Resource Utilization and Costs of Age-Related Macular Degeneration

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Data were analyzed from the 1999-2001 Medicare Beneficiary Encrypted Files for patients with age-related macular degeneration (AMD), an ophthalmic condition characterized by central vision loss. Classifying AMD subtype by International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM) (Centers for Disease Control and Prevention, 2003) code, resource utilization rates increased with disease progression. Individuals with more severe disease (wet only or wet and dry AMD) had greater costs than did those with less severe disease (drusen only or dry only). Costs among patients with wet disease increased yearly at rates exceeding inflation, possibly due in part to increased rates of treatment with photodynamic therapy among these individuals and the aging of the population.

INTRODUCTION

AMD is an ophthalmic condition characterized by acquired lesions of the macula region. These pathologic changes usually appear in individuals age 50 or over and result in alteration of central visual function. Lesions are associated with abnormalities of the retinal pigment epithelium and/or the sensory retina (cone and rod photoreceptors), and may be related to the appearance of drusen (hyaline deposits beneath the retinal pigment epithelium). The appearance of drusen alone does not cause vision loss, although change in drusen size or number is associated with increased risk for development of AMD.

There are two basic forms of AMD: atrophic (dry) and exudative (wet). Dry AMD, the more common form of the disease, occurs in approximately 85 to 90 percent of patients with AMD and is generally slow to progress. An advanced form of dry AMD, geographic atrophy, occurs in about 5 percent of patients and may be characterized by a gradual loss of visual function. Wet AMD, which is characterized by choroidal neovascularization (CNV), is usually more severe and is responsible for 90 percent of vision loss attributed to AMD. It occurs in only about 10 percent of patients with AMD (Macular Degeneration Partnership, 2005). A recent report from the Age-Related Eye Disease Study (AREDS) indicated that approximately 8 million persons in the U.S. age 55 or over have some form of intermediate or advanced AMD (Clemons et al., 2003).

Wet AMD is commonly associated with clinically significant loss of vision, regardless of either the original location or characteristics of the CNV. Treatment options for AMD are limited. Currently, three approved treatment options exist for patients with exudative AMD: (1) laser photocoagulation, (2) ophthalmic photodynamic therapy (PDT) with verteporfin, and (3) pegaptanib sodium injection. Many AMD patients do not meet the criteria for treatment, i.e., they have early or intermediate AMD without CNV (American Academy of Ophthalmology, 2005). For those who do meet the criteria and are

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treated, patients may still experience high rates of recurrence in treated vessels, the need for repeat procedures, and/or clinically significant vision loss (Fine et al., 2000; O'Neill et al., 2001). In addition to these currently used therapies, other therapies are being investigated.

In addition to increasing morbidity and decreasing patient quality of life, AMD is likely associated with substantial medical care costs. However, much of the literature on the costs of visual impairment has focused on glaucoma, cataracts, and diabetic retinopathy. These conditions are more prevalent than AMD in the U.S. population age 50 or over. Prevalence of glaucoma is 8 percent among individuals with diabetes and 4 percent in people without diabetes; prevalence of cataracts is 34 versus 20 percent in individuals with and without diabetes, respectively; and prevalence of diabetic retinopathy is 10 percent (Centers for Disease Control and Prevention, 2004). In contrast, the prevalence of AMD is approximately 3 percent in older Americans, regardless of diabetes status (Centers for Disease Control and Prevention, 2004). In a review of cost of illness issues in AMD, O'Neill and colleagues (2001) reported that few data are available on the direct costs of AMD. Given the age distribution of AMD, most patients in the U.S. receive coverage of medical services from Medicare; thus, Medicare data could be considered the most appropriate source of information on resource utilization and costs of AMD. The objective of this study was to evaluate resource utilization, treatment patterns, and medical care costs for AMD patients using Medicare claims data and to compare results for patients with dry versus wet disease.

