Cataract Surgery Rates in Latin America: a Three-Year Longitudinal Study of 19 Countries

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Running Head: Cataract Surgery Rates in Latin America

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Summary

Background: Little data exists regarding cataract surgery rates (CSRs) in Latin America. Accordingly, the study collected CSR data in 19 countries over a 3-year period.

Methods: CSRs were obtained from national society of ophthalmology and Ministry of Health representatives for each country for 2005 to 2007. Economic and other data were collected from publicly available databases. Appropriate CSRs for each country were estimated by using recent CSR data from Ontario, Canada, as a baseline, and adjusting it for the proportion of the population aged 60 or older and threshold visual acuity for each country.

Findings: Most countries increased their CSRs, but the actual increases were small, with the exception of Costa Rica (53%), Cuba (95%), Nicaragua (1.2-fold), and Venezuela (83%). Data for 2007 indicated a regional mean CSR of 1420 per million population with a growth over the study period of 27%. A fair correlation between CSR and gross national income per capita (purchasing power parity method) was found (Pearson correlation 0.638, $p = .003$). Comparison of 2007 CSRs with the estimated appropriate CSRs by country showed large disparities.

Interpretation: Unless the regional CSR increases considerably, the VISION 2020 goal of eliminating avoidable blindness by cataract will not be met. Several factors are likely responsible: lack of dedicated surgery centers, infrastructure, financing, and patient awareness.

Introduction

Projections made in 1999 suggested that 75 to 200 million individuals could be visually impaired by the year 2020 and of those affected, an estimated 90% would be from developing countries.[1] However, more recent global data indicate that there are 45 million blind people worldwide and an additional 269 million who are visually impaired.[2] In 1999, the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB) launched VISION 2020: The Right to Sight, with the goal of eliminating avoidable blindness by the year 2020.[3] In Latin America the efforts of the VISION 2020 initiative are focused on improving primary eye care, and developing surgical and corrective treatments for cataract, low vision, refractive error, glaucoma, diabetic retinopathy and childhood blindness.[4]

The prevalence of cataract increases with age from less than 5% in persons under 65, to approximately 50% in persons 75 years or older,[5] although these figures can vary widely according to geographical location. Contributing to the problem of blindness and visual impairment is increasing longevity, which is true for less economically developed countries, as well as the industrialized world. This does not necessarily mean a proportional increase in blindness; for example, while Congdon et al[6] suggest that the prevalence of cataract in the United States could double by the year 2020, Murthy et al[7] indicate that blindness in India due to cataract might only increase by 6%, provided increases in cataract surgery materialize as projected.

Studies performed in Latin America and the Caribbean confirm cataract as the leading cause of blindness and visual impairment,[8] with 47%-87% of individuals bilaterally blind due to cataract.[9] The cataract surgical rate (CSR), the annual number of cataract operations performed per million population, is often tied to the social and economic development of countries,

although this is not always true, such as in the cases of India and China. In developed countries the CSR is probably approaching 10 000 per million population,[10-12] while in Latin America, the CSR has been reported to range from 500-2000 with the lowest rates in the poorest regions.[8]

There are several factors that influence the CSR. There is a low demand for surgery due to fear, and because of poor surgical outcome.[13] There is also a lack of ophthalmologists in poor and rural areas.[4] Affordability also limits the utilization of services available to treat cataract, and access, the distance between the consumer and the services, can be problematic, especially in countries with isolated or difficult-to-reach areas. However, perhaps the single most important point is that relatively few ophthalmologists carry out cataract surgery, and thus there is a poor correlation between number of ophthalmologists per million population and surgery output.

In order to assess trends related to goals of the VISION 2020 initiatives in the region and because published data concerning the CSR in Latin America is so limited, we undertook a study to analyze available CSR and economic data for 19 countries in Latin America over a period of nearly 3 years. In addition, we examined some simple methods of estimating the number of cataract surgeries required in the region and whether the CSR is a good metric of assessing how well cataract cases are treated.

Methods

Relevant data on Gross National Income (GNI) per capita (purchasing power parity method) from 19 countries in South and Central America were obtained from the World Bank (available at http://web.worldbank.org; accessed April 3, 2008). Data used were in international dollars for 2006. For Cuba, the GNI was obtained from the CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/index.html; accessed March 4, 2008) since the data were not available from the World Bank. Cataract surgery rates (CSRs)

were obtained from key individuals at the national society of ophthalmology and/or Ministry of Health for each country, once or twice a year and averaged if not identical. Data was double-checked from original sources and cross-correlated with other data available from NGOs if it seemed high or low compared to the previous reported period. Related ophthalmologist data for the same period of time were compiled from WHO National VISION 2020 implementation data (available at www.who.int; accessed March 2008). Population data were obtained from the United Nations (available at unstats.un.org; accessed March 2008), most recent census data from 2005-2006. Proportions of the population ≥ 60 years old for each country (most recent data) were obtained from PAHO (Pan American Health Organization) (www.paho.org/english/dd/ais/coredata.htm; accessed June 9, 2008).

