Healthcare Systems Process Improvement Conference 2019

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Improving Veteran Access to Eye Care Using Facility Location Models

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Rx

A prescription to address system complexity in healthcare

INNOVATING HEALTHCARE DELIVERY

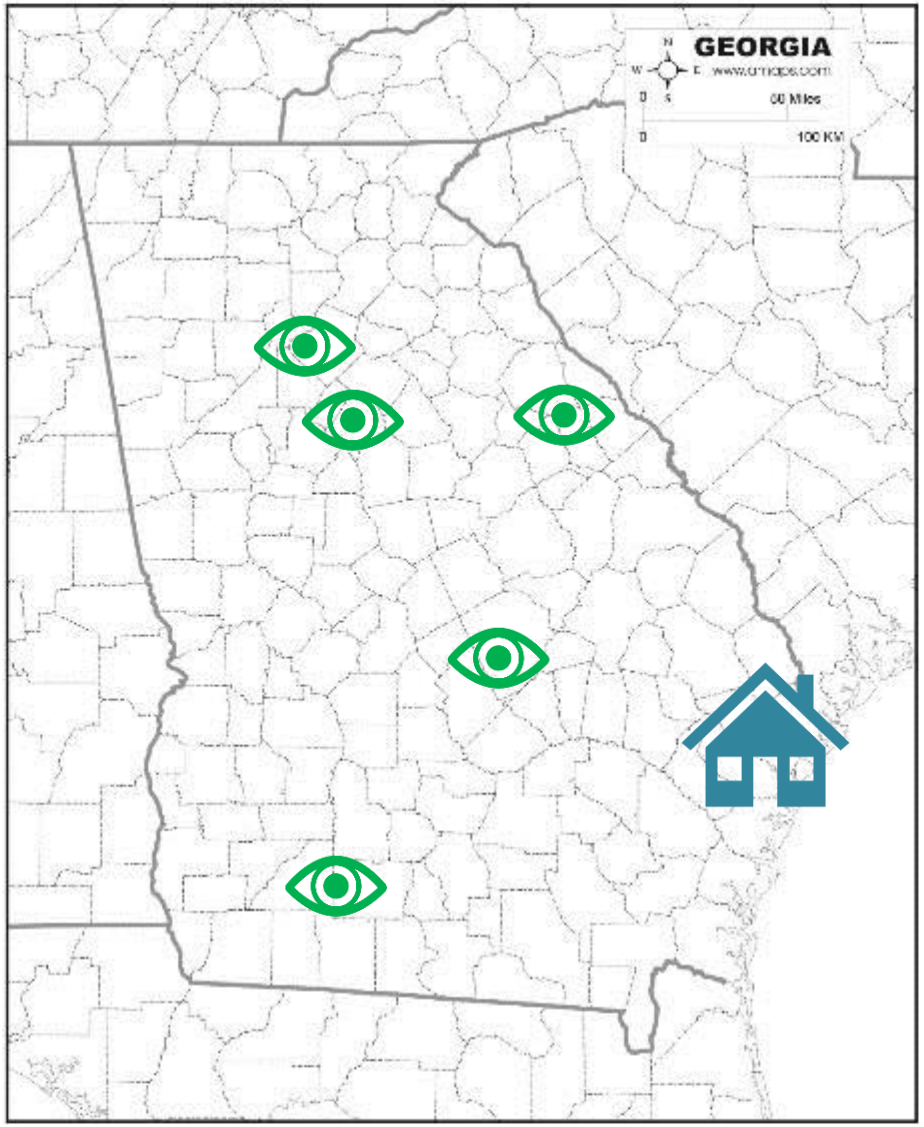
FOSTERING LEARNING

BUILDING COMMUNITY

POSITIVE IMPACT THROUGH...

