

The Differences between Cost Drivers of Rural and Urban Hospitals

**Capstone 1 - Final Project Report
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1. Introduction

Hospital transparency stands as a critical cornerstone within the framework of modern healthcare systems, embodying essential principles such as openness, accountability, and patient-centered care. Recognizing the significance of this transparency, RefMed has committed itself to a mission aimed at elucidating healthcare costs, fostering an understanding among individuals about the charges they incur, and establishing a comparative framework for costs across different hospitals. In response to the growing demand for increased transparency, a recent legislative development now mandates hospitals to provide machine-readable files containing comprehensive information about their pricing structures. This legal requirement aligns with our objective of collecting and analyzing data furnished by hospitals in adherence to these transparency regulations.

Through this initiative, RefMed seeks to enable them to make informed decisions based on cost considerations and highlight pricing variations among healthcare institutions. These discrepancies may arise from insurance coverage, geographic location, or whether the hospital serves a rural or urban population. By delving into the intricacies of these cost differentials, our endeavor is to help contribute to the healthcare landscape of hospital transparency, and to improve patient outcomes.

2. Customer Needs, Objectives and Team Interpretation

The sponsor, Todd McDaniel from RefMed, is the pioneering force behind market-referenced pricing in the healthcare industry. RefMed, an independent entity free from affiliations with insurance companies or physician associations, has embarked on a mission to introduce transparency to healthcare pricing. This section's discussion revolves around Todd McDaniel's insights into the project goals, how the team interpreted these objectives, and the outlined plans to deliver a functional product aligned with the sponsor's vision. The narrative also explores the team's set objectives for the project, aiming to create a practical and effective solution for RefMed.

2.1 Customer Needs

The sponsor requested a shoppable dashboard that helps consumers make informed decisions when planning a future procedure. The sponsor expressly referred to Power BI, a tool for visualizing interactive data. The dashboard should include a location look-up menu that interacts with a map to show alternative hospitals, rural and urban, to choose from within a certain radius; A menu box to enter a particular procedure name and take CPT or DRG codes; An informative box that shows the price of the procedure (cash, Medicare, etc.) for alternative locations. The sponsor also expressed that the team should explain why there may be price differences between hospital locations, whether between rural and urban areas or within the rural or urban areas. The format of providing an understanding of why there may be price differences between locations is still speculative. The customer's need for this information could be in report style of findings or worked into the dashboard.

2.2 Team Interpretation

Before starting any work, time was taken to assess what the sponsor needed. It was concluded that the interpreted primary need was for healthcare customers to understand and visualize the cost differences between hospitals for procedures those facilities provide. The dashboard will take user input and output the best options for their situation. Additionally, the team desires customers to see the difference between the prices for their unique service, a secondary need.

Lastly, by giving customers a tool to understand the pricing difference, they are provided the necessary information to make educated decisions. Medical pricing is often filled with jargon, and the customer pays outrageous prices for services required for their well-being.

2.4 Functional and Non-functional Requirements –

For the requirements of the dashboard, customers should be able to use the dashboard without any technical know-how. The only knowledge that the customer should have is the location and procedure needed. The Dashboard should be intuitive and responsive to the customers' selections and changes to the input that they provide (procedure name or DRG/CPT code). For the dashboard maintenance, the dashboard should be easily updated with new information when available. Additionally, the dashboard widgets should be easily added or moved for future updates. The use of the dashboard should be easily manipulated and transformed when customers select items in the dashboard. For instance, customers should be able to select points on the map that transform tables showing price differences and other related information. Likewise, customers should be able to click tables or other toggles that will also manipulate the map.

2.3 Limitations

During the research phase of the project, it was found that some hospitals did not have fully readable data or complete data or did not have a hospital transparency form at all. This had proven to be tricky for the team when trying to find rural hospitals for comparison with the 22 that were shown to be in Florida. With the rural hospitals deemed to be usable, another issue appeared was the problem of if they fell within the scope of area. Some rural hospitals were scattered across Florida, with some being in the Keys, while others were almost within the Georgia border. With this new information barrier and constraints had to be considered before answering "where is the line to be drawn for comparison?"

As different criteria had to be taken into consideration for the data being sifted through, it was also important to choose between CPT or DRG codes. This created a new issue of finding hospitals, both rural and urban, that contained these codes for use, or if there would be a way to transform them to compare them. Some of the data sets that were found to be within the criteria had been in varying forms or simplicity, which was alerting to the fact that some work would need to be done to data clean them to make them usable. An example would be that some hospitals had their price transparency in a JSON format that was simple and readable, while others were made within an Excel file.