The proportion of older individuals in a given population and visual acuity threshold for cataract surgery are the 2 biggest factors that impact the CSR, and a simple method for estimating an appropriate CSR given the age of a population and a visual acuity threshold was developed using Canada as a "model country," with 2004 CSR data from the Ontario province.[13] Using the CSR figure of 8942 per million population for Ontario as the starting point, CSRs were calculated by adjusting for preoperative visual acuity (VA) using a figure of 0.72 logMAR units for the study countries,[14] and a preoperative VA of 0.54 logMAR units for Canada (mean of 3 studies, weight adjusted for *N* in each study[16-17]). The 2005 data from Taylor et al[18] were then used to calculate the number of cataract surgeries required based upon the different visual acuity thresholds for cataract surgery. A second adjustment was made based upon the proportion of the population aged 60 years or older to include the risk for cataract based upon age as some populations will have a higher proportion of older individuals than others.

The form of the calculation was:

$$CSR = (8942 \times [\{C_1 - C_2\}]/C_2) \times (P_1/P_2)$$

Where C_1 represents the number of required cataract surgeries at a VA of 0.54 logMAR units, C_2 the number of required cataract surgeries at a lower VA threshold, P_1 the proportion of individuals aged 60 years or more in the study country, and P_2 the proportion of individuals aged 60 years or more in Canada (21.6%).

Appropriate CSR ranges for given proportions of the population aged ≥ 60 years and visual acuity thresholds of 0.7 to 1.3 logMAR units were also calculated by taking the calculated CSRs as a mean point and estimating the range as ± 10%.

A Pearson correlation analysis was performed for GNI per capita versus CSR. Mean CSRs were compared using Student *t* tests. Data were statistically analyzed using SPSS v16 (SPSS, Inc., Chicago IL) with a *p* value of < .05 regarded as significant.

Results

Over the study period, while most countries increased their CSRs, the actual increases were small or modest, with the exception of Costa Rica (53%), Cuba (95%), Nicaragua (1.2-fold), and Venezuela (83%) (Table 1). The mean CSRs for 2005, 2006, and 2007 for the region were 1119 (SD = 572.05), 1333 (604.16), and 1420 (683.92) per million population, respectively, with a growth over the study period of 27%, concurrent with an increase of 184 million in the population. The difference between the mean CSRs for 2007 and 2007 is not significant ($t = 1.423$, $df = 33$, $p = 0.160$).

The number of ophthalmologists per million population varied by more than an order of magnitude. The lowest figure was for Honduras (8-9 per million) and the highest for Argentina (90-116 per million). An increase of approximately 2.7 ophthalmologists per million population occurred over the study period with an overall mean of 38.8 ophthalmologists per million

population for the region in 2007. These figures would translate to a small increase of 6.4 cataract surgeries per ophthalmologist with an overall mean of 33.8 cataract surgeries per ophthalmologist for the study period. These are statistical figures and do not represent the true situation since only a small percentage of ophthalmologists perform cataract surgery.

The GNI per capita for 2006 plotted against CSR data from 2006 showed a statistically significant correlation (Pearson correlation 0.638, $p = .003$) (Figure 1).

A comparison of the study CSRs for 2007 with appropriate rates calculated using country-specific age population data and a uniform preoperative visual acuity threshold showed large disparities (Figure 2). A more general format indicating satisfactory CSR ranges for given proportions of the population aged ≥ 60 years and a variety of visual acuity thresholds is shown in Table 2.

Discussion

In Latin America, data collection to support the assessment of the effect of VISION 2020 initiatives as they relate to CSR is a difficult task, because of the lack of comprehensive data. For the first time, we report here CSR data for 19 Latin American countries over a 3-year period. The results demonstrate that the region is a long way from achieving rates that will eliminate blindness due to cataract by 2020. Most importantly, the rapidly aging population in such countries as Uruguay, Cuba, Chile, or Argentina will make the overall goal of eliminating blindness by 2020 even more difficult. What rates, therefore, are appropriate to meet VISION 2020 goals?

