

Previously Unrecognized Trends in Diabetes Consumption Clusters in Medicare

A. Enrique Caballero, MD; Jaime Davidson, MD; Angelo Elmi, PhD; James Gavin, MD, PhD; Kenyatta Lee, MD; Gail L. Nunlee-Bland, MD; Farhad Zangeneh, MD; and Gary A. Puckrein, PhD

Previous studies have demonstrated that a relatively small proportion of Medicare beneficiaries are the principal consumers of Medicare benefits.¹⁻⁶ By comparing healthcare expenditures over a number of years, Berk and Monheit² noted that there is a large amount of stability in the spending distribution over time. Because of the stable, skewed distribution of healthcare expenditures, the prevailing approach to reducing healthcare spending has been to focus on those who are receiving large amounts of care.

However, it has recently become clear that disease management programs that focus on those receiving the largest amounts of care have not been successful. A recent report from the Congressional Budget Office describes an evaluation of Medicare's demonstration projects on disease management.⁷ Six major disease management and care coordination demonstrations were evaluated by independent researchers. The results showed that most programs did not reduce Medicare spending, despite the fact that the programs specifically targeted beneficiaries who were high users of healthcare services.⁷

Our study extends the previous work by reviewing consumption and hospitalization patterns for fee-for-service Medicare beneficiaries living with diabetes. Consistent with previous findings, the proportions of patients in the various spending clusters were stable over time. However, when the behavior of individual beneficiaries was studied further it became clear that the populations in the spending clusters were dynamic, reconstituted each year while retaining the same proportional dimensions, as beneficiaries migrated from 1 cluster to another within definable parameters. These findings show that there is a previously unreported trend for beneficiaries in the lowest-spending clusters to transition to the highest-spending clusters in subsequent years. We discuss the potential implications of these findings for future approaches to reducing healthcare spending.

RESEARCH DESIGN AND METHODS

Retrospective expenditure data were collected from Medicare records. Medicare patients with diabetes were identified with an algorithm that required at least 1 inpatient, skilled nursing facility, or home health agency claim, or 2 Health Options Program or carrier

(defined as Medicare administrative

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Objective: To examine the annual cost profiles of Medicare beneficiaries with diabetes to identify patterns in their consumption of benefits.

Methods: Retrospective expenditure data were collected from Medicare records. Beneficiaries with diabetes were grouped into 5 consumption clusters ranging from "crisis consumers" at the high end to "low consumers" at the low end.

Results: The percentages of beneficiaries and expenditures for the consumption clusters remained generally constant from year to year. As expected, most of Medicare's budget each year was spent on crisis, heavy, and moderate consumers. However, a notable proportion of low and light consumers from one year go on to become crisis and heavy consumers in subsequent years. A review of total 2001 through 2006 inpatient costs for the year 2000 clusters revealed that 47% of these costs were for year 2000 low and light consumers and only 27% were for year 2000 crisis and heavy consumers.

Conclusions: This analysis revealed previously unrecognized trends, whereby a notable proportion of low and light consumers during one year went on to become crisis and heavy consumers in subsequent years, representing a large proportion of inpatient costs. These findings have important implications for disease management programs, which typically focus intervention efforts exclusively on crisis and heavy consumers.

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Take-Away Points

This study analyzed annual cost profiles of Medicare beneficiaries with diabetes to identify patterns in their consumption of benefits.

- The consumption clusters were very dynamic, with patients migrating from one consumption cluster to another each year.
- A notable proportion of low and light consumers in one year went on to become crisis and heavy consumers in subsequent years.
- This previously unrecognized migration from the lowest to the highest consumption clusters has important implications for the design of diabetes disease management programs.