3. Determination of Analytical Approach

The openness of the customer needs the sponsor provided and the team's interpretations coerced the team to set out a more unpredictable path. That path was dependent on available data and answers to further clarifying questions for the sponsor that resulted from unforeseen technical implications found from research. Data availability and clearly defining further expectations arising from new information is what determines the analytical approach.

3.1 Literature Search

The Literature Search section delves into a comprehensive review of existing research and products pertinent to three primary topics explored within the capstone project. This review serves the dual purpose of establishing a foundational understanding and critically evaluating the existing

landscape within each research domain. The synthesis and analysis of these sources contribute significantly to informing subsequent discussions and analyses within this paper. Readers are encouraged to refer to Appendix 2 at the end of the report for more detailed insights into each of the cited literature if desired.

Understanding US Healthcare System and DRG Codes:

The initial phase of research involved comprehending the fundamental workings of the US healthcare system, focusing on the differences between routine doctor visits and emergency room services. Sources explored foundational aspects, shedding light on the intricate mechanisms governing cost distribution and insurance reimbursement processes (**De Lew et al., Health Care Financ Rev, 1992**). Notable findings highlighted the divergence in patient journeys and cost dynamics between these healthcare scenarios. Additionally, the understanding of Diagnosis-Related Group (DRG) codes emerged as a crucial component within this domain (**Davis, Health Insurance Medicare, 2023**). Sources delved into the significance of DRG codes in categorizing and reimbursing hospital services. This understanding was instrumental in framing the analysis of rural and urban healthcare services, providing a standardized means to compare specific medical services and their associated costs (**Torrey, Verywell Health, 2020**).

Cost Drivers in Healthcare:

The subsequent research phase delved deeper into identifying and understanding the key cost drivers within the healthcare system, encompassing administrative costs, technological utilization, and other pivotal factors influencing healthcare economics (**Cooper, Health Affairs Forefront, 2019**). Insights gleaned from various sources shed light on the direct correlation between these cost drivers and escalated pricing, notably in larger urban healthcare facilities (**Norbeck, Mo Med, 2013**). Understanding these policy-driven dynamics is crucial in comprehending pricing strategies and overall spending trends within the healthcare sector. Behavioral drivers affecting healthcare utilization patterns and their subsequent impact on costs also garnered attention (**Ho et al., Health Affairs, 2023**). This included examining patient and provider behaviors, decision-making processes, and the psychological factors influencing healthcare spending for more effective cost management strategies.

Transport Network System in Healthcare:

The ongoing exploration delves into the intricate healthcare transport system, with a primary focus on Emergency Medical Services (EMS). Key sources, including 'Modeling and Optimization for Emergency Medical Services Network,' shed light on the interconnected nature of call centers, ambulance stations, and emergency departments (**Liu et al., IEEE Transactions on Automation Science and Engineering, 2022**). These sources aim to address ambulance offload delays and congestion in EDs. Furthermore, 'Locating emergency medical services to reduce urban-rural inequalities' examines multi-objective optimization models to enhance EMS accessibility and coverage, emphasizing strategic station placement for improved local EMS capacity (**Luo et al., Socio-Economic Planning Sciences, 2022**). 'Improving emergency service in rural areas: a bi-objective covering location model for EMS systems' discusses the equilibrium between ambulatory services in rural and urban areas through bi-objective covering location models (**Chanta et al., Annals of Operations Research, 2014**). Insights from these sources revolve around optimizing ambulance queues, reducing ED bed costs, and strategically situating EMS stations, all pivotal aspects for comprehending decision-making processes and competitive implications within the healthcare market.

3.3 Analysis of Alternatives

When introduced to this project by the sponsor RefMed, the opportunity to analyze a variable scope with varying complexity was given. One of the first key tasks was finding out the definition of a Rural hospital and their locations across Florida. The simplest definition is defined by the Florida 2023 Statutes Chapter 395.602, a “Rural hospital” means an acute care hospital licensed under this chapter, having 100 or fewer licensed beds and an emergency room. There are many other definitions stated, such as: a “hospital, in a county with a population density of up to 100 persons per square mile, which is at least 30 minutes of travel time, on normally traveled roads under normal traffic conditions, from any other acute care hospital within the same county”.

Likewise, any Critical Access Hospital (CAH) is also classified as a Rural Hospital under the statute. So then what is a CAH? It is a hospital located in a rural area, maintaining no more than 25 inpatient beds, and also located at least 35 miles from another hospital. One complication is that there are exceptions to the classifications within the statutes, so depending on how each location is defined within this project, the entire approach and results could change. At this time, the Florida Rural Health Association’s contact list for rural hospitals was used to start research on 21 Rural hospital locations. This is the most up-to-date list found, from June 2023.

