Challenges in Controlling Medicare Spending: Treating Highly Complex Patients*

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ABSTRACT

Complex patients with many comorbid conditions are among the highest-cost users of Medicare, and they constitute an important source of growth in Medicare expenditures. This paper analyzes the universe of 2009 Medicare claims to characterize the complexity of patients with multiple comorbid conditions. The analysis finds that such patients cannot be placed into a small number of clinical bins; instead, the number of different combinations of comorbid conditions is staggeringly large and there are often very few patients with any particular combination of conditions. Furthermore, Medicare expenditures on patients grow non-linearly with the number of comorbid conditions afflicting patients. The results have important implications for existing risk adjustment methods used by Medicare, which do not sufficiently account for the way interactions among comorbid conditions tend to increase costs. Finally, the results suggest that disease management and care coordination programs will face a difficult challenge in coping with the heterogeneity of patient health conditions.

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1 INTRODUCTION

Medicare expenditures are rising at a persistent rate, with the government unable to maintain current levels of per capita services in the next several decades without either substantial increases in taxes or large reductions in other domestic spending. Over the long-term, Medicare faces significant financial challenges because of rising overall health care costs, increasing enrollment as the population ages, and a decreasing ratio of workers to enrollees. Total Medicare spending is projected to increase from 15% of all federal outlays in 2010 to nearly 18% of outlays by 2020, reaching 4% of the gross domestic product (GDP). By 2035, Medicare expenditures are expected to consume almost 6% of GDP.

Any policy offering hope of success in mitigating the unsustainable rise in Medicare expenses must focus its impacts on the highest-cost users of Medicare. For example, a May 2005 Congressional Budget Office analysis found that Medicare users who were ranked in the top 5% of health expenditures accounted for 43% of all expenditures; those ranked in the top 10% accounted for 61% of expenditures; while those ranked in the top 25% accounted for 81% of all expenditures. (CBO, 2005) Clearly, Medicare is unlikely to control spending growth unless it also controls spending growth of costs for high cost users because that is where the bulk of expenditures can be found.

Determining the characteristics of the high-intensity users is not as easy a task as one might first surmise, for this alone provides few insights unless one can also develop profiles linking attributes of these groups to their intense utilization. Uncovering such attributes reveals what behaviors policies must alter to be successful in curtailing program costs. For example, studies indicating that the majority of high-cost users are in their last year of life suggest that a large fraction of expenditures go to postponing inevitable mortality, implying that society must value short extensions in life at high values to justify the expenditures. Further, it suggests that capping expenses per person over a year will have only a minor impact on mortality, for such a policy primarily brings about an inevitable death earlier. Alternatively, programs proposed in Medicare to manage diseases or chronic conditions maintain that these afflictions identify high-cost users and that improved treatment will lower overall expenditures by preventing worsening circumstances leading to utilization of expensive services.

This study reveals that beneficiaries with multiple illnesses cost considerably more than would be predicted by adding up the costs of treatments for each disease/illness condition in isolation; increasing the number of comorbidities induces a multiplicative rather than an additive cost structure. While it is well known that patients with multiple co-morbidities (i.e., patients with more than one disease) account for a disproportionate amount of expenditures and mortality, the critical link between medical complexity and costs is not well understood. Moreover, the findings presented here highlight further complications since the patterns of disease/illness combinations are quite diverse with individual combinations populated by small numbers of patients. These empirical findings demonstrate that most Medicare expenditures are associated with small sets of medically complex patients.

The depictions of high-cost users uncovered in this study provide important policy insights into the designs of both Medicare reimbursements and approaches for incentivizing medical practices likely to be effective in lowering the growth of Medicare spending. In the area of reimbursement policy, the findings suggest that the risk adjustment models currently used by Medicare inadequately compensate for complex patients due to their cost structure that principally assumes linearity in health-condition indicators. In the area of policies aimed at encouraging medical practices to focus on lowering the expenses of treating high-cost patients, quality improvement programs such as disease management and care coordination must be formulated to individualize treatments necessary for patients suffering from a wide array of illnesses. Although these forms of medical practice can offer flexibility in dealing with comorbidities, the level of variability in comorbidities documented in this report indicates that care coordination models will be continually challenged with novel clinical situations. The relatively common occurrence of rare disease/illness combinations explains why popular care management paradigms have not produced anticipated cost savings and have frequently led to higher overall expenditures.

What follows in this report is organized into four remaining sections. Section 2 describes our approach for measuring the illness complexity of Medicare patients and presents the incidence and composition of illnesses among the patient population. Section 3 documents the extent to which medically complex patients have higher costs than patients with less complexity. Section 4 briefly discusses several implications regarding Medicare reimbursement policies. Finally, Section 5 presents a summary of results.

2 ILLNESS COMPLEXITY OF MEDICARE PATIENTS

This section describes the approach implemented in this analysis to assess the illness complexity of Medicare patients. To characterize the relationship between medical expenses and the complexity of patients' health status, the analysis first adopts a systematic method for classifying patient comorbidities, and then investigates how expenditures increase with increasing patient complexity. Section 2.1 explains the approach for classifying patients based on their illnesses and number of comorbidities, and Section 2.2 presents the incidence and composition of illnesses among the patient population.

2.1 Classification of Illnesses and Comorbidities

Since one of our essential goals in this research is to characterize patient complexity, we must first choose a disease classification system. In this choice, we are guided by several principles. First, we focus on a disease classification system based upon a system that is in active use by Centers for Medicare and Medicaid Services (CMS) for the purposes of provider payment, risk adjustment, or other important activities. This principle guarantees that our results will have direct operational implications for Medicare.

Second, we analyze disease classification systems that range from simpler to more detailed for the purposes of sensitivity analysis. Our choice of disease classification system has direct implications for our calculation of the number of patients with a distinct combination of diseases. A simple classification system, which aggregates many similar diseases, will necessarily elide clinical differences between patients. For instance, such a system might group together patients with early- and late-stage cancer. A too simple classification system will thus produce an underestimate of the range of patients with differing combinations of conditions.

Conversely, an overly detailed classification system makes clinical distinctions that, while important to medical personnel caring for patients, are not particularly important in predicting health care expenditures. Such a system will produce an overestimate of the range of patients with differing combinations of conditions. By analyzing multiple disease classification systems ranging from simpler to more detailed, our estimates will bracket the true complexity of Medicare patients.

Patients' diseases and comorbidities are key inputs into many of Medicare's payment systems. Perhaps the most well-known disease classification system used by CMS is the Hierarchical Condition Category (HCC) system. Medicare Advantage uses the HCC methodology, for instance, to amend a beneficiary's premiums based on the beneficiary's risk factors. This system is based on an underlying disease classification system, called condition categories (CCs), which though not as detailed as the full ICD-9 or ICD-10 disease classification system, still contains considerable detail distinguishing between various disease conditions. In this paper, we adopt and analyze the CC disease classification system since it meets both of our selection principles – the system is in use by Medicare, and it makes useful distinctions between diseases in classifying patient disease.