Statistical Analysis

All analyses were conducted with SAS software, version 9.1 (SAS Institute Inc, Cary, North Carolina). On the basis of their annual cost profiles, beneficiaries with diabetes were grouped into 5 consumption clusters. Simple percentages were used to describe patterns of Medicare expenditures for the clusters: (1) crisis consumers (beneficiaries accounting for the 99th percentile [top 1%] of aggregate Medicare payments); (2) heavy consumers (90th through 98th percentiles); (3) moderate consumers (75th through 89th percentiles); (4) light consumers (50th through 74th percentiles); and (5) low consumers (1st through 49th percentiles).

contractors or carriers that oversee the administration of both Medicare part A and part B policies) claims with the following diagnosis codes (any diagnosis on the claim) during the 2-year period: 249.00, 249.01, 249.10, 249.11, 249.20, 249.21, 249.30, 249.31, 249.40, 249.41, 249.50, 249.51, 249.60, 249.61, 249.70, 249.71, 249.80, 249.81, 249.90, 249.91, 250.00, 250.01, 250.02, 250.03, 250.10, 250.11, 250.12, 250.13, 250.20, 250.21, 250.22, 250.23, 250.30, 250.31, 250.32, 250.33, 250.40, 250.41, 250.42, 250.43, 250.50, 250.51, 250.52, 250.53, 250.60, 250.61, 250.62, 250.63, 250.70, 250.71, 250.72, 250.73, 250.80, 250.81, 250.82, 250.83, 250.90, 250.91, 250.92, 250.93, 357.2, 362.01, 362.02, and 366.41.

An annual cost profile for each Medicare fee-for-service beneficiary with diabetes for the years 2000 through 2006 was constructed using a unique beneficiary identifier to link the Beneficiary Annual Summary Files to Medicare's Chronic Condition Data Warehouse flags, which identified beneficiaries who received Medicare reimbursements for diabetes.⁸ Total annual Medicare expenditures for each beneficiary with diabetes were calculated as the sum of all reimbursements made for inpatient and outpatient care, skilled-nursing facilities, carriers, durable medical goods, and home health and hospice care during a calendar year. In 2000, there were 106,995 (2.1%) diabetes beneficiaries whose primary payer for their medical expenses was not Medicare. Medicare total reimbursements therefore did not reflect their real insured healthcare expenditures. We removed such beneficiaries from study for the years 2000 through 2006. In 2000, there were 1376 (0.03%) diabetes beneficiaries with negative Medicare reimbursement values. Among these beneficiaries, 141 were removed because Medicare was not the primary payer of their medical expenses. For each year, the study included beneficiaries enrolled in Medicare part A and part B for at least 10 months and excluded all beneficiaries enrolled in Medicare Advantage because of the lack of complete reimbursement data. Beneficiaries were only removed from the study when they had at least 1 month of managed care for the year. The date of the death of a beneficiary was determined by the date given in the summary file.

An analysis was performed to determine whether the annual repopulation of a cluster followed any discernible pattern. Percentages were calculated to ascertain what proportions of the beneficiaries in a cluster migrated from one of the prior year's consumption clusters. For example, what percentages of crisis consumers in 2001 were crisis, heavy, moderate, light, or low consumers in 2000? These migration studies were conducted for each of the clusters for the years 2001 through 2006. Once these calculations were completed, a comparison was made to determine whether the migration patterns among clusters were stable, with similar proportions from one year to the next.

The influence that expenditures for inpatient care had on migration patterns was examined by calculating reimbursements for hospitalization for the 5 consumption clusters from 2000 through 2006. Percentages were derived by dividing total expenditures for inpatient care by the total of all expenditures in a given year.

The annual risk for hospitalization for each of the 5 clusters in a given year was obtained by following each cluster from each year as a distinct cohort. For example, crisis consumers in the year 2000 were analyzed for their risk for inpatient stays in the succeeding years (2001-2006). Cluster members who did not remain fee-for-service beneficiaries from 2000 through 2006 were excluded from the analysis. Hospitalization in a given year was defined as a yes/no variable based on whether or not a beneficiary in a cluster had a record of any inpatient stay during a calendar year; a logistic regression analysis was conducted to determine an annual aggregated risk for hospitalization for each cluster based on its members' prior histories of hospitalization.