Dataset acquisition then began as a team effort to locate good locations based on set requirements. As shown as an example in Figure 1, some hospital datasets can be quite simple and only show the cash price for a procedure. Because of this the focus of the dashboard is on each hospital’s cash price vs competitors. Additionally, confirming that Medicare data was accessible for the same procedure codes, each hospital’s cash price vs. Medicare as a baseline can be included. After validating that datasets would be cross comparable through CPT/DRG codes, remaining tasks like ranking and selecting hospitals would be needed.

Service Code	Service Description	Cash Price
74177	Abdomen and Pelvis CT Scan with Contrast	350.71
74177	Abdomen and Pelvis CT Scan with Contrast	368.12
G0480	Acetaminophen Test	114.43
80074	Acute Hepatitis Panel	47.63
82040	Albumin Level	4.95
82140	Ammonia Level	14.57
82150	Amylase (Enzyme) Level	6.48
86880	Antihuman Globulin Test (Coombs)	53.03
29130	Application of Finger Splint	106.66
29125	Application of Forearm Splint	106.66
29530	Application of Knee Strap	106.66
29105	Application of Long Arm Splint	134.50
29505	Application of Long Leg Splint	134.50
29515	Application of Lower Leg Splint	134.50

Figure 1. Simple Procedure Dataset sourced from Lakeside Medical Center

3.4 Flow Chart of Design Process

As discussed in section 3.1, the RefMed team has conducted background research on different subjects involving the nature of cost drivers in health care, codes that represent costs of services, etc. Then as a starting point, hospital procedure prices for different coverages are starting to be sourced

from hospitals selected by different criteria. All chosen rural hospital data has been sourced, whereas urban hospital data has been a work in progress. Needed potential outside data refers to data more relevant to cost drivers, as opposed to lists of services and costs, and that still needs sourced as soon as it is identified. Though, sourcing potential outside data and urban hospital data are not steps that need to be completed prior to starting the cleaning process to setup for the aggregation of all the data. Once workable via processing, analysis will enable the discovery of insights to feed into a user-friendly dashboard for browsing or consulting purposes.

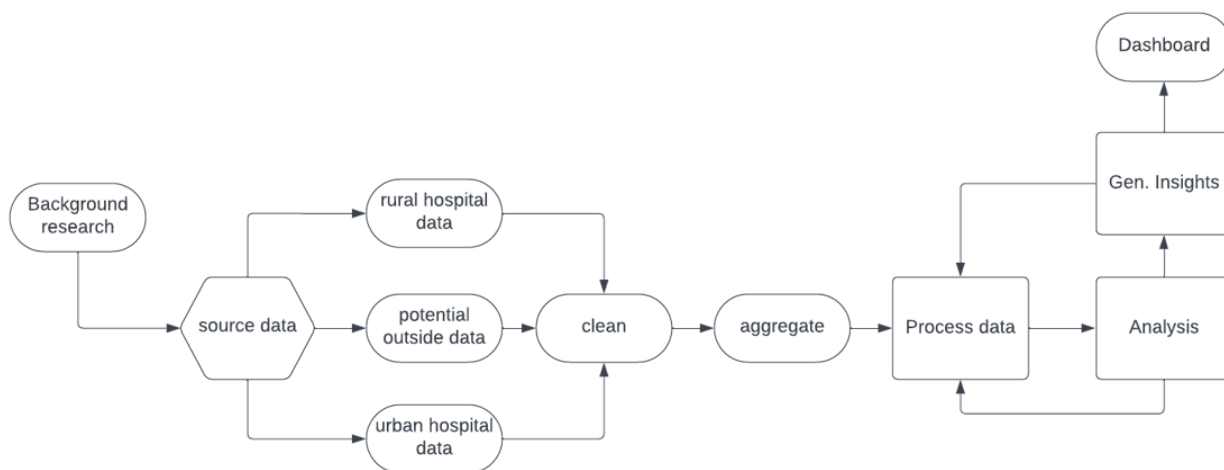


Figure 2. Team Flow Chart of Design Process

4.0 Preliminary Data Collection and Analysis

Much of this project revolves around the collection and analysis of data sourced from hospitals' websites. This data is available as hospitals are now legally required to provide a machine-readable file of the prices they charge. As stated previously, the aim of this project is to provide people with a way to find the price differences between the same procedure at different hospitals. This will be done by visualizing the data collected from hospitals onto a dashboard that shows these price differences in an easy to understand manner. This project aims to achieve this by spring of 2024.

4.1 Current Progress

There are 6 rural hospitals that have been chosen for comparison against their surrounding non-rural hospitals. These rural hospitals as well as 20 nearby non-rural hospitals have all had their datasets gathered from their respective websites. These 26 hospitals were selected as they meet the requirements of being within 50 miles of a rural hospital, containing HCPS and/or CPT codes, and contain simple and consistent data.

