Investing in Public Health in Monterrey

Underserved Populations in Mexico’s World Class Health Care Hub

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CRP 386
Monterrey, Mexico is known as a health care hub with world class health care facilities. This report is about whether these health care resources are being distributed fairly across the city. The first goal is to find out if there is an underserved population that does not have access to the health care system, and if there is, to identify the location of the underserved population. The second goal is to identify a vacant lot in which the city could build a public hospital. These issues are important because Monterrey’s resources could be distributed more equally to serve the entire population.

In the analysis I identify locations of the most vulnerable members of the population, or *underserved population*. The criteria include data about access to a health care institution, age (the elderly and small children), disability and poverty. One assumption I make is that the new public hospital will not be built near an existing public hospital. A buffer around existing public hospitals limits the blocks included in the analysis, even if these blocks fall into the underserved category. Since most public hospitals are near the center of the city, the use of this buffer resulted in a narrow study area only comprising neighborhoods in the periphery.

After the underserved areas in the periphery were identified, a mean center point in each area was calculated to serve as the ideal location for the hospital within each region. Each region was ranked according to the number of persons living in the underserved blocks and distance to the nearest existing hospital. Finally, the hospital should be located in a vacant parcel near a major highway, minimizing the distance to the mean center point.

According to my findings, there is an underserved population in Monterrey. However, the underserved population is located across the city and not concentrated in any one specific area. Public hospitals tend to be located near the center of the city, particularly in the south west or Region 1. Region 1 has less underserved persons than any other region. There are a disproportionate number of underserved persons in Regions 2, 6 and 7 which are also farther away from the cluster of public hospitals. If Monterrey is to increase health services to the underserved population in the periphery, the three vacant parcels identified would maximize the number of underserved persons who resided in relative proximity to the hospital.

Additional analysis is needed to determine whether the underserved population exists only in the periphery or across the entire city. It is difficult to identify the reasons behind the lack of access and whether physical proximity alone would increase access significantly. However, currently there are no hospitals in the periphery, and it is important to acknowledge the lack of investment in these regions as they continue to grow and make up larger portions of the population.
INTRODUCTION

Monterrey is one of the wealthiest municipalities in Mexico and the health care system is world class and one of the best Latin America. Monterrey has both government owned Federal and State hospitals as well as private hospitals. The subject of this project is whether or not the public health resources in Monterrey are distributed fairly. It is important for policy makers and government officials to identify areas where the local population is underserved in the area of health. The goal is to identify underserved populations in the region so that future policy can help to increase investment in health facilities in underserved areas. The State government of Monterrey is currently building a children’s hospital in the Guadalupe suburb. Is this new government funded hospital located in an area that will improve access to underserved populations? The question is particularly important for State funded hospitals because governments are the representatives of the larger public interests and should not overlook underserved populations.

BACKGROUND

The Mexican health care system is a mix of public and private institutions. The government run public health system was established in 1943 with the creation of two institutions, the Mexican Social Security Institute (IMSS) and the Ministry of Health. These public institutions were created as a response to the needs of a growing working class population resulting from mass industrialization and urbanization. The IMSS provides public health care to the formally employed and accounts for 33% of the country’s total health spending. The Ministry of Health covers those that are not formally employed and cannot afford private health insurance, approximately 13% of total health spending. Fifty-four percent of health spending is serviced by the private sector (Barraza Llorens, 51).

In her article “Health Reform in Mexico, the Promotion of Inequality,” Ana Cristina Laurell provides empirical data that show that the government's goals of universal coverage have not been met. She states that “the Mexican health care system has evolved into a series of disjointed subsystems that are incapable of delivering universal health insurance ( Laurell, 291).”

When comparing cost of health care in Mexico to other countries, Mexicans spend 52.9 percent of total health spending from out of pocket. Comparatively, U.S. Americans spend 16.6 percent, Colombians spend 25.9 percent and the British spend 3.1 percent (Barraza Llorens, 49).
In an analysis of health care in low income and developing countries, Razzak and Kellermann argue for a global policy that emphasizes prompt medical care to underserved populations. Razaak and Kellermann discuss the importance of access to emergency medical care for the poor. Although there are various factors that contribute to a person’s ability to access health care facilities (such as cost, insurance, etc), the physical aspect (distance) is important in emergency situations. Getting to a hospital in a timely manner is difficult for those living in the periphery where there are fewer roads and no hospitals (Razzak and Kellermann).