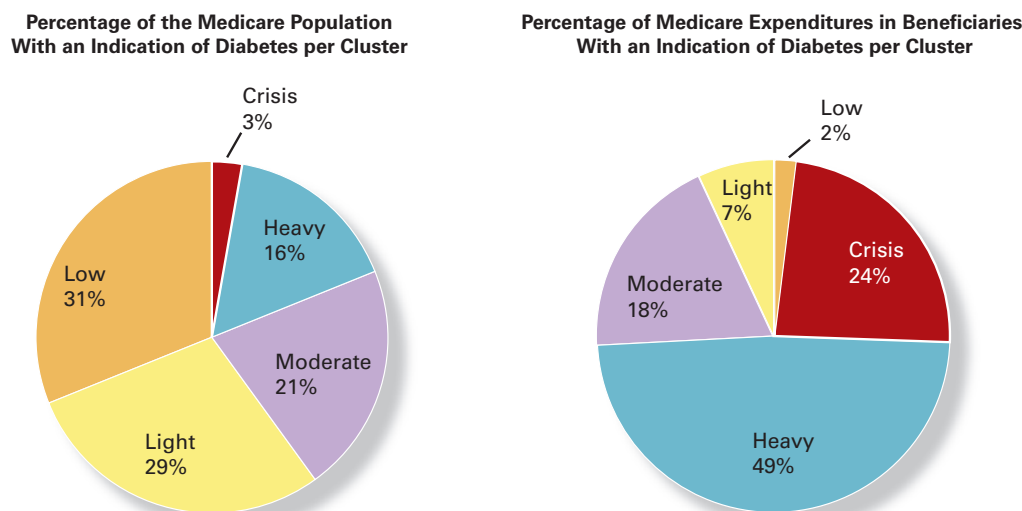
To distinguish the percentage of total inpatient costs for the years 2001 through 2006 attributable to a particular year 2000 consumption cluster, the calculation included the sum

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■ **Table 1.** Annual Expenditures Associated With Consumer Clusters of Medicare Beneficiaries With Diabetes