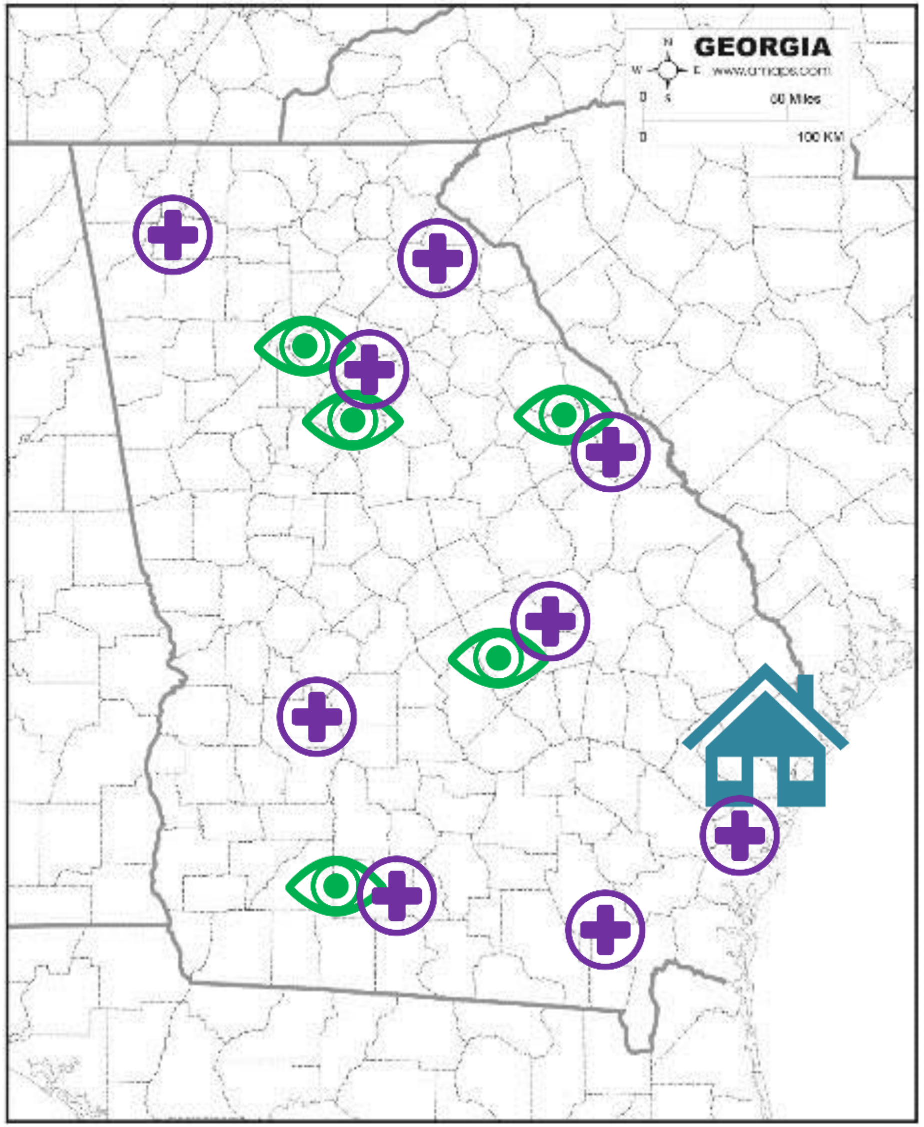
Research
Education
Implementation
Outreach
Dissemination

Veteran Eye Care in Georgia



VA Eye Care

Add Screening Options



VA Eye Care
VA Primary Care

What are we trying to solve?

VA primary care visit

Tech performs eye screening

What kind of problem is this?

- Combinatorial matching problem
  - Deciding locations to offer eye care and how to staff those locations
- Constrained resources
- Multi-criteria decision
  - Consider cost, distance traveled, number of patients seen, etc.