In India, Murthy et al[7] indicate that that the CSR target for 2000 (3000 per million population) has finally been reached 8 years later, and exceeded in some regions. The study would also appear to show that a CSR rate of 6000 is possible by the year 2020, but this will not

be enough to achieve VISION 2020 goals. In the authors' opinion achieving a high CSR rate is not sufficient; the SRR (sight restoration rate) must also be considerably improved, otherwise the VISION 2020 goal will not be met.

In Latin America at the outset of the VISION 2020 initiative, estimates placed the CSR between 500 and 2000.[13] Our analysis shows that the current CSR in the Latin American region at 1420 per million, which indicates that progress has been slow. As demonstrated in our study, there is only a fair correlation between the CSR and GNI per capita, which suggests that the cataract surgery rate, a surrogate for cataract surgery "consumption," is not economically driven in all countries. By using recent CSR data from Canada as a model,[8] which has a socialized health care system, and applying preoperative visual acuity and age factors, we also attempted obtain approximate estimates of an appropriate CSR for each country, as well as ranges based on different preoperative visual acuities and age of a population (Table 2). The results of this analysis showed how sensitive the calculations are to these factors, and also demonstrated that the CSR for most countries is far behind what it should be.

Theoretically, 10 eye surgeons per million population are able to treat all blinding cataracts, providing they have a well-developed technical and administrative infrastructure,[19] and the ophthalmologists are well distributed throughout the country. The results from our study indicate a mean of 38.8 ophthalmologists per million population in the region, which should be sufficient to meet the needs of the population, provided that a third of these ophthalmologists are dedicated to cataract surgery. The problem is that we do not know in each country how many ophthalmic surgeons are actually performing cataract surgery, how many surgeries each is performing annually, and what the outcomes are for each surgery. Furthermore, assuming data accuracy of ± 5-10%, which is reasonable, based upon our experience; CSRs have not changed

significantly during the study period. So, what is preventing larger increases in cataract surgery rates?

Yorston[20] lists several key factors on the demand side of the equation that must be addressed to ensure successful high volume cataract surgery: awareness, cost elasticity, and distance, which may be more a function of social than geographic distance. Awareness that cataract can be treated by surgery is a function of literacy, and education through outreach. It may be higher in urban areas compared to rural areas, simply because advertising of ophthalmology services through mass media is higher, although word of mouth is still the most important factor. In rural areas, improving awareness can occur when ophthalmology teams are committed to regularly visiting such areas in coordination with community health care workers and other organizations. However, the creation of many cataract services in India and Europe has shown that this is not a necessary prerequisite.

Although bad service, which includes poor outcomes, has been a factor in Latin America,[21] fear of the surgery or lack of knowledge concerning the surgery is also common, which can only be overcome with patient education.[22] Even when outreach programs are in place, and free transportation is provided, cost has still been cited as a barrier to cataract surgery in many developing countries. Little published data is available for the Latin American region, but in our experience, the problem is establishing cataract surgery centers in which wealthier patients and ancillary ophthalmic services subsidize patients who cannot afford to pay the full cost, a system that has successfully been established in several countries, most notably India.[23]

In spite of these factors, we believe the single most important metric to increasing CSRs in the region is the establishment of dedicated, high-volume cataract surgery centers that operate with high efficiency and yet provide good outcomes in terms of postoperative visual acuity.

While financing of these centers is essential, many existing ophthalmic centers can improve their efficiency through infrastructure and procedural changes, as was recently demonstrated in a public university hospital in Brazil.[24]

In the more affluent countries of Latin America, a higher proportion of cataract surgery is carried out in the private sector. Data from Western countries also show that the cataract surgery rate is not greatly influenced by the proportion of cataract surgeries that are paid for by a national government (single payer plan). For 2001-2005, based upon Medicare data[25] and other sources, Taylor et al[18] calculated that the U.S. government paid for about three-quarters of all surgeries, while in Canada in the late 1990s, about 90% of all cataract surgeries were paid for by the government.[25] Yet, cataract surgery rates were similar. Moreover, as DeCoster and Brownell[26] intimate in their Canadian study, how surgery is paid for (private versus government) is not a significant factor in the growth of CSRs. The take-home message for Latin America, therefore, should be to determine the out-of-pocket costs for patients in all areas; the presence of private or government health insurance is no guarantee that a CSR will increase. What is driving CSRs upward in Western countries is both the aging population, and lower VA thresholds for surgery. For example, in the United States, we have calculated that recent VA thresholds in the range of 0.50-0.54 logMar units (about 6/20 in Snellen units), with a CSR for 2007 of approximately 9155 per million. Yet, as recent data have shown, relatively high CSR rates are not the complete answer. In both the UK and Canada, waiting lists were longer than they should have been (they have improved recently), people were still blind because of cataract, and the consequences of long wait times can cause problems.[27-30] As these and other studies have shown, the problem results in part from limited resources that have to address all medical (and other ophthalmic)

issues versus that of cataract. Again, part of the solution was dedicated surgery centers matched to area demand.