Another study shows that in Monterrey an increase in the number of sites of ambulance dispatch from two to four reduced deaths among patients en route to hospital, suggesting the importance of physical access and proximity to public health facilities (Arreola-Risa).

**MONTERREY MEXICO**

In 1950 Monterrey’s population represented 45.8% of the total state population of Nuevo Leon. In the following decades the growth of the manufacturing sector led to rapid urbanization to Monterrey, especially of rural migrants who sought jobs and better living conditions in the city. At the time the majority of the demand for labor was in manufacturing (46%). Between 1950 and 1979 Monterrey’s population more than doubled. Currently, the Metropolitan region of Monterrey makes up 85% of the total State of Nuevo Leon population with a population of more than 3 million (Gobierno del Estado de Nuevo Leon, (2008).

Metropolitan Monterrey is one of the wealthiest cities in Mexico, and is considered one of the most developed regions within the country. Monterrey has become an important financial and business center in Mexico. The manufacturing economy includes the production of iron and steel, cement, glass, and auto parts. The population has a relatively high level of education and high standard of living. The Metropolitan area accounts for 95% of the state of Nuevo Leon’s GDP (Gobierno del Estado de Nuevo Leon, (2008).

Monterrey has been noted for having some of the best private hospitals in Mexico and in the Americas. However, the private hospitals are only accessible to the well off and the majority of the population relies on the public health system, the IMSS regional hospitals and the services of the Health Ministry discussed above. There are stark differences between the services and facilities provided by private and public sector hospitals. In addition, as the informal service economy grows and the formal manufacturing economy declines, the number of workers that are not insured through their jobs increases. Monterrey continues to have a large number of informal sector workers that are not insured by the state and cannot afford to pay for private medical care.
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HYPOTHESES and RESEARCH QUESTIONS

- Even though Monterrey has some of the best health care facilities in Latin America, my hypothesis is that there is an underserved population that has less access to health care. The assumption is that the private world class health facilities are reserved for wealthier classes and that the services of public health care institutions, which serve the majority of the poor, are unequally distributed across the city.

- Where are the underserved populations in Monterrey located? The underserved populations will be identified according to criteria based on health care access, age, disability, and poverty.

- Where could Monterrey focus its future investments in health care to better serve these populations? Once the underserved population are located, the question is about how to maximize the number of people that will benefit from building a new hospital.

- How can investments in future health care facilities reduce existing gaps in health care access across the city?

METHODOLOGY

In order to conduct the analysis, I first identified criteria to define underserved population. I combined information about access to health care with characteristics indicating a special need for health care. The special needs categories were the elderly over 65 years, children under 5 years, persons living with a physical or mental disability and persons living in poverty. Each of these characteristics in conjunction with the data that indicated "no access to a health care institution" were the criteria used to define an underserved area.

In addition to the demographic and health care data by block, I also identified the locations of public hospitals in Monterrey. The project focused on public facilities because the purpose was to explore whether government investments in health care were being unequally distributed across the city. The project can be used to inform public
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officials about the location of underserved neighborhoods in need of health care facilities.

Providing health care to the general public with a more or less fair distribution of resources is a primary responsibility of public hospitals because of the government responsibility to represent the public interest. Private hospitals, on the other hand, do not have a responsibility to provide fair access to health care to the general public across the city. The hospitals included in the study were large full service hospitals that provide a wide range of services including emergency, general surgery, gynecology, obstetrics, pediatrics, trauma, ophthalmology, urology and preventive medicine. Finally, information about vacant lots and whether the vacant lots were near by a major highway was necessary in order to maximize access to the hospital.

DATA SOURCES

• The majority of the data, including block and street shapefiles were provided by Dr. Peter Ward at the LBJ School of Public Affairs, from his project *The Rehabilitation of Consolidated Irregular Settlements in Latin American Cities towards a Third Generation of Public Policy*.