Application

- Low-vision/blindness can have debilitating effects
  – Challenge with low-vision and driving
- Prevalence of diabetes in VA patients (11.4%) higher than general US population (7.2%)
  – Diabetes strongly associated with eye disease and vision impairment

Application, continued

- Why VA research?
  - VA is cost-incentivized to reduce barriers to accessing care
  - Patient utilization of care is relatively consistent

- Why this population?
  - Veterans report greater delays in seeking care than non-veterans
  - Eye care is 3rd most utilized service in VA (after primary care and mental health)

Problem Statement

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- Goal: Evaluate **which locations** to offer eye care screenings and **what provider type(s)** to staff each eye care location
- Assumptions:
  - Patients go to "assigned" clinic for eye care screening
  - One-year time frame
  - Patients have homogeneous screening need (one screening every other year)
- Limitations:
  - Considering eye care screening only (follow-up care not included)
  - No consideration for patients' provider preferences

General modeling approach

Possible eye care locations

- 25 VA locations in Georgia

Decide

- At which locations do we offer eye care?
- What kind(s) of provider(s) should staff each location?

"Assign" patients

- Patients from a given zip code assigned to clinic location(s)

Consider scenarios

- Start from current state
- Start from scratch

Model Overview: Feasibility Constraints

- Patient Capacity

$$\sum_{z \in Z} x_{zc}^t \leq v^t * y_c^t \qquad \forall\, c \in C,\ \forall t \in T$$

- Demand

$$\sum_{t \in T} \sum_{c \in C} x_{zc}^t \geq n_l * p_z \qquad \forall\, z \in Z$$

$$\sum_{t \in T} \sum_{c \in C} x_{zc}^t \leq n_u * p_z \qquad \forall\, z \in Z$$

- Provider Capacity

$$y_c^t \leq g_c^t \qquad \forall t \in T, \forall c \in C$$

$$\sum_{t \in T} y_c^t \leq g_c \qquad \forall c \in C$$

Model Overview: Three objective functions

I. Maximize patients assigned

+ constraints: budget, distance

$$Maximize \sum_{z \in Z} \sum_{c \in C} \sum_{t \in T} x^t_{zc}$$

II. Minimize overall costs

+ constraints: patients, distance

$$Minimize \; [\sum_{c \in C} \sum_{z \in Z} \sum_{t \in T} (a^t_c * x^t_{zc} + (d_{zc} * x^t_{zc}) * r + f^t_c * y^t_c)] + h * \sum_{z \in Z} (n_u * p_z - \sum_{t \in T} \sum_{c \in C} x^t_{zc})$$