There remain some non-rural hospitals within 50-miles of the aforementioned rural hospitals that possibly meet the requirements that have not had their data collected and analyzed yet. Additional information about the hospitals including their classification of the type of town, suburb, or city they are in has been collected. The hospitals' county with its population has also been collected.

4.1.1 Market Analysis & Visualization

The main goal of the mapping tool is to show the competition that these rural hospitals will be compared to. In order to do this, the radius distance must be chosen. At first, the sponsor suggested using a 35-mile radius around each hospital, which matches the cutoff point for the aforementioned CAH definition. However, after analysis of the situation and rural hospitals utilized, a 50-mile radius was chosen for comparisons. Exceptions to the CAH classification were seen, as well as the fact that fewer Urban hospitals exist for analysis in a 35-mile radius (See Appendix 1 [Figure 1](#)). As shown in the figure, the expansion of the radius to 50 miles for Lakeside Medical Center increases the availability of comparable hospitals significantly. The 50-mile radius was also chosen as it is a reasonable amount of driving for someone shopping for a future procedure/surgery.

In order to locate and record each location, the 2023 Florida Hospital Association's Directory of All Hospitals was utilized. Going line through line for each county, the hospital search results generated within the Rural Radii were verified. After finishing the records, toggle slicers were assigned to each Rural hospital to filter out radius lines and competing locations as needed. After the search, 64 total hospitals were located within the radii offering an ample comparison for the analysis (Appendix 1 [Figure 2](#)). The next step is for these hospitals to be recorded, classified, and datasets compiled. In the final consumer dashboard, this map will be recreated in Microsoft PowerBi in a user-friendly comparison for consumers.

4.2 Spring Timeline

In January, the data will finish being collected and will be compiled into a database consisting of the rural and non-rural hospitals. By the end of February, a simple working dashboard to shop between the hospitals along with further visualizations will be made. Throughout March the models and dashboards will be improved and refined into a complete product. April will consist of any finalizations to the dashboard as well as preparations for the final presentation of this project.

5.0 Conclusions and Future Work

Overall, much work has been completed this semester, and much more is yet to be done. The research and design processes have been started and much progress has been made in those areas. All the customers' needs and requirements have been identified. With these things being identified the timeline and necessary steps needed to complete the project are marked clearly, allowing a smooth transition into the next semester.

5.1 Conclusions and Project Summary

In conclusion, Refmed is a company seeking to help customers understand healthcare costs by using the new Hospital Transparency act. The goal of the project is to use the newly freely given hospital data to create a database and interactive dashboard to help customers understand and identify the differences in costs between different hospitals in rural and urban areas.

Overall, the efforts put into this project so far have resulted in much progress. The customers', functional, and non-functional needs have been identified. As well as the limitations of the project. Initial research and the design process have been completed. The preliminary data collection and analysis have resulted in identifying usable hospitals. The Market analysis and visualization have also

been completed. By completing these necessary steps, the database and interactive dashboard can soon be created in the coming semester.

5.2 Plan for End-Product Demonstration

The current plan for the end-of-product demonstration involves the completion of the interactive dashboard. This dashboard will demonstrate and compare the rural and urban hospital procedure costs. Comparing the cash prices of the procedures. The end result will allow the users to input information and find the best-suited hospital for their situation.

5.3 Future Work

When first given the project title “Rural vs. Non-Rural Hospital Costs”, it implied a clear cut line for separating hospitals in different locations that are serving an area. However, this is not always the full story. Hospitals help people from all over, meaning it must include comparison locations that serve rural communities regardless of their own location/classification. After conversing with the sponsor, it was concluded that this would be an appropriate addition to the models following the initial prototype dashboard. Starting first with the comparison breakdown between Rural and Non-Rural, then focus was moved to be more on the specific outreach of certain hospitals.

A published dataset and tool by the NCES will be used to start the classification process of recorded hospitals utilized for comparison. As shown in [Figure 3](#) of Appendix 1, the tool allows the user to see the specific governmental classification of an area based on a point, instead of the population of a zip code. The State of Florida Statute 288.0656 defines a rural county as: “A county with a population of 75,000 or less” or “A county with a population of 125,000 or less which is contiguous to a county of 75,000 or less” (See Appendix 1 [Figure 4](#)). Essentially, rural communities living on the edge of a county in which a dense urban area exists far away may have been overlooked using a traditional distinct county classification. Implementing this tool on all potential hospitals within the dataset will help the team to analyze more insight into how rural communities are served and how the increase in large healthcare networks is affecting the state.

