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ABSTRACT

Purpose: **To assess the impact of vision loss on healthcare cost for patients with Medicaid and Medicare and whether these costs are adequately captured by Medicare hierarchical condition categories (HCC) risk adjustment methodology.** ***Data Sources:*** **The public use data set of the Program of All-Inclusive Care for the Elderly (PACE) for 1994–1998, and the Medicare 5% Sample datasets for 2003 and 2004.** ***Methods:*** **For the first analysis, up to five years of PACE data for each individual was used to calculate HCC scores (n = 3,459). For the second analysis, claim or encounter data from Medicare Fee-for-Service (FFS) and Medicare Advantage (MA) were used to estimate the cost for each beneficiary in the upcoming payment year (n = 2,108).** ***Results:*** **The increase in medical cost risk overall for visually impaired PACE participants was 10%, increasing to 13% for the non-institutionalized, community-based cohort, but PACE participants in nursing homes with vision loss did not generally result in increased costs. In the Medicare 5% sample, the HCC model under-predicts costs by about 17%.** ***Conclusion:*** **Our analyses provide evidence that healthcare cost risk attributable to vision loss is not adequately captured by Medicare HCC risk adjustment methodology. We hypothesize this is due to additional morbidity and treatment patterns associated with visual impairment.**

INTRODUCTION

Vision loss among older adults is common: while 14% of individuals between the ages of 70–74 have trouble seeing even with glasses, this increases to 32% for those 85 years old or older. Moreover, three of the four most common causes of vision loss in adults—age-related macular degeneration, glaucoma, and cataracts—all increase in prevalence with age.[1] Blindness and visual impairment are among the ten most common causes of disability in the United States[2] and are associated with reduced life expectancy[3] as well as quality of life.[4] Based on data from the 2000 US census, an estimated 937,000 Americans, 0.78% of the US population over age 40, were legally blind—20/200

or less in the better eye with best correction—and an additional 2.4 million Americans (1.98%) had low vision (20/40 or less with best correction). By 2020, the prevalence of blindness is expected to increase to 1.6 million individuals or 1.1% of the US population, while the prevalence of people with low vision is estimated to increase to 3.9 million or 2.5%, both reflecting the growth and aging of the US population.[5]

Vision plays a critical role in many cognitive tasks that affect functional ability and status. Vision loss and blindness result in reduced physical functioning and increased Activity of Daily Living (ADL) impairment[6] which are commonly used to qualify individuals for institutional status under both Medicare and Medicaid rules. Vision loss also contributes significantly to falls, fractures and restrictions in mobility[7] adding to the healthcare cost associated with these events. For example, in a sample of women with decreased acuity and/or contrast sensitivity, there was an increased risk for deaths due to trauma such as falls, with mortality rates approximately three times greater than for those in the group with the best acuity and contrast sensitivity. Over a period of 12.2 years, the increased overall mortality risk was 19% greater for those with the poorest acuity and 39% greater for those with the worst contrast sensitivity, as compared to those with the best acuity and contrast sensitivity, respectively.[8]

Lee and colleagues,[9] using data from the National Health Information Survey designed to be representative of the non-institutionalized, non-military US population, found that among females, bilateral vision loss is associated with an increase in all-cause mortality. Lee also reported vision impairment is an independent predictor of increased mortality, although recognizing that the relationship between vision impairment and mortality could be mediated by changes in psychosocial functioning brought about as a result of vision loss.

Vision impairment and blindness are associated with an increased need for healthcare. For example, vision impairment contributes significantly to hospital length of stay and post-discharge need for rehabilitative care.[10] Visually impaired patients experience more problems after discharge,[11] and along with other disabled patients, are less satisfied with their healthcare.[12] Vision loss has been associated with lower emotional, physical and social functioning and often results in lowered affective state and increased levels of depression,[13,14] a leading cause of functional impairment.