METHODS

Data were analyzed from the 1999, 2000, and 2001 Medicare Beneficiary Encrypted Files (BEF). The BEF represents a random 5-percent sample of all Medicare enrollees and is representative of all U.S. citizens age 65 or over. The random sample used for this claims data set is selected based on the same algorithm each year. Thus, the same patients are included in the BEF data each year (unless they die) as well as new patients entering each year; therefore, longitudinal treatment patterns can be evaluated. The BEF data consist of seven claims components: (1) Inpatient; (2) Outpatient; (3) Durable Medical Equipment; (4) Hospice; (5) Home Health Agency; (6) Skilled Nursing Facility (nursing home); and (7) Physician/Supplier (Part B) claims.

For this study, data from the Outpatient and Part B (Physician/Supplier) files from all patients with two or more claims for AMD (ICD-9-CM 362.5) were included. Two separate claims with an AMD diagnosis code were required as patients with a single claim for this diagnosis may be related to a rule-out visit for AMD. Furthermore, patients were included in the analysis only if they had one or more claims with ICD-9-CM diagnosis codes for specific subtypes of AMD, namely dry (ICD-9-CM 362.51), wet (362.52), or drusen (362.57). Based on these diagnosis codes, patients were classified as having dry AMD, wet AMD, both dry and wet AMD, or drusen only. Patients were classified in the drusen only group if they did not have claims specific for either wet or dry AMD. This group was included in the analysis because of the increased risk for development of AMD compared to a general population. Any AMD patient may have also had a concomitant diagnosis

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of drusen; however, patients with a concomitant drusen diagnosis comprised less than 8 percent of each group.

Resource utilization for AMD patients was determined from Outpatient and Part B claims. Costs were derived from Medicare payments. All data analysis was performed using SAS® Version 8.1 (SAS Institute Inc., 2002).

RESULTS

Table 1 presents demographic characteristics of the Medicare BEF patients by AMD subtype and study year (1999, 2000, or 2001). With the exception of drusen-only patients, the proportion of patients with AMD generally increased with age. The greatest proportion of patients in the drusen only category (the earliest stage of AMD) occurred in the 75 to 79 age group. Approximately two-thirds of patients were female and the overwhelming majority (>90 percent) was white.

Table 2 presents resource utilization data from 1999 for the included AMD patients. Resource utilization is presented for all four AMD subtypes. Further, for patients classified as wet only or wet and dry who received PDT, resource utilization is presented separately. In most instances, drusen only patients had the highest rates of resource utilization for diagnostic services. These diagnostic services per patient included retinal ultrasound (0.069) for drusen only, visual refraction (0.56), and visual field examinations (0.13). However, drusen only patients had lower rates of indocyanine-green angiography (0.0024), a procedure used in detecting occult neovascularizations, compared to wet only (0.065) or wet and dry (0.091) AMD patients. Drusen only patients also had lower rates of ophthalmologist visits (1.4), generalist physician visits (0.80), and specialist consultations (0.15) compared to the other specified subgroups. Patients with dry only had similar rates of resource utilization to drusen only patients.

In 1999, both wet only and wet and dry AMD patients had similar rates of resource utilization for certain diagnostic tests, including retinal ultrasound and visual field examinations. However, wet only patients had lower rates than wet and dry patients for visual refraction (0.25 versus 0.37) and indocyanine-green angiography (0.065 versus 0.091). Similarly, wet only AMD patients had lower average annual numbers of ophthalmoscopy (0.82) and of fundus photographs (0.91) compared to values for wet and dry patients (1.39 and 1.43, respectively). With respect to therapeutic procedures, both groups had similar rates of photocoagulation (0.10 versus 0.11) and similar annual number of PDT procedures (0.12 versus 0.16). Wet and dry patients had higher annual numbers of ophthalmologist visits (1.97), generalist physician visits (2.28), and specialist consultations (0.64) compared to all other groups.

Striking differences were seen among wet only and wet and dry patients who received one or more PDT procedures during the year versus those that did not receive any PDT. Patients receiving at least one PDT procedure were also more likely to undergo photocoagulation, fluorescein angiography, indocyanine-green angiography, ophthalmoscopy, and fundus photography. In contrast, patients who did not receive any PDT procedures were more likely to receive retinal ultrasound or visual field examination.

