

APPENDIX

Zulman DM, *et al.* Multimorbidity and health care utilization among high-cost patients in the U.S. Veterans Affairs Health Care System. *BMJ Open*.

Appendix Table 1. Prevalence of chronic conditions^a among high-cost patients and the remaining population receiving VA care in 2010

	High-Cost Patients ^b n = 261,699 %	Remaining Population n = 4,972,295 %	Relative Prevalence ^c RP (95% C.I.)
Circulatory Conditions	70	37	1.89 (1.89, 1.90)
Hypertension	63	34	1.88 (1.88, 1.89)
Ischemic Heart Disease	27	9	3.09 (3.07, 3.11)
Heart Failure	13	2	7.67 (7.58, 7.76)
Peripheral Vascular Disease	10	2	4.87 (4.81, 4.93)
Stroke	8	2	4.47 (4.40, 4.54)
Mental Health Conditions and Dementia	48	19	2.57 (2.56, 2.58)
Depression	29	11	2.76 (2.74, 2.77)
Post-Traumatic Stress Disorder	17	8	2.26 (2.24, 2.28)
Bipolar Disorder	6	2	3.98 (3.91, 4.04)
Alcohol/Drug Dep/Abuse	20	4	5.35 (5.30, 5.39)
Borderline	1	0.1	9.35 (8.89, 9.83)
Other Personality Disorder	2	0.3	6.97 (6.76, 7.20)
Schizophrenia	6	1	5.19 (5.10, 5.28)
Other Psychosis	2	0.4	6.13 (5.95, 6.31)
Alzheimer's	1	0.3	3.34 (3.19, 3.49)
Endocrine Conditions	39	21	1.87 (1.86, 1.88)
Diabetes	34	18	1.87 (1.86, 1.88)
Thyroid disorder	8	4	2.21 (2.18, 2.24)
Musculoskeletal Conditions	34	16	2.13 (2.12, 2.14)
Low Back Pain	21	10	2.15 (2.13, 2.17)
Arthritis	19	8	2.41 (2.39, 2.43)
Osteoporosis	2	1	2.92 (2.83, 3.01)
Genitourinary Conditions	25	7	3.39 (3.36, 3.41)
Chronic Renal Failure	14	2	6.01 (5.94, 6.08)
Prostatic Hypertrophy	11	5	2.32 (2.29, 2.34)
Urinary Incontinence	6	1	4.73 (4.65, 4.82)
Cancer	25	5	4.75 (4.73, 4.80)
Respiratory Conditions	21	6	3.41 (3.38, 3.43)
Chronic Obstructive Pulmonary Disease	19	5	3.83 (3.80, 3.86)
Asthma	3	2	2.26 (2.22, 2.31)
Nervous System/Sense Organs	19	12	1.57 (1.55, 1.58)
Parkinson's	1	1	2.57 (2.49, 2.67)
Multiple Sclerosis	1	0.2	4.56 (4.36, 4.77)
Vision Disorder	9	4	2.51 (2.48, 2.54)
Hearing Disorder	10	9	1.14 (1.13, 1.15)
Gastrointestinal Conditions	18	7	2.62 (2.60, 2.65)
Acid-Related Disorder	18	7	2.62 (2.60, 2.65)
Infectious Diseases	9	2	5.14 (5.07, 5.21)
Hepatitis C	8	2	5.41 (5.33, 5.49)
HIV/AIDS	2	0.4	4.80 (4.64, 4.96)
Spinal Cord Injury	2	0.3	11.39 (11.02, 11.77)

^aChronic condition body system groupings per Agency for Healthcare Research and Quality HCUP 2011 algorithm.

^bHigh-cost patients represent the 5% highest cost patients who received inpatient or outpatient care in the VA healthcare system between October 1, 2009 and September 30, 2010.

^cRelative prevalence was calculated by comparing the prevalence of a condition (or body system affected by chronic conditions) among high-cost patients and the remaining population receiving VA care. The 95% confidence intervals were calculated on the ratio of proportions.

