

Cost of screening and timely treatment versus the comprehensive management of the severe visual impairment due to retinopathy of premature

Costo del tamizaje y tratamiento oportuno versus el manejo integral de la discapacidad visual severa por retinopatía del prematuro

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What do we know about the subject matter of this study?

Retinopathy of prematurity (ROP) is one of the leading causes of preventable blindness worldwide. In advanced ROP (stages 4 and 5), fibrovascular proliferation leads to retinal detachment, visual impairment, and blindness. Early screening and treatment clearly reduce blindness related to this pathology.

What does this study contribute to what is already known?

This study in Guatemala shows the need to improve the coverage of screening and timely treatment in patients with ROP, based on an analysis of the individual and collective economic consequences of severe visual impairment secondary to undiagnosed and untreated ROP.

Abstract

Retinopathy of prematurity (ROP) is one of the leading causes of preventable blindness worldwide. In Guatemala, a large number of premature infants are born in hospitals outside the capital city and present for evaluation at advanced stages of the disease. **Objective:** To compare the cost of screening and timely treatment versus the total cost of comprehensive management of patients with visual impairment secondary to ROP. **Patients and Method:** The cost of the disease was calculated in patients who consulted due to low vision or blindness secondary to ROP. Direct costs were calculated based on those directly related to the management of the disease: medical care, rehabilitation, education, technical support, transportation, personal assistance, adaptations, and home equipment, compared with the costs of screening and timely treatment. **Results:** The total cost of managing a child with severe visual impairment due to ROP is USD 214,666.37 and the cost of screening and timely treatment is USD 1,223.12, meaning an additional cost of USD 213,443.24 in patients who were not screened and treated on time. **Conclusion:** The cost of screening and timely treatment represents only 0.57% of the total cost of lifelong management of a child with severe visual impairment.

Keywords:
Retinopathy of
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Introduction

Retinopathy of prematurity (ROP) is one of the leading causes of preventable blindness worldwide. With the increasing survival of newborns with decreasing gestational ages, the absolute number of children with visual impairment secondary to ROP has increased, accounting for 3-11% of blind children¹.

In advanced ROP (stages 4 and 5), fibrovascular proliferation leads to retinal detachment, visual impairment, and blindness. Early screening and treatment clearly reduce blindness related to this pathology^{2,3}.

Many national and private hospitals in Guatemala City have screening and treatment programs. However, many preterm infants are born in hospitals outside the capital and present for evaluation with advanced stages of ROP².

In Guatemala, the incidence of ROP in preterm infants requiring treatment is estimated between 24.32% and 8.15-9.46%⁴⁻⁶. According to studies, currently in Guatemala it is necessary to evaluate all patients less than or equal to 37 weeks gestation and/or weight less than or equal to 2000 grams at birth⁵⁻⁷. Worldwide, the success rate of laser treatment is 84.4-91%⁸ and, in Guatemala, it is 83.60%⁶.

Knowing the social impact of ROP and subsequent blindness should be considered a priority to determine the appropriate allocation of health resources cost-effectively. Therefore, a study on the cost of the disease is of utmost importance⁹.

The objective of this research is to compare the cost of screening and timely treatment versus the total cost of comprehensive management of a patient with severe visual impairment due to ROP.

Patients and Method

Study on the cost of the disease of the comprehensive management of the patient with low vision or blindness considering the prices or tariffs of the *Benemérito Comité Pro Ciegos y Sordos de Guatemala* for medical care, education, and rehabilitation throughout the life of patients with low vision or blindness¹⁰ secondary to ROP, in a private, non-profit, social, and educational institution in Guatemala City.

In our institution, the process of education and rehabilitation of the patient with low vision or blindness secondary to ROP is based on an action model of 3 stages: diagnosis, treatment, and follow-up. The first stage refers to the knowledge needed regarding the causes of blindness, the degree of visual remnant (if any), whether the visual disorder is progressive, etc. All this information is provided by the ophthalmologist.

Ideally in our institution, the frequency of ophthalmologic evaluations in a child with a diagnosis of severe ROP is on average 4 appointments per year during the first 6 years and then every year for life. In addition, the patient should be evaluated by a psychologist who will report on intellectual abilities and the presence or absence of emotional disturbances. Other professionals are needed depending on the specific needs of each patient (neurologist, speech therapist, physiotherapist, etc.).