Annual costs reflect these differences in resource utilization. Costs for drusen only and dry only AMD patients for 1999 are similar ($204 to $206). Wet only AMD patients had annual costs two and one-half times those of dry only AMD patients

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Table 1

Demographic Characteristics of Medicare Beneficiary Encrypted File Patients, by Age-Related Macular Degeneration Subtype and Year: 1999-2001

Demographic	All Patients	Drusen Only	Dry Only[1]	Wet Only[2]	Dry and Wet[3]
1999	*N*=58,594	*N*=7,788	*N*=38,376	*N*=7,441	*N*=4,989
Age			Percent		
<65 Years	1.1	2.2	1.0	1.2	0.5
65-69 Years	7.6	13.0	7.0	6.5	5.1
70-74 Years	16.3	23.4	15.4	15.2	13.3
75-79 Years	23.8	26.4	23.3	22.7	25.5
80-84 Years	24.2	20.0	24.4	26.0	26.5
>84 Years	27.0	15.0	28.9	28.6	29.0
Sex					
Male	32.7	31.8	32.5	34.2	33.0
Female	67.4	68.2	67.5	65.8	67.0
Race					
White	94.7	92.4	94.9	94.7	96.9
Black	2.3	3.8	2.2	2.0	0.8
Other	3.0	3.8	2.9	3.3	2.3
2000	*N*=61,977	*N*=7,788	*N*=40,301	*N*=8,070	*N*=5,793
Age					
<65 Years	1.0	1.8	1.0	1.1	0.4
65-69 Years	7.1	12.4	6.6	6.2	4.7
70-74 Years	15.8	22.4	15.1	14.6	13.3
75-79 Years	23.6	26.2	23.3	23.2	23.0
80-84 Years	24.5	21.5	24.5	25.7	27.0
>84 Years	28.0	15.7	29.6	29.3	31.6
Sex					
Male	32.5	31.6	32.2	34.3	33.6
Female	66.5	68.4	67.8	65.7	66.4
Race					
White	94.8	92.4	94.8	95.3	97.0
Black	2.1	3.6	2.1	1.6	0.7
Other	3.1	4.0	3.1	3.1	1.8
2001	*N*=60,896	*N*=6,942	*N*=39,162	*N*=8,290	*N*=6,502
Age					
<65 Years	1.0	2.1	0.9	1.0	0.5
65-69 Years	6.2	10.7	5.7	5.9	4.8
70-74 Years	15.0	21.8	14.5	12.8	12.9
75-79 Years	23.0	25.4	22.6	22.7	23.4
80-84 Years	25.4	22.6	25.3	26.4	28.2
>84 Years	29.4	17.5	31.0	31.2	30.3
Sex					
Male	32.5	30.9	32.2	35.0	32.9
Female	67.5	69.1	67.8	65.0	67.1
Race					
White	95.6	93.1	95.5	96.0	97.9
Black	2.1	3.8	2.2	1.5	0.9
Other	2.3	3.1	2.3	2.5	1.2

[1] The proportion of dry only patients who also have a diagnosis of drusen is 4.1 percent in 1999, 4.5 percent in 2000, and 4.9 percent in 2001.

[2] The proportion of wet only patients who also have a diagnosis of drusen is 4.6 percent in 1999, 5.2 percent in 2000, and 5.5 percent in 2001.

[3] The proportion of wet and dry patients who also have a diagnosis of drusen is 7.2 percent in 1999, 7.5 percent in 2000, and 8.2 percent in 2001.

SOURCE: Halpern, M.T., Schmier, J.K., Exponent Inc., Covert, D., Alcon Research Ltd. and Venkataraman, K., AstraZeneca, LP, 2006.

($513), while wet and dry patients had annual costs almost four times those of dry only AMD patients ($767).

