Trends Over Time and Regional Variations in the Rate of Laser Trabeculoplasty in the Medicare Population

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IMPORTANCE Laser trabeculoplasty (LTP) is routinely used to treat open-angle glaucoma; hence, understanding variations in its use over time and region is important.

OBJECTIVE To determine trends over time and the regional variation in the performance of LTP.

DESIGN, SETTING, AND PARTICIPANTS Database analysis of a 5% random sample of all Medicare beneficiaries 65 years or older with continuous Part B (medical insurance) coverage and no enrollment in a health maintenance organization for each year from 2002 through 2009.

INTERVENTIONS We counted unique claims with a Current Procedural Terminology code of 65855 (LTP) submitted by ophthalmologists, optometrists, ambulatory surgery centers, or outpatient hospitals by region for each year. We examined trends over time and regional variation in LTP rates in 9 large geographic regions.

MAIN OUTCOMES AND MEASURES Rate of LTP per 10,000 Medicare beneficiary person-years and per 10,000 diagnosed open-angle glaucoma (OAG) person-years.

RESULTS The LTP rates per 10,000 Medicare beneficiary person-years were 36.3, 60.1, and 53.5 for 2002, 2006, and 2009, respectively. The 65.6% increase between 2002 and 2006 and the 11.0% decrease between 2006 and 2009 were statistically significant (tests for linear trend, P = .009 and P < .001, respectively). Similarly, the LTP rate among Medicare beneficiaries with OAG increased from 507.9 per 10,000 person-years in 2002 to 824.3 per 10,000 person-years in 2006 (62.3% increase; P = .009) and then decreased to 741 per 10,000 person-years by 2009 (10.1% decrease; P = .004). The rates per 10,000 OAG person-years differed significantly by region, ranging from 314 in the East South-Central region to 607 in the East North-Central region in 2002 (93.2% higher; P < .001). A similar range of variation was observed in subsequent years.

CONCLUSIONS AND RELEVANCE The rate of LTP for Medicare patients with OAG peaked in 2006 and then decreased through 2009. Nearly twice as many LTP procedures per Medicare beneficiary were performed in some regions compared with others throughout the period.

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Since its introduction into clinical care for open-angle glaucoma (OAG) in the 1980s, laser trabeculoplasty (LTP) has remained an important component of glaucoma therapy, along with medical treatment and incisional surgery. Laser trabeculoplasty was estimated to have been performed in about 5% of Medicare beneficiaries with a coded diagnosis of OAG in 2009, comprising 7% of the total payments for OAG care to beneficiaries in that year.

Ramulu et al and Schmier et al reported on trends over time in the rate of LTP in the United States, noting that rates decreased between 1996 and 2001 and then more than doubled between 2001 and 2006. They speculated that this turnaround might be related to the advent of a new technology, selective laser trabeculoplasty (SLT), and/or to widening of the indications for LTP.

The precise role of LTP in the management of glaucoma remains unclear. As with other chronic conditions, ophthalmologists may adopt their own practice style that can be influenced by factors other than the characteristics of their particular patient population. Large geographic variation in medical and surgical care may imply overuse or underuse, although objective standards are not available to assess the appropriateness of use rates in most medical procedures. Previous ophthalmic research has documented geographic variation in the performance of cataract surgery, preoperative gonioscopy, visual field testing, type of retinal detachment repair, and the diagnosis of glaucoma.

Medicare billing data permit the study of large numbers of patients who are representative of the elderly US population. In this investigation, we examined whether the increase in LTP noted between 2001 and 2006 continued in the next 3 years and if regional variations existed in using LTP to treat glaucoma.

Methods

The research protocol was approved by the Privacy Board at the Centers for Medicare & Medicaid Services. The Johns Hopkins University School of Medicine and Wake Forest School of Medicine Institutional Review Boards determined that this study qualified for an exemption from institutional review board review and oversight. Statistical analyses were performed using SAS, version 9.3, of the SAS System for Unix (SAS Institute, Inc).

Data Source

We obtained 5% Medicare research-identifiable files for 2002 through 2009 from the Research Data Distribution Center at the Centers for Medicare & Medicaid Services. These files contain a 5% random sample of all Medicare beneficiaries' information on payment for health care services provided by Medicare in the fee-for-service sector. Files obtained included the carrier (formerly physician or supplier Part B file), outpatient facility, and denominator or beneficiary summary files for each year. Claims files contain information on dates and place of service; International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and Current Procedural Terminology (CPT) procedure codes; provider identifier numbers for the provider submitting the claim; provider type (e.g., ophthalmologist or optometrist); billing codes and associated charges; and payments. In addition to individual provider claims, the carrier file also contains facility claims from ambulatory surgery centers.

