Abstract

Louisiana Dept. of Health & Hospitals is spatially quantifying statewide inpatient, acute care hospital supply disparities by carefully specifying supply and demand. Network analysis is applied between those nodes and is critical in quantifying access. Stewards of centralized health information can fulfill their role as the source for global data and GIS application by publicly sharing such products to better inform all stakeholders.
Hot Spotting Low Birth Weight (UC12’)

Read Blvd. area is split by two tracts (right image) partially masking a LBW anomaly.
Hospital Network Adequacy (UC13’)

[Map showing hospital network adequacy with marked areas and cities]
Executive Summary

• This effort utilizes departmental data on Licensed Adult ICU beds in Louisiana (1,294).

• Combining information about demand and delivery: population, morbidity, and road networks reveals spatial patterns of access.

• Neighborhood birth weight averages were calculated.

• Access can be measured in different ways though we should be focused on where there’s agreement.

• Louisiana is not a “Certificate of Need” state but this application could make that a more quantifiable and transparent process.

• This process is generally applicable to all bed types, not just Adult ICU.
The Challenge: What to do with “Big Data”

DATA SCIENCE
Wedded to our data assets

INTERPRETATION
Why it matters

BIG DATA

VIZUALIZATION
How we see it

AMBIGUITY
Making it fit

STORY-TELLING
Making it relevant

ACTIONABLE OUTCOMES
Embedded into our organizational processes

‘RIGHT’ DATA

DATA ART

DEPARTMENT OF HEALTH AND HOSPITALS
Location and Revelation

Where?

Why?

When?

What?

Who?

Race

Natural Disaster

Age

Stroke

Heart Attack

Educ.

Life Course

Smoking
Step 1: The catchment of physician location $j$ is defined as the area within 30-min driving zone (Lee, 1991). Within each catchment, compute three travel time zones with minute breaks of 0–10, 10–20 and 20–30 min (zones 1–3, respectively). Search all population locations ($k$) that are within a threshold travel time zone ($D_r$) from location $j$ (this is catchment area $j$), and compute the weighted physician-to-population ratio, $R_j$, within the catchment area as follows:

$$R_j = \frac{S_j}{\sum_{k \in [d_{kj} \in D_1]} P_k W_r}$$

$$= \frac{S_j}{\sum_{k \in [d_{kj} \in D_1]} P_k W_1} + \frac{S_j}{\sum_{k \in [d_{kj} \in D_2]} P_k W_2} + \frac{S_j}{\sum_{k \in [d_{kj} \in D_3]} P_k W_3}$$

(4)

where $P_k$ is the population of grid cell $k$ falling within the catchment $j$ ($d_{kj} \in D_r$), $S_j$ the number of physicians at location $j$, $d_{kj}$ the travel time between $k$ and $j$, and $D_r$ the $r$th travel time zone ($r = 1–3$) within the catchment. $W_r$ is the distance weight for the $r$th travel time zone calculated from the Gaussian function, capturing the distance decay of access to the physician $j$.

Step 2: For each population location $i$, search all physician locations ($j$) that are within the 30-min travel time zone from location $i$ (that is, catchment area $i$), and sum up the physician-to-population ratios (calculated in step 1), $R_j$, at these locations as follows:

$$A_i^F = \sum_{j \in [d_{ij} \in D_1]} R_j W_r$$

$$= \sum_{j \in [d_{ij} \in D_1]} R_j W_1 + \sum_{j \in [d_{ij} \in D_2]} R_j W_2 + \sum_{j \in [d_{ij} \in D_3]} R_j W_3$$