Our second selection principle requires us to consider a simpler classification system in addition to the detailed CC system. To this end, this analysis develops an illness condition (IC) classification system to identify the health conditions a patient has in a given month. This IC classification system is based on a simplification of the CC system. The following discussion describes the IC classification system and the process used to measure illness complexity.

Medicare uses a total of 71 different CCs to compute cost differentials, where each CC identifies whether a beneficiary experiences a particular illness.[1] A CC is assigned based on the diagnosis codes (ICD-9-CM) recorded on the individual's Parts A and B fee-for-service (FFS) claims, including those from inpatient (IP), skilled nursing (SNF), home health (HH), hospice (HS), outpatient (OP), physician (PB), and durable medical equipment (DME) claim files. Some groups of CCs identify the same illness, with individual CCs measuring different levels of severity within the illness; other CCs identify unique illnesses. Assigning a hierarchy to the CCs linked to a common illness produces the HCC representing this group.

The IC classification system developed here represents an alternative aggregation of the CC system, with the goal of aggregating CCs to ICs by unique illnesses. In particular, the analysis groups each CC in a set designating the same illness at different severity levels and into a single IC. Table 1 presents the complete mapping of CCs to the IC system. The left column designates a unique number for each of the 44 ICs for identification purposes; the center column describes the illness defined by the IC; and the last column lists the set of CCs aggregated into the IC. Among the 44 ICs, 16 of them are aggregations of multiple CCs while the remaining 28 each belong to a distinct CC illness category. For example, IC 8, myocardial infarction, consists of three CCs used in the HCC methodology to compute cost differentials: 81, 82, and 83. Conversely, IC 17, HIV/AIDS, only includes one CC.

Our IC classification system is more appropriate for our purposes than the HCC classification system. The latter system assigns patients a diagnosis code at the top of a hierarchy on the basis of the relative expenditures required for caring for patients with the conditions that make up that hierarchy. This procedure suppresses the complexity of caring for patients with conditions that are both high and low in the hierarchy. Instead, our IC system lumps together patients in the CC hierarchy, and thus reduces the *observed* clinical heterogeneity of patients. Our IC results are meant to be compared against our CC results, which (unlike the HCC or IC systems) reflect all of the complexity in the CC system.

[1] The standard 70 CCs used to calculate risk scores are incremented by Renal Failure which is used as a separate risk adjustment factor.

Table 1: List of Illness Categories

IC Number	Illness Category	CCs Included
1	Cancer	7-10
2	Diabetes	15-19, 119
3	Liver	25-27
4	Substance Abuse	51-52
5	Schizophrenia/Depression (Psychiatric)	54-55
6	Shock	2, 79
7	Respiratory Arrest	77-78
8	Myocardial Infarction	81-83
9	Stroke	95-96
10	Renal Failure	129-131
11	Skin Ulcers	148-149
12	Head Injury	154-155
13	Opportunistic Infections	5, 111-112
14	Paralysis	67-68, 100
15	Vertebral/Spinal Disorders	69, 157
16	Peripheral Vascular Disorders	104-105
17	HIV/AIDS	1
18	Protein-Calorie Malnutrition	21
19	Intestinal Obstruction/Perforation	31
20	Pancreatic Disease	32
21	Inflammatory Bowel Disease	33
22	Bone/Joint/Muscle Infect/Necrosis	37
23	Rheum Arthritis/Inflam Conn Tissue	38
24	Severe Hematological Disorders	44
25	Disorders of Immunity	45
26	Muscular Dystrophy	70
27	Polyneuropathy	71
28	Multiple Sclerosis	72
29	Parkinson’s and Huntington’s Disease	73
30	Seizure Disorders and Convulsions	74
31	Coma, Brain Compression/Anoxic Damage	75
32	Congestive Heart Failure	80
33	Specified Heart Arrhythmias	92
34	Cerebral Palsy, Other Paralytic Syndromes	101
35	Cystic Fibrosis	107
36	Chron. Obstructive Pulmonary Disease	108
37	Nephritis	132
38	Extensive Third-Degree Burns	150
39	Hip Fracture/Dislocation	158
40	Traumatic Amputation	161
41	Major Comp. of Medical Care/Trauma	164
42	Major Organ Transplant Status	174
43	Artificial Opens for Feeding/Elimination	176
44	Amputee Status/Lower Limb/Amput. Compl.	177

2.2 Incidence and Composition of Illnesses

Our analysis characterizes the illness complexity of a patient by counting the number of distinct combinations of ICs and CCs afflicting the patient during each month making up a calendar year. The assignment of a CC and an IC in a month is determined by checking diagnoses on eligible FFS claims in the five-month window surrounding the selected month, with the window comprised of the current month, the two months prior, and the two months after.[2] For the depiction of the health experiences presented here, the following empirical analysis calculates measures using the universe of FFS Medicare beneficiaries who had continuous Part A and B enrollment in 2009 while alive, preceded by two months of A and B enrollment in 2008 and followed by two months of A and B enrollment in 2010. The population consists of 32.9 million beneficiaries, 1.46 million of whom died during 2009.

Table 2 summarizes the incidence of each IC, as well as the number of distinct IC combinations and the total and average costs associated with beneficiaries with each IC. The second column reports the number of unique beneficiaries afflicted by the IC at least one month during 2009, and the third lists the total number of beneficiary-months with an assignment to the IC. The next two columns present the total number of *unique* IC combinations among beneficiary-months classified into each IC and the number of *unique* CC combinations among beneficiary-months classified into each IC, respectively. The calculation of Medicare payment includes all FFS claims for a beneficiary with service dates in that month, and the totals sum across months assigned to the designated IC.

Table 2 shows that there are many complex patients within each IC, and there is extreme variability among these patients regarding the combinations of comorbid conditions. Taking diabetes as an example, among the more than eight million patients in the diabetes IC category in 2009, there were over a million unique types of patients on the basis of IC combinations and over 3.2 million unique types of patients when characterized on the basis of the less aggregated CC system. This example demonstrates incredible clinical heterogeneity among diabetic Medicare patients, regardless of whether a more or less detailed clinical classification system is used to characterize comorbid conditions. Thus, the particular set of comorbid conditions experienced by a given diabetes patient may be rare among other diabetes patients, and the same holds true for patients classified into the other ICs reported above. Since IC and CC combinations in Table

[2] The assignment applies the same algorithm used in the CMS risk adjustment model. Considering inpatient, outpatient, and physician claims eligible for CMS risk adjustment, the algorithm excludes denied claims and claims that are not from an approved provider type. It further excludes physician and outpatient claims where the procedure codes indicate the claim was primarily used for laboratory tests, equipment, supplies, orthopedic, ambulance, or radiology services. The results presented in this paper registers occurrence of a health condition when relevant diagnoses show up on at least one claim in the 5 month window. The findings reported here change only marginally if a two claim threshold replaces the one claim criteria.

2 are defined at the month level, an individual beneficiary whose set of comorbidities changes across the year may account for multiple IC or CC combinations.