The denominator files provide demographic and residence information and Medicare eligibility status for all beneficiaries in the 5% sample. We limited each yearly denial file to beneficiaries from one of the 50 states or the District of Columbia who were 65 years or older with continuous Part B eligibility and no health maintenance organization enrollment in that year. Beneficiaries with partial-year eligibility, either due to death or enrollment after January of that year, were also included, with the person-years adjusted to account for the amount of time that they were enrolled. The number of beneficiary person-years was calculated by summing the amount of time that each beneficiary contributed for a given year.

LTP Treatments

All claims with a CPT code of 65855 (LTP) were extracted from the carrier and outpatient facility files for each calendar year. Claims for postoperative management only (modifier code 55) were deleted. Professional fee claims, supplemented by information from facility fee claims, were used to classify each treatment as unilateral or bilateral using procedure modifier codes. Bilateral treatments on the same visit day were counted as 2 treated eyes. Total number of treated eyes was summed for every beneficiary for each calendar year. We estimated the total number of LTPs per year nationally in this population by multiplying the number of claims in our 5% sample by 20. Data were examined to determine the number of LTP re-treatments each patient received, as well as the number of LTP re-treatments per eye.

Categorization of Glaucoma Diagnosis

Carrier claims from each year were used to categorize patients by type of glaucoma as previously described. Briefly, each claim with a glaucoma ICD-9-CM diagnosis code was grouped into type of glaucoma. Analyses of rates were limited to patients diagnosed with OAG suspect (OAG-s; ICD-9-CM codes 365.0, 365.00, 365.01, 365.03, and 365.04) and OAG (ICD-9-CM codes 365.1, 365.10-365.13, 365.15, 365.3, 365.52, 365.81, and 365.82), the 2 most common types of glaucoma treated with LTP. Patients having both OAG-s and OAG claims in a calendar year were classified according to the diagnosis on their last glaucoma claim in that year.

Annual Rates of LTP Treatment

The annual LTP rate per 10 000 Medicare beneficiary person-years was calculated by dividing the total number of treated eyes by the total number of beneficiary person-years for each year from 2002 through 2009 and multiplying by 10 000. Rates per 10 000 person-years also were calculated separately for patients diagnosed with OAG-s and OAG. The 95% CIs were calculated for all rates using generalized linear models with a test for trend to compare mean LTP rates over time.
Regional Variation in LTP Rates

Regional variation in LTP rates was examined among 9 large regions (Figure 1). Mean rates of LTP per 10,000 beneficiary person-years, per 10,000 OAG-s person-years, and per 10,000 OAG person-years were compared among these 9 regions for each year using generalized linear models. Mean rates, adjusted for age, sex, and race, were compared among regions also.

Results

The estimated total number of LTPs performed in all aged Medicare beneficiaries receiving care in the fee-for-service sector increased 64.4% from 102,020 in 2002 to a peak at 167,680 in 2006 and then decreased slowly from 2006 through 2009 by a total of 14.6% to 143,220. The size of the fee-for-service Medicare population changed little during this time; thus, the LTP rate per 10,000 beneficiary person-years followed a similar pattern of fluctuation, with rates of 36.3, 60.1, and 53.5 for 2002, 2006, and 2009, respectively (Figure 2). The 65.6% increase from 2002 to 2006 and 11.0% decrease from 2006 to 2009 were statistically significant linear trends (P = .009 and <.001, respectively). Of the approximately 143,000 LTPs performed in 2009, a total of 125,000 (87.4%) were performed in eyes with a diagnosis of OAG, 9,500 (6.6%) in eyes with a diagnosis of OAG-s, and 8,500 (5.9%) in eyes with other or multiple (eg, angle closure glaucoma and OAG) glaucoma diagnoses. The proportion performed in these 3 diagnosis groups was similar for each year from 2002 through 2009. Rates of LTP per 10,000 OAG person-years among OAG beneficiaries ranged from 507.9 in 2002 to 824.3 in 2006 (62.3% increase; P = .009) to 741.1 in 2009 (10.1% decrease; P = .004) (Figure 3). Rates of LTP were lower among the OAG-s population, ranging from 52.1 to 89.6 per 10,000 OAG-s person-years. The trend in rates was similar across all beneficiaries as well as beneficiaries with OAG and OAG-s, even after adjustment for demographic factors.
Among patients with a diagnostic code for OAG, regional differences were evident in the frequency of LTP use throughout the period studied. In 2002, rates per 10,000 OAG person-years ranged from 314 in the East South-Central region to 607 in the East North-Central region (a 1.9-fold difference; \( P < .001 \)) (Figure 4A). In general, the increase in the rate of LTP between 2002 and 2006 was greatest for those regions that had the lowest rates in 2002, such as the West North-Central region, which had an increase of 151.2%, and least for those regions that had the highest rates in 2002, such as New England, with a 21.3% increase. Rates of LTP per 10,000 OAG person-years in 2006 ranged from 650.0 in the Mountain region to 924.9 in the East North-Central region, a 1.4-fold difference (\( P < .001 \)). In 2009, LTP rates per 10,000 OAG person-years ranged from 563.2 in the East South-Central region to 931.0 in the Pacific region, a 1.7-fold difference (\( P < .001 \)). Regional variation was not substantially altered when the data were adjusted for age, sex, and race.