The second stage is focused on education and rehabilitation, considering education as a process that should last 12 years of school (corresponding to grades pre-kindergarten to third grade)¹¹. Visual stimulation should be performed every month in the first 8 years of life and then visual rehabilitation every year for life. In the rehabilitation division, there are complementary programs to school education, which can be carried out only once a year.

The costs of a disease are defined by direct and indirect factors. These were based on the ROP economic model of screening and treatment³. Direct costs are those related to the management of the disease: medical care, rehabilitation, education, technical aids, transportation and trips, personal assistance, and home adaptations and equipment.

Indirect costs are those related to society associated with the loss of productivity of both the visually impaired person and her/his caregiver in charge^{3,8,12}.

Direct costs

Direct costs were calculated based on:

1. Medical division:
Cost of medical consultation x No. of annual visits x life expectancy in Guatemala (74 years).
2. Visual rehabilitation:
Consultation cost x No. of annual visits x life expectancy in Guatemala (74 years).
3. Educational division:
Annual school fees x No. of years attended (12 years).
4. Rehabilitation division (abacus, Braille, computer, cooking, audiobooks, job placement program, etc.):
One-time fee of independent course (one course on average) taken after graduation from special education school.
5. Technical aids (cane, audiobooks, programs, magnifiers, telescopes, etc.):
Cost of technical aids x the number of times it was necessary to buy them (3 times) in their school stage (12 years).
To obtain the costs of transportation and trips, as well as home adaptations and equipment, a survey was conducted among parents and/or caregivers of

children attending the “Santa Lucía” educational center for visually impaired children in Guatemala City, after obtaining informed consent and the approval of the Ethics Committee of the Institute of Vision Sciences:

6. Transportation and trips:
Annual cost x number of years they must attend the special education school (12 years).
7. Home adaptations and equipment: cost per one-time investment.

Indirect costs

Indirect costs (social cost) were calculated based on:

Social cost = loss of caregiver productivity (GDP: Guatemala's 2019 gross domestic product per capita USD 3,875.64)¹² x economically active years (45 years)¹⁴⁻¹⁵.

Cost of screening and treatment

The annual cost of ROP screening per patient was calculated based on the salary of the pediatric ophthalmologist, the supplies needed to perform the funduscopic examination (topical tetracaine 0.5%, tropicamide 0.8% with phenylephrine 5%, blepharostat, indirect ophthalmoscope, 28 diopter lens, and indenter)

and transportation.

The cost of the treatment was obtained from the cost of the laser equipment, as well as the cost of general anesthesia and the ophthalmologic evaluations required after the treatment. The depreciation of the equipment was estimated at 8 years of useful life, so 12.5% of the total cost per year was calculated⁸.

Total cost

Finally, the annual direct and indirect costs were summed (total cost of the disease) to obtain the cost per severely visually impaired child and compared with the costs of ROP screening and treatment.

Results

Direct Costs

Table 1 shows the costs of each item.

At the “Santa Lucía” school for blind children of the *Benemérito Comité Pro Ciegos y Sordos de Guatemala*, there are currently 84 students, of which 21 (25%) have a diagnosis of ROP. The parents of 15 students agreed to answer the survey for the calculation of the items of transportation and trips, and home adaptations and equipment.

Table 1. Direct costs of severe visual impairment of blindness due to ROP

Division	Calculation	Cost per person per unit of time
Medical Division (Medical staff, nursing, social work, equipment and supplies)	Annual 4 annual consultations for 6 years and 1 annual consultation for the remaining years of life expectancy (74 years)	USD 171.49 per year USD 3,944.25 per life expectancy
Visual Rehabilitation (Visual stimulation, optical aids and psychology)	Annual Every month for 8 years and then annual consultation for the rest of the years of life expectancy	USD 514.47 per year USD 6,945.31 per life expectancy
Educational Division	Annual 12 years of special education school	USD 1,747.12 per year USD 20,965.39 per life expectancy
Rehabilitation Division (Abacus, braille, computers, cooking, audiobooks, job placement program, etc.)	Single investment	USD 2,620.84 per life expectancy
Technical Aids (Walking stick, audiobooks, programs, magnifying glasses, telescopes, etc.)	For each purchase Total (investment 3 times in the school age)	USD 280.65 total per purchase USD 841.93 per life expectancy
Transportation and displacement	Annual School stage (12 years attended in the special education school)	USD 377.42 per year USD 4529.03 per life expectancy
Home adaptations and equipment	Single investment	USD 417.04 per life expectancy
Total	Annual Life cycle	USD 6129.00 USD 40263.78

USD: United States Dollar.