Table 2: Incidence, Composition, and Costs of Illness Categories

Illness Category (IC)	# Beneficiaries	# Bene Months	# Distinct IC Combinations	# Distinct CC Combinations	Total Medicare Part A/B Cost (millions)	Average Cost Per Bene Month
Respiratory Arrest	189,289	764,396	229,443	361,823	$12,580	$16,458
Third-Degree Burns	1,941	7,545	2,565	2,905	$116	$15,427
Cerebral Palsy	162,329	595,668	162,188	235,816	$6,762	$11,353
Malnutrition	803,879	3,251,735	637,787	1,121,418	$33,504	$10,303
Opportunistic Infections	860,009	3,457,486	561,525	1,101,990	$30,513	$8,825
Traumatic Amputation	54,785	262,230	60,160	104,924	$2,194	$8,368
Artificial Openings for Feeding/Elimination	367,252	1,836,347	365,456	569,180	$15,260	$8,310
Shock	2,623,864	11,470,864	1,120,007	2,551,410	$82,772	$7,216
Intestinal Obstruction/Perforation	834,837	3,400,597	441,813	774,567	$23,766	$6,989
Amputation	151,113	828,813	137,673	279,793	$5,694	$6,870
Trauma	1,426,494	6,378,361	615,012	1,239,189	$42,745	$6,702
Bone/Joint/Muscle Infection	398,169	1,929,716	269,033	497,871	$11,927	$6,180
Hip Fracture/Dislocation	601,626	2,889,510	244,021	421,016	$15,908	$5,505
Severe Hematological Disorder	406,786	2,345,658	261,575	482,959	$12,163	$5,185
Disorders of Immunity	345,965	1,776,422	176,886	328,699	$9,165	$5,159
Paralysis	720,901	3,881,990	431,552	796,082	$19,943	$5,137
Head Injury	308,769	1,318,585	171,933	270,757	$6,532	$4,954
Major Organ Transplant	77,623	562,163	69,222	119,296	$2,735	$4,865
Nephritis	314,648	1,569,702	156,675	337,230	$7,146	$4,552
Skin Ulcers	1,663,903	8,970,141	672,330	1,575,324	$38,646	$4,308
Renal Failure	3,864,397	24,942,694	1,062,844	2,769,880	$96,517	$3,870
Pancreatic Disease	544,758	2,627,137	242,323	420,950	$10,050	$3,825

Illness Category (IC)	# Beneficiaries	# Bene Months	# Distinct IC Combinations	# Distinct CC Combinations	Total Medicare Part A/B Cost (millions)	Average Cost Per Bene Month
Stroke	1,879,021	9,679,151	642,118	1,287,280	$36,974	$3,820
Vertebral/Spine	881,076	4,161,272	320,248	595,480	$14,813	$3,560
Cystic Fibrosis	8,692	49,527	7,549	9,651	$170	$3,442
Myocardial Infarction	3,305,127	16,554,603	608,504	1,706,839	$56,106	$3,389
Substance Abuse	608,278	3,098,318	256,207	467,987	$10,472	$3,380
Coma	5,045,466	31,684,378	1,082,904	2,770,567	$106,357	$3,357
Liver	454,089	2,691,715	234,741	481,393	$8,975	$3,334
Heart Arrhythmias	179,279	971,264	103,150	150,316	$2,943	$3,030
Seizure Disorders and Convulsions	1,177,065	7,592,712	462,119	814,415	$20,736	$2,731
Peripheral Vascular Disease	6,344,000	39,468,824	1,086,509	2,816,761	$101,168	$2,563
Polyneuropathy	2,116,592	11,783,943	503,750	1,143,192	$29,163	$2,475
Inflammatory Bowel Disease	312,395	1,856,224	128,624	196,399	$4,569	$2,461
Congestive Heart Failure	4,814,660	35,550,728	844,886	2,052,953	$87,305	$2,456
COPD	5,493,492	36,042,267	920,743	2,224,269	$86,409	$2,397
Muscular Dystrophy	22,961	140,401	16,262	20,883	$325	$2,316
Parkinson's/ Huntington's	570,521	4,317,794	196,521	345,475	$9,326	$2,160
Cancer	4,396,160	31,904,703	619,102	1,708,936	$62,600	$1,962
HIV/AIDS	116,835	1,089,221	55,540	86,946	$1,967	$1,806
Multiple Sclerosis	182,011	1,422,276	76,445	113,731	$2,513	$1,767
Psychiatric	2,514,992	19,416,247	499,391	1,042,345	$33,113	$1,705
Rheumatoid Arthritis	1,741,038	12,050,335	303,015	578,686	$18,256	$1,515
Diabetes	8,657,223	76,192,689	1,088,021	3,278,663	$114,998	$1,509

To provide a sense of the dynamics of individuals across states of illness complexity, Table 3 broadly examines patients' transitions across complexity spells. A spell here represents the span of time that a patient is classified in a given range of complexity level. The spell ends when either the patient's complexity level changes, the patient dies, or calendar year 2009 ends. This table demonstrates that "very complex" spells (consisting of seven or more ICs), while comparatively rare, are substantially more costly than less complex spells. Across the study period, about five percent of the total spells fell into the "very complex" category. The average monthly cost for these spells is $11,276, nearly three times the cost of "complex" spells (consisting of 4 to 6 ICs) and nearly 16 times the cost of "sick" spells (consisting of 1 to 3 ICs). Moreover, the high costs of "very complex" spells are not exclusively driven by expensive services associated with end-of-life care. About 18 percent of spells within this category ended in death, but over half ended with the patient moving to a lower level of complexity. Thus, complex patients do not tend to die at the end of a disease spell, but very often survive and transition into a healthier state.

Table 3: Transitions across Spells of Different Illness Complexities

Classification of Spell Complexity	**# Spells**	**Avg. Length of Spell** (months)	**Avg. Monthly Cost**	**Share of Spells Ending in Less Complex**	**Share of Spells Ending in More Complex**	**Share of Spells Ending in Death**	**Share of Spells Ending in the End of Period**
Sick (1-3 ICs)	27,563,337	6.1	$705	31%	15%	2%	52%
Complex (4-6 ICs)	7,055,328	3.5	$3,478	51%	14%	6%	29%
Very Complex (7+ ICs)	1,785,517	3.5	$11,276	54%	--	18%	29%

3 MEDICAL EXPENSE OF COMORBIDITIES

To explore the extent to which medically complex patients—those with more ICs in a given month—have higher costs than patients with less complexity, this section elaborates the relationship between costs and illness complexity in the Medicare population. Section 3.1 describes the distribution of Medicare expenditures across incidence of illness complexity, and Section 3.2 details how costs are compounded by any increase in illness complexity.