Psychiatric diagnoses, particularly depression, are often co-morbid with vision loss and have also been demonstrated to increase healthcare utilization. In a cross-sectional, observational analysis, the presence of psychiatric diagnoses increased total healthcare costs by a factor of 2.24; higher costs for patients with depression were attributable to greater use of medical services.[15] Impaired vision and depression are both strongly associated with functional impairment and dependence on ADLs. Rovner and Ganguli[14] found higher rates of depression among community-based residents with low vision (30%) than among those with adequate vision (9%). A strong relationship between depression and functional disability in individuals with low vision has also been demonstrated.[16]

Depression combined with vision loss can be expected to result in greater functional disability than either condition independently. The impact of vision loss on healthcare utilization and costs has been understudied and gaps remain in understanding the impact of vision loss on healthcare delivery, utilization and cost. However, it appears that additional costs may be incurred in providing care to patients with vision loss and that these costs flow from the excess morbidity that results when the effects of vision loss are compounded with other medical conditions. The purpose of this study was to assess the impact of vision loss on healthcare cost for patients with Medicaid and Medicare and to assess whether these costs are adequately captured by Medicare hierarchical condition categories HCC risk adjustment methodology.

METHODOLOGY

Hierarchical condition categories

Hierarchical condition categories were developed as a methodology to risk adjust Medicare payments to Medicare Advantage plans and are designed to be: (1) clinically meaningful, (2) predictive of medical expenditures, (3) able to produce accurate and consistent estimates of expenditures, (4) able to characterize illness levels and multiple diseases, (5) relatively immune to "reimbursement gaming," and (6) internally consistent. The seminal HCC document describes how each of more than 15,000 International Classification for Diseases, 9th Revision (ICD-9) codes are assigned to one of 804 diagnostic groups, which are then aggregated into 189 condition categories that represent a broad set of similar diseases.[17]

The HCC model was finalized in 2003 by the Centers for Medicare and Medicaid Services[18] (CMS). Prior to 2003, CMS adjusted Managed Medicare health plan payments for demographic factors, including Medicaid eligibility and county of service, with only a few exceptions. The current reimbursement model is designed to reflect the relative health status of a health plans' beneficiary population. Each Medicare beneficiary is assigned an HCC score which takes into consideration the demographics of the beneficiaries and the diseases that are coded in their medical claims.

Demographics

The demographic elements used by the HCC Model to calculate the enrollee's risk factor include age, sex, Medicaid status, institutional status and reason for original entitlement—i.e., either disability or age.

Disease groups

The HCC model currently in use considers major diseases which are represented in the model by 70 distinct HCCs for community-based and long-term institutionalized beneficiaries. To be considered in the HCC Model, the ICD-9 code must:

1. be included within the major diseases represented by the model,
2. be submitted by one of three providers: inpatient hospital, outpatient hospital, and/or physician, and
3. pass additional criteria as described in more detail in CMS's risk adjustment data collection instructions.

Coexisting conditions

Comorbidities may contribute to additional complications and, therefore, increased costs. For this reason, the HCC model considers six disease interactions for community-based beneficiaries and two disease interactions for institutionalized beneficiaries. Examples of these interactions include (1) diabetes mellitus and congestive heart failure (CHF) or (2) chronic obstructive pulmonary disease (COPD), cerebrovascular disease and coronary artery disease (CAD).

Sample

Because the analysis of PACE and Medicare data were conducted using publicly released data, no institutional review board or ethics committee approval was required. Although claims data analyses have limitations, claims data provide large population sizes, which is particularly useful for vision loss studies since many causes of vision loss are low incidence disorders which might evade inclusion if a smaller sample is used.[19]

The first analysis was conducted on the Program of All-Inclusive Care for the Elderly (PACE) public use data set.[20] At the time individuals joined the PACE program, they were:

- eligible for nursing home admission, but residing at home
- eligible for both Medicaid and Medicare Parts A and B
- at least 55 years old.

PACE data are a valuable source for information on the risks associated with visual impairment because it contains, by individual, both ICD-9 codes and a separate indicator for visual impairment. The ICD-9 codes are generated from hospital claims, while the standard application of HCC scores uses codes from both hospital and physician claims data. Although the usual calculation of HCC scores uses one year of data, we used up to five years of PACE data for each individual in an attempt to compensate for the absence of physician claim volume. The PACE sample size used was 3,459.