In developing countries, educational level and public awareness are both factors that affect whether an individual is likely to seek eye care. Although public health expenditures as a percentage of GNI have increased in Latin America and are not far from other developed countries, such as Canada, efficiently targeting these resources to poorer and rural communities remains a challenge.[31] This was evident from results of a national survey carried out in Colombia in 2000, in which 55% of respondents with lens opacities over 49 years of age were unaware that they had a treatable eye condition.[32] While, in our opinion, universal access to surgical centers is a necessary prerequisite, utilization of eye services does not necessarily depend on availability and the presence of a demand. For example, in Nepal, evidence showed that even when offered free surgery and transport, utilization of services was below 60%.[33] In traditional or alternative medical systems, it is difficult to promote biomedical interventions and to dispel misinformation. Even in India, which has seen vast improvement in infrastructure, pricing, and availability of services and personnel, many people still refuse cataract surgery; we may not like it, but sight is not always a priority compared to security, water access, or other issues.

Finally, the CSR should only be regarded as a metric of eye care consumption and changes in such consumption patterns. It tells us little about how many patients are being treated in geographical areas of a country, which is a function of cataract surgery coverage (CSC), nor the outcomes, which can be simply estimated through the SRR. What would be helpful in Latin America is an estimation of the CSC and SRR country by country, and a correlation with CSR data. Furthermore, analysis of out-of-pocket surgery costs in context of the health care systems

available would indicate where the shortfalls are in regard to socioeconomics of the population, and point toward better solutions.

Our study does have some limitations. First, we did not have complete data from all countries for each point in time over the study period. Second, 3 years is a relatively short time over which to assess trends; 5-8 years would be better. Third, in calculating appropriate CSRs we assumed that the proportion of the population aged 60 years or more would capture that segment in which cataract most develops. One could argue that the age should be lower (e.g., 50 years) or that a proportion tailored to the country's population should be used. More sophisticated forms of modeling incorporating age as a risk factor for cataract have been developed but we chose a more simplistic method that could be understood by non-mathematicians. In addition, data for most countries supporting a more sophisticated form of modeling was lacking. Likewise due to lack of visual acuity data, our attempt to estimate appropriate CSRs for each country is an approximation based upon an empirical value, and may have resulted in too low or high rates for many countries.

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Author Contributions

ME Nano and M Martens collected the data.

VC Lansingh, K Tingley-Kelley, and MJ Carter analyzed the data.

All authors contributed toward writing the paper or provided intellectual content, saw the final version, and approved it.

Conflict of Interest

The authors do not report any conflicts of interest.

The corresponding author (MJ Carter) had final responsibility for the decision to submit for publication.

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Table 1. Cataract surgery rate (CSR) and number of ophthalmologists per million population (NO) for Latin America countries. Blank cells (—) indicate no data available.

Country	2005	2006	2007
Argentina			
CSR	1769	2100	2089
NO	90	116	116
Bolivia			
CSR	563	602	667
NO	21	23	23
Brazil			
CSR	2448	2352	2212
NO	62	62	61
Chile			
CSR	1751	1930	2132
NO	50	49	46
Colombia			
CSR	1189	1350	1278
NO	30	31	31
Costa Rica			
CSR	1400	2049	2144
NO	26	27	27
Cuba			
CSR	1600	2219	3125
NO	55	60	77
Dominican Republic			
CSR	710	682	779
NO	25	26	29
Ecuador			
CSR	801	831	856
NO	25	26	26
El Salvador			
CSR	1104	1151	1411
NO	21	19	21
Guatemala			
CSR	810	900	875
NO	12	13	13
Honduras			
CSR	940	558	631
NO	9	9	8
Mexico			
CSR	958	1200	1138
NO	32	41	35

Nicaragua			
CSR	460	822	999
NO	10	15	15
Panama			
CSR	—	1180	1159
NO	43	43	41
Paraguay			
CSR	800	895	957
NO	28	29	31
Peru			
CSR	761	863	880
NO	30	30	30
Uruguay			
CSR	—	2000	1898
NO	65	57	54
Venezuela			
CSR	960	1646	1754
NO	52	55	53

Table 2. Appropriate CSRs for a given proportion of population aged 60 years or more and visual acuity threshold. CSR ranges represent calculated results ± 10%.