3.1 Relating Costs to Illness Complexity

Table 4 characterizes medical condition complexity by evaluating the number of combinations of ICs and CCs present in a patient during a month, and then measures the incidences of each status along with showing heterogeneity of illnesses within the status and costs associated with the level of complexity. The first group of columns shows the incidence of various illness complexities in the Medicare population in 2009. About 65% (21.4 of 32.9 million) of beneficiaries experienced at least one month with no ICs, and 45% of beneficiary-months in 2009 have no IC occurrence. The second group displays the number of distinct combinations of ICs and CCs making up each illness complexity level. The last group of columns present total Medicare expenditures in the months associated with each level of illness complexity, along with the average payment per beneficiary month, the average payment per IC per month, and the marginal change in the average cost per IC per month attributable to increasing medical complexity by an incremental IC.

Table 5 presents an alternative depiction of the information in Table 4 showing the cost of caring for beneficiaries categorized by their highest degree of illness complexity experienced during 2009. This table shows that 31% of beneficiaries experienced no ICs throughout the year, and that these beneficiaries jointly had nearly 113 million months of enrollment in 2009. For 6% of beneficiaries, their most complex month of illness complexity involved having 4 simultaneous ICs, and these beneficiaries jointly accounted for about 37 million months of enrollment in 2009. The remaining columns in Table 5 present numbers analogous to those in Table 4 with calculations done for the months listed in the third column.

Table 4: Expansion of Costs Associated with Illness Complexity

# Illness Categories	# Beneficiaries with Illness Complexity for at Least 1 Month	# Bene-Months with Illness Complexity	Share of Illness Complexity Months	# Distinct IC Combinations Associated with Illness Complexity	# Distinct CC Combinations Associated with Illness Complexity	Total Medicare Payments ($millions)	Share of Medicare Payments	Avg. Payment Per Bene Month	Avg. Payment Per IC Per Month	Marginal Change in Payment Per IC Per Month
0	21,447,305	166,847,086	45.48%	0	0	$24,921	8.3%	$149	--	--
1	17,168,325	96,090,578	26.19%	44	168	$40,788	13.6%	$424	$424	--
2	11,216,501	48,797,948	13.30%	932	8,446	$41,238	13.8%	$845	$423	-$2
3	6,862,826	24,476,762	6.67%	10,784	109,686	$37,343	12.5%	$1,526	$509	$86
4	4,223,018	12,926,046	3.52%	60,332	452,557	$32,864	11.0%	$2,542	$636	$127
5	2,654,623	7,235,988	1.97%	175,975	868,816	$28,282	9.4%	$3,909	$782	$146
6	1,699,076	4,229,539	1.15%	305,757	1,043,544	$23,692	7.9%	$5,602	$934	$152
7	1,092,717	2,531,285	0.69%	368,524	962,929	$19,164	6.4%	$7,571	$1,082	$148
8	698,512	1,527,395	0.42%	354,040	762,048	$15,049	5.0%	$9,853	$1,232	$150
9	440,125	915,266	0.25%	294,004	540,338	$11,371	3.8%	$12,424	$1,380	$149
10	273,395	545,512	0.15%	223,347	353,639	$8,337	2.8%	$15,282	$1,528	$148
11	166,927	320,362	0.09%	156,254	219,663	$5,988	2.0%	$18,693	$1,699	$171
12	99,502	185,079	0.05%	101,968	131,150	$4,102	1.4%	$22,164	$1,847	$148
13	58,070	105,008	0.03%	63,159	76,583	$2,718	0.9%	$25,883	$1,991	$144
14	32,373	56,797	0.02%	36,248	42,379	$1,671	0.6%	$29,428	$2,102	$111
15	17,184	29,507	0.01%	19,558	22,516	$985	0.3%	$33,389	$2,226	$124
>15	10,900	25,702	0.01%	18,064	20,403	$997	0.3%	$38,791	$2,320	$94

Table 5: Costs of Treating Beneficiaries Classified by Their Highest Degree of Illness Complexity

# Illness Categories	# Beneficiaries with Illness Complexity in Most Complex Month	# Bene-Months	Share of Beneficiaries	# Distinct IC Combinations Associated with Illness Complexity	# Distinct CC Combinations Associated with Illness Complexity	Total Medicare Payments ($millions)	Share of Medicare Payments	Avg. Payment Per Bene Month	Avg. Payment Per-IC Per-Month	Marginal Change in Payment Per-IC Per-Month
0	10,234,740	112,667,232	31.12%	0	0	$13,918	4.6%	$124	--	--
1	8,185,024	92,820,030	24.89%	45	168	$28,329	9.5%	$305	$494	--
2	5,351,918	61,080,948	16.28%	970	7,645	$34,460	11.5%	$564	$448	-$46
3	3,283,812	37,321,325	9.99%	10,819	88,339	$35,132	11.7%	$941	$494	$46
4	2,052,791	23,028,297	6.24%	58,718	362,531	$33,496	11.2%	$1,455	$573	$79
5	1,320,342	14,507,768	4.02%	175,436	771,449	$30,728	10.3%	$2,118	$670	$97
6	870,727	9,337,048	2.65%	330,990	1,084,757	$27,328	9.1%	$2,927	$773	$103
7	575,924	6,021,968	1.75%	453,591	1,192,854	$23,388	7.8%	$3,884	$879	$107
8	378,487	3,863,796	1.15%	503,611	1,117,835	$19,341	6.5%	$5,006	$988	$109
9	244,062	2,443,357	0.74%	486,185	932,916	$15,317	5.1%	$6,269	$1,096	$108
10	154,311	1,521,062	0.47%	422,644	709,197	$11,730	3.9%	$7,712	$1,207	$111
11	96,052	935,066	0.29%	337,620	502,903	$8,754	2.9%	$9,362	$1,326	$118
12	58,529	563,452	0.18%	249,240	336,485	$6,308	2.1%	$11,195	$1,443	$117
13	34,907	333,435	0.11%	171,989	215,993	$4,396	1.5%	$13,185	$1,552	$109
14	20,134	191,839	0.06%	110,886	131,701	$2,914	1.0%	$15,188	$1,652	$100
15	11,142	105,815	0.03%	67,013	76,649	$1,827	0.6%	$17,265	$1,740	$87
> 15	10,900	103,422	0.03%	70,938	79,290	$2,142	0.7%	$20,715	$1,845	$105

Table 4 further reveals that beneficiaries with multiple complex illnesses account for most Medicare spending. Only about 1% percent of beneficiary months have 6 ICs, and yet these months alone account for 8% of Medicare spending. Less than 1% of beneficiary months have 8 assigned ICs, and yet these months account for 5% Medicare spending. By contrast, the months with no IC nearly make up about *half* the months during the year, and yet only 8% of spending occurs in these months. The average monthly cost of caring for such beneficiaries is about $149. The average monthly cost of care per beneficiary rises steeply as the number of ICs rises, with the average monthly cost of caring for patients with 5 ICs nearly ten times the cost of caring for beneficiaries with one IC, and only a third of the cost of caring for patients with 9 ICs.

Comparing the results in Tables 4 and 5 suggest that illness complexity tends to be a transitional state for individuals. Whereas Table 5 indicates that about 7% of beneficiaries concurrently experience 6 or more ICs sometime during the year, Table 4 shows that these experiences account for only about 3% of total months of services during the year. This implies that Medicare patients who suffer from many comorbid conditions either develop additional conditions or recover from some their conditions later in the year. Beneficiaries who simultaneously experience 6 or more ICs sometime during the year receive 41% of Medicare services, but the months when care is given for 6 or more ICs account for only 31% of Medicare expenditures. This indicates that beneficiaries suffering from 6 or more ICs typically do not spend all of the year with this severity of illness complexity.