For the second analysis, we used data from the 2003 and 2004 Medicare 5% samples, which are longitudinal databases of a statistically representative sample of Medicare beneficiaries. CMS assembles historical claims from Medicare Fee-for-Service (FFS) and Medicare Advantage (MA) plans; the data include ICD-9 information. In keeping with the HCC methodology of using the claims in the prior year as a predictor of costs in the subsequent year, we used 2003 data as the base year to calculate individuals' HCC scores to predict their 2004 year costs. We excluded enrollees with Transplant, ESRD and/or Renal Failure related procedures and diagnoses from the base year because these rare diagnoses are often associated with very high costs which could introduce instability into our results. Similarly, we excluded institutionalized beneficiaries. We included only those with a full 12 months of Parts A and B coverage for both dual (Medicare and Medicaid) and non-dual (Medicare only) eligible enrollees. The sample size of visually impaired beneficiaries from the 5% sample was 2,108.

Procedure

For the analysis of PACE participants we calculated HCC risk adjustors using five-year (1994–1998) age/gender, inpatient admission diagnoses, assessment data and used the CMS-HCC model and demographically normalized the results using the *Milliman Health Cost Guidelines, Age 65 and Over,* Age/Gender Factors.[21] We used inpatient data, which was the only available data containing ICD-9 codes, and assigned an individual's vision status based on the earliest indication of visual impairment. We considered the individual not visually impaired prior to that indication, which was recorded quarterly in the assessment data. We calculated ages as of February 1, 1996, the midpoint of our experience period. Institutional status was recorded as of the 3rd quarter, 1998.

Vision impairment is defined in the PACE dataset as "Cannot see at all or sees some light or shadows but vision is so poor that the participant is not able to see obstacles in his or her path" which, in functional terms, means that to be considered visually impaired in the PACE dataset, a participant would have to be legally blind. HCC Risk Scores for Medicare members are normally calculated from both Part A and Part B Medicare claims experience, and such figures will vary from those we calculated for PACE members since the PACE diagnosis data come from inpatient admissions only. We applied the Medicare risk adjusted payment methodology to the PACE Public Use Dataset and compared the results of visually impaired and non-visually impaired PACE enrollees.

For the analysis using the Medicare 5% Sample dataset, we identified individuals who were visually impaired in 2003 and survived into 2004. We tabulated their HCC scores in 2003 and their actual claim costs in 2004. Because the Medicare 5% Sample is longitudinal, we were able to tabulate for each individual actual 2004 costs and the HCC score predicted cost for 2004. We applied the 2003 HCC score to the CMS published 2004 basic Medicare Advantage premium for each beneficiary's county to create a predicted value for Medicare cost for 2004. We then compared the predicted costs for these individuals based on the HCC methodology to their actual costs.

We identified the target population for the predicted Year (2004) using ICD-9 codes for vision loss. These are presented in Table 1. We then identified the base year diagnoses for these individuals and applied CMS-specified HCC data submission filters (e.g., excluded non-covered facilities, specialties, and services as documented in the *Risk Adjustment Basic Training Manual*[22]) and produced risk scores using CMS' *2007 HCC Software*. We tabulated the predicted year claim costs for our target population and trended the costs by broad service category to 2007. The HCC-adjusted premiums were similarly trended to 2007.

RESULTS

The results of the PACE analysis are presented in Table 2. For the five year period from 1994–1998, the age-gender adjusted average risk for the vision-impaired non-institutionalized is 13% higher than for non-vision impaired non-institutionalized, confirming our hypothesis that visually impaired people are more costly. The table presents, by both vision impaired and institutionalized status, the risk scores calculated, the age/gender factors used and the adjusted risk, relative to the average PACE population.

Table 3 presents the mean HCC scores, with standard deviations and beneficiary counts for visually impaired Medicare beneficiaries from the Medicare 5% sample dataset. The numbers of beneficiaries in each HCC risk band are sufficient for reasonable inferences to be made about the differences between actual and predicted costs for the cohorts.