Year and Cluster	Beneficiaries With Diabetes		Expenditures				
	No.	%	Range	Total	%	Inpatient Total	%
2000							
Crisis consumers	128,828	3	≥\$58,278.68	\$11,556,901,390	24	\$7,199,444,486	62
Heavy consumers	785,944	16	\$14,442.22-\$58,278.67	\$22,580,922,539	49	\$11,796,842,073	52
Moderate consumers	1,064,128	21	\$3848.68-\$14,442.21	\$8,219,682,595	18	\$3,163,869,370	38
Light consumers	1,470,359	29	\$1009.92-\$3848.67	\$3,043,588,113	7	\$129,754,954	4
Low consumers	1,516,818	31	≤\$1009.91	\$744,108,033	2	\$42,160	0
Total	4,966,077			\$46,145,202,669		\$22,289,953,043	48
2001							
Crisis consumers	134,451	3	≥\$62,568.10	\$12,979,470,213	25	\$8,012,485,280	62
Heavy consumers	824,411	16	\$15,846.77-\$62,568.09	\$25,632,454,363	48	\$12,974,728,383	51
Moderate consumers	1,128,354	21	\$4358.26-\$15,846.76	\$9,690,388,786	18	\$3,596,617,099	37
Light consumers	1,558,638	29	\$1175.10-\$4358.25	\$3,702,739,891	7	\$179,378,823	5
Low consumers	1,628,628	31	≤\$1175.09	\$934,044,837	2	\$130,320	0
Total	5,274,482			\$52,939,098,090		\$24,763,339,905	47
2002							
Crisis consumers	143,476	3	≥\$65,591.18	\$14,535,939,712	24	\$8,958,434,993	62
Heavy consumers	882,209	16	\$16,794.46-\$65,591.17	\$28,882,614,310	48	\$14,392,545,184	50
Moderate consumers	1,214,131	21	\$4631.15-\$16,794.45	\$11,051,447,533	19	\$4,035,903,318	37
Light consumers	1,678,363	29	\$1273.23-\$4631.14	\$4,261,523,082	7	\$217,187,938	5
Low consumers	1,784,085	31	≤\$1273.22	\$1,112,223,225	2	\$210,272	0
Total	5,702,264			\$59,843,747,863		\$27,604,281,704	46
2003							
Crisis consumers	152,678	3	≥\$67,932.09	\$15,905,039,008	24	\$9,635,023,231	61
Heavy consumers	943,934	15	\$18,118.94-\$67,932.08	\$32,545,763,088	48	\$16,009,434,371	49
Moderate consumers	1,305,291	21	\$5068.19-\$18,118.93	\$12,895,614,408	19	\$4,624,333,364	36
Light consumers	1,794,768	29	\$1406.32-\$5068.18	\$5,019,788,185	7	\$269,069,418	5
Low consumers	1,950,951	32	≤\$1406.31	\$1,335,938,036	2	\$250,501	0
Total	6,147,622			\$67,702,142,725		\$30,538,110,886	45
2004							
Crisis consumers	160,305	3	≥\$72,785.05	\$17,734,839,959	23	\$10,413,458,041	59
Heavy consumers	995,768	15	\$19,691.93-\$72,785.04	\$36,958,708,308	48	\$17,766,997,551	48
Moderate consumers	1,383,309	21	\$5532.54-\$19,691.92	\$14,916,958,721	19	\$5,265,763,027	35
Light consumers	1,904,847	29	\$1571.21-\$5532.53	\$5,892,099,112	8	\$308,549,306	5
Low consumers	2,094,948	32	≤\$1571.20	\$1,596,509,536	2	\$355,836	0
Total	6,539,177			\$77,099,115,635		\$33,755,123,760	44
2005							
Crisis consumers	165,627	2	≥\$76,518.47	\$19,357,127,936	23	\$11,336,479,249	59
Heavy consumers	1,031,047	15	\$20,998.18-\$76,518.46	\$40,315,567,505	48	\$19,020,067,149	47
Moderate consumers	1,432,456	21	\$6018.05-\$20,998.17	\$16,669,493,149	19	\$5,874,275,324	35
Light consumers	1,986,877	29	\$1729.86-\$6018.04	\$6,707,694,978	8	\$367,997,772	5
Low consumers	2,228,446	33	≤\$1729.85	\$1,851,835,544	2	\$422,940	0
Total	6,844,453			\$84,901,719,111		\$36,599,242,435	43
2006							
Crisis consumers	166,951	2	≥\$80,090.01	\$20,384,409,065	23	\$11,754,952,567	58
Heavy consumers	1,036,735	15	\$22,058.64-\$80,090.00	\$42,381,688,459	47	\$19,386,504,300	46
Moderate consumers	1,447,366	21	\$6389.41-\$22,058.63	\$17,780,292,473	20	\$6,117,727,527	34
Light consumers	2,018,697	29	\$1860.92-\$6389.40	\$7,270,943,954	8	\$392,655,598	5
Low consumers	2,275,125	33	≤\$1860.91	\$2,023,516,391	2	\$451,969	0
Total	6,944,874			\$89,840,850,343		\$37,652,291,961	42

■ **Figure 1.** Proportions of the Medicare Population With an Indication of Diabetes and Medicare Expenditures per Cluster for the Year 2000



of all inpatient costs for the years 2001 through 2006 for a cluster (the numerator) divided by all hospitalization costs for the same period for all year 2000 clusters (the denominator).

RESULTS

Table 1 shows the annual expenditures and populations of each consumer cluster. As expected, a small proportion of the population (ie, the crisis and heavy consumers) represented the majority of the expenditures (**Figure 1**). Analysis of the clusters over time revealed that they were stable in the sense that the percentages of beneficiaries and expenditures that differentiated each cluster remained generally constant from one year to the next (**Figure 2**). For example, crisis consumers ranged between 2% and 3% of all beneficiaries, and 23% to 25% of total reimbursements were for their care.