III. Minimize furthest distance traveled

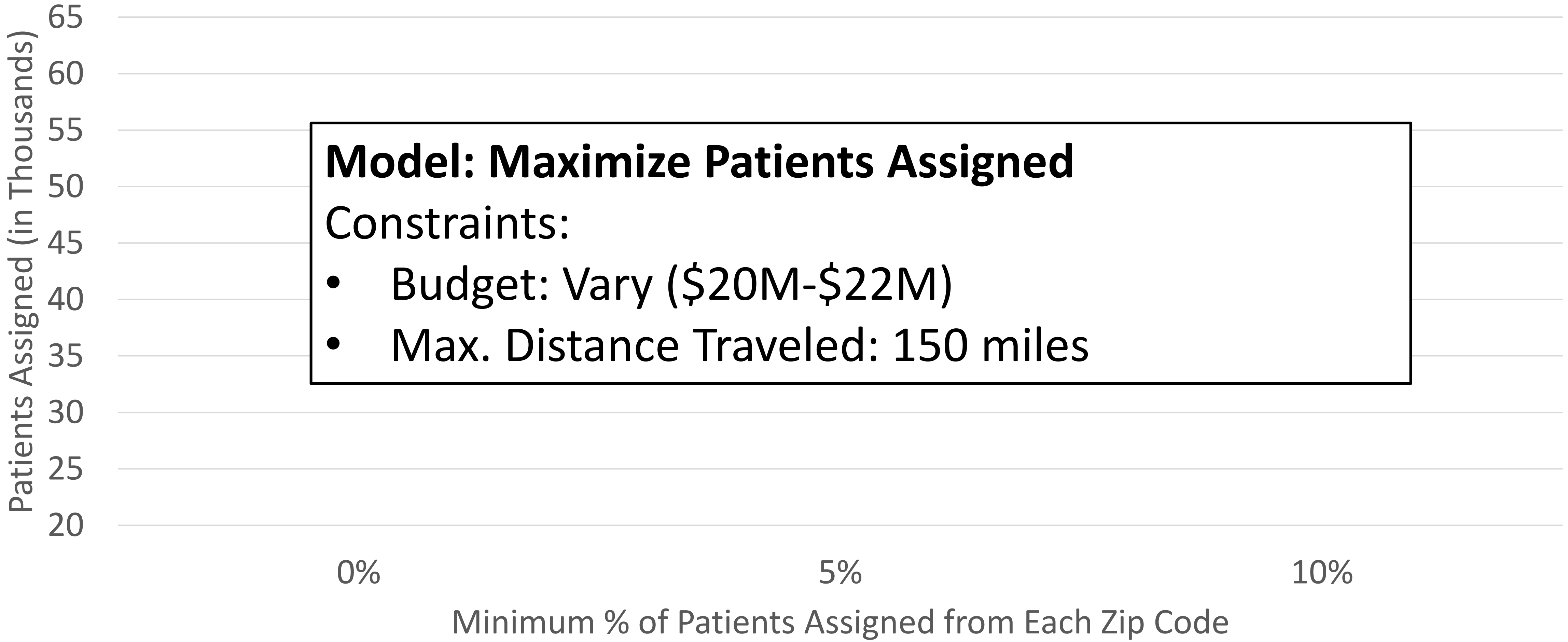
+ constraints: budget, patients

$$Minimize \; m$$

Data Overview

- Patients accessing Georgia VA for (any) care in 2017
  - Approx. 200,000 patients, grouped by zip code
- Clinic locations
  - 25 VA clinics in Georgia
- Driving distance from center of each zip code to each clinic location calculated via Google API
- Budget/costs, provider capacities, and other clinic-specific values obtained from VA
- Model implemented in CPLEX