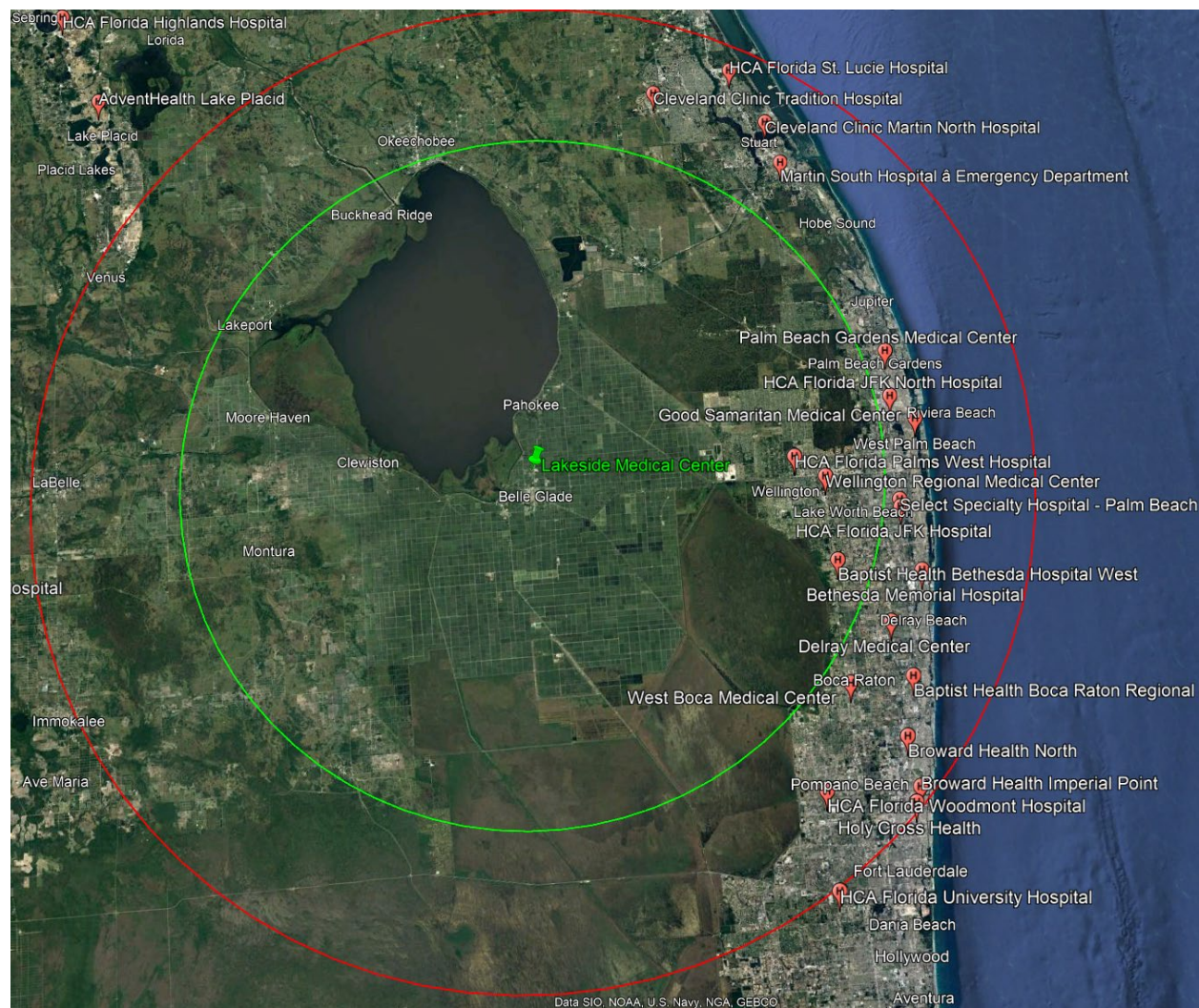
Appendix 1 – Data and Methods

Figure 1. Lakeside Medical Center: Green=35mi Radius, Red = 50mi Radius