The costs and revenue by HCC risk score band are illustrated below in Table 4. Visually impaired beneficiaries' actual costs are higher than expected. Medicare's HCC methodology understates Medicare revenue by about 18% for visually impaired beneficiaries. The under-prediction of costs is greatest with visually impaired beneficiaries with lower HCC scores; this means that the predicted costs were most understated for visually impaired beneficiaries with the lowest HCC scores. Expected cost, per member per month (PMPM), is based on the

Table 1. International Classification for Diseases, 9th Revision Clinical Modification (ICD9-CM) Codes Defining Vision Loss

ICD9-CM Code	Description
369.0	Profound impairment, both eyes
369.00	Impairment level not further specified
369.01	Better eye: total impairment; lesser eye: total impairment
369.02	Better eye: near total impairment; lesser eye: not further specified
369.03	Better eye: near total impairment, lesser eye: total impairment
369.04	Better eye: near total impairment, lesser eye: not further specified
369.05	Better eye: profound impairment; lesser eye: not further specified
369.06	Better eye: profound impairment; lesser eye: total impairment
369.07	Better eye: profound impairment; lesser eye: near total impairment
369.08	Better eye: profound impairment; lesser eye: profound impairment
369.4	Legal blindness, as defined in the U.S.
369.1	Moderate or severe impairment, better eye; profound impairment, lesser eye
369.10	Impairment level not further specified
369.11	Better eye: severe impairment; lesser eye: blind, not further specified
369.12	Better eye: severe impairment; lesser eye: total impairment
369.13	Better eye: severe impairment; lesser eye: near total impairment
369.14	Better eye: severe impairment; lesser eye: profound impairment
369.15	Better eye: moderate impairment; lesser eye: blind, not further specified
369.16	Better eye: moderate impairment; lesser eye: total impairment
369.17	Better eye: moderate impairment; lesser eye: near total impairment
369.18	Better eye: moderate impairment; lesser eye: profound impairment
369.2	Moderate or severe impairment, both eyes
369.20	Impairment level not further specified
369.21	Better eye: severe impairment; lesser eye: not further specified
369.22	Better eye: severe impairment; lesser eye: severe impairment
369.23	Better eye: moderate impairment; lesser eye: not further specified
369.24	Better eye: moderate impairment; lesser eye: severe impairment
369.25	Better eye: moderate impairment; lesser eye: moderate impairment
369.3	Unqualified visual loss, both eyes
369.6	Profound impairment, one eye
369.60	Impairment level not further specified
369.61	One eye: total impairment; other eye: not specified
369.62	One eye: total impairment; other eye: near normal vision
369.63	One eye: total impairment; other eye: normal vision
369.64	One eye: near total impairment; other eye: not specified
369.65	One eye: near total impairment; other eye: near normal vision
369.66	One eye: near total impairment; other eye: normal vision
369.67	One eye: profound impairment; other eye: not specified
369.68	One eye: profound impairment; other eye: near normal vision
369.69	One eye: profound impairment; other eye: normal vision
369.7	Moderate or severe impairment, one eye
369.70	Impairment level not further specified
369.71	One eye: severe impairment; other eye: not specified
369.72	One eye: severe impairment; other eye: near normal vision
369.73	One eye: severe impairment; other eye: normal vision
369.74	One eye: moderate impairment; other eye: not specified
369.75	One eye: moderate impairment; other eye: near normal vision
369.76	One eye: moderate impairment; other eye: normal vision
369.8	Unqualified visual loss, one eye
369.9	Unspecified visual loss

Medicare Advantage capitated premium methodology which is used as a surrogate for expected Medicare covered medical cost.

DISCUSSION

Visually impaired PACE beneficiaries have higher HCC scores than PACE enrollees without vision loss, supporting the view that visually impaired people tend to use healthcare re-sources to a greater extent. This finding is consistent with the findings of Javitt, Zhou and Willke[23] who recently demonstrated that Medicare beneficiaries with vision loss incur significantly higher costs than similar beneficiaries without vision loss, and that 90% of the excess cost was not related to eye care; these costs increase as vision loss progresses.