Results

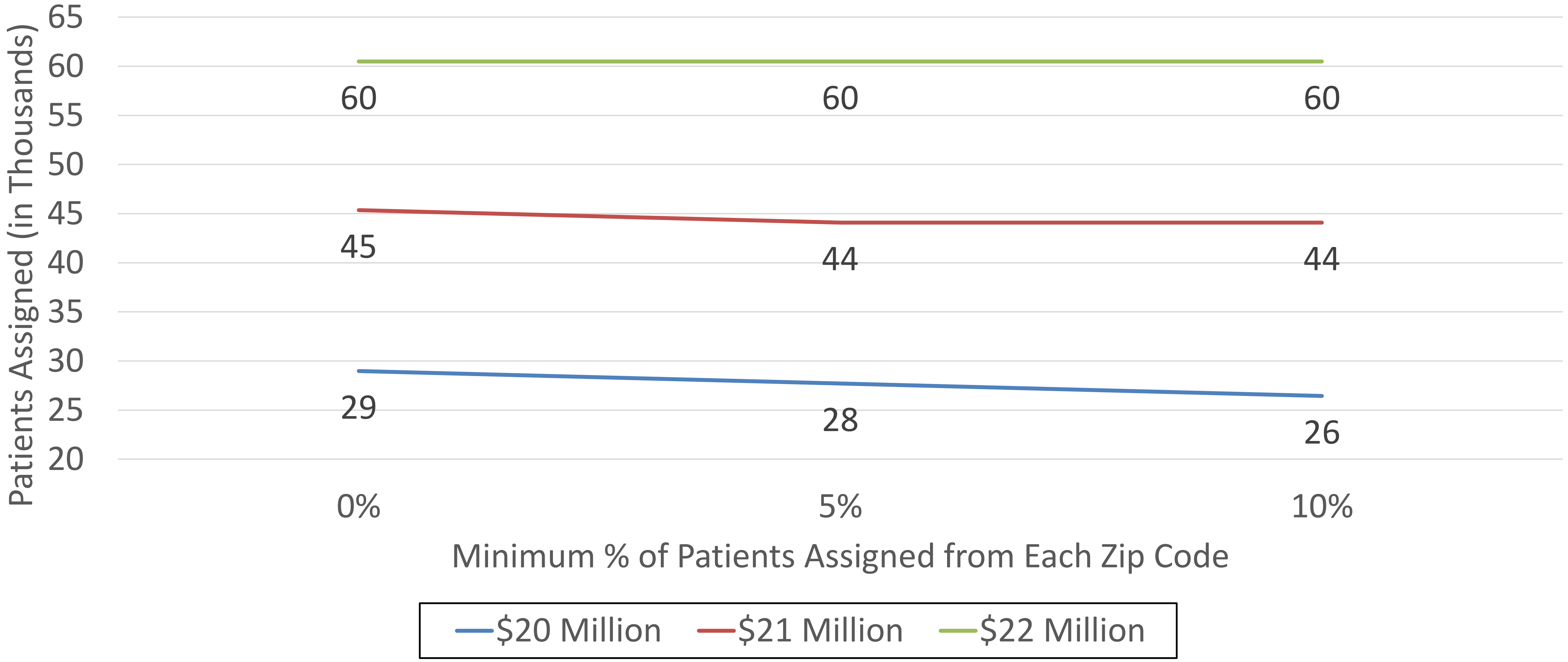


Model: Maximize Patients Assigned

Constraints:

- Budget: Vary ($20M-$22M)
- Max. Distance Traveled: 150 miles

Results: Maximize Patients Assigned



(max dist: 150 miles)

Results

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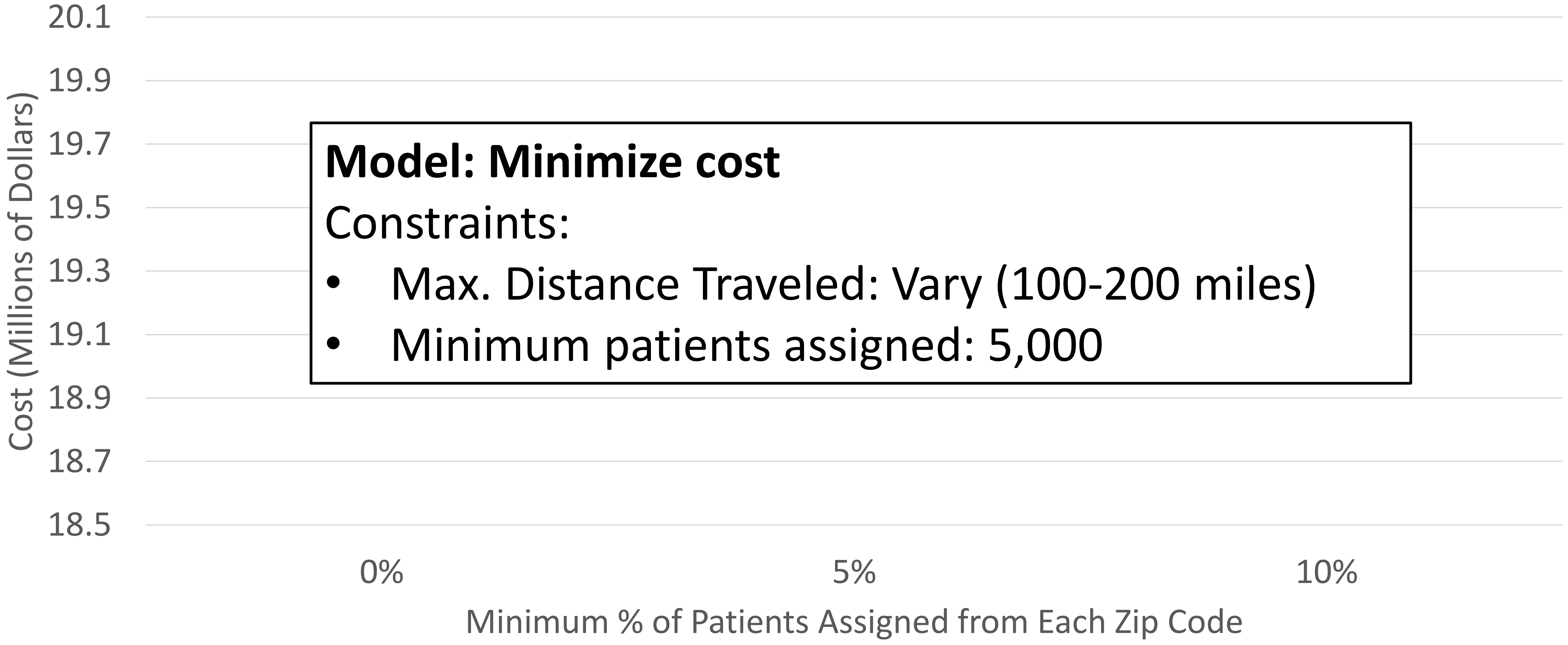