• Data downloaded from the Instituto Nacional de Estadística y Geografía (INEGI) from the Censo General de Población y Vivienda, 2000.

• Hospital and vacant lot data from DWG AutoCAD files from Cristina Saborio, PhD candidate in Urban Planning at the University Tecnológico de Monterrey and INEGI.

• Google Earth for aerial images of vacant parcels and major roadways.

ANALYSIS

1. Identified public hospitals and located each one in Google Earth. Matched the Google Earth image to the shapefile and created a new shapefile representing the locations of seven public hospitals.
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2. Created a 3 mile buffer around the public hospitals in order to narrow the study area. The assumption was that a new hospital should not be located within three miles of an existing public hospital.

3. Created a map of the variable “SS” defined as “No Access to a Health Care Institution.” Then I manually selected every block with 10% or more with no access to health care institution and created a new shapefile from these blocks.

4. Created maps of the variables persons above 65, children under 5, persons with a disability and persons living in poverty. These maps were all represented with quantile breaks and four intervals.

5. Each map was overlaid with the shapefile I previously created indicating 10% or more with no access to a health care institution.

6. Next I manually selected all blocks that overlapped with 10% or more without health care and one of the special needs variables. I repeated this process for each variable until I only had a few blocks left over. The blocks left over represented those blocks that had no access to health care institution, had a certain percentage of elderly, a certain percentage of children and certain percentage of poverty. In addition all blocks that contained a certain percentage of the disabled and no access to health care were included.

7. The city was divided into seven regions based on the natural topography separating the built environment and neighborhoods (hills, mountains and rivers). Each region had a group of underserved blocks located within it. A center mean for the group of blocks within each region was calculated. The center mean was calculated because the location of the new hospital should maximize its proximity to all the underserved blocks within a region.

8. I compared the center mean points of the underserved regions to the existing public hospitals by measuring the distance in GIS. I calculated the number of people that live in the underserved blocks. The number of people residing in the underserved area in addition to the distances between the center mean and the nearest hospital determine which regions would be prioritized. The goal was to maximize the number of people that can be served by building a new hospital.

9. A 3 mile buffer was created around the mean center points. The hospital should be located as close to this point as possible in order to serve the entire underserved region.

10. Finally, I searched for large vacant parcels close to the mean center point and also adjacent to a major highway in Google Earth. The Google Earth images of vacant lots will be included along with the same location in GIS.
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**No Access to Health Care Institution**

Percent with No Access per Block:
- 0% - 5%
- 6% - 7%
- 8% - 9%
- 10% - 100%

Map 2

**Metropolitan Monterrey**

Source: INEGI Censo General de Poblacion y Vivienda, 2000
NAD 1927 Lambert Conformal Conic

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Maps 3

**Persons Over 65 Years**

**Over 65 Years and No Access to Health Care Institution**

Percent over 65 per Block
- 0% - 7%
- 8% - 18%
- 19% - 10%
- 11% - 100%

Percent with No Access per Block
- 10% - 100%

Map 3

Metropolitan Monterrey

Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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Map 5

**Disabled Persons**

**Disabled Persons and No Access to Health Care Institution**

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**Map 5**

**Metropolitan Monterrey**
Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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Map 6

**Persons Living in Poverty**

**Persons Living in Poverty and No Access to Health Care Institution**

Percen in Poverty per Block:
- 0% - 2%
- 3% - 8%
- 9% - 20%
- 21% - 100%

Percent with No Access per Block:
- 10% - 100%

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**Metropolitan Monterrey**

Source: INEGI Censo General de Poblacion y Viviendas, 2000

NAD 1927 Lambert Conformal Conic

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**Characteristics of Underserved Blocks**