Higher HCC scores for PACE beneficiaries with visual im-pairment would be consistent with our expectations based on

Table 2. Medicare Hierarchical Condition Category Risk Adjustor Analysis of PACE data

	Last 5 Years 1994 to 1998	Age & Gender Adjusted Average Within-Group Risk Score
ALL ENROLLEES		
Age-Gender Adjusted Relative Risk		1.000
Patient Count	3,459	
Member Years	5,119	
VISION IMPAIRED		
Age-Gender Adjusted Relative Risk		1.097
Patient Count	107	
Member Years	164	
NON-IMPAIRED		
Age-Gender Adjusted Relative Risk		0.994
Patient Count	3,369	
Member Years	4,955	
VISION IMPAIRED NON-INSTITUTIONALIZED		
Age-Gender Adjusted Relative Risk		1.131
Patient Count	91	
Member Years	141	
NON-IMPAIRED NON-INSTITUTIONALIZED		
Age-Gender Adjusted Relative Risk		1.004
Patient Count	2,802	
Member Years	4,017	
VISION IMPAIRED INSTITUTIONALIZED		
Age-Gender Adjusted Relative Risk		0.910
Patient Count	16	
Member Years	23	
INSTITUTIONALIZED		
Age-Gender Adjusted Relative Risk		0.892
Patient Count	463	
Member Years	730	

PACE = Program of All-Inclusive Care for the Elderly.

the literature, although the HCC methodology does not directly address blindness. The PACE program premium calculation, which, in the past, added a frailty adjustment to the HCC methodology, does not explicitly capture the impact of visual impairment since these adjustments are based on reported ADLs, none of which are specific to visual loss. Our findings provide support for adjusting premium payments upward for visually impaired beneficiaries when premiums are adjusted for health condition cost risks.

While several diagnoses for ophthalmic conditions are included in the HCC methodology, these diagnoses are not specific to blindness. For example, people who are not blind could easily receive treatment for diagnoses in HCC 119, Proliferative Diabetic Retinopathy and Vitreous Hemorrhage. On the other hand, patients with diabetes-related blindness who are also being treated for other conditions might not have their diagnosis

of blindness reported if it is seemingly irrelevant to their current treatment. Nevertheless, the presence of visual impairment can readily affect how a patient is treated in acute care and in follow-up. Both the visual impairment and treatment path chosen because of visual impairment may be significant contributors to healthcare cost.

Onset of legal blindness results in a 78% increase in the likelihood of an Instrumental ADL limitation among the elderly[6] while binocular visual acuity worse than 20/40 has been found to negatively impact activities of daily living (ADLs), instrumental activities of daily living (IADLs), physical functioning, and social interaction.[24] An analysis of the Longitudinal Study of Aging data indicated that otherwise healthy persons with self-reported vision disorders at baseline were 30% more likely to decline in ADL by the time of follow-up than were those without vision impairment.[25]

Table 3. Mean Hierarchical Condition Category (HCC) Scores, Standard Deviations and Counts for Visually Impaired Medicare Beneficiaries

HCC	0.00–<0.50	0.50–<1.00	1.00–<1.25	1.25–<1.50	1.50–<1.75	1.75–<2.0	≥2.00	All Scores
Count	247	643	260	201	152	121	484	2,108
Mean HCC score	0.36	0.76	1.11	1.37	1.63	1.87	3.16	1.49
Standard Deviation	0.09	0.14	0.07	0.07	0.07	0.08	1.14	1.14

Table 4. Expected and Actual Costs by Hierarchical Condition Category (HCC) Risk Score Band for Visually Impaired Medicare Beneficiaries

HCC Score	<0.50	0.50–1.00	1.00–<1.25	1.25–<1.50	1.50–<1.75	1.75–<2.00	≥2.00	Total
Cost Per member/per month	$616	912	1,219	1,518	1,744	1,836	2,413	$1,430
Expected Cost Per member/per month	$281	593	878	1,079	1,282	1,473	2,507	$1,178
Claim Costs/Revenue	219%	154%	139%	141%	136%	125%	96%	121%
Average HCC score	0.357	0.756	1.113	1.372	1.629	1.869	3.156	1.490

Dollars projected to 2007.

An estimated 20% of functional blindness and 37% of visual impairment could be remedied by proper refractive correction,[26] which could reduce excess morbidity. For example, Marx et al.[27] found that vision impairment was related to excess ADL disability, and that correction of vision problems resulted in improvement in disability levels. Even where the vision loss was irreversible, low vision rehabilitation and low vision aids were found to be useful to enhance vision and, consequently, improve ADL function.