Model: Minimize cost

Constraints:

- Max. Distance Traveled: Vary (100-200 miles)
- Minimum patients assigned: 5,000

Results: Minimize Cost

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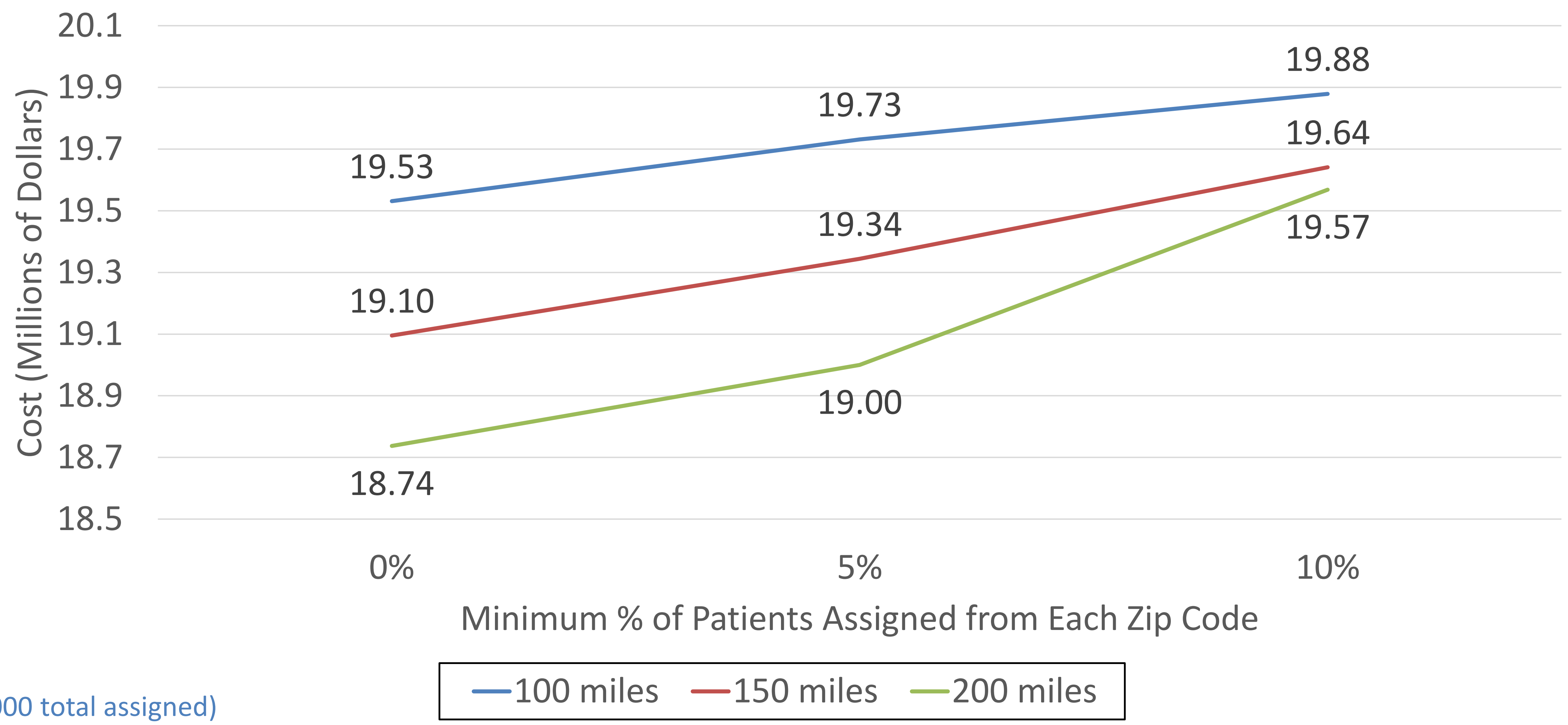