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of Blocks</th>
<th>Minimum People per Block</th>
<th>Maximum People per Block</th>
<th>Total Persons in Underserved Region</th>
<th>Distance to Nearest Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1</td>
<td>18</td>
<td>6</td>
<td>115</td>
<td>795</td>
<td>5.15 miles</td>
</tr>
<tr>
<td>Region 2</td>
<td>41</td>
<td>11</td>
<td>166</td>
<td>2189</td>
<td>4.5 miles</td>
</tr>
<tr>
<td>Region 3</td>
<td>23</td>
<td>7</td>
<td>144</td>
<td>1173</td>
<td>5.3 miles</td>
</tr>
<tr>
<td>Region 4</td>
<td>11</td>
<td>11</td>
<td>162</td>
<td>746</td>
<td>5.2 miles</td>
</tr>
<tr>
<td>Region 5</td>
<td>13</td>
<td>1</td>
<td>95</td>
<td>362</td>
<td>6.1 miles</td>
</tr>
<tr>
<td>Region 6</td>
<td>72</td>
<td>1</td>
<td>108</td>
<td>2222</td>
<td>5.1 miles</td>
</tr>
<tr>
<td>Region 7</td>
<td>57</td>
<td>5</td>
<td>126</td>
<td>2236</td>
<td>9.8 miles</td>
</tr>
</tbody>
</table>

**Metropolitan Monterrey**

Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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Metropolitan Monterrey
Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

Map 8

Underserved Blocks
Region 2
Region 6
Region 7

Region 2
Region 6
Region 7

0 2.5 5 10 Miles

0.9 Miles

1 Mile

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Region 2 - Colonia San Rafael

Selected Parcel

Metropolitan Monterrey

Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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Metropolitan Monterrey

Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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Region 7 -- Colonia Guadalupe

Selected Parcel

Metropolitan Monterrey
Source: INEGI Censo General de Poblacion y Viviendas, 2000
NAD 1927 Lambert Conformal Conic

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ANALYSIS

The hypothesis for this project includes two claims. The first is that there exists an underserved population in Monterrey and within this hypothesis is the additional question about where the underserved population is located. Is the underserved population concentrated in one region or is it spread evenly across the city? The second hypothesis is that public health care services are unequally distributed across the city. According to the criteria used to define underserved population, the findings show that there is an underserved population in Monterrey. The population is characterized by lack of access to a health care institution, age, disability or poverty. However, the maps show that the underserved population is not located in one region but spread out across the city. In addition, the fact that the analysis did not include the blocks within 3 miles of existing hospitals indicates that the underserved population as I have defined them may also be located within this buffer zone which was not included in the analysis.

Even though the underserved population is spread out across all seven regions in the city’s periphery, there still seems to be differences between regions that have more underserved blocks than others. The table on Map 7 reports that the 57 underserved blocks in Region 7 contain 2,236 residents and the center point is located 9.8 miles from the nearest hospital. Region 7 is the most populated underserved region and the farthest away from existing hospitals. Region 6 follows with 72 blocks containing 2,222 persons and located 5.1 miles from the nearest hospital. Region 2 is third with 41 blocks, 2,189 persons and 4.5 miles from the nearest hospital. It is interesting to note that the remaining regions (1, 3, 4 and 5) contain less than half the number of underserved blocks and far fewer residents indicating that a hospital would serve fewer people in these locations.

The findings show that even though there are underserved persons across the city, there are certain regions that have more concentrations of need than others. Another important finding is that 5 out of the 7 existing public hospitals are clustered around the same area. When evaluating distance and spread, public hospitals are not distributed equally across the city.

Where could Monterrey focus its future investments in health care to better serve these populations? The proposed vacant parcels in regions 2, 6 and 7 minimize the distance of the hospital from each of the underserved blocks in each region. The selected parcels minimize the distance to the mean center point. This point was calculated using the average distance of each feature block from every other feature block. The mean center points of regions 2 and 7 are located inside or adjacent to a vacant parcel and a major highway. In region 6 the mean center point is located 0.9 miles from the selected parcel site because the selected site was the closest vacant lot adjacent to a major highway.
CONCLUSIONS

One flaw in the current analysis is the exclusion of the center city in the analysis of the underserved population. These blocks were left out of the analysis for two reasons. The first was the need to scale down the number of blocks included in the analysis for the scope of this project. Second, I relied on the assumption that a new hospital should not be built in proximity to an existing hospital. However, it would have still been useful to use the same criteria I used for the periphery, to define health care needs for the entire city. It is possible that by using the same criteria, a large number of underserved people may appear in close proximity to an existing hospital. These people were automatically removed from the analysis in the beginning. A more complete analysis of health needs and vulnerable populations would include data for the entire city. In addition, it is important to consider other barriers to accessing health care institutions. There are, for example, financial barriers which play a major role. In future analyses these factors should be considered.