(5)

where $A_i^F$ represents the accessibility of population at location $i$ to physicians, $R_j$ the physician-to-population ratio at physician location $j$ that falls within the catchment centered at population $i$ (that is, $d_{ij} \in D_r$), and $d_{ij}$ the travel time between $i$ and $j$. The same distance weights derived from the Gaussian function used in step 1 are applied to different travel time zones to account for distance decay.
Stage 1: Score each Destination (Hospitals)

\[ R_j = \frac{S_j}{\sum_{k \in \{d_{kj} \in D_r\}} P_k W_r} \]

\[ = \frac{S_j}{\sum_{k \in \{d_{kj} \in D_1\}} P_k W_1 + \sum_{k \in \{d_{kj} \in D_2\}} P_k W_2 + \sum_{k \in \{d_{kj} \in D_3\}} P_k W_3} \]

Stage 2: Score each Origin (Block Groups)

\[ A_i^F = \sum_{j \in \{d_{ij} \in D_r\}} R_j W_r \]

\[ = \sum_{j \in \{d_{ij} \in D_1\}} R_j W_1 + \sum_{j \in \{d_{ij} \in D_2\}} R_j W_2 + \sum_{j \in \{d_{ij} \in D_3\}} R_j W_3 \]
Census Block Groups (3,471)
Adult ICU Beds (96 Facilities)
Catchment Areas
Major Improvements

• Created a continuous distance decay variable \( (1/t) \) for all block groups in lieu of catchment areas. Replace \( W \) with \( 1/t \)!

\[
A_i^F = \sum_{j \in \{d_{ij} \in D_r\}} R_j W_r \\
= \sum_{j \in \{d_{ij} \in D_1\}} R_j W_1 + \sum_{j \in \{d_{ij} \in D_2\}} R_j W_2 + \sum_{j \in \{d_{ij} \in D_3\}} R_j W_3
\]

• Included morbidity data for each Block Group
LAHIDD


- 0-4: 24.3%
- 5-9: 2.0%
- 10-14: 1.9%
- 15-17: 3.8%
- 18-19: 6.8%
- 20-21: 8.3%
- 22-24: 8.9%
- 25-29: 9.3%
- 30-34: 9.4%
- 35-39: 8.6%
- 40-44: 7.7%
- 45-49: 7.9%
- 50-54: 8.8%
- 55-59: 10.3%
- 60-61: 12.4%
- 62-64: 14.3%
- 65-66: 15.6%
- 67-69: 20.1%
- 70-74: 22.2%
- 75-79: 27.1%
- 80-84: 34.7%
- 85+: 42.8%
- 54.1%
3,471 Origins to 96 Destinations!?
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What do we know now?

- Hospital Scores based on capacity and proximity AND morbidity-weighted demand
- Each Block Group’s estimated demand and proximity to every hospital
Results

Louisiana Access to Adult ICU Bed Facilities using Ex2 2SFCA, June 2014

Access Scores
- 150,001 - 1,246,456 (High)
- 125,001 - 150,000
- 100,001 - 125,000
- 75,001 - 100,000
- 50,001 - 75,000
- 25,001 - 50,000
- 0 - 25,000 (low)

Scale: 0 - 25 - 50 Miles

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Results

Louisiana Access to Adult ICU Bed Facilities using Ex2 2SFCA, June 2014

Access Scores:
- 150,000 - 1,246,456 (High Access)
- 125,000 - 150,000
- 100,000 - 125,000
- 75,000 - 100,000
- 50,000 - 75,000
- 25,000 - 50,000
- 0 - 25,000 (Low Access)

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Distribution of Access Scores

Statistics of tl_2010_22_bg10_BGAccess_txt

Field

Statistics:
- Count: 3471
- Minimum: 0
- Maximum: 1246456
- Sum: 460797991.990002
- Mean: 132756.551999
- Standard Deviation: 73512.401336
- Nulls: 0

Frequency Distribution
Future Work

- Share methodology/results with Partners
- Apply to other types of supply
- Refine population morbidity measures
- Predictive modeling
Thanks

Henry Yennie
Emergency Preparedness
Louisiana Department of Health and Hospitals

Cathy Brunson
Health Standards (Hospital Licensure)
Louisiana Department of Health and Hospitals
Links

Papers on Floating Catchment Methods

Esri Resources of Network Analyst