Proportion of Population Aged 60 Years or More (%)	**Visual Acuity Threshold (LogMAR Units)**	**Satisfactory CSR Range (Per Million Population)**
5	1.3	734-897
5	1.1	887-1084
5	0.9	1416-1730
5	0.7	1665-2036
10	1.3	1468-1794
10	1.1	1773-2168
10	0.9	2832-3461
10	0.7	3331-4071
15	1.3	2202-2691
15	1.1	2660-3251
15	0.9	4247-5191
15	0.7	4996-6107
20	1.3	2936-3588
20	1.1	3547-4335
20	0.9	5663-6922
20	0.7	6662-8142

Figure 1. Correlation of cataract surgery rates with gross national income per capita for the study countries in 2006.

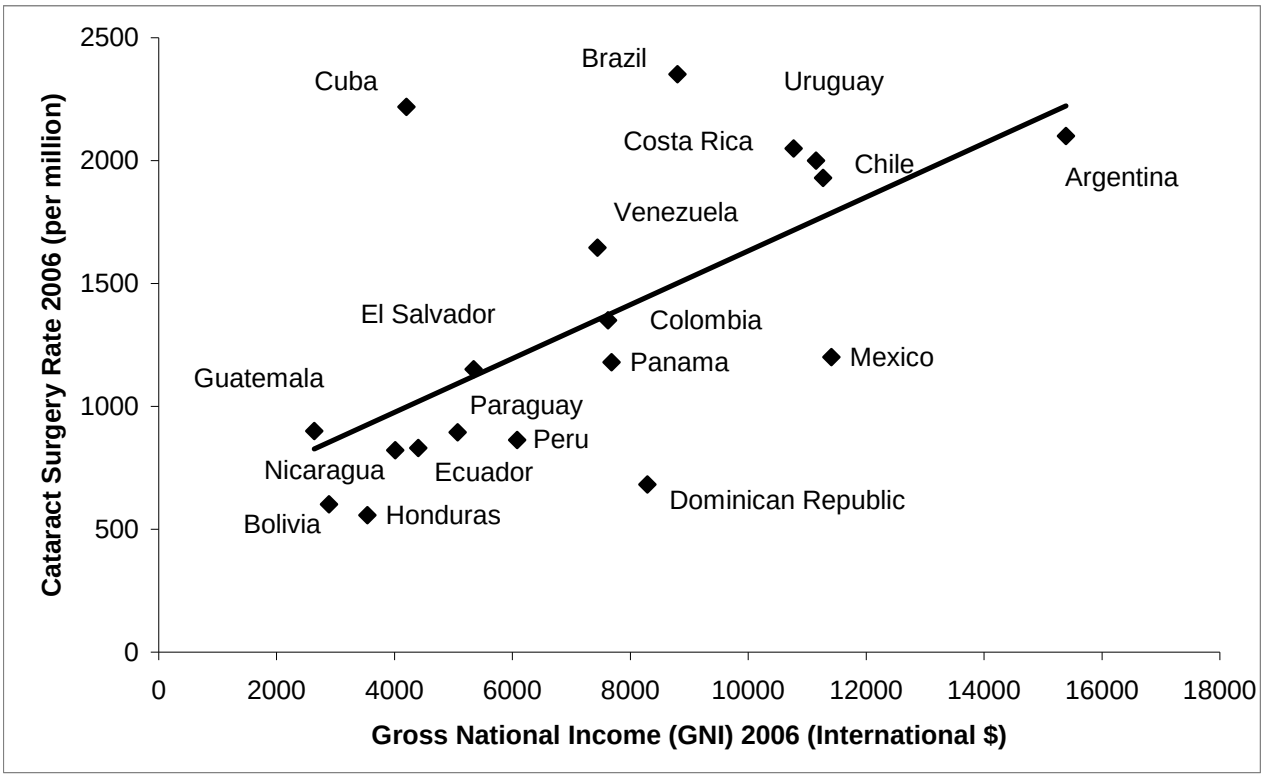

Figure 2. Cataract surgery rates for the study countries and an estimated rate required for incident cataract cases using country-specific proportion of the population over 60 years of age and a preoperative visual acuity of 0.72 logMAR units.