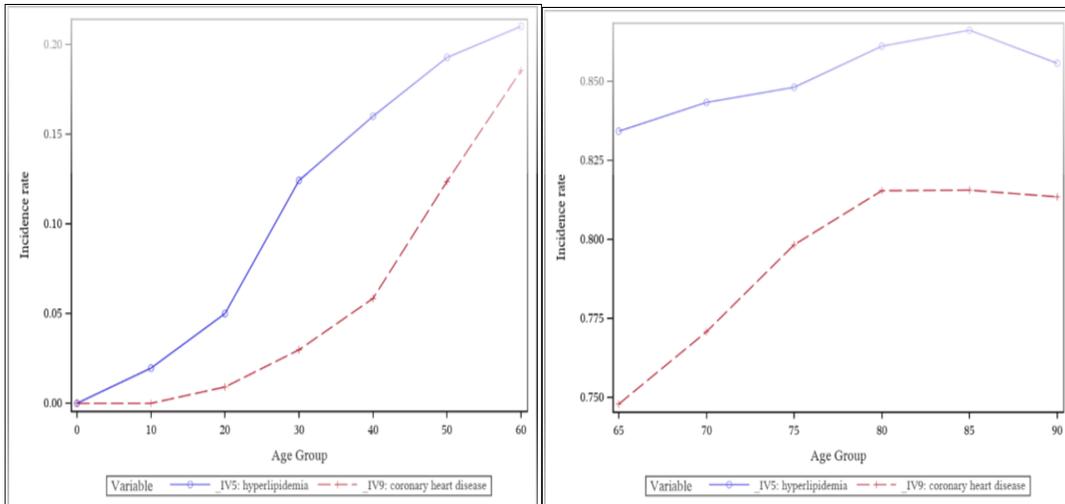


Figure 5-2. Clustering of comorbidities (Left: COM Group 1, Right: CMS Group 5)

Next, the medication patterns for hypertension patients are considered. Table 6, Figures 7-1, 7-2, and Tables 8-1 and 8-2 show patients that have taken one medication or two medications. The COM group uses more ACE inhibitors than beta blockers.

Drug Name	Member Count	Percent(%)
ACE_INHIBITO	965	63.11
BETABLOCKER	755	49.38
Number of Patients with Event	1529	100.00

Drug Name	Member Count	Percent(%)
ACE_INHIBITO	8159	68.52
BETABLOCKER	7389	62.05
Number of Patients with Event	11908	100.00

Table 6. Medication patient count (Left: COM, Right: CMS)

Figure 7-1 shows the partial age groups from both the COM and CMS data. The 60-69 age group in CMS data has a lower count because this age group begins over 65. The frequency is number of prescription fills.