Table 2. Indirect costs of severe visual impairment or blindness due to ROP.

Heading	Calculation	Cost per person per unit of time
Caregiver unearned income	Annual GPD	USD 3875.61 per year
	Economically active years (45 years)	USD 174402.58 per life expectancy

USD: United States Dollar, GDP: Gross Domestic Product.

Table 3. Cost of screening and timely treatment of ROP

Heading	Cost per person
Screening	USD 883.76
Treatment	USD 339.36
Total	USD 1223.12

USD: United States Dollar.

Indirect costs

Table 2 summarizes the results.

Cost of face-to-face screening

See table 3.

The annual cost of ROP screening for each patient includes the salary of the pediatric ophthalmologist and the necessary supplies to perform the funduscopic examination and transportation, based on an average of 179 premature patients per year evaluated in the ROP screening program of the *Benemérito Comité Pro Ciegos y Sordos de Guatemala* in a neonatal intensive care unit. Each premature patient has an average of 5 screening evaluations per year (statistical data from the program).

Cost of treatment

See table 3.

The charge to the patient for the laser procedure performed under general anesthesia in both eyes is USD 339.36 (table 3) in a single application, requiring approximately 4 ophthalmologic evaluations after the procedure.

Total cost

The total cost of comprehensive management of a child with visual impairment due to ROP is USD 214,666.37 while the cost of screening and timely treatment is USD 1,223.12; that is, a difference of USD 213,443.24. Therefore, timely screening and treatment represent only 0.57% of the cost of lifetime management of a child with severe visual impairment.

Discussion

This study shows the need to improve the coverage of screening and timely treatment in patients with ROP, based on an analysis of the individual and collective economic consequences of severe visual impairment secondary to undiagnosed and untreated ROP. The prevention of diseases and/or their consequences should not only be part of the national health policy but also a cost containment measure. According to the World Health Organization (WHO), for every US dollar invested in increasing measures against preventable diseases in low- and lower-middle-income countries, there would be a benefit to society of approximately USD 7 derived from increased employment, productivity, and life expectancy¹⁶.

Retinopathy of prematurity remains the leading cause of preventable childhood blindness. Screening is the most effective strategy because in developed countries preventable blindness is a problem that is increasing with demographic changes¹⁷.

The cost of screening and timely treatment per ROP patient in this study is USD 1,223.12 compared with the cost of raising a blind child for life (direct and indirect costs) of USD 214,666.37. The latter is similar to Peru in which the cost is USD 195,257⁸. In other studies in Mexico and the United States, it was USD 205,907 million¹¹ and, in a study of the cost of overall blindness in Australia, it was USD 4,800 million¹⁶ which is significantly higher than that found in this series.

If we consider that the GDP in Guatemala is USD 3,875.64 per year, the caregiver of a child with severe visual impairment would have to spend 75% of her/his annual salary (USD 2,900.90) in order to cover the necessary conditions for lifelong medical care, special education, and rehabilitation.

The cost of timely screening and treatment is a one-time investment in the patient's life of USD 1,223.12, which represents only 31.56% of the annual GDP, which is more feasible to be met by the patient's caregiver.

It is beyond the scope of this study to analyze and compare the cost of other alternatives for the detection of ROP, but it is important to note that technology

can be an ally to improve coverage and reduce costs. It makes sense to evaluate the use of equipment such as the RetCam Envision™ system or other fundus cameras such as Pictor Plus™ (Volk Optical), Phoenix ICON™, 3nethra neo portable, PanoCam™ LT, among others, with telemedicine programs¹⁸.

Regarding treatment, it is worth mentioning that vascular endothelial growth factor inhibitors (anti-VEGF) are currently a therapeutic option as an alternative or adjuvant to laser therapy, which could reduce the need for the use of equipment and anesthesia. However, they are not yet approved, little is known about their systemic effects, and the difficulty of both short- and long-term follow-up in our patients should be considered¹⁹.

The main limitation of this study is that it only contemplates the costs in a reference center, so, in the future, it will be important to complement the data obtained with information from other institutions that perform similar functions.

Conclusion

The cost of screening and timely treatment represents only 0.57% of the total cost of the lifelong management of a child with visual impairment due to ROP, so it is essential to screen all at-risk premature patients according to local guidelines in each place. It is necessary to expand the coverage of face-to-face and/or telemedicine programs in all hospitals in Guatemala where premature patients are treated, as part of a

public policy that includes the constant availability of resources over time.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

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