Horowitz,[28] in a study of nursing home patients, found that vision impairment was significantly predictive of ADL impairment and concluded that appropriate rehabilitative, educational and environmental interventions could reduce the deleterious impact of vision loss on daily functioning and improved functioning may reduce medical care utilization and cost. Despite these findings, ICD-9-CM codes that specifically describe visual impairment—369.00 to 369.9—are not found among the ICD-9-CM codes used in the HCC model. The impact of vision loss on ADLs and on successful rehabilitation, is a factor that clearly contributes to healthcare cost, even those largely evading scrutiny.

Our analysis suggests that visually impaired beneficiaries incur higher healthcare costs than would be predicted using the HCC risk score methodology. The HCC risk score does not consider specific visual impairment ICD-9-CM codes, but does consider conditions that may result in visual impairment, however, visual impairment alone may increase cost. The actual cost for the healthiest visually impaired beneficiaries (with HCC scores < .50) is more than double the predicted cost, while the actual cost for the sickest beneficiaries (HCC scores > 2.00) is very close to the predicted cost. In our experience, this sickest group is similar in HCC score to the average for those who would be classified as "institutional eligible." The HCC model appears to underpredict the most for visually impaired individuals who are less ill (lower HCC score) and better predict the costs of visually impaired individuals who are more ill (higher HCC score).

Vision loss has been found to be predictive of decline in ADLs and IADLs[29] and limitations in IADLs and mobility are three to five times more likely among those with poor visual acuity as compared to those with good visual acuity, after controlling for chronic diseases, cognitive function and other factors.[30] We speculate the impact of vision loss on functional status is greater for those whose functioning is limited by vision loss rather than other factors; by contrast, the impact of vision loss for those with additional physical limitations is smaller. For example, a newly blinded individual with poor ADLs and mobility skills may require a significantly greater degree of personal care or home health aide intervention than a similar, but sighted, counterpart but when bed-ridden, both sighted and vision impaired patients would require similar amounts of assistance.

Our findings from analysis of PACE data from the 1990s are broadly consistent with the more robust and more recent Medicare 5% sample data: the disparity for visually impaired beneficiaries has persisted over the past decade and remains a significant factor in increased healthcare cost. Under-reporting of a patient's complete healthcare status and consequent under-coding in claims submitted for reimbursement is a significant obstacle to understanding the excess costs that may be attributable to vision loss. Given the prevalence of vision loss and its role in functional status and morbidity, the authors believe addressing this issue can appropriately affect reimbursement and patient care.

Improved reporting of vision loss will not result in an immediate change in Medicare/Medicaid reimbursement. Rather, better reporting will facilitate identification of factors that contribute to healthcare cost and over time, may lead to both enhanced reimbursement for care given to some patients, reduced reimbursement for others, as well as changes in care that more specifically address the full range of a patient's care needs. Estimating differential use of healthcare resources based on diagnosis or functional limitations has great potential for planning of resource need as well as the economic impact of changes in population morbidity.

Visual impairment may be a consequence of conditions included in the HCC model; however, individuals with visual impairment generate significantly more cost than similar patients without visual impairment. There are a number of plausible hypotheses for this. Mobility and travel limitations may make routine, preventative or non-emergent physician visits more difficult, and may result in missed follow-up visits. Consequently, by the time patients present for treatment, their condition may be more advanced. In addition, healthcare staff who are unaccustomed to working with patients who have vision loss may make flawed accommodations in their care planning for these patients. For example, rather than encouraging ambulation to

use a bathroom shortly after a surgical procedure, a patient may be left in bed with an indwelling catheter, increasing risks (e.g., infection and DVT) and delaying discharge.

Rehabilitation services may be initiated more slowly or modified inappropriate with an excess of caution; clinicians frequently do not understand of the nature and implications of a patient's vision diagnosis and functional vision loss. Slower initiation of rehabilitation may increase the total length of time necessary for recovery. Hospital discharge planners may not appreciate the differential needs of patients with impaired vision and may lack knowledge of community resources available for such patients. More widespread knowledge about vision loss and a better understanding of the functional implications of vision loss will improve patient care and reduce healthcare cost.

Limitations

These findings should be interpreted cautiously due to the relatively small sample size.