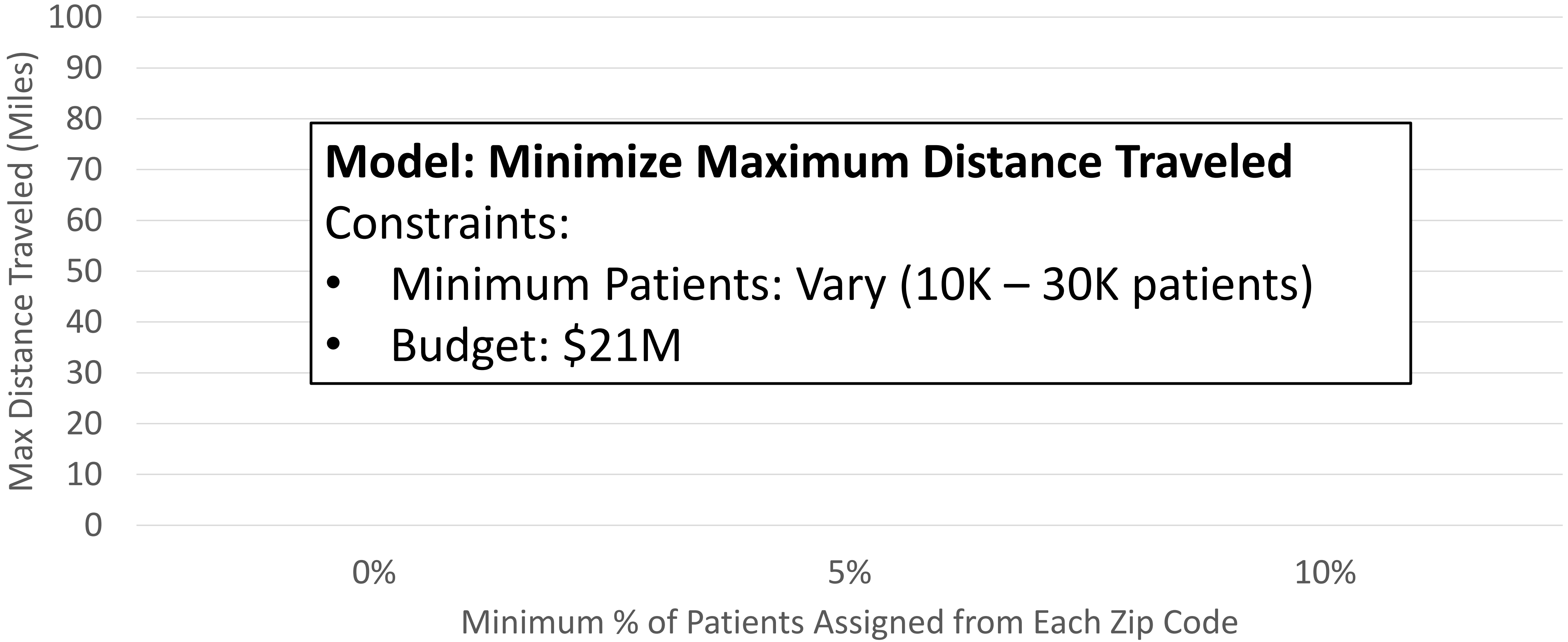
(min 5,000 total assigned)