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Appendix Table 2. Chronic condition triads observed among high-cost VA patients^a

Condition 1	Condition 2	Condition 3	Prevalence of Triad (%)
Diabetes	Hyperlipidemia	Hypertension	19.2
Hyperlipidemia	Hypertension	Ischemic Heart Disease	16.9
Diabetes	Hypertension	Ischemic Heart Disease	12.2
Depression	Hyperlipidemia	Hypertension	10.5
Diabetes	Hyperlipidemia	Ischemic Heart Disease	10.2
Cancer	Hyperlipidemia	Hypertension	8.6
COPD	Hyperlipidemia	Hypertension	8.2
Hyperlipidemia	Hypertension	Lower Back Pain	7.9
Hyperlipidemia	Hypertension	Tobacco/Nicotine Dependence	7.7
Depression	Diabetes	Hypertension	7.7
Chronic Renal Failure	Diabetes	Hypertension	7.6
Congestive Heart Failure	Hypertension	Ischemic Heart Disease	7.3
Congestive Heart Failure	Hyperlipidemia	Hypertension	7.1
Chronic Renal Failure	Hyperlipidemia	Hypertension	7.1
Congestive Heart Failure	Diabetes	Hypertension	6.5
Cancer	Diabetes	Hypertension	6.4
COPD	Hypertension	Ischemic Heart Disease	6.3
Depression	Diabetes	Hyperlipidemia	6.1
Hyperlipidemia	Hypertension	PTSD	6.0
COPD	Diabetes	Hypertension	6.0
Depression	Hypertension	PTSD	6.0
Depression	Hypertension	Lower Back Pain	5.9
Congestive Heart Failure	Hyperlipidemia	Ischemic Heart Disease	5.8
Depression	Hypertension	Ischemic Heart Disease	5.6
Diabetes	Hypertension	Lower Back Pain	5.6
Chronic Renal Failure	Hypertension	Ischemic Heart Disease	5.6
Hyperlipidemia	Hypertension	Peripheral Vascular Disease	5.5
Depression	Hypertension	Tobacco/Nicotine Dependence	5.5
Hyperlipidemia	Hypertension	Prostatic Hyperplasia	5.3
COPD	Hyperlipidemia	Ischemic Heart Disease	5.2
Chronic Renal Failure	Diabetes	Hyperlipidemia	5.0

^a High-cost patients represent the 5% most costly patients (n = 261,699) who received inpatient or outpatient care in the VA healthcare system between October 1, 2009 and September 30, 2010. Triads are reported if they were observed among $\geq 5\%$ of high-cost patients.

COPD = Chronic Obstructive Pulmonary Disease, PTSD = Post-Traumatic Stress Disorder

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Appendix Table 3. Sensitivity analyses examining relationship between multimorbidity and absolute^a and share^b of total costs generated through inpatient, outpatient, and pharmacy care among high-cost VA patients, after excluding individuals who died in year of investigation (n = 226,241)

Number of Body Systems Affected by Chronic Conditions		TOTAL ^c	INPATIENT		OUTPATIENT		PHARMACY	
n	Predicted Costs	Predicted Costs	Predicted Share of Total	Predicted Costs	Predicted Share of Total	Predicted Costs	Predicted Share of Total	
1	26,575	69,192	38,901	48.2	17,560	30.7	4,736	8.2
2	48,664	67,406	37,195	49.0	18,977	32.5	4,482	7.8
3	59,395	69,137	37,642	48.4	20,370	34.0	4,525	8.0
4	48,465	71,434	38,757	47.7	21,743	35.5	4,713	8.2
5	27,646	73,311	39,783	47.4	22,722	36.5	5,082	8.5
6	11,447	76,869	41,792	46.7	24,103	37.4	5,401	8.8
7+	4,049	80,188	43,080	46.2	25,539	38.2	6,043	9.0
Average Difference ^d		1,714*	670*	-0.4*	1,306*	1.4*	161*	0.2*

^a Predicted absolute costs are generated via multivariate linear regression examining associations between number of body systems affected by chronic conditions and costs, adjusting for age, sex, race/ethnicity, marital status, homelessness, and insurance status.

