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Hospital das Clínicas - UFMG

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

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1. Introduction
2. Methods
3. Results
4. Conclusion

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# 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.

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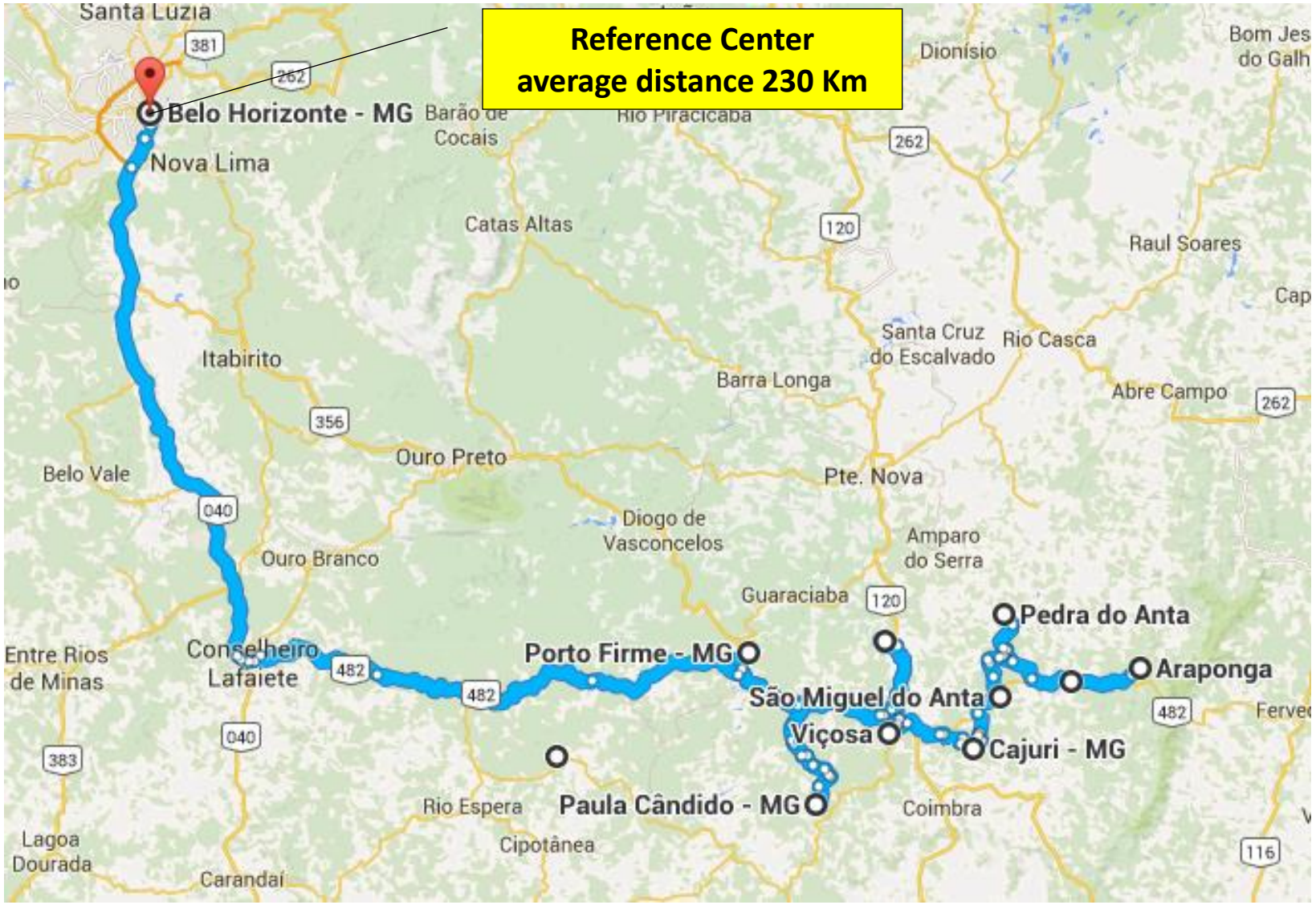
# Situation 1