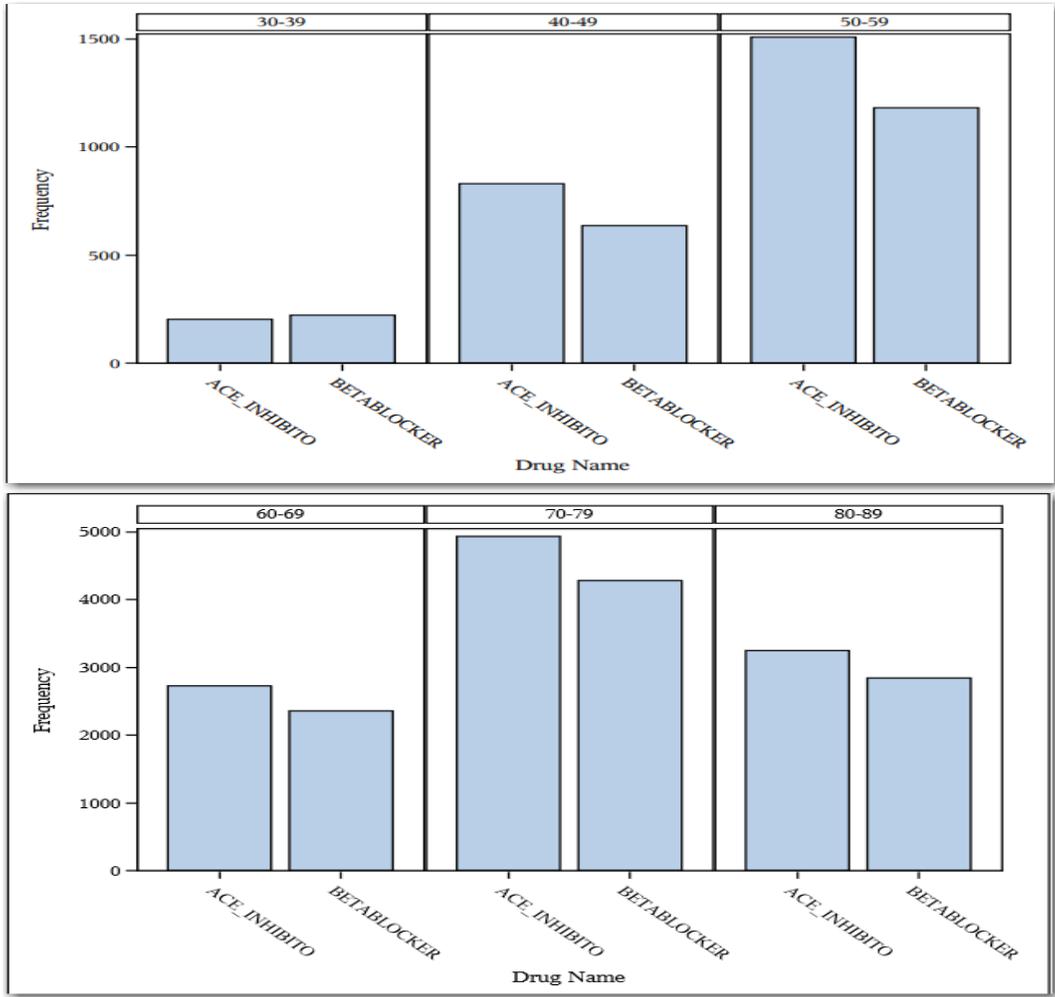


Figure 7-1. Medications fill count by age (Top: COM, Bottom: CMS)

By gender, the younger group of females has a similar count of two medications.

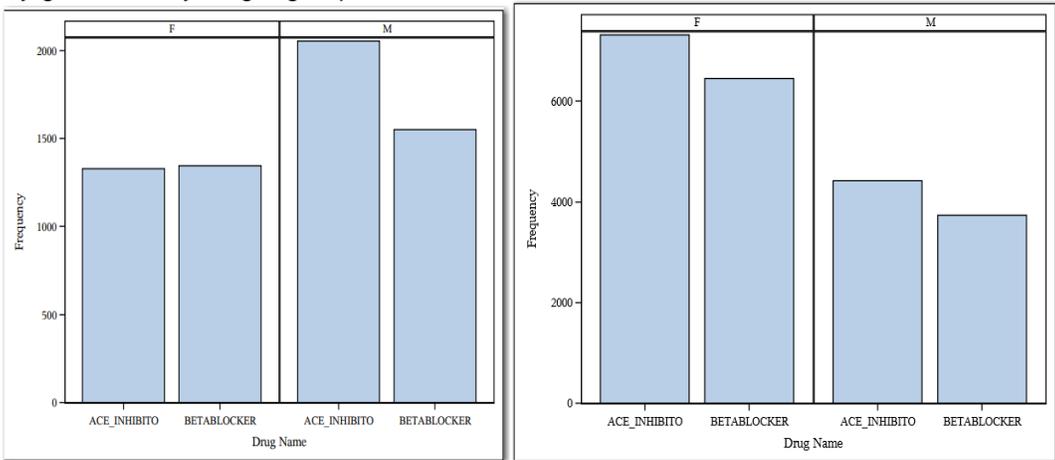


Figure 7-2. Medications fill count by gender (Left: COM, Right: CMS)

Table 8-1 and 8-2 show how patients keep or switch medication classes. The COM population takes ACE inhibitors longer with stopping, but the CMS population takes one drug for a longer time without a gap.