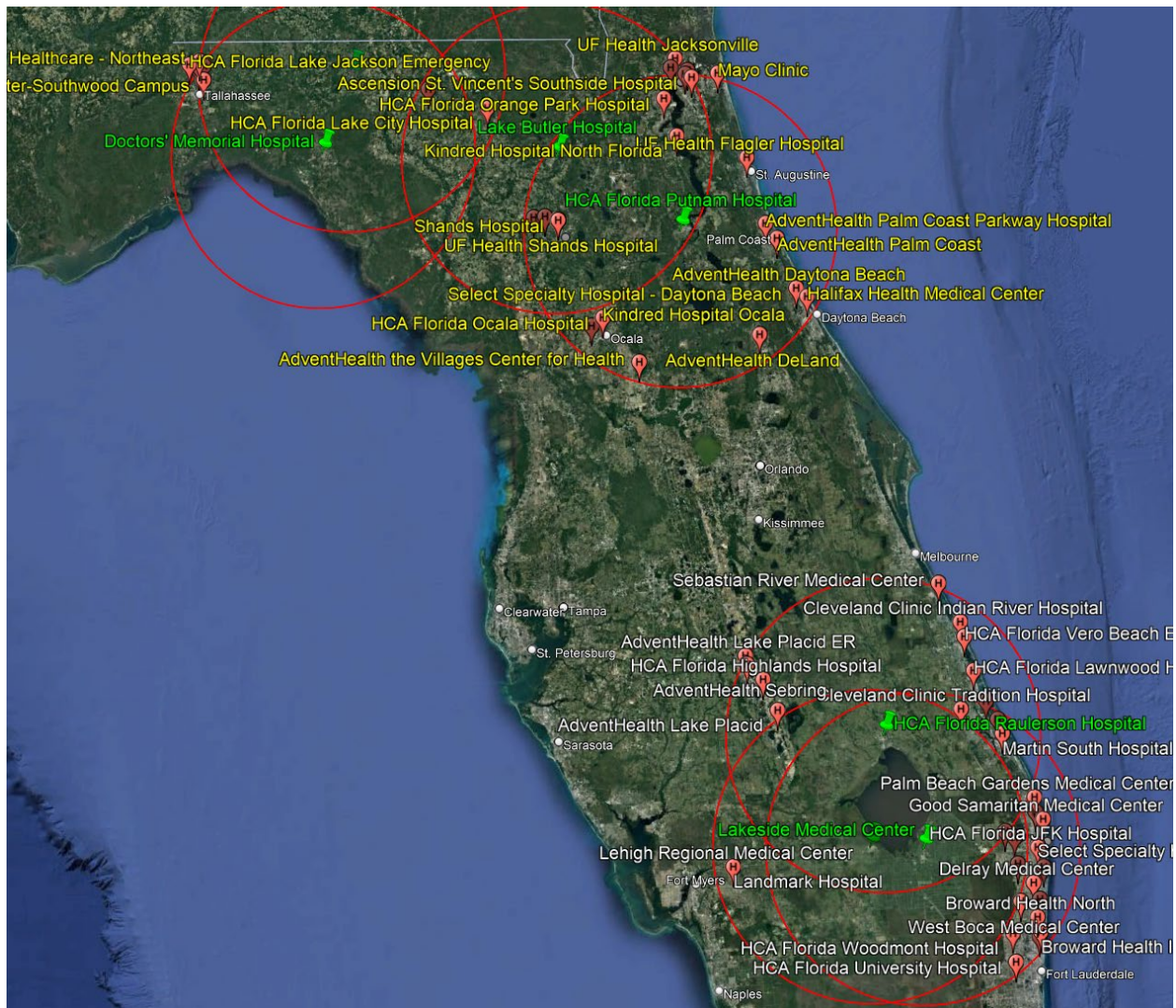


Figure 2. Visualization showing 7 Rural Hospitals with 64 competing locations within area