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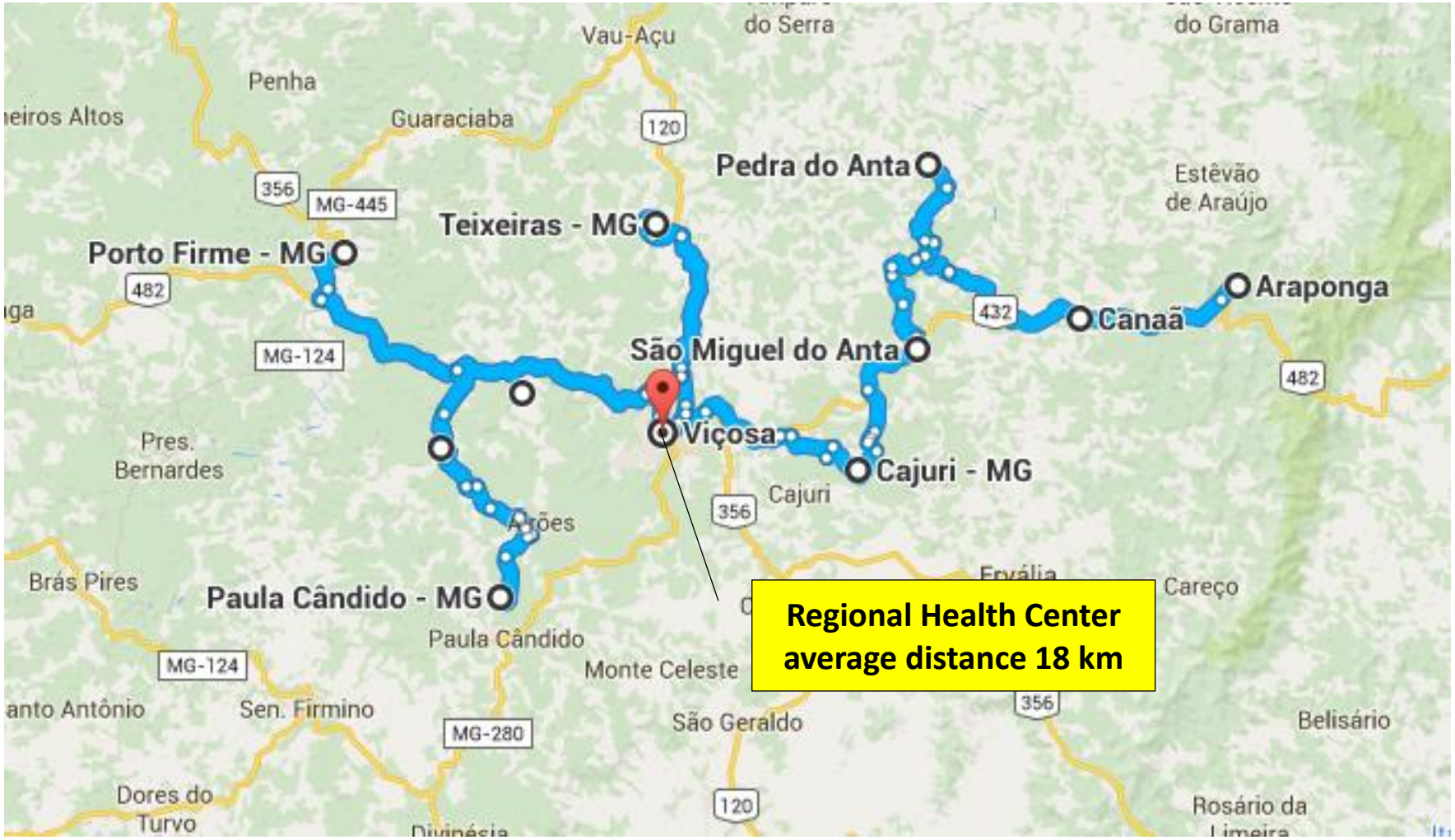
# Situation 2

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# 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

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# 2. Methods – Economic analysis

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

$$\Delta \text{Cost} = [Cf_1 + Cv_1 \times n_p] - [Cf_2 + Cv_2 \times n_p]$$

$Cf_1$, $Cf_2$ = fixed costs for Situations 1 and 2 (US$/month)

$Cv_1$, $Cv_2$ = variable costs for Situations 1 and 2 (US$/patient)

$n_p$ = number of referred patients

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# 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.