1-Initial Episode	2-Second Episode	3-Third Episode	Frequency Count	Percent(%)
ACE_INHIBITO (n=902)			244	27.05
ACE_INHIBITO	ACE_INHIBITO		158	17.52
ACE_INHIBITO	ACE_INHIBITO	ACE_INHIBITO	385	42.68
ACE_INHIBITO	ACE_INHIBITO	BETABLOCKER	15	1.66
ACE_INHIBITO	BETABLOCKER		23	2.55
ACE_INHIBITO	BETABLOCKER	ACE_INHIBITO	51	5.65
ACE_INHIBITO	BETABLOCKER	BETABLOCKER	26	2.88
BETABLOCKER (n=627)			176	28.07
BETABLOCKER	ACE_INHIBITO		5	0.80
BETABLOCKER	ACE_INHIBITO	ACE_INHIBITO	14	2.23
BETABLOCKER	ACE_INHIBITO	BETABLOCKER	17	2.71
BETABLOCKER	BETABLOCKER		87	13.88
BETABLOCKER	BETABLOCKER	ACE_INHIBITO	14	2.23
BETABLOCKER	BETABLOCKER	BETABLOCKER	314	50.08

1-Initial Episode	2-Second Episode	3-Third Episode	Frequency Count	Percent(%)
ACE_INHIBITO (n=6416)			3193	49.77
ACE_INHIBITO	ACE_INHIBITO		982	15.31
ACE_INHIBITO	ACE_INHIBITO	ACE_INHIBITO	432	6.73
ACE_INHIBITO	ACE_INHIBITO	BETABLOCKER	312	4.86
ACE_INHIBITO	BETABLOCKER		794	12.38
ACE_INHIBITO	BETABLOCKER	ACE_INHIBITO	393	6.13
ACE_INHIBITO	BETABLOCKER	BETABLOCKER	310	4.83
BETABLOCKER (n=5492)			2799	50.97
BETABLOCKER	ACE_INHIBITO		768	13.98
BETABLOCKER	ACE_INHIBITO	ACE_INHIBITO	313	5.70
BETABLOCKER	ACE_INHIBITO	BETABLOCKER	357	6.50
BETABLOCKER	BETABLOCKER		740	13.47
BETABLOCKER	BETABLOCKER	ACE_INHIBITO	260	4.73
BETABLOCKER	BETABLOCKER	BETABLOCKER	255	4.64

Table 8-1. Distribution of medications over time (Top: COM, Bottom: CMS)

1-Initial Episode	2-Second Episode	3-Third Episode	Frequency Count	Percent(%)
Initial Drug (n=1529)			420	27.47
Initial Drug	Continue Drug		245	16.02
Initial Drug	Continue Drug	Continue Drug	699	45.72
Initial Drug	Continue Drug	Switch Drug	29	1.90
Initial Drug	Switch Drug		28	1.83
Initial Drug	Switch Drug	Continue Drug	40	2.62
Initial Drug	Switch Drug	Switch Drug	68	4.45

1-Initial Episode	2-Second Episode	3-Third Episode	Frequency Count	Percent(%)
Initial Drug (n=11908)			5992	50.32
Initial Drug	Continue Drug		1722	14.46
Initial Drug	Continue Drug	Continue Drug	687	5.77
Initial Drug	Continue Drug	Switch Drug	572	4.80
Initial Drug	Switch Drug		1562	13.12
Initial Drug	Switch Drug	Continue Drug	623	5.23
Initial Drug	Switch Drug	Switch Drug	750	6.30

Table 8-2. Distribution of medication changes over time (Top: COM, Bottom: CMS)

Tables 9,10, and 11 show the number of patients that have not taken combinations of two medications. Table 9 shows the total medical cost for each group, Table 10 shows length of stay, and Table 11 shows heart disease counts. We can use the three tables to create a guideline for medications and determine which drug treatment group can save costs or reduce length of stay or heart disease rate.

Table 9 shows that the beta blockers and ACE inhibitors group saves the most in terms of total medical cost using either COM or CMS data.

First Treatment	Second Treatment	Count	Number of Patients having Nonzero Cost	Mean of Cost	STD of Cost	Minimum of Cost	Maximum of Cost
ACE_INHIBITO		774	737	11524.70	22154.57	73.14	242500.63
ACE_INHIBITO	BETABLOCKER	128	116	16163.48	30290.40	95.67	269370.72
BETABLOCKER		564	532	15309.72	28850.75	70.59	291657.35
BETABLOCKER	ACE_INHIBITO	63	59	10901.59	15953.88	110.71	93838.19

First Treatment	Second Treatment	Count	Number of Patients having Nonzero Cost	Mean of Cost	STD of Cost	Minimum of Cost	Maximum of Cost
ACE_INHIBITO		4521	4207	11701.02	15916.70	10	232446
ACE_INHIBITO	BETABLOCKER	1906	1769	10997.07	14376.67	10	147050
BETABLOCKER		3755	3488	11999.45	15499.24	20	162582
BETABLOCKER	ACE_INHIBITO	1748	1612	10445.98	14423.49	10	164074