For the scope of this project several assumptions were needed. Although these assumptions limited the project, it is useful for city officials to be aware of the underserved population in their city. It is especially useful as a comparative tool between regions. It is clear, for example, that region 2, 6 and 7 have far more social and economic problems and are more limited to access health care than regions 1, 4 or 5. It is also important to recognize that all public hospitals have been built in the same general vicinity and to acknowledge the lack of health care facilities in the periphery. Finally, in the case that the government was to fund a public hospital in the periphery, it is important to know the social demographic and socio-economic characteristics of the regions, as well as the numbers of residents living in the neighborhoods where the investment would take place.
REFERENCES


INEGI Instituto Nacional Estadistica y Geografia - Censo General de Poblacion y Vivienda, 2000


APPENDIX
DATA SOURCES AND INFORMATION

1. Data set and Shapefiles provided by Dr. Peter Ward from his project The Rehabilitation of Consolidated Irregular Settlements in Latin American Cities towards a Third Generation of Public Policy. Dr. Peter Ward, 512-475-862 or peter.ward@mail.utexas.edu.


4. Hospital and vacant lot data from DWG AutoCAD files from Cristina Saborio, PhD candidate in Urban Planning at the University Tecnológico de Monterrey cfsaborio@gmail.com

5. Google Earth

6. The data is divided into manzanas which is the equivalent to blocks in the United States. Each row in the attribute table contains information about all of the households in one manzana. The data set contains information about how many built homes there are, how many inhabitants and a range of social and demographic variables, including information about access and right to a health institution per person for each manzana. The data set specifies when the information given is per household or per individual within the manzana or block unit.

METADATA

Shapefiles provided by Dr. Peter Ward

Projection: Lambert Conformal Conic

Linear Unit: (meters)

Geographic Coordinate System: GCS_North_American_1927

Datum: D_North_American_1927
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ANALYSIS

1. Where are existing public hospitals?

Hospitals:

- Hospital general de Zona 34:
- Hospital Regional Materno Infantil de Alta Especialidad
- SS, Dr. Bernardo Sepulveda Metropolitan
- Centre of Gynaecology and Obstetrics of Monterrey (P)
- Hospital de Traumatologia y Ortopedia #21
- Dr. Jose E. Gonzalez University Hospital
- Clinica 25 del IMSS en Ave. Lincoln, Monterrey Nuevo León
- México

- The project will focus on public facilities because the purpose is to explore whether government investments in health care are being unequally distributed across the city. The project can be used to inform public officials about the location of underserved neighborhoods in need health care facilities. Providing health care to the general public with a more or less fair distribution of resources is a primary responsibility of public hospitals because government serves the tax payers. Private hospitals, on the other hand, do not have an inherent responsibility to provide fair access to health care to the general public across the city. The hospitals included in the study will be the large general hospitals that have a wide range of services including emergency, general surgery, gynecology, obstetrics, pediatrics, trauma, ophthalmology, urology and preventive medicine. The focus is on large full-service hospitals providing all-inclusive services to the public, NOT on small clinics specializing in specifics areas. The hospitals also should be publicly funded by the federal or local governments.

- List public hospitals and their addresses from the Municipio de Monterrey government website and other online research
  
  i) http://www.monterrey.gob.mx/
  
  ii) http://www.enjoymexico.net/monterrey-hospitals-mexico.php

- Locate each hospital in Google Earth and then match the location to the GIS Shapefile. I will then create a new shapefile that includes a point for each of the hospitals.
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- Symbolize the hospitals in the streets shape file by creating a descriptive map of all the public hospitals in Monterrey.

2. Location of residents with no access to health care facility.

- The first step is to identify the population in Monterrey who is underserved or in-need in terms of health care. This population will be identified by using two main criteria.

  - Criteria 1 No Access
    Number of people per manzana that do not have access to a health care facility or institution will be mapped. These are the people who are not covered by the Mexican Social Security Institute or by the Health Ministry and that do not pay for private health care.