Results

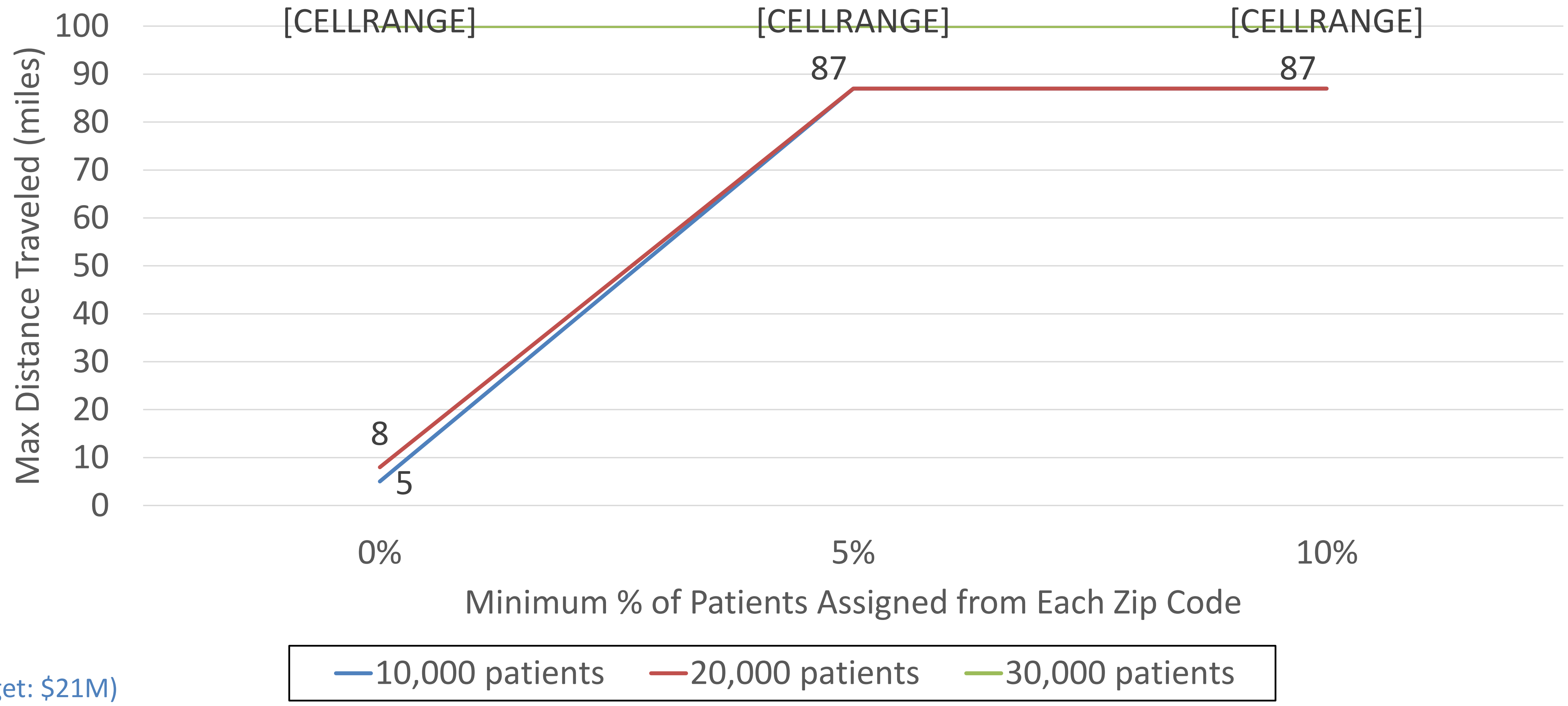
Model: Minimize Maximum Distance Traveled

Constraints:

- Minimum Patients: Vary (10K – 30K patients)
- Budget: $21M



Results: Minimize Maximum Distance Traveled



(budget: $21M)

Conclusions & next steps

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- Maximizing number of patients assigned is of most interest to clinical collaborators
- Each objective function inherently considers trade-offs
- Tool can be used by VA when evaluating community care integration
- Next…
  - Incorporate stochasticity
  - Consider implications for follow-up care
  - Generalize beyond Georgia

Acknowledgements

- VA:VISN 7
  - Dr. April Maa
  - Cliff Guyton
- The Seth Bonder Foundation
- Center for Healthcare Engineering and Patient Safety (CHEPS)
- Team members:
  - Jordan Goodman
  - Michelle Chen
  - Matthew Levenson
  - James McAuliffe
  - Muhammed Ugur
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