Applicability and economic assessment of teleophthalmology screening for diabetic retinopathy in Southeastern Brazil

Renato Minelli Figueira

D.V. Vasconcelos-Santos, M.B. Alkmin, L. A. Pereira de Sousa, L. Bonisson, L. C. Molinari Gomes
Mede Tel 2016
1. Introduction
2. Methods
3. Results
4. Conclusion
1. Introduction

• Diabetes mellitus (DM) in Brazil:
  • 8% population between 40 and 69 years old
  • 20% population over 70

• Diabetic retinopathy (DR):
  • Major microvascular complication of DM
  • Leading cause of blindness in 50% of diabetic individuals

• Early diagnosis and prompt therapy of DR are essential to prevent visual loss

• Teleophthalmology may be an interesting and cost-effective alternative for DR screening
1. Introduction

• Objective:

To assess cost-effectiveness of fundus photography-based teleophthalmology screening for DR in the public health system of the state Minas Gerais, Brazil.
2. Methods – Study Design

• Two regional public health centers in MG with repressed demand for DR screening in diabetic patients due to lack of professionals. Patients had to be referred.

• **Situation 1**: ordinary DR screening performed by an ophthalmologist (fundus examination) at the remote referral city.

• **Situation 2**: teleophthalmology DR screening using fundus photography at health centers, images transmitted to our university hospital-based telehealth center for analysis and report.
Situation 1

Reference Center
average distance 230 Km
Situation 2

Regional Health Center
average distance 18 km
2. Methods – Implementation of Teleophthalmology Service

• Using telehealth infrastructure at our university hospital, part of the Teleassistance Network of Minas Gerais (TNMG)
• Software development/customization/testing
• Training team of health technicians to operate the fundus camera and to use software for image capture and transmission
• Two ophthalmologists responsible for the reports
2. Methods – Economic analysis

- Aim of the study: to compare referral costs for the two situations:

\[ \text{Cost} = [C_f^1 + C_v^1 \times n_p] - [C_f^2 + C_v^2 \times n_p] \]

- \( C_f^1, C_f^2 \) = fixed costs for Situations 1 and 2 (US$/month)
- \( C_v^1, C_v^2 \) = variable costs for Situations 1 and 2 (US$/patient)
- \( n_p \) = number of referred patients
2. Methods – Economic analysis

• Relevant referral fixed costs:
  • salaries and benefits,
  • insurance & depreciation of vehicles
  • internet & telephone.

• Relevant referral variable costs:
  • fuel,
  • tires,
  • maintenance of vehicles,
  • driver’s travel expenses.
2. Methods – Economic analysis

- Since the fixed costs are the same for the two situations
  \[ \text{Cost/Patient} = \frac{\text{Cost}}{n_p} = C_{v1} - C_{v2} \]

- Data collected between January and March/2015:
  - number of patients referred,
  - cost and consumption of fuel,
  - cost and consumption of tires,
  - cost and frequency of vehicle maintenance,
  - total monthly distance travelled and
  - driver’s travel expenses
2. Methods – Economic analysis

• From this information it was possible to calculate the following parameters:
  • cost with fuel, expressed in US$/km
  • cost with maintenance, US$/km
  • cost with tires, US$/km and
  • travel expenses, US$/patient.

• Referral distances: Google Maps considering the route used by each municipality to refer the diabetic patients

• Above parameters + distance = $Cv_1$

• Intermunicipal Health Consortium (responsible for regional refers) = $Cv_2$ (cost to transport each patient)
2. Methods – Economic analysis

• Break Even Point (BEP): is the minimum number of exams to make teleophthalmology screening economically viable

• It is the number of exams in Situation 2 for which the referral savings ($\Delta$ Cost) are equivalent to the total cost to perform the exam.

• That is:

$$n_{p}^{\text{BEP}} (C_{v}^{1} - C_{v}^{2}) = C_{f}^{R} + C_{v}^{R} \cdot n_{p}^{\text{BEP}}$$

$C_{f}^{R}, C_{v}^{R}$ = fixed and variable teleophthalmology exam costs

$n_{p}^{\text{BEP}}$ = number of exams at BEP
3. Results

• Implementation: 4 weeks from the first technical visit to the first report.
• 1488 eyes of 744 patients: mean age 61, with 60.6% females

<table>
<thead>
<tr>
<th>Assessment of image quality</th>
<th>No. of eyes (%)</th>
<th>No. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptable</td>
<td>1007 (67.7%)</td>
<td>512 (68.8%)</td>
</tr>
<tr>
<td>Limited</td>
<td>331 (22.2%)</td>
<td>166 (22.3%)</td>
</tr>
<tr>
<td>Insufficient</td>
<td>150 (10.1%)</td>
<td>66 (8.9%)</td>
</tr>
</tbody>
</table>
3. Results

<table>
<thead>
<tr>
<th>Clinical Results</th>
<th>No. of eyes (%)</th>
<th>No. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of diabetic retinopathy</td>
<td>910 (61.2%)</td>
<td>489 (65.7%)</td>
</tr>
<tr>
<td>Presence of diabetic retinopathy (any stage)</td>
<td>513 (34.5%)</td>
<td>331 (44.5%)</td>
</tr>
<tr>
<td>Mild nonproliferative stage</td>
<td>221 (14.9%)</td>
<td>124 (16.7%)</td>
</tr>
<tr>
<td>Moderate nonproliferative stage</td>
<td>158 (10.6%)</td>
<td>105 (14.1%)</td>
</tr>
<tr>
<td>Severe nonproliferative stage</td>
<td>23 (2.5%)</td>
<td>16 (2.2%)</td>
</tr>
<tr>
<td>Proliferative stage</td>
<td>22 (1.5%)</td>
<td>14 (1.9%)</td>
</tr>
<tr>
<td>Not classified (including post-treatment)</td>
<td>221 (6.0%)</td>
<td>55 (7.4%)</td>
</tr>
</tbody>
</table>
3. Results

• Referral costs
  • Situation 1: 30.48 US$/patient
  • Situation 2: 1.72 US$/patient

• Exam costs
  • Equipment: 58.000 US$
    • Maintenance: 5% per year
    • Depreciation: 20% per year
  • Salaries & benefits: 1.500 US$/month
  • Final exam costs
    • Fixed (maintenance, depreciation and salaries): 2.700 US$/month
    • Variable (infrastructure, ophthalmologists): 4.62 US$/exam
3. Results

Referral Savings vs. Exam Cost (US$/Month)

- **Break-even point**: 112 exams/month
- **Monthly demand**: 296 exams
- **Liquid savings**: ~4,500 US$/month
5. Conclusion

• In this particular situation, with a demand of 296 exams/month
  
  teleophthalmology is a viable and cost effective alternative under the public health service perspective.

• In addition, it allowed rapid resolution of repressed demand, with early DR diagnoses and reduction on future treatment costs.
Thank you

Renato Minelli Figueira
renatominelli@me.com