Figures 1 and 2 summarize results in Table 4. Figure 1 depicts the distribution of the number of months with different levels of illness complexity and the average cost associated with these months. As the figure illustrates, the average monthly cost sharply increases with illness complexity, even as the number of beneficiary months decreases. Figure 2 shows the relationship between the share of Medicare beneficiaries and share of expenditures by number of patient ICs. According to this figure, patients with five or more coexisting ICs represent only about 11 percent of the Medicare population but account for 41 percent of Medicare expenditures. Beneficiaries with six or more ICs account for only three percent of months, but 31 percent of payments.

Figure 1: Number Beneficiary Months & Per Month Spending by Illness Complexities

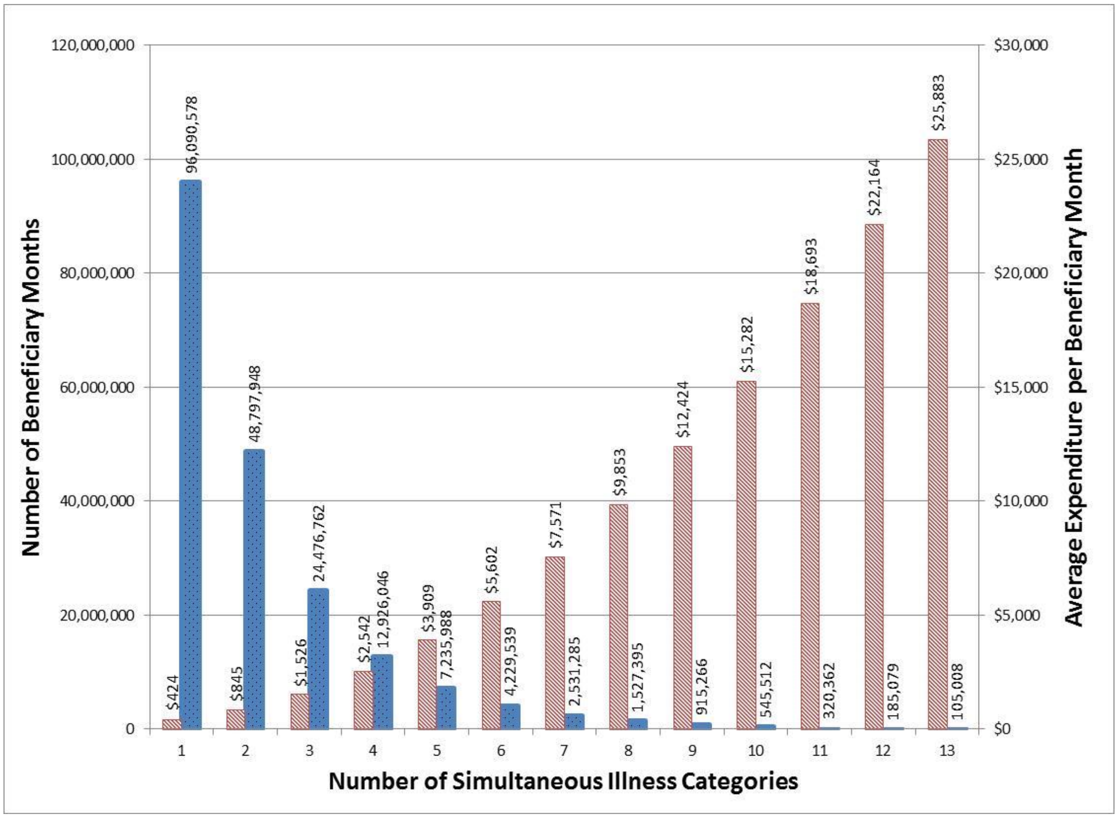
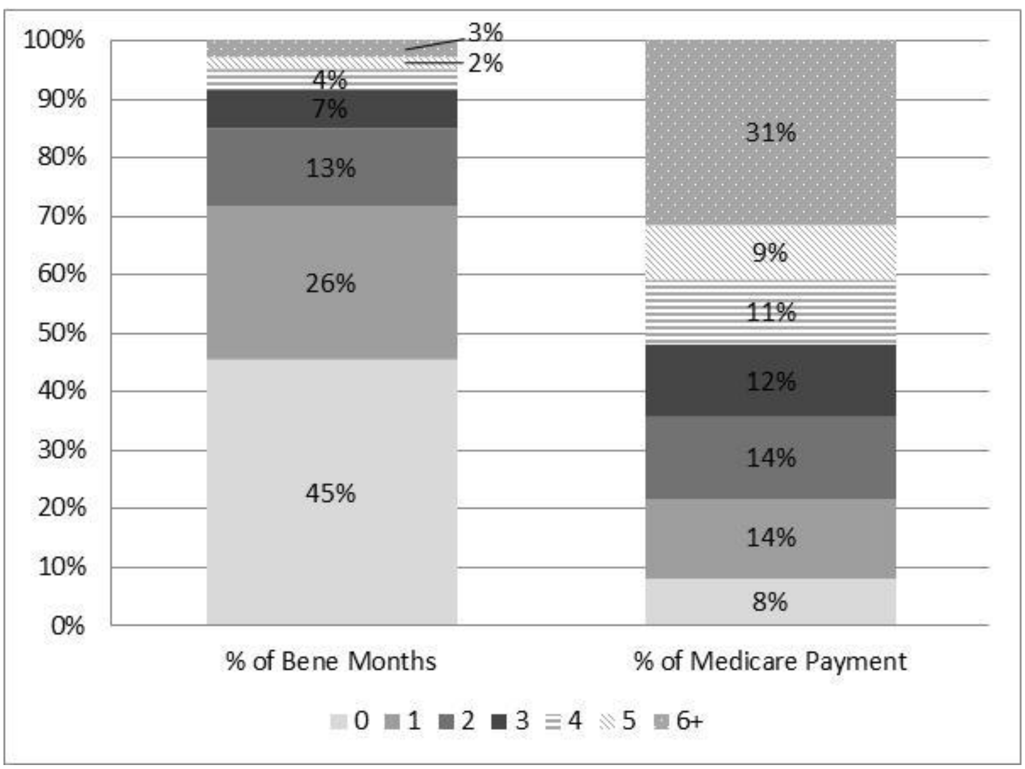


Figure 2: Share of Beneficiary Months and Expenditures by Illness Complexities



These findings support the conclusion that the majority of medical expenditures are for complex (high comorbidity) medical patients. As increased patient complexity (high comorbidity) is strongly associated with higher Medicare expenses, ignoring the complexity of patient health circumstances leads to overestimating of Medicare expenditures for less complex patients and underestimating of Medicare expenditures for more complex patients. For example, ignoring this synergistic effect will lead to an overestimation of Medicare expenditures of about $2,500 for a patient with no ICs, and an underestimation of about $1,300 for a patient with five ICs.