Table 9. Total cost in taking one or two medications (Top: COM, Bottom: CMS)

In Table 10, for the COM data, ACE inhibitors have a 7.9% inpatient rate; ACE inhibitors and beta blockers have a 7.0% inpatient rate; beta blockers have a 7.8% inpatient rate; beta blockers and ACE inhibitors have a 11.1% inpatient rate. Those patients taking ACE inhibitors and beta blockers have a lower admission rate. For the CMS data, ACE inhibitors have an 18.8% coronary heart disease rate; ACE inhibitors and beta blockers have a 16.8% coronary heart disease rate; beta blockers have a 19.8% coronary heart disease rate; beta blockers and ACE inhibitors have a 16.6% coronary heart disease rate. Those patients taking beta blockers and ACE inhibitors have a lower admission rate.

First Treatment	Second Treatment	Count	Number of Inpatients	Mean of LOS	STD of LOS	Minimum of LOS	Maximum of LOS
ACE_INHIBITO		774	61	4.89	4.78	2	38
ACE_INHIBITO	BETABLOCKER	128	9	5.67	2.55	3	10
BETABLOCKER		564	44	4.82	4.42	1	26
BETABLOCKER	ACE_INHIBITO	63	7	3.71	1.80	2	7

First Treatment	Second Treatment	Count	Number of Inpatients	Mean of LOS	STD of LOS	Minimum of LOS	Maximum of LOS
ACE_INHIBITO		4521	850	6.63	5.53	1	36
ACE_INHIBITO	BETABLOCKER	1906	321	6.77	5.62	1	36
BETABLOCKER		3755	745	6.60	5.44	1	36
BETABLOCKER	ACE_INHIBITO	1748	290	6.27	4.90	1	36

Table 10. Length of stay in taking two medications (Top: COM, Bottom: CMS)

In Table 11, for the COM data, ACE inhibitors have a 4.9% coronary heart disease rate; ACE inhibitors and beta blockers have an 8.6% coronary heart disease rate; beta blockers have a 6.4% coronary heart disease rate; and beta blockers and ACE inhibitors have a 7.9% coronary heart disease rate. Those patients taking only ACE inhibitors have a lower occurrence of coronary heart disease. For the CMS data, ACE inhibitors have a 24.6% coronary heart disease rate; ACE inhibitors and beta blockers have a 12.3% coronary heart disease rate; beta blockers have a 23.7% coronary heart disease rate; beta blockers and ACE inhibitors have a 14.9% coronary heart disease rate. Those patients taking ACE inhibitors and beta blockers have a lower occurrence of coronary heart disease.

First Treatment	Second Treatment	Count	Number of Patients having _IV9_coronaryheartdisease
ACE_INHIBITO		774	38
ACE_INHIBITO	BETABLOCKER	128	11
BETABLOCKER		564	36
BETABLOCKER	ACE_INHIBITO	63	5

First Treatment	Second Treatment	Count	Number of Patients having _IV9_coronaryheartdisease
ACE_INHIBITO		4521	1111
ACE_INHIBITO	BETABLOCKER	1906	234
BETABLOCKER		3755	891
BETABLOCKER	ACE_INHIBITO	1748	261

Table 11. Heart disease count in taking two medications (Top: COM, Bottom: CMS)

CONCLUSION

For the COM population, stroke, coronary heart disease, and chronic kidney disease have the highest occurrence in males. For the CMS population, comorbidities do not display as large of a gender difference as seen in the COM population. In the CMS population, mostly heart-related diseases dominate. In the COM population, depression shows up as the top comorbidity for the 20-39 age group. In both COM and CMS populations, hyperlipidemia and heart disease belong to the same group, but this indicates different patterns for each population.

The beta blockers and ACE inhibitors group saves the most on total medical costs for both COM and CMS populations. For the COM population, those patients taking ACE inhibitors and beta blockers have a lower admission rate; those patients taking only ACE inhibitors have lower occurrence in coronary heart disease. For the CMS population, those patients taking beta blockers and ACE inhibitors have a lower admission rate; those patients taking ACE inhibitors and beta blockers have lower occurrence in coronary heart disease.

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