The change in LTP rate per OAG beneficiary over time was not uniform among regions. In 5 regions, the overall trend was for an increase from 2002 through 2006, with a subsequent fall to 2009. In New England and Mountain regions, however, there was a modest increase from 2002 through 2009, with no significant fall. In other regions, such as Pacific and East North-Central, a substantial increase by 2006 was followed by a plateau in the subsequent years. Figure 4B depicts the rate with all Medicare beneficiaries, as opposed to those with OAG, in the denominator. The variation between regions was greater when expressed in terms of all beneficiaries rather than beneficiaries with OAG in 2002 and 2006. The greatest variation in 2002, 2006, and 2009, between the Mid-Atlantic and Mountain regions, was 2.9-, 2.1-, and 1.7-fold, respectively. In addition, the regions of minimum and maximum LTP rates were different for the LTP rate per beneficiary than for the LTP rate per beneficiary with OAG.

A small percentage of providers performed LTP, but the percentage increased from 2002 through 2006 across all regions, with the greatest growth in the areas with the lowest percentage of providers in 2002. In 2002, the percentage of providers performing LTP among patients with OAG and OAG's ranged from 7.3% in the Mountain region to 14.4% in the East North-Central region. In 2006, the percentage of providers performing LTP ranged from 12.2% in the Mountain region to 19.4% in the East North-Central region.

In 92.4% of eyes, we could ascertain the laterality of treatment. Among those eyes, 78.9% received a single LTP during the study period, 16.6% had 2 LTPs, 3.2% had 3, and 1.3% had 4 or more LTPs.

### Discussion

We report that the use of a therapeutic procedure, LTP, increased dramatically in the Medicare population between 2002 and 2006 but decreased during the 3 subsequent years. It is possible that the increase observed between 2002 and 2006 and the decline thereafter are attributable to the advent of SLT as a newer form of LTP. The introduction of a new instrument for LTP coincided with increased rates of LTP. This could have occurred because of successful marketing that suggested SLT is safer than argon LTP (ALT) and perhaps more repeatable. Eye-care specialists who purchased the laser specific to SLT would be motivated to use it, potentially in patients who have not had ALT, increasing the overall rate of trabeculoplasty. By 2006, penetration of the procedure to suitable patients could have been complete. After 2006, either there were fewer untreated patients to treat, or practitioners had become less enthusiastic about SLT’s effectiveness, thereby decreasing the rate. Unfortunately, Medicare billing data do not differentiate between SLT and ALT, so we are not able to test this hypothesis directly. A possible second contributing factor to the decline in LTP use was the fact that there was an 18.6% decline in allowed charge for the procedure, from $361 in 2006 to $294 in 2009, although there was also a 14.3% decline between 2002 and 2006 (from $421 to $361) as the use of LTP was increasing (using constant 2009 dollars in Baltimore, Maryland, as an example).

Fraser and Wormald examined data from the National Health Service in the United Kingdom and reported a 60% decrease in the number of LTPs performed between 1998 and 2004, but the absolute number of procedures performed was so small (307 procedures in the last year studied), that no direct comparison with our data should be drawn. Rachmiel et al studied a database from the Ontario Health Insurance Program and noted that the rate of LTP per 1000 persons with primary OAG decreased from 149 per 1000 to 71 per 1000 between 1996 and 2001 and then increased to 162 per 1000 by 2004. Although their reported rates are twice those that we re-
port, perhaps due to different definitions of glaucoma, they observed the same increase in the first half of the last decade that we observed.