Resource utilization patterns for 2000 (Table 3) and 2001 (Table 4) are similar to those from 1999. Patients with drusen only and dry only AMD had similar rates of resource utilization, and had higher rates of most diagnostic tests compared those with wet only or wet and dry AMD. Conversely, drusen only and dry only AMD patients had lower rates of indocyanine-green angiography and photocoagulation procedures, fewer generalist physician visits, and fewer specialist consultations compared to the other specified subgroups. Comparing wet

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Table 2

Medicare Age-Related Macular Degeneration (AMD) Resource Utilization and Costs, by AMD Subtype: 1999

			Wet Only			Wet and Dry		
	Drusen Only	Dry Only	All	Wet Only, No PDT	Wet Only, PDT	All	Wet and Dry, No PDT	Wet and Dry, PDT
AMD Subtype	*N*=7,788	*N*=38,376	*N*=7,441	*N*=6,955	*N*=486	*N*=4,989	*N*=4,566	*N*=423
Diagnostic Procedures[1]								
Fluorescein Angiography	0.14	0.2	1.08	0.84	4.51	1.7	1.41	4.79
Fundus Photography	0.21	0.24	0.91	0.73	3.6	1.43	1.19	4.02
Indocyanine-Green Angiography	0.0024	0.0016	0.065	0.049	0.29	0.091	0.067	0.35
Ophthalmoscopy	0.54	0.41	0.82	0.77	1.5	1.39	1.31	2.26
Retinal Ultrasound	0.069	0.069	0.051	0.053	0.023	0.062	0.066	0.023
Visual Field Exam	0.13	0.1	0.1	0.11	0.054	0.12	0.12	0.082
Visual Refraction	0.56	0.46	0.25	0.25	0.24	0.37	0.38	0.33
Therapeutic Procedures[1]								
Photocoagulation	0.012	0.0084	0.1	0.097	0.2	0.11	0.11	0.15
Photodynamic Therapy (PDT)	0	0	0.12	0	1.85	0.16	0	1.84
Physician Interactions[1]								
Ophthalmologist Visits	1.4	1.31	1.38	1.37	1.53	1.97	1.95	2.19
Generalist Visits	0.8	0.89	1.32	1.28	1.99	2.28	2.25	2.65
Consultations	0.15	0.17	0.36	0.33	0.81	0.64	0.61	0.97
Total Reimbursement[2]	$205.93	$204.43	$512.52	$392.25	$2,233.74	$767.03	$612.95	$2,430.30

[1] Annual rate of resource utilization per patient.

[2] Annual cost per patient.

SOURCE: Halpern, M.T., Schmier, J.K., Exponent Inc., Covert, D., Alcon Research Ltd. and Venkataraman, K., AstraZeneca, LP, 2006.

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Table 3

Medicare Age-Related Macular Degeneration (AMD) Resource Utilization and Costs, by AMD Subtype: 2000

AMD Subtype	Drusen Only	Dry Only	Wet Only			Wet and Dry		
			All	Wet Only, No PDT	Wet Only, PDT	All	Wet and Dry, No PDT	Wet and Dry, PDT
Number of Patients	7,813	40,301	8,070	7,293	777	5,793	5,127	666
Diagnostic Procedures[1]								
Fluorescein Angiography	0.15	0.22	1.25	0.93	4.19	1.94	1.54	4.96
Fundus Photography	0.24	0.25	0.96	0.75	2.87	1.53	1.25	3.69
Indocyanine-Green Angiography	0.0013	0.0007	0.063	0.036	0.31	0.085	0.058	0.29
Ophthalmoscopy	0.55	0.42	0.86	0.78	1.6	1.43	1.34	2.2
Retinal Ultrasound	0.085	0.073	0.049	0.052	0.02	0.077	0.08	0.053
Visual Field Exam	0.13	0.11	0.078	0.08	0.05	0.1	0.1	0.1
Visual Refraction	0.58	0.47	0.25	0.26	0.19	0.36	0.36	0.34
Therapeutic Procedures[1]								
Photocoagulation	0.013	0.0087	0.063	0.063	0.067	0.061	0.061	0.063
Photodynamic Therapy (PDT)	0	0	0.17	0	1.8	0.22	0	1.87
Physician Interactions[1]								
Ophthalmologist Visits	1.48	1.4	1.46	1.44	1.71	2.16	2.14	2.25
Generalist Visits	0.74	0.81	1.23	1.17	1.8	2.03	1.94	2.69
Consultations	0.17	0.2	0.43	0.39	0.8	0.75	0.71	1.1
Total Reimbursement[2]	$264.36	$258.83	$665.01	$485.09	$2,353.77	$1,000.00	$773.43	$2,744.22

[1] Annual rate of resource utilization per patient.