Tables 4 and 5 also highlight that patient heterogeneity increases dramatically with the number of coexisting conditions. According to Table 4, 11.2 million of total service months with 2 concurrent ICs are associated with only about 900 distinct combinations of ICs and over 8,000 combinations of CCs; by way of contrast, the 1.7 million service months with 6 ICs involve over 305 thousand combinations of ICs and over one-million combinations of CCs.

The average number of beneficiary months per distinct IC combination also falls as the number of simultaneously experience illness categories increases. For Medicare beneficiaries in the IC = 6 classification of service months, the numbers in Table 4 imply on average about 14 patient months per distinct IC combination and a little more than 4 patient months per distinct CC combination.

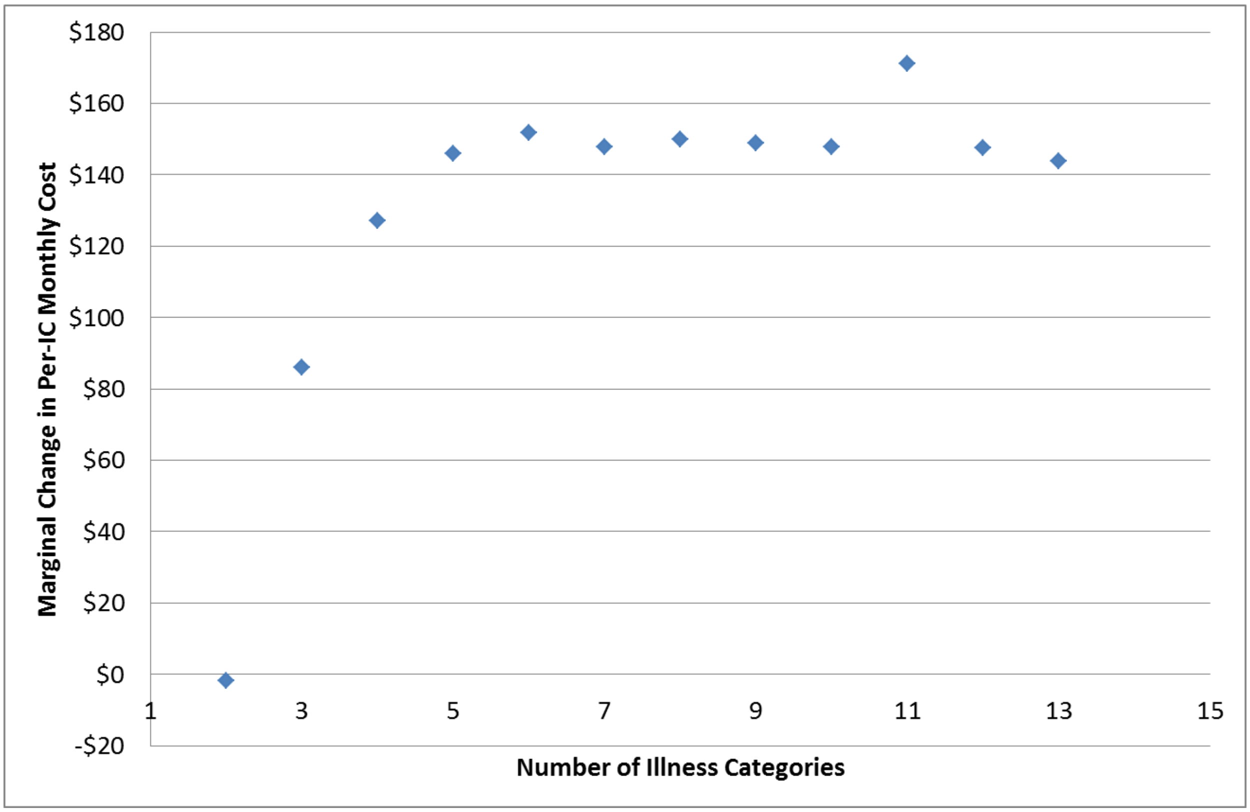
Table 5 also shows that for the nearly 1 million beneficiaries who experience more than seven ICs sometime during the year, these patients must be concurrently treated for over 2.4 million unique combinations of ICs and more than 4 million unique combinations of CCs, which translates into 4 distinct CC combinations per Medicare highly complex patient.

Regardless of the perspective used here to assess medical complexity, patients become increasingly distinct and increasingly unique as the number of comorbidities grows.

3.2 Comorbidities Entail Compounding Medical Costs

Because medical conditions interact to increase the cost of care, beneficiaries with multiple illnesses have greater expenditures than would be predicted by treating each condition in isolation. Figure 3 depicts this trend by graphing the relationship conveyed by the last column of Table 4. The figure shows that the monthly cost per IC increases by $100-$150 for each additional IC beyond 3. Consequently, the average cost of treating each illness category compounds as illness complexity increases. For example, the cost of treating a beneficiary's diabetes, CHF and COPD is more expensive for a patient with another IC than for a beneficiary with no other ICs.

Figure 3: Increment to Per IC Monthly Cost of Increasing Illness Complexity



The implications of Figure 3 on Medicare spending are best summarized by inferring how monthly expenditures per beneficiary change with added illness complexity. Our purpose is to make clear in a stylized way how each additional diagnosis adds to the average cost of caring for a patient by imposing marginal costs above and beyond the costs of caring for a patient with fewer diagnoses. Let $\$AE_n$ denote average monthly Medicare expenditure per beneficiary with n illness conditions. Figure 1 implies the following approximate difference equation for n=1 IC conditions:

$$\$AE_{n+1} = \$AE_n + \$425 \quad (1)$$

or, after rearranging difference equation (1):

$$\$AE_{n+1} = (n+1)\cdot\frac{\$AE_n}{n} \quad \text{with} \quad \$AE_1 = \$425 \quad (2)$$

From Figure 3, it is clear that each additional IC condition diagnosed adds an additional amount to the average costs of caring for a patient. To simplify matters, we assume that each additional IC condition above the first one adds \$140 to average costs. Thus, for $n \geq 2$ IC conditions

$$\$AE_{n+1} = (n+1)\cdot\left(\frac{\$AE_n}{n} + \$140\right) \quad (3)$$

Equations (1) and (3) provide an approximate depiction of the results shown in the last column of Table 5. These equations clearly depict the compounding effect on cost of increasing illness complexity. Not only does the average monthly costs of treating ICs rise due to the cost of treating the additional IC, the costs of treating each of the pre-existing ICs also rises. So, for instance, as a given beneficiary shifts to having five ICs from four, on average *each* of this person's five conditions cost about \$140 more to treat than if this individual had just four ICs.