The definition used for the PACE analysis—"Cannot see at all or sees some light or shadows but vision is so poor that the participant is not able to see obstacles in his or her path"—captured only those participants who were legally blind. This is restrictive but because functional vision data are generally not present in the medical record unless quite severe, we felt that applying this criteria would avoid Type I errors (including individuals without severe visual impairment in the impaired group).

Moreover, data supporting a different standard were not uniformly available in the PACE data set. That said, only a small percentage, generally estimated to be approximately 10% of the visually impaired population, is actually legally blind. If a more liberal standard for vision loss were available and applied, our results could differ significantly. A study with more robust vision data would be useful in assessing the impact of increasing levels of vision loss on healthcare cost and could show increasing cost differentials with greater vision loss.

One difficulty in studying vision loss is that because vision loss, in most cases, does not contribute to additional reimbursement, providers have no incentive to add vision codes to their diagnoses. This was not entirely unexpected since it is something that has been encountered previously.[13] However, we believe it produces a sample size much smaller than the actual number of visually impaired people in the Medicare 5% Sample.

For the PACE data, we applied the HCC methodology to multiple years of inpatient claims, although its intended use is one year of hospital and physician claims. We believe our use of relative HCC scores mitigates introduced biases, although we did not test that view.

The diagnosis codes captured in Medicare claims data are those provided by physicians or healthcare providers who submit claims for reimbursement to Medicare. Coding practices are imperfect and variable. Moreover, while eye <u>diseases</u> may be identified and coded, the codes listed in Table 1 which denote level of visual *impairment* are most often omitted, because

Medicare reimbursement does not generally depend on accurate coding of a beneficiary's visual impairment. We believe this results in significant under-coding of visual impairment: many patients not identifiable as visually impaired in the Medicare database may actually have significant vision loss. It also is possible that the beneficiaries whose claims did identify vision loss are atypical of the general visually impaired population. This may mean our results do not accurately represent the actual visually impaired population.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. Desai M, Pratt LA, Lentzner H, Robinson KN. Trends in vision and hearing among older Americans. *Aging Trends*, No. 2. Hyattsville, MD: National Center for Health Statistics.
2. CDC. Prevalence of disabilities and associated health conditions among adults—United States, 1999. *MMWR,* 2001;50:120–125.
3. McCarty CA, Nanjan MB, Taylor HR. Vision impairment predicts 5 year mortality. *Br J Ophthalmol*. 2001; 85:322–326.
4. Vu HT, Keeffe JE, McCarty CA, Taylor HR. Impact of unilateral and bilateral vision loss on quality of life. *Br J Ophthalmol*. 2005; 89:360–363.
5. Congdon N, O'Colmain B, Klaven CC, Klein R, Munoz B, Friedman DS, Kempen J, Taylor HR, Mitchel P. Eye Diseases Research Prevalence Group: Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol*. 2004; 112: 477–485.
6. Sloan FA, Osterman J, Brown DS, Lee PP. Effects of changes in self-reported vision on cognitive, affective, and functional status and living arrangements among the elderly. *Am J Ophthalmol*. 2005;140(4):618–627.
7. Cacciatore F, Abete P, Maggi S, Luchetti G, Calabrese C, Viati L, Leosco D, Ferrara N, Vitale DF, Rengo F. Disability and 6-year mortality in elderly population. Role of visual impairment. *Aging: Clin Exper Res*. 2004;16(5):382–388.
8. Pedula KL, Coleman AL, Hillier TA, Ensrud KE, Nevitt MC, Hochberg MC, Mangione CM, Visual Acuity, contrast sensitivity, and mortality in older women: Study of osteoporotic fractures. *J Am Geriatric Soc*. 2006;54:1871–1877.
9. Lee DJ, Gomez-Marin O, Lan BL, Zheng D. Visual acuity and mortality in US adults. *Arch Ophthalmol*.2002;120:1544–1550.
10. Morse AR, Yatzkan ES, Berberich B, Arons, RR. Acute care hospital utilization by patients with visual impairment. *Arch Ophthalmol*. 1999;117:943–949.
11. Boter H, Mistiaen P, Duijnhouwer E, Groenewegen I. The problems of elderly patients at home after ophthalmic treatment. *J Ophthalmic Nur Tec*hnol. 1998;17(2):59–65.
12. Iezzoni LI, Davis RB, Soukup J, O'Day B. Quality dimensions that most concern people with physical and sensory disabilities. *Arch Internal Med*. 2003;163:2085–2092.