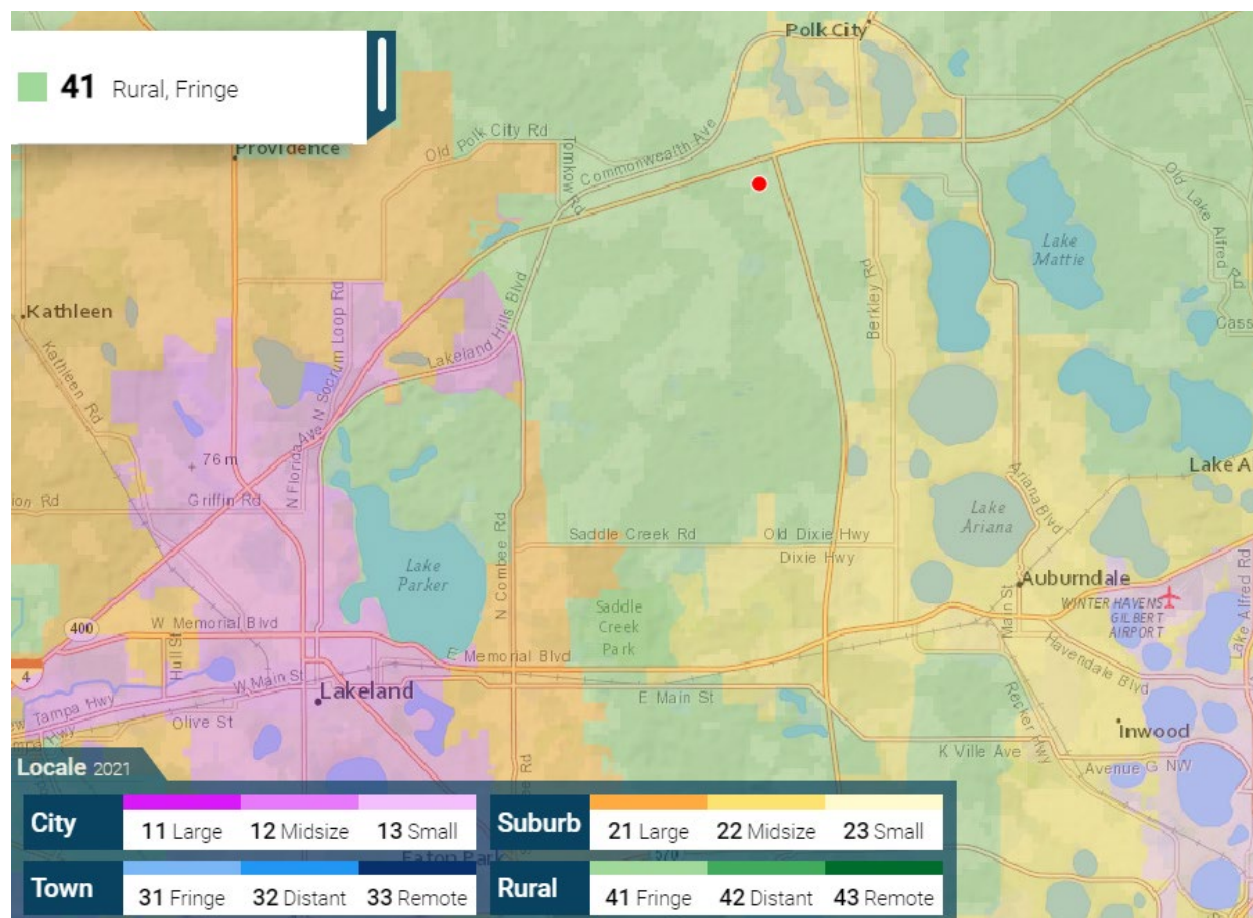
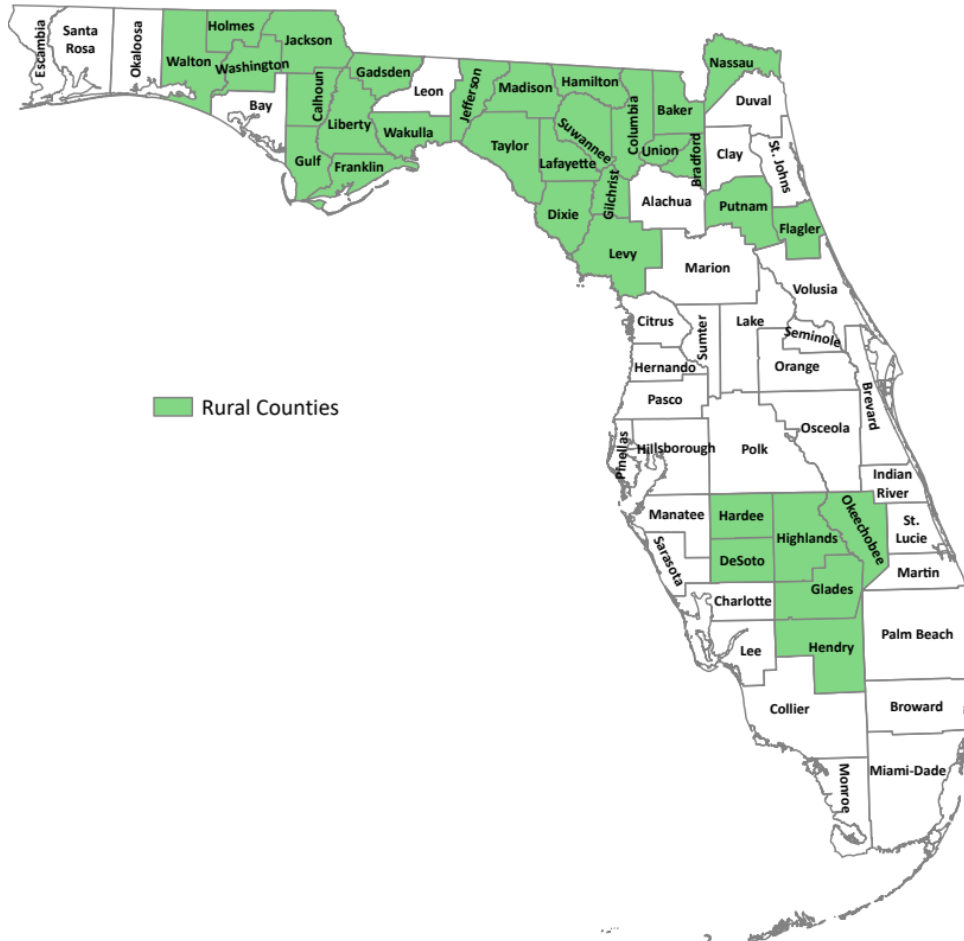