Figure 4: Predicted Average Monthly Expenditures with Increasing Illness Complexity

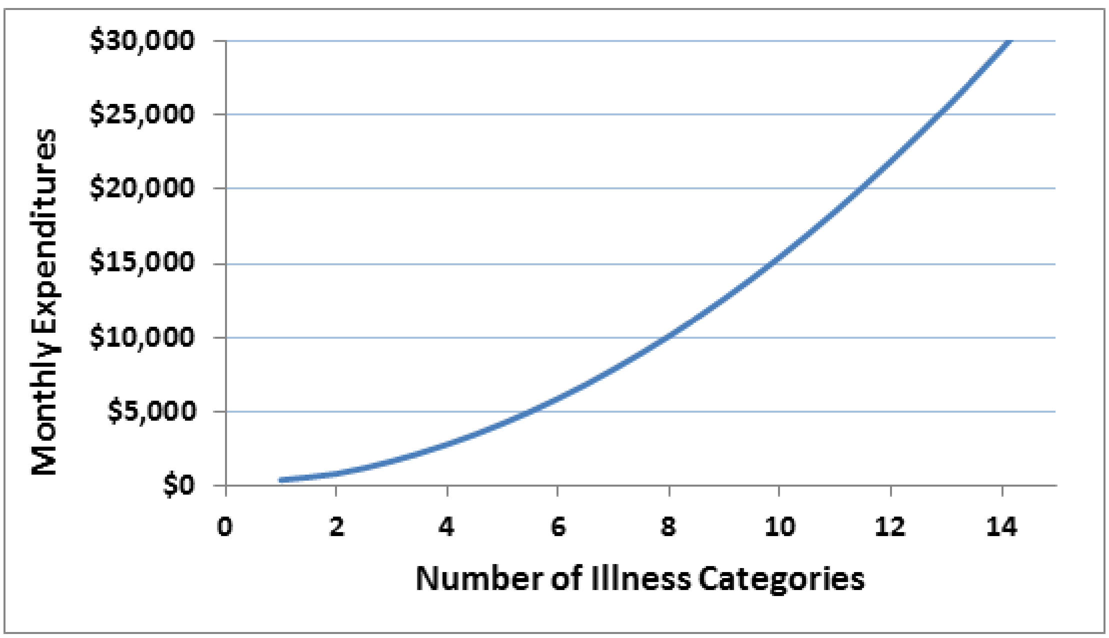


Figure 4 plots the relationship between predicted monthly expenditures and the numbers of concurrent illness categories implied by formulas (1)-(3). It is the counterpart of monthly expenditure bars depicted in Figure 1; the close tracking of predicted monthly expenditures in

Figure 4 to the observed monthly expenditures in Figure 1 verifies the accuracy of the above formulas in characterizing the dependence of average monthly Medicare spending on the number of IC conditions. The key point to note in Figure 4 is that, after the first two health conditions, further increases in the number of illness categories leads to rapidly increasing growth in predicted average monthly expenditures by Medicare.

4 POLICY IMPLICATIONS OF FINDINGS

Better managing the care of high-cost patients is a central tenet of many health reform proposals such as Accountable Care Organizations (ACOs), disease management, and pay-for-performance. These reimbursement policies focus on establishing incentives for providers to implement innovative and evidence-based treatment guidelines to care efficiently for patients, especially those with multiple chronic diseases which are known to consume a disproportionate share of Medicare resources. One prominent component of these polices involves the application of risk adjustment modifiers to amend provider payments by accounting for patients' pre-existing conditions. A second component includes the promotion of integrated care management of patients with multiple chronic conditions to lower expenses for treating patients with projected high costs. The portrait of high-cost users presented above offers a useful setting for considering the designs of both these policy components.

The following discussion explores the implications of the above empirical findings in adapting the risk-adjustment and coordination-of-care programs currently found in Medicare to enhance their chances of attaining savings in medical costs. Section 4.1 explores some of the reasons why complex patients might have costs that increase non-linearly with their number of health conditions. Section 4.2 examines the implications of our results for appropriate risk-adjustment of Medicare payments to providers who care for complex patients. Section 4.3 briefly assesses the consequences of our results for disease management programs. Finally, Section 4.4 broadly considers data analytic methods to cope with patient heterogeneity and complexity.

4.1 Likely Drivers of Increased Costs

The above empirical findings establish a clear correlation between an increased number of health conditions and increased cost associated with each condition. They also show that the effect becomes more pronounced as patient complexity increases. To assess the implications of these findings further, the following discussion contemplates what might be the source of these increased costs.

One possible source is that synergistic relationships between conditions limit physicians' ability to provide cost effective treatment. For example, the best medication for one condition may be contraindicated by another condition, as when an ACE inhibitor normally prescribed for congestive heart failure becomes contraindicated when the patient is also taking NSAIDs or diuretics for a different condition. This requires the physician to choose alternative therapies that are likely to be more expensive or less effective (if they are neither of these things, they would likely be the preferred therapy). The more conditions a patient has, the more likely that he or she will have one or more synergistic interactions that mandate a change in treatment. Thus, the limited treatment options available to complex patients may contribute to the higher costs associated with treating such patients.

A second driver of high health care costs among complex patients may be the paucity of reliable data on unique condition combinations and treatment interactions. With every additional condition a patient has, the number of potential combinations of those conditions increases dramatically. A patient with two ICs will have one of a possible 946 different IC combinations. A patient with three ICs has over 13,000 IC combinations. This complexity is borne out by the actual patient data. Of the roughly three million Medicare patients that have three ICs, there are over 9,000 unique patient types (when categorized by ICs), each of which may present different contraindications and complications. When facing a dearth of well-established treatment protocols for highly complex patients, physicians may need to resort to trial and error that can directly increase costs as a result of the need for additional services, and indirectly increase costs by introducing possible treatment complications, which will also require attention.

Compounding this problem is the reality that highly complex patients are more likely to require the services of multiple specialists, who may be either unaccustomed or unequipped to work together. In situations where the right combination of specialists are unable to share data and coordinate a plan of care, one would expect to see an escalation in costs, owing to certain inefficiencies (e.g., redundant tests) and the need for trial and error in treatment as described in the previous paragraph. These shortcomings may be less pronounced in the context of managed care, which theoretically would draw some advantages from its integrated delivery methods. As information from Medicare managed care plans was not included in this study, future research may be required to see if the synergistic effects of comorbidities are less pronounced in a managed care setting; however, the common use of capitation payments may complicate efforts to determine the exact cost per patient.

4.2 Implications for Risk Adjustment

To compensate physicians for providing care to Medicare patients with medical complications, CMS uses risk-adjustment methods to award higher payments for serving these beneficiaries. These adjustments are necessary to reimburse providers adequately for the increased time and resources involved in the care of complex patients. Risk-adjustment is used, for example, to reimburse managed care plans, calculating bundled payments for ESRD patients and payment for inpatient hospitalizations (Newhouse et al., 2011). Furthermore, risk adjustment methods are a critical element in the viability and success of the state-level health insurance exchanges called for in the Affordable Care Act (ACA), matching compensation to differences in enrollees' health status across different health plans (Weiner et al., 2012).