To our knowledge, no previous study has studied regional variation in an ophthalmic laser procedure in the United States. However, in Canada, Campbell et al15 have examined provincial differences in the rates of LTP and reported that the increase in LTP in Canada as a whole was entirely accounted for by large increases in Ontario and British Columbia. Buys et al16 examined whether higher physician remuneration fees in a Canadian province might in part explain an increased performance rate of trabecuoplasty but could not find a relationship.

Geographic variations in preoperative glaucoma diagnostic procedures and in cataract surgery have been reported, with a magnitude similar in recent years to the 2-fold or less variation of LTP we found in those diagnosed with OAG.7,10 At the level of those undergoing glaucoma laser treatment or surgery, preoperative gonioscopy varied 2-fold in those with narrow angles or glaucoma, whereas preoperative visual field testing varied only 1.1-fold in those with OAG across regions.10 Geographic variation in cataract surgery was analyzed at the beneficiary level. Data from 1986 and 1987 reported an 11-fold variation in cataract surgery across 181 US areas and a mean annual rate of 25.4 cataract operations per 1000 beneficiaries.7 By 2003 through 2004, the mean rate of cataract surgery increased to 61.8 per 1000 person-years, and variation declined to 1.9-fold across the 48 contiguous states.8 This decrease in regional variation is likely related to improved availability of the procedure over time.

The less than 2-fold regional variation of LTP and other ophthalmic procedures is at the lower end of the regional variation of most inpatient, invasive general surgical and medical procedures, which vary 1.5- to 10.1-fold across regions.17–22 Observed differences in regional variation across studies may be attributable to a large number of factors, including different degrees of diagnostic variation across diseases, environmental factors affecting disease severity and need for treatment, access to tertiary care providers and facilities, differing physician practice patterns, and methodologic differences in defining the study population. Many previous studies have conducted analyses using the entire aged Medicare population within a region for the denominator of the rates. In this study of regional variation in LTP rates, the variation was less at the OAG patient level (1.4- to 1.9-fold) than at the Medicare beneficiary level (1.7- to 2.9-fold). We have previously reported regional variation in glaucoma diagnosis23; whether diagnostic variation would have an effect on variation in rates of procedures cannot be determined definitively from these data. However, the observation that regional variation was less when the procedure rate was expressed in terms of beneficiaries with OAG as opposed to all Medicare beneficiaries is consistent with previous studies suggesting a greater regional variability in factors influencing diagnosis, including beneficiary educational level, median income, and access to preventive care, rural clinics, and tertiary care providers, especially for conditions that are not readily apparent or easily diagnosed.27,3,22

Previous studies have noted that regional variation is greater for newer procedures than for more established ones and those with a higher regional variation in procedure volume.18,30,31 In some regions, the increase followed by a decrease in the LTP rate was much more dramatic than in other regions that had a more modest, monotonic increase or an increase with no subsequent decrease. These differences did not, however, lead to more uniform behavior across regions and thus have no immediate explanations from the rational analysis of practice patterns.

Re-treatment after initial LTP was uncommon. Among the 92.4% of patients for whom we could identify laterality of treatment, most eyes (78.9%) received only a single LTP with no retreatment during the study period. Because Medicare claims do not differentiate between 180° and 360° procedures, a full-circumference LTP performed over multiple time points could have been coded as multiple procedures performed on the same patient or eye, overestimating the number of LTP re-treatments. Thus, the true proportion of patients and eyes undergoing re-treatment was likely to have been even lower than we reported.

The limitations of this study are those inherent in the use of the Medicare database. They include errors that may have occurred in the coding of diagnoses, eye treated, and procedures, potentially resulting in misclassification. In addition, we could not differentiate between ALT and SLT. Finally, our findings cannot be extrapolated to patients with glaucoma who are too young to be enrolled in Medicare or to those who are in Medicare health maintenance organizations.

Conclusions

The use of LTP in the aged Medicare fee-for-service population increased from 2002 through 2006 and declined from 2006 through 2009. Regional variation ranged from a 1.4- to 1.9-fold difference over time when expressed in terms of patients with OAG but was as great as 2.9-fold when conveyed in terms of Medicare beneficiaries. In all regions, only a small proportion of providers performed LTP. Re-treatment with LTP in the same eye and treatment with more than 2 LTPs in the same patient were uncommon.
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