[2] Annual cost per patient.

SOURCE: Halpern, M.T., Schmier, J.K., Exponent Inc., Covert, D., Alcon Research Ltd. and Venkataraman, K., AstraZeneca, LP, 2006.

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Table 4

Medicare Age-Related Macular Degeneration (AMD) Resource Utilization and Costs, by AMD Subtype: 2001

AMD Subtype	Drusen Only	Dry Only	Wet Only			Wet and Dry		
			All	Wet Only, No PDT	Wet Only, PDT	All	Wet and Dry, No PDT	Wet and Dry, PDT
Number of Patients	6,942	39,162	8,290	6,558	1,732	6,502	5,086	1,416
Diagnostic Procedures[1]								
Fluorescein Angiography	0.15	0.25	1.61	0.89	4.31	2.31	1.54	5.06
Fundus Photography	0.27	0.32	1.2	0.74	2.95	1.76	1.22	3.73
Indocyanine-Green Angiography	0	0.0008	0.078	0.036	0.24	0.11	0.072	0.23
Ophthalmoscopy	0.67	0.53	1.07	0.94	1.55	1.76	1.56	2.5
Retinal Ultrasound	0.096	0.091	0.048	0.051	0.035	0.067	0.074	0.041
Visual Field Exam	0.16	0.13	0.076	0.084	0.045	0.12	0.13	0.095
Visual Refraction	0.73	0.57	0.28	0.3	0.18	0.39	0.4	0.33
Therapeutic Procedures[1]								
Photocoagulation	0.01	0.0097	0.051	0.057	0.03	0.043	0.042	0.046
Photodynamic Therapy (PDT)	0	0	0.55	0	2.63	0.53	0	2.45
Physician Interactions[1]								
Ophthalmologist Visits	1.95	1.79	1.97	1.86	2.39	2.8	2.68	3.23
Generalist Visits	0.74	0.86	1.28	1.16	1.74	2.01	1.87	2.53
Consultations	0.17	0.24	0.46	0.38	0.74	0.82	0.73	1.15
Total Reimbursement[2]	$334.16	$346.89	$1,190.44	$567.35	$3,549.69	$1,592.33	$913.59	$4,030.23

[1] Annual rate of resource utilization per patient.

[2] Annual cost per patient.

SOURCE: Halpern, M.T., Schmier, J.K., Exponent Inc., Covert, D., Alcon Research Ltd. and Venkataraman, K., AstraZeneca, LP, 2006.

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only and wet and dry AMD patients in 2000 and 2001, wet only patients had lower rates of most diagnostic procedures (visual refraction, indocyanine-green angiography, ophthalmoscopy, and fundus photographs). Wet only AMD patients also had lower annual numbers of ophthalmologist visits, generalist physician visits, and specialist consultations. Despite these lower levels of resource utilization among wet only AMD patients, therapeutic procedures (photocoagulation and PDT) were similar between wet only and wet and dry patients. Total costs reflect these differences in resource utilization in a similar manner to that seen in Table 2.