  - The data from the INEGI census is joined to the shape file by manzanas or blocks. One of the variables is SS (Servicio de Salud) and is defined as “population with no right to health care services in some health institution.” These are the people who are not covered by the Mexican Social Security Institute or by the Health Ministry and that do not pay for private health care.

- Map the location of no access according to the “SS” variable by manzana.

  - The maps were represented using four intervals and quantile breaks. The highest interval was used as the group that would represent “need.” In other words, the data itself defined where the cut off point would be in order to be defined as a special need population, according to quantile breaks.

  - The underserved areas are located across the city. The city is divided into 7 regions according to the pattern in the built environment and topographic divisions in the land such as mountains, hills and rivers.

  - This analysis will result in a base map where the MOST underserved areas are highlighted.

  - I will overlay this map of most underserved areas with a series of second criteria variables.

3. Where are the special needs populations? Each of the below variables will be mapped separately. In each map, I will also include the variable SS in the map created in step 3 above.

- Criteria 2 Special Need
Population with special health care needs will be identified. Special health care needs will be identified by isolating the populations with the following characteristics:

- Households with children under 5 years
- Households with elderly over 65
- Households with a person living with a physical or mental disability
- Households considered to be living in poverty

- Create a map of households with children of under five years.
- Add to this map the variable “SS” percent with no access.
- Are there any overlaps of households with children under five years and percent with no access?
  - If yes, then highlight these areas as critical areas that need access to health care.

- Create a map of households with elderly over sixty-five years.
- Compare this map with the map of percent with no access.
- Are there any overlaps of households with elderly over sixty-five years and percent with no access?
  - If yes, then label these areas as critical areas that need access to health care.

- Create a map of households with a person living with a physical disability.
- Compare this map with the map of percent with no access.
- Are there any overlaps of households with a person living with a physical disability and percent with no access?
  - If yes, then label these areas as critical areas that need access to health care.

- Create a map of households living in poverty.
- Compare this map with the map of percent with no access.
- Are there any overlaps of households living in poverty and percent with no access?
  - If yes, then label these areas as critical areas that need access to health care.

The previous section should have resulted in five maps identifying the locations of special needs populations. Each of these maps contains two variables, one is the characteristic of the special need (such as elderly or disabled populations) and the second variable is the percent with no access to health care. The result will be critical underserved areas where percent no access overlaps with the special needs populations.

4. Where are the critical areas?
A new shape file and map will be created that contains all of the overlaps of the critical underserved areas from each of the seven maps above (step 3).

This can be done by selecting each critical area from each map and exporting the data into a new shape file. This will result in 7 new shape files. Once the seven new shape files are created you can merge them together into one shape file of critical underserved areas using all the criteria in steps 3 and 4.

5. Compare the critical underserved areas to the existing medical facilities.

- Take the maps of underserved areas created in step 5, and add to it the layer of hospital locations.

- Calculate the center mean point for each of the regions. This point represents the average center between all of the underserved blocks in a region and it is the point that is equally close to all underserved blocks.

- Using the measuring tool in GIS, measure the distance from each of the center mean points in the critical regions to the closest existing hospital.

- Identify the critical underserved areas that are the furthest away from a hospital according to the measurements.

- Calculate the number of people that come from the underserved blocks in each of the regions. The goal is to maximize the number of people that live in close proximity to the new hospital.

- The more people that are within a critical area, the more likely we will choose to the area as a good area to build a hospital.

6. Once we have ranked the underserved critical areas based on population, find the closest vacant lots to the mean center point that are adjacent to a major highway.

- Locate the mean center point from the GIS map in Google Earth. Once located, search the surrounding area for vacant parcels. Select the vacant parcels from Google Earth on the map in GIS. Locate the closest vacant parcel that I also adjacent to a major highway.

- The result is 3 vacant lot areas where hospitals could be built.

- The locations of the most underserved areas as defined by the overlays above will be compared to the locations of public hospitals and medical facilities. These distances can be displayed both visually in the maps and in tables indicating the exact measurements in miles. The most underserved critical areas with the highest
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populations, and the farthest distance to medical facilities will be identified as areas that should receive future investment.