^b Predicted shares of total cost are generated via fractional logistic regression examining associations between number of body systems affected by chronic conditions and shares of total cost within each domain of care, adjusting for age, sex, race/ethnicity, marital status, homelessness, and insurance status.

^c Component costs and cost shares sum approximately to total when VA-sponsored contract care (omitted for clarity) is included. Note that dividing predicted component costs by predicted total costs does not equal the predicted share of total. The former is a ratio of means and the latter is a mean of ratios, and although both procedures estimate the same quantity, they are not guaranteed to produce the same result. The two procedures do, however, produce comparable results.

^d Average differences represent change in costs (for absolute costs) or percentage point change in share of cost (for share of total cost generated within each domain of cost) for each additional body system affected by chronic conditions.

* P < 0.01.

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Appendix Table 4. Sensitivity analyses depicting the relationship between multimorbidity (as measured by number of chronic conditions) and absolute^a and share^b of total costs generated through inpatient, outpatient, and pharmacy care among high-cost VA patients (n = 253,650)

Number of Chronic Conditions	n	TOTAL ^c		INPATIENT		OUTPATIENT		PHARMACY	
		Predicted Costs	Predicted Costs	Predicted Share of Total	Predicted Costs	Predicted Share of Total	Predicted Costs	Predicted Share of Total	
1	19,920	73,819	42,371	47.9	15,634	26.5	5,556	9.0	
2	33,232	69,433	39,316	49.6	17,277	29.5	4,981	8.1	
3	45,042	68,403	38,547	50.5	18,387	31.2	4,453	7.5	
4	47,129	69,855	39,578	50.6	19,426	32.5	4,279	7.2	
5	40,474	71,957	41,060	50.5	20,615	33.6	4,322	7.2	
6	29,802	74,404	42,790	50.4	21,311	34.2	4,345	7.2	
7	18,753	77,059	44,583	50.6	22,153	34.6	4,422	7.2	
8	10,524	80,732	46,751	50.6	23,482	34.9	4,744	7.4	
9	5,080	82,738	48,827	51.2	23,835	34.9	4,793	7.3	
10+	3,694	88,502	52,333	50.8	24,823	34.7	5,264	7.7	
Average Difference ^d			1,034*	0.2*	1,024*	1.0*	-76.80*	-0.2*	

^a Predicted absolute costs are generated via multivariate linear regression examining the association between number of chronic conditions and costs, adjusting for age, sex, race/ethnicity, marital status, homelessness, and insurance status.

^b Predicted shares of total cost are generated via fractional logistic regression examining the association between number of chronic conditions and shares of total cost within each domain of care, adjusting for age, sex, race/ethnicity, marital status, homelessness, and insurance status

^c Component costs and cost shares sum approximately to total when VA-sponsored contract care (omitted for clarity) is included. Note that dividing predicted component costs by predicted total costs does not equal the predicted share of total. The former is a ratio of means and the latter is a mean of ratios, and although both procedures estimate the same quantity, they are not guaranteed to produce the same result. The two procedures do, however, produce comparable results.

^d Average differences represent change in costs (for absolute costs) or percentage point change in share of cost (for share of total cost generated within each domain of cost) for each additional chronic condition.

* P < 0.01

The sensitivity analyses depicted in Appendix Table 4 can be compared to primary analyses reported in Table 2 in the main text. Analyzing multimorbidity in terms of number of chronic conditions (Appendix Table 4) instead of number of systems affected by chronic conditions (Table 2) results in subtle pattern differences. Because there are more chronic conditions than body systems, the results are more granular in Appendix Table 4, and the high-cost extreme values drive the average differences in cost and share of cost. This is particularly noticeable for predicted total costs and predicted inpatient costs, and results in a small but statistically significant increase in inpatient share of total cost (compared to the decrease observed in the primary analyses). The positive and strong association between multimorbidity and predicted share of outpatient costs is unchanged, however.