The proportion of wet only patients receiving PDT increased over this 3-year period, reflecting the increasing acceptance of PDT into general practice. The proportion of wet only patients receiving one or more PDT treatments increased from 7.3 percent in 1999 to 10.4 percent in 2000 and 21.2 percent in 2001. In contrast, rates of photocoagulation among wet only AMD patients decreased from over 11 percent of patients in 1999 to approximately 6 percent in 2000 and 4 percent in 2001. Among patients who received any PDT treatments, the number of annual treatments remained fairly constant between 1999 (1.84) and 2000 (1.87), but increased substantially in 2001 (2.45). The rates of diagnostic procedures also increased over this 3-year period. For example, among drusen only and dry only AMD patients, retinal ultrasound increased from less than 7 percent in 1999 to over 9 percent in 2001; fundus photography also increased in these groups. Rates of fluorescein angiography increased annually among wet only AMD patients. Further, the annual number of ophthalmologist visits and specialist consultations increased for each group each year, while the annual number of generalist physician visits tended to decrease. This suggests that over this 3-year period, as specialists performed more of the medical care for AMD patients, use of specialized techniques (both diagnostic and therapeutic procedures) became more common.

Costs for care of AMD increased each year for each subgroup. However, the increase in costs was greater than that attributable to inflation using the medical care services component of the consumer price index (CPI). For example, average annual costs for patients with wet only AMD increased by approximately 30 percent from 1999 to 2000 and by almost 79 percent from 2000 to 2001. In contrast, the increase in the medical care services CPI was 4.3 percent from 1999 to 2000 and 4.8 percent from 2000 to 2001. This increase reflects both greater numbers of patients receiving expensive services (e.g., PDT) and more frequent use of these services.

DISCUSSION

This study evaluated rates of resource utilization and costs for individuals with AMD. In general, rates of resource utilization increased with disease progression. Patients with drusen or dry AMD generally experienced the lowest rates of resource utilization, while those with wet AMD or mixed wet and dry experienced the greatest. For certain diagnostic procedures associated with defining AMD type or monitoring AMD progression, resource utilization rates were higher among the earlier stage patients. However, for all therapeutic procedures, rates were greater among those with more advanced disease. In all cases, individuals with wet or wet and dry AMD had greater costs than did drusen or dry AMD patients.

Results in this study are based on classification of patients using ICD-9-CM codes for AMD subtypes. A large proportion of the total Medicare AMD population

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did not have claims with diagnosis codes specifying subtype (i.e., they had claims with diagnosis codes only for unspecified AMD). These individuals were therefore not included in the analysis. If patients with Medicare claims for only unspecified AMD are substantially different from those with specified AMD subtypes, our results may have limited generalizability. However, our results are still generalizable to the Medicare population with AMD subtype(s) specified.

In this study, we were able to present results only in terms of cost per patient, not per eye. There are no ICD-9-CM diagnosis codes that separate binocular from monocular AMD. Further, while physicians can report on the eye receiving treatment as part of the Medicare billing process (as a Healthcare Common Procedure Coding System modifier code) (Centers for Medicare & Medicaid Services, 2005), specifying the eye or eyes involved is not required to receive payment. Thus, few of the claims in the Medicare data included specification of left or right eye. Among the subgroup of patients who did have one or more claims specifying left versus right eye, approximately one-half of the patients had binocular disease (i.e., they had separate claims for the left and right eyes) while the other one-half had claims associated with only one eye. This does not mean that one-half of the Medicare AMD population had monocular disease; rather, among one-half of the AMD patients, we are unable to determine whether they had monocular or binocular disease.

Little information is available regarding the incidence of monocular versus binocular AMD and the risk of progression from monocular to binocular disease. A number of studies have indicated that approximately 50 percent of patients with AMD have binocular disease (Vinding, 1990). However, in a small study from Japan (17 patients with diagnosed unilateral AMD), drusen were found in 15 (88 percent) of the 17 undiagnosed fellow eyes (Ishiko et al., 2002). This suggests a risk for development of binocular disease among AMD patients with diagnosed monocular disease. Drusen have been reported to represent a risk factor or preliminary stage of AMD (Wang et al., 2003). In the present study, a small proportion of patients (4 to 8 percent) in the dry only, wet only, and wet and dry categories also had diagnoses for drusen. These patients may be a greater risk for progression to binocular AMD.