Of all the clusters, low consumers were the most numerous. Each year they accounted for approximately 32% of all fee-for-service beneficiaries living with diabetes. Total reimbursements for this cluster were approximately 2% of all dollars spent on diabetes in the program. Together, low and light consumers represented 61% of Medicare beneficiaries living with diabetes, but only 9% of the program's dollars went to their care each year. The mean per capita expenditure for low consumers was \$494 in 2000, increasing to \$815 in 2006; the corresponding expenditures for crisis consumers were \$95,847 in 2000 and \$126,789 in 2006. Of total reimbursements, 91% were spent on crisis, heavy, and moderate consumers, who represented 39% of beneficiaries.

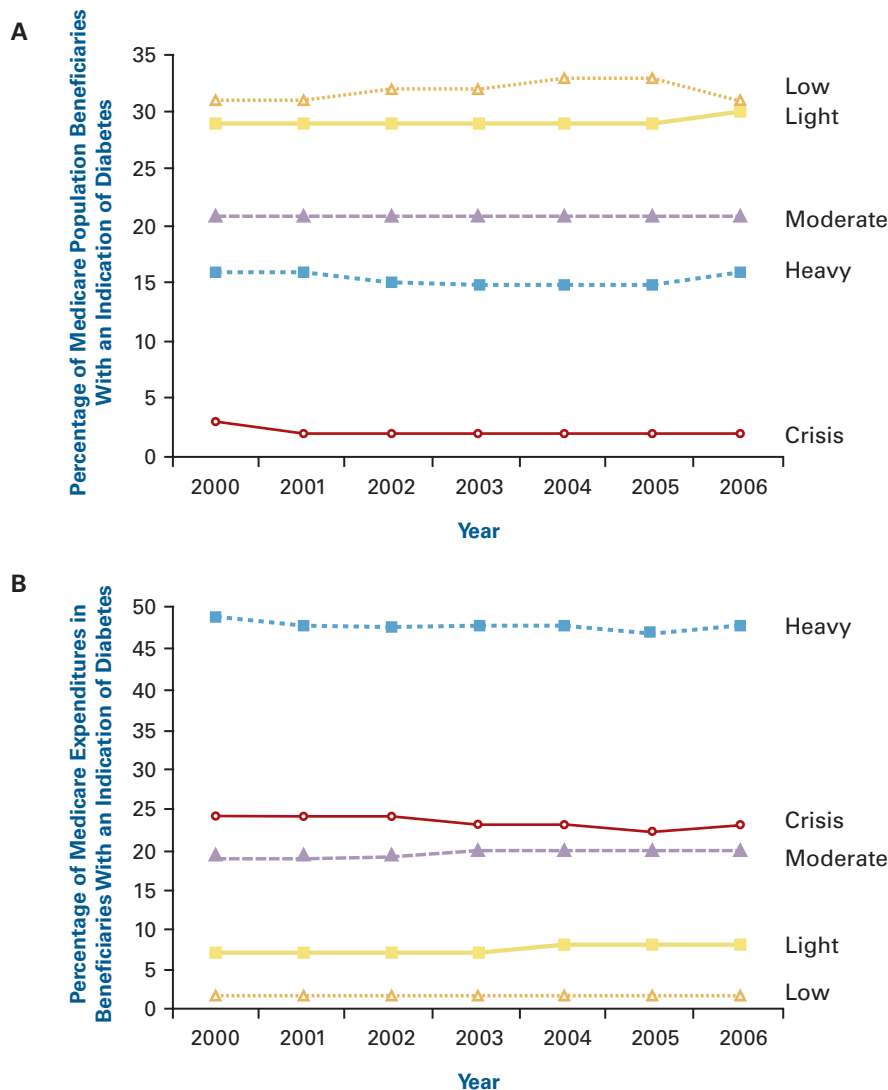
The populations within the clusters were dynamic, reconstituted each year as beneficiaries migrated from one cluster

to another. Migration was not unidirectional; some beneficiaries moved to higher-cost clusters and some moved to lower-cost clusters. The percentages of beneficiaries moving among clusters had stable patterns. **Table 2** summarizes annual migration into the crisis-consumer and low-consumer clusters. Discernible patterns were evident. Each year, for example, approximately 20% of crisis consumers remained in that cluster, and about 8% migrated to become low consumers. Routinely, about 39% of crisis consumers had been heavy consumers in the prior year. About 60% of low consumers remained in the cluster from one year to the next. Fewer than 1% of low consumers had been crisis consumers in the previous year.