13. Capella-McDonald ME. The effects of single and dual sensory loss on symptoms of depression in the elderly. *Intern J Ger Psychiatry*. 2005;20(9):855–861.

14. Rovner BW, Ganguli M. Depression and disability associated with impaired vision: the Movies Project. *J Am Geriatric Soc*. 1998;46(5):617–619.

15. Thomas MR, Waxmonsky JA, Gabow PA, Flanders-McGinnis G, Socherman R, Rost K. Prevalence of psychiatric disorders and costs of care among adult enrollees in a Medicaid HMO. *Psychiatric Serv*. 2005;56(11):1394–401.

16. Shmuely-Dulitzki Y, Rovner BW, Zisselman PM. The impact of depression on function in low vision elderly patients. *Am J Geriatric Psychiatry,* 1996;44:181–184.

17. Pope GC, Kautter J, Ellis RP, Ash AS, Ayanian J, Iezzoni L, Ingber M, Levy JM, Robst J. Risk adjustment of Medicare capitation payments using the CMS-HCC model. *Health Care Finan Rev*. 2004;25(4):119–141.

18. Centers for Medicare and Medicaid Services (CMS). CMS-HCC Payment Model (2004 Computer Software). www.cms.hhs.gov/healthplans/rates/2004/hccsoftware.zip (accessed October 4, 20078).

19. Coleman AL, Orgenstern H. Use of insurance claims databases to evaluate the outcomes of ophthalmic surgery. *Surv Ophthalmol*. 1997;42(3):271–278.

20. NPA. PACE Public Use Dataset (1998 Data file). 2000. Alexandria, VA: National PACE Association.

21. Millman, Inc. Milliman Health Cost Guidelines: Ages 65 and Over, Age/Gender Factors. 2007. Seattle: Milliman, Inc.

22. CMS. *Risk Adjustment Data Basic Training Manual*. Centers for Medicare and Medicaid Services, February 16, 2006. Centers for Medicare and Medicaid Services.

23. Javitt JC, Zhou Z, Willke RJ. Association between vision loss and higher medical care costs in medicare beneficiaries. *Ophthalmology* 2007;114(2):238–245.

24. West SK, Munoz B, Rubin GS, Schein OD, Bandeen-Roche K, Zeger S, German S, Fried LP. Function and visual impairment in a population-based study of older adults. The SEE Project. Salisbury Eye Evaluation. *Invest Ophthalmol Vis Sci*. 1997;38:72–82.

25. Mor V, Murphy J, Masterson-Allen S, Wiley C, Razmpour A, Jackson ME, Greer D, Katz S. Risk of functional decline among well elders. *J Clin Epidemiol*. 2989;42:95–904.

26. Tielsch JM, Javitt JC, Coleman A, Katz J, Sommer A. The prevalence of blindness and visual impairment among nursing home residents in Baltimore. *New Engl J Med*. 1995;332:1205–1210.

27. Marx MS, Werner P, Cohen-Mansfield J, Feldman R. The relationship between low vision and performance of activities of daily living in nursing home residents. *J Am Geriatrics Soc*. 1992;40:1018–1020.

28. Horowitz A. Vision impairment and functional disability among nursing home residents. *The Gerontol*. 1994;34:316–332.

29. Lin MY, Gutierez PR, Stone KL, Yaffe K, Ensrud KE, Fink HA, Sarkisian CA, Coleman AL, and Mangione CM. Study of Osteoporotic Fractures Research Group. Vision impairment and combined vision and hearing impairment predict cognitive and functional decline in older women. *J Am Geriatric Soc*. 2004;52(12):1996–2002.

30. Laitinen A, Koskinen S, Rudanko S-L, Laatikainen L, and Aromaa A. The association between visual acuity and functional limitations: Findings from a nationally representative population survey. *Ophthalmic Epidemiol*. 2007;14(6):333–342.