Without appropriate risk-adjustment, providers may be overpaid for some types of patients and underpaid for others. If payments don't match the level of resources used to care for different groups of patients, providers will have an incentive to avoid care of certain populations (the undercompensated) versus an incentive to provide care to others (the overcompensated). For example, Part D Medicare payments have been shown not to reimburse insurers sufficiently for the relatively high medication use of low-income populations, creating perverse incentives for plans to avoid this part of the Part D market (Hsu et al., 2010). In addition, incorrect risk adjustment creates incentives for providers to counsel the use of services that are more lucrative, whether or not these services are medically appropriate. Adequate risk-adjustment of provider payments will increase in importance as Medicare continues to move away from a FFS payment model towards episode-based or capitated payment policies.

CMS currently risk-adjusts payments according to the presence of medical conditions identified for Medicare patients based on diagnostic claims coding, and categorizes these according to specific HCCs. The CCs, which are also used in the present analysis, represent more than 200 illnesses/diseases organized into organ systems, upon which a hierarchy based on the severity of the disease is then applied to obtain 70 HCCs (Pope et al., 2004). Payments are adjusted according to a formula based upon multivariate regression of total Medicare payments on these individual conditions and six interactions of HCCs, with weights for each of the health conditions determined by the regression coefficients. The current CMS risk-adjustment model takes into account 4 two-way and 2 three-way interactions among 6 common and high cost chronic diseases (Frogner et al. 2011). The presence of combinations of these specific conditions increases reimbursements above the individual payments for any individual condition alone.

Our results strongly suggest that the accounting for a small set of interactions between chronic conditions in risk adjustment methods is insufficient to capture the costs associated with the complexity of caring for patients with more than two or three conditions. Each extra condition adds considerable complexity to patient management, as the optimal care for one of the conditions may impinge on or even prevent the treatment of other conditions. Further, the medical expenditures required to care for such complicated patients grows strongly and non-linearly with the number of conditions. Any appropriate risk-adjustment methodology must account for this sort of complexity.

Addressing this problem in CMS's risk adjustment methodology will be a challenging task given a further dispiriting implication of our results. The above findings reveal that a very large number of combinations of conditions (whether measured by CCs or ICs) exist within the group of patients with any given number of conditions. This implies that among complex Medicare patients there are very few patients with *any particular* combination of conditions despite the fact that our analysis considers the universe of Medicare beneficiaries. Consequently, a risk-adjustment methodology that takes into account the full complexity of disease interactions will thus face the problem of very small sample sizes in many of the disease combination cells, hampering the ability of an analyst to produce reliable estimates of risk-adjustment modifiers.

4.3 Implications for Disease Management

Patient complexity also raises important concerns about disease management and care coordination programs. Because there are an overwhelming number of potential combinations of ICs, it is not feasible to study every such combination. This has two profound implications for disease management. First, as already noted it is likely that providers will discover that certain preferred treatments are unavailable to them because of their interactions with other treatments or conditions, particularly those prescribed by other specialists. Second, even setting such contraindications to the side, it is likely that many health care providers will have limited experience with the precise combination of conditions presented in a given patient, and will face uncertainties in determining the optimal treatment. Taken together, these two factors greatly complicate the delivery of care for complex patients.

As noted previously, it is likely that highly complex patients will require treatment by a large number of specialists, who may not be used to working together, and who may disagree on how best to treat the patient. It would be expected for each type of specialist to be focused on treating their particular areas of specialty, and to be less aware of or concerned about the effects that their prescribed treatments may have on a patient's other co-existing conditions. This problem is likely to be especially pronounced among highly complex patients because the sheer number of specialists involved would make collaboration and complete access to all relevant medical records impractical. Absent a complete medical history and understanding of all co-existing patient conditions, patient care and treatment outcomes could suffer.

Thus, patient complexity of the sort characterized above poses a difficult challenge for disease management and care coordination programs. At the same time, traditional approaches to caring for complicated patients, which involve minimal communication among multiple autonomous providers, could produce even worse results than active disease management programs. At the very least, disease management programs might be better positioned to avoid duplication of tests, provide patient education, and perhaps prioritization of care when the best treatment for a condition affecting one organ system is contraindicated by the presence of another condition. Despite the challenges of multiple comorbid conditions, good disease management programs may be the only way to cope with patient complexity. It remains to be seen whether disease management programs can control the costs of care with complex patients, while maintaining high quality outcomes.

4.4 Minimizing the Consequences of Patient Complexity

There are a number of potential courses of action that may help mitigate the consequences of high patient complexity. One question outside the scope of this research is whether integrated delivery models, such as those used by managed care plans, achieve a superior level of care for highly complex patients given their systems for sharing patient histories. As this has often been touted as a selling point by the managed care plans, it would be interesting to see whether either health care costs or health outcomes for highly complex patients in managed care settings differ meaningfully from their FFS counterparts. If so, issues of adverse selection aside, difficulties in sharing patient data across providers may be a material determinant of health care costs and patient health outcomes among complex patients.

A second option would be to improve access to patient records through continued shifts towards electronic recordkeeping. This would allow physicians treating highly complex patients to access the other conditions and treatments in their patients' medical histories more easily. In addition, if a Health Insurance Portability and Accountability Act-compliant patient database could be created, and made sufficiently accessible and searchable, physicians could draw upon the experiences of the select few others who have already treated similar combinations of conditions in the past, and avoid reinventing the wheel with trial and error each time a patient presents with an uncommon combination of conditions.

A related third option would be for CMS or the National Institute of Health to promote more research on effective disease management models for complicated patients. Given the small number of patients with a given mix of diagnoses and the large number of possible combinations, a complete catalog of best practices is not practical. However, a well-developed research program might uncover best practices among providers with the best results caring for complicated patients. A carefully developed set of principles for patient care developed from a comprehensive analysis of available data, rather than a cook book of medicine, would likely prove useful to all providers.

5 SUMMARY OF FINDINGS

The empirical results of this study tell a simple story: a substantial segment of the highest-cost users of Medicare consist of beneficiaries with highly complex and diverse arrays of medical conditions. About 52% of Medicare spending goes to treat 8% of the total service months when beneficiaries are afflicted by 4 or more major health conditions (e.g., cancer, diabetes, renal failure, chronic heart failure, etc.). During these periods of treatment, beneficiaries suffer from nearly 5.5 million combinations of major health conditions. Around 31% of spending goes to treat less than 3% of the time when Medicare beneficiaries suffer from 6 or more major health conditions; and, during these periods, beneficiaries suffer from nearly 4.2 million combinations of major conditions.

Translated into an annual context for beneficiaries, 18% of Medicare beneficiaries are afflicted by 4 or more major health conditions sometime during the year, and they account for 63% of total Medicare spending. These beneficiaries suffer from nearly 7.5 million combinations of major health conditions during the year. About 7% of Medicare beneficiaries are afflicted by 6 or more major health conditions and account for 41% of Medicare spending. These beneficiaries alone suffer from more than 6.4 million combinations of major illnesses, with an average of 3 distinct combinations per Medicare beneficiary with six or more health conditions. Regardless of the perspective used to assess medical complexity, patients are strikingly more expensive to treat and more distinct as the number of comorbidities grows.

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