Each consumption cluster exhibited a unique pattern of risk for future hospitalizations. Logistic regression analysis was used to estimate annual hospitalization risk of the year 2000 consumption clusters for 2001 through 2006 (**Table 3**). The analysis was predicated on members' having been hospitalized each year, with the exception of low and light consumers, who for the most part were not hospitalized in 2000. A year 2000 low consumer had a 15% chance of being hospitalized in 2001, but with that hospitalization the risk for inpatient care in 2002 rose to 30%. Two consecutive years of hospitalization brought the risk to 43% in 2003. By 2006 the risk had grown to 69%. Year 2000 crisis consumers had the highest risk for inpatient care, beginning with 58% in 2001 and culminating at 89% in 2006. For all beneficiaries, consecutive years of hospital care raised future risks. If there was an intervening year or years in which there was no hospitalization, new risk patterns that were unique to the clusters were found. Similar longitudinal analyses were conducted for the clusters starting with other years studied; there was no significant change in risk.

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Figure 2. Proportion of the Medicare Population per Cluster (A) and Medicare Expenditures per Cluster (B) Among Beneficiaries With an Indication of Diabetes From 2000 Through 2006



Most of Medicare's budget each year was spent on crisis, heavy, and moderate consumers. Nevertheless, an important trend was seen when analyzing total hospitalization costs between 2001 and 2006 for the year 2000 clusters. This analysis revealed that 47% of all inpatient costs from 2001 through 2006 were for year 2000 low and light consumers and only 27% were for year 2000 crisis and heavy consumers (Table 4, Figure 3). Members of clusters in 2001 and 2002 exhibited similar patterns in succeeding years.

DISCUSSION

This study aggregated Medicare beneficiaries with diabetes into consumption clusters and found that they consumed future benefits within measurable parameters. These

clusters were stable in the sense that the percentages of beneficiaries and expenditures that differentiated each cluster remained generally constant from one year to the next, supporting previous observations that a small number of beneficiaries consume more than 70% of the program's diabetes budget. These findings are also consistent with more general healthcare spending analyses, which show a large amount of stability in the spending distribution over time.²

Interestingly, clusters' populations were dynamic, reconstituted each year while retaining the same proportional dimensions as beneficiaries migrated from one cluster to another within definable parameters. Although the annual migration patterns were proportionally stable, they were not unidirectional: beneficiaries migrated to less expensive as

■ **Table 2.** Migration Patterns Into Crisis-Consumer and Low-Consumer Clusters of Medicare Beneficiaries With an Indication of Diabetes

Years	Beneficiaries Migrating From:	Beneficiaries Migrating To:			
		Crisis Consumers		Low Consumers	
		No.	%	No.	%
2000-2001	Crisis consumers	20,390	20	2851	0
	Heavy consumers	40,298	39	64,068	5
	Moderate consumers	19,820	19	154,096	11
	Light consumers	14,030	14	360,907	25
	Low consumers	7947	8	845,856	59
	Total	102,485		1,427,778	
2001-2002	Crisis consumers	21,531	20	2799	0
	Heavy consumers	41,847	39	67,045	4
	Moderate consumers	20,914	20	161,801	11
	Light consumers	14,315	13	392,159	26
	Low consumers	8052	8	914,334	59
	Total	106,659		1,538,138	
2002-2003	Crisis consumers	23,498	21	3054	0
	Heavy consumers	45,307	40	71,435	4
	Moderate consumers	22,011	19	174,148	10
	Light consumers	14,897	13	433,188	26
	Low consumers	8646	8	1,009,946	60
	Total	114,359		1,691,771	
2003-2004	Crisis consumers	25,112	21	3203	0
	Heavy consumers	48,553	40	75,659	4
	Moderate consumers	23,026	19	184,700	10
	Light consumers	15,207	13	464,169	25
	Low consumers	8968	7	1,105,522	60
	Total	120,866		1,833,253	
2004-2005	Crisis consumers	27,102	22	3253	0
	Heavy consumers	50,257	40	80,152	4
	Moderate consumers	23,915	19	197,086	10
	Light consumers	15,183	12	498,138	25
	Low consumers	9176	7	1,179,314	60
	Total	125,633		1,957,943	
2005-2006	Crisis consumers	27,894	22	3254	0
	Heavy consumers	50,999	40	81,614	4
	Moderate consumers	23,543	19	201,286	10
	Light consumers	14,788	12	504,221	25
	Low consumers	9096	7	1,213,982	61
	Total	126,320		2,004,357	