A number of previous studies have evaluated ophthalmologic services covered by Medicare. In 1983, ophthalmology was second only to internal medicine in the total volume of approved charges in Medicare (Frenkel, 1986). An analysis of the 1991 Medicare 5-percent sample found that the mean number of visits per eye care beneficiary is 2.7, although the mode was one visit (Ellwein et al., 1996). Males and females had almost the same number of visits per year (2.72 versus 2.73), and there was an increase in visits by age group. In addition, black beneficiaries received more visits (3.09 per year) than white beneficiaries (2.71 per year). Macular degeneration was the primary diagnosis code listed for 4.9 percent of ophthalmologist visits and 4.8 percent of optometrist visits. Cataracts and glaucoma were the only more common diagnoses listed for visits to eye care professionals than macular degeneration.

In our study, rates of AMD-related resource utilization increased from 1999 to 2001. Ellwein and Urato (2002) also reported that the proportion of Medicare beneficiaries receiving eye care through fee-for-service providers increased over an 8-year period. Over two-thirds of eye care visits and charges were for ophthalmologist care, but the proportion of visits with optometrists increased from 10.8 to

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14.3 percent during the study period. The proportion of Medicare patients having one or more claims for macular degeneration increased each year from 1991-1998, from 3.52 to 4.53 percent. This may reflect increasing incidence of AMD over time or changes in the detection and diagnosis of AMD.

In a study of Medicare recipients, Javitt et al. (2003) reported the 3-year incidence of wet AMD as being between 9.4 and 11.4 per 1,000 Americans age 65 or over. The results from their study may not be directly comparable to our study, as these investigators included patients with serous/exudative detachment of retinal pigment epithelium (ICD-9-CM 362.42) and hemorrhagic detachment of retinal pigment epithelium (362.43), while we excluded these patient groups. Further, they excluded patients with dry AMD (ICD-9-CM 362.51) or drusen (362.57); we included these patients to assess differences in resource utilization rates and costs associated with different types of AMD. They also used criteria separating ophthalmologists broadly from retinal specialists (based on proportion of all surgery performed that was retinal surgery) in patient ascertainment. Despite these differences in patient selection, their results combined with ours illustrate important trends in AMD treatment over time. The 3-year incidence of AMD treated with laser photocoagulation was 2.3 per 1,000 in 1996-1998 (Javitt et al., 2003), corresponding to photocoagulation being used as a treatment among 20 to 25 percent of all Medicare AMD patients over this period. Among the Medicare population in our study, photocoagulation was received by approximately 10.6 percent of wet AMD patients in 1999, 6.2 percent in 2000, and 5.0 percent in 2001. This decrease was accompanied by an increase in rates of PDT over our 3-year study period.

Costs of inpatient care may also be higher for patients with visual impairment, as was shown using New York State hospital discharge data (Morse et al., 1999). The average length of stay among patients with visual impairment was 2.4 days longer than that for patients without visual impairment. The increased length of stay for patients with visual impairment could be due to lack of discharge planning, which may be more complicated for those with low vision. This suggests that the visual impairment associated with AMD can have substantial costs, in addition to treatment for AMD.

In summary, these results indicate substantial rates of resource utilization and associated Medicare reimbursements for individuals with AMD. Further research in the prevention, treatment, and outcomes associated with AMD is needed to quantify the burden of this condition to Medicare enrollees as well as to develop appropriate guidelines for its treatment. Results from AREDS, evaluating the impacts of nutritional supplements on AMD progression, indicated that use of nutritional supplements could prevent more than 300,000 cases of advanced AMD over the next 5 years (Bressler et al., 2003). The results of the present study, demonstrating increases in resource utilization rates and costs by AMD type, suggest that interventions preventing progression of AMD at earlier stages could produce considerable cost savings in addition to beneficial patient outcomes. Policies associated with funding of AMD services, in particular secondary prevention services to prevent disease progression among individuals diagnosed with AMD, should be reviewed and strengthened. Treatments that prevent or delay progression of AMD are likely have substantial benefits in terms of improving patient well-being, maintaining vision, and decreasing medical care costs.

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