Figure 3. NCES.gov Locale Lookup Tool with Florida Poly selected on map



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Appendix 2- References

(Davis, Health Insurance Medicare, 2023) Davis, Elizabeth, RN. "What Are Diagnostic-Related Groups (DRG)? Fixed fees for services ensure hospitals don't run up costs unnecessarily." Health Insurance Medicare. Updated May 15, 2023, fact-checked by Nick Blackmer.

- This article provides a comprehensive overview of Diagnostic-Related Groups (DRGs) and their role in controlling healthcare costs. Davis highlights the significance of fixed fees within DRGs to ensure hospitals' cost containment strategies. It's a recent update, focusing on the contemporary relevance of DRGs in the healthcare system.

(De Lew et al., Health Care Financ Rev, 1992) De Lew, Nancy, George Greenberg, and Kraig Kinchen. "A Layman's Guide to the U.S. Health Care System." Health Care Financ Rev, vol. 14, no. 1, 1992, pp. 151-169. PMC4193322, PMID: 10124436.

- De Lew et al. offer an accessible guide to the complex landscape of the US healthcare system. Published in 1992, this article serves as a foundational piece explaining various facets of the system, providing insights into healthcare finance and delivery.

(Torrey, Verywell Health, 2020) Torrey, Trisha. "Understanding Healthcare Reimbursement." Verywell Health, February 27, 2020.**

- Torrey's work sheds light on the intricacies of healthcare reimbursement, offering insights into the payment mechanisms within the healthcare system. This piece, published in 2020, serves as a contemporary exploration of reimbursement practices and their implications for healthcare service delivery.

(Ho et al., Health Affairs, 2023) Ho, Vivian, Sasathorn Tapaneeyakul, and Heidi Voelker Russell. "Price Increases Versus Upcoding As Drivers Of Emergency Department Spending Increases, 2012-19."

- This study in *Health Affairs* delves into the drivers behind rising emergency department spending. It specifically examines the impact of price increases versus upcoding practices during the period from 2012 to 2019. The authors assess how these factors contribute to the escalation of healthcare costs within emergency services.

(Cooper, Health Affairs Forefront, 2019) Cooper, Zack. "High Prices Drive High Health Care Spending In The US, But So Too Do Other Factors: A Response To Anderson And Colleagues."

- This article, featured in *Health Affairs Forefront*, presents a response to previous research by Anderson and colleagues. Cooper argues that while high prices are indeed a substantial driver of healthcare spending in the United States, other factors beyond pricing also significantly contribute to the increased expenditure in the healthcare sector.

(Norbeck, Mo Med, 2013) Norbeck, Timothy B. "Drivers of Health Care Costs: A Physicians Foundation white Paper - Second of a Three-Part Series."

- Published in *Mo Med*, this white paper by Norbeck is part of a three-part series investigating the drivers behind escalating healthcare costs. Focused on identifying the primary factors leading to increased healthcare expenditure, this paper offers insights into various elements influencing the rising costs in healthcare.

(Liu et al., IEEE Transactions on Automation Science and Engineering, 2022) Liu, Ran et al. "Modeling and Optimization for Emergency Medical Services Network."

- This study, published in *IEEE Transactions on Automation Science and Engineering* in 2022, focuses on modeling and optimizing emergency medical services (EMS) networks. The paper investigates methodologies to enhance the structure and efficiency of EMS networks, aiming to improve their responsiveness and effectiveness in emergency situations.

(Luo et al., Socio-Economic Planning Sciences, 2022) Luo, Weicong et al. "Locating emergency medical services to reduce urban-rural inequalities."

- Featured in *Socio-Economic Planning Sciences* in 2022, this research article explores strategies to address urban-rural disparities in accessing emergency medical services. The authors propose and analyze approaches aimed at strategically locating emergency medical services to mitigate discrepancies in healthcare access between urban and rural areas.

(Chanta et al., Annals of Operations Research, 2014) Chanta, Sunarin, Maria E. Mayorga, and Laura A. McLay. "Improving emergency service in rural areas: a bi-objective covering location model for EMS systems."

- This article, found in the *Annals of Operations Research* from 2014, introduces a bi-objective covering location model tailored for emergency medical service (EMS) systems in rural areas. The paper outlines a framework aimed at enhancing emergency services' accessibility and efficiency within rural settings.