Table 3. Yearly Risk of Hospitalization for Year 2000 Consumption Clusters Based Upon Consecutive Years of Inpatient Care

Year 2000 Cluster	Risk of Hospitalization, %					
	2001	2002	2003	2004	2005	2006
Crisis consumers	58	62	68	73	78	89
Heavy consumers	44	54	55	69	75	78
Moderate consumers	35	49	58	65	72	77
Light consumers ^a	23	38	50	59	67	73
Low consumers ^a	15	30	43	53	63	69

^aMost light and low consumers were not hospitalized in 2000 and so the risk is actually based on no prior year inpatient care.

well as to more expensive clusters. Each cluster was associated with a specific risk pattern for future hospitalizations.

These findings have potentially important implications for future approaches to reducing healthcare spending. Recent findings show that disease management and care coordination demonstration programs that focus interventions on the highest-consuming clusters did not reduce Medicare spending. The findings in the current study indicate that low consumers represent a significant proportion of future high-expenditure patients. Therefore, research should be conducted to identify the characteristics of the low-consuming beneficiaries who subsequently become high-consuming beneficiaries. Healthcare costs may be significantly reduced by focusing intervention efforts on these high-risk, low-consuming patients.

Although the immediate purpose of this study was to document the stability of consumption patterns among all fee-for-service beneficiaries, it should be noted there were slight differences in diabetes consumption group patterns between disabled patients and those without a disability. The differences were mainly found in the percentages who were crisis, light, and low consumers. For example, 4.4% of all diabetes beneficiaries with a disability were crisis consumers compared with 2.6% of diabetes beneficiaries who had no disability. The majority of the crisis consumers (82%), however, had diabetes without any disabilities. The disabled/non-disabled variation suggests that further research might find subgroups within the main 5 consumption groups that make some contribution to the larger migration patterns characterized in this study.

One potential limitation of this study involves data acquisition for Medicare-enrolled patients. Data for 100% of Medicare-enrolled beneficiaries are available from the Chronic Condition Data Warehouse. The Beneficiary Summary File is created annually and contains demographic and enrollment data for all beneficiaries who are alive and enrolled in Medicare for any part of the year. This file is available in the current layout for 1999 forward. Therefore, the Chronic Condition Data Warehouse data used in this study should include all Medicare-enrolled beneficiaries from 2000 through 2006.⁹

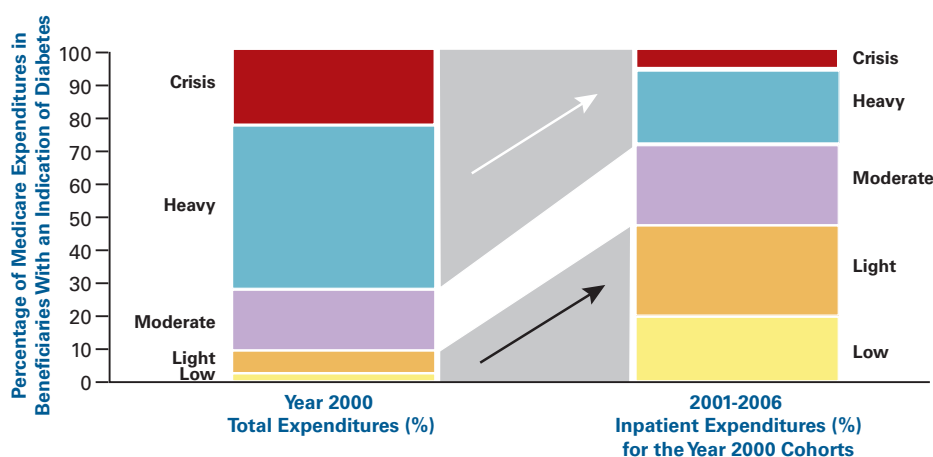
Table 4. Contribution of Each Year 2000 Cluster to the Overall Cost of Inpatient Care From 2001 Through 2006