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# 2. Methods – Economic analysis

- Since the fixed costs are the same for the two situations

$$\Delta \text{Cost/Patient} = \Delta \text{Cost}/ n_p = Cv_1 - Cv_2$$

- 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

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# 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)

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# 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 (Δ Cost) are equivalent to the total cost to perform the exam.
- That is:

$$n_p^{BEP} (C_v^1 - C_v^2) = C_f^R + C_v^R . n_p^{BEP}$$

$C_f^R$, $C_v^R$ = fixed and variable teleophthalmology exam costs

$n_p^{BEP}$ = number of exams at BEP

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# 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

| Assessment of image quality | No. of eyes (%) | No. of patients (%) |
|---|---|---|
| *Acceptable* | *1007 (67.7%)* | *512 (68.8%)* |
| *Limited* | *331 (22.2%)* | *166 (22.3%)* |
| *Insufficient* | *150 (10.1%)* | *66 (8.9%)* |

# 3. Results

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

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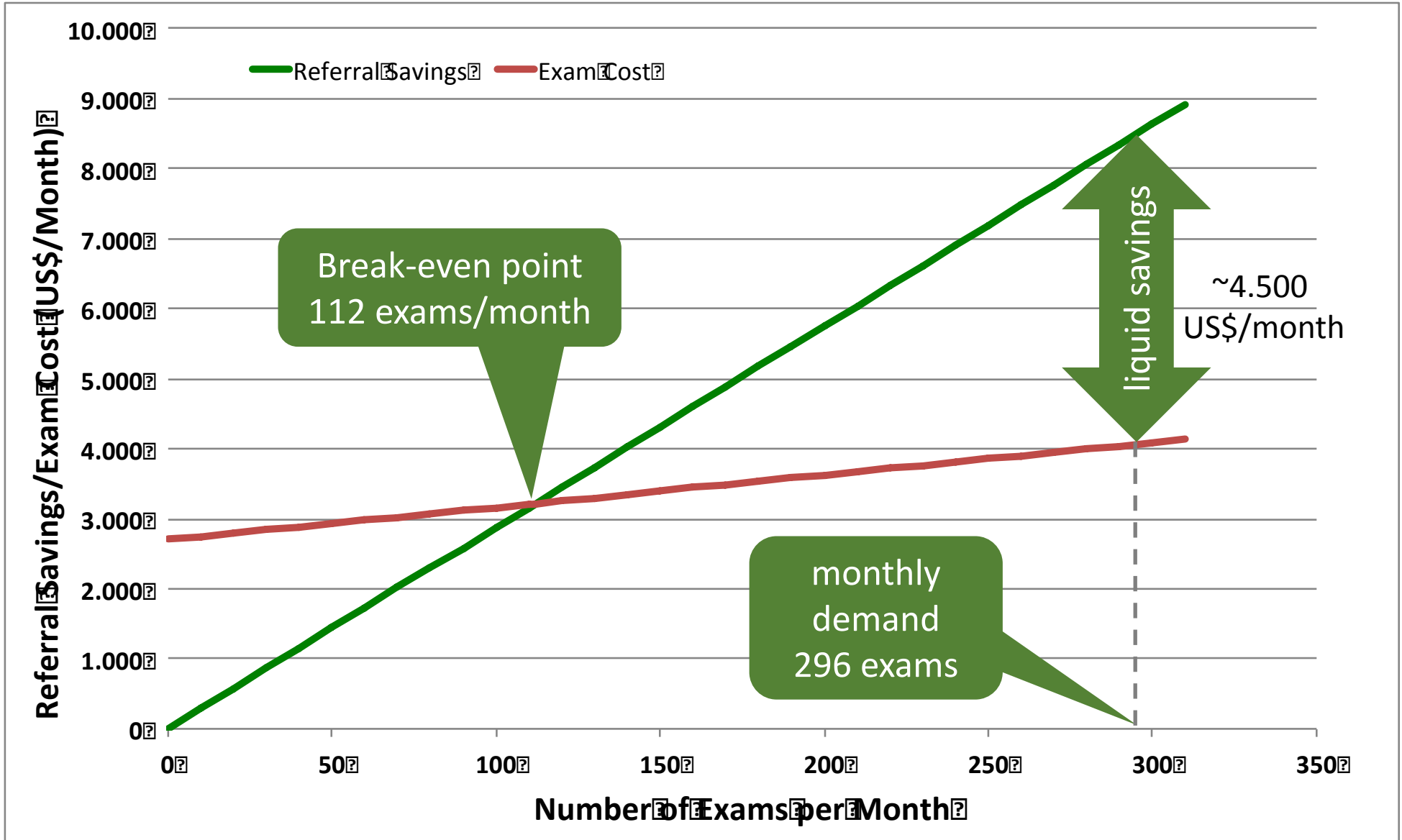
# 3. Results

- 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
Exam Cost
Referral Savings/Exam Cost (US$/Month)
Number of Exams per Month
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0
0
50
100
150
200
250
300
350
Break-even point
112 exams/month
liquid savings
~4.500
US$/month
monthly
demand
296 exams

# 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.

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# *Thank you*

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