Year 2000 Cluster	Inpatient Cost 2001-2006	
	Total	%
Crisis consumers	\$6,186,651,076	5
Heavy consumers	\$27,588,372,847	22
Moderate consumers	\$30,918,708,117	25
Light consumers	\$33,026,245,520	27
Low consumers	\$25,065,661,574	20
Total	\$122,785,639,133	

A second limitation of this study involves the algorithm used to identify Medicare beneficiaries with diabetes. Although the algorithm is adequately sensitive, highly specific, and reliable, there is still some probability that beneficiaries with diabetes were not identified by the algorithm (type II error).¹⁰ This error could influence the results, but it is unlikely to alter the study conclusions.

It is possible that a proportion of the low consumers are not receiving adequate medical care. A patient with diabetes should be managed according to clinical guidelines, which help delineate appropriate consumption of essential medical products and services according to a specific timetable to achieve glucose control and to ensure the necessary screenings to detect the onset of complications. A cost structure is associated with these products and services. At a minimum, a well-managed patient with diabetes should have an annual expenditure pattern (cost profile) reflecting that cost structure. A diabetes patient whose cost profile falls significantly below that minimum may be underconsuming, according to established recommendations for optimal care. Future research will need to determine whether the cost profile of low consumers meets those minimum requirements or whether underconsumption may be raising their risk for future inpatient care. Alternatively, it may be that a low consumer is being man-

■ **Figure 3.** Shift in Expenditures: Comparison of Expenditures for Year 2000 Cluster and the Overall Cost of Inpatient Care From 2001 Through 2006 for Beneficiaries With an Indication of Diabetes From the Year 2000 Clusters



aged according to clinical guidelines and that the 15% yearly risk for hospitalization and upward migration simply expresses the progressive state of the disease and the somewhat limited long-term impact of current treatment strategies and technology, such as lifestyle modification programs, pharmacologic interventions, and devices.

Additional research is needed to identify the factors that influence the migration of low consumers into more expensive clusters, where the potential for inpatient care in succeeding years increases dramatically. If this upward migration of low consumers can be retarded (by improved technology, better care management, or both), short-term and medium-term cost reductions in the Medicare program might be achieved.

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Author Affiliations: From Joslin Diabetes Center, Harvard Medical School (AEC), Boston, MA; University of Texas Southwestern Medical School (JD), Dallas, TX; George Washington University School of Public Health and Health Services (AE), Washington, DC; Healing Our Village (JG), Lanham, MD; Commonwealth Family Practice Group (KL), Jacksonville, FL; Howard University (GLN-B), Washington, DC; George Washington University School of Medicine (FZ), Washington, DC; National Minority Quality Forum (GAP), Washington, DC.

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(AEC, JD, AE, JG, KL, GLN-B, GAP); drafting of the manuscript (AEC, AE, JG, FZ); critical revision of the manuscript for important intellectual content (AEC, JD, AE, JG, KL, FZ, GLN-B); statistical analysis (AE); obtaining funding (GAP); and supervision (GAP).

Address correspondence to: Gary A. Puckrein, PhD, National Minority Quality Forum, 1200 New Hampshire Ave, NW, Ste 575, Washington, DC 20036. E-mail: gpuckrein@nmqf.org.

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