IDENTIFYING TARGET AREAS FOR CANCER CONTROL ACTIVITIES IN LOUISIANA THROUGH GEOSPATIAL ANALYSIS

LCRA 2017

October 12th, 2017

Christina Lefante, MPH, CTR

LSU Health NEW ORLEANS Louisiana Tumor Registry

CCRT

BACKGROUND

Background

- In 2015, the Louisiana Colorectal Cancer Roundtable (LCCRT) sought assistance from the Louisiana Tumor Registry (LTR) to visualize the burden of colorectal cancer in Louisiana
  - LCCRT
    - Modeled after the National Colorectal Cancer Roundtable
    - Mission:
      - To raise screening rates in order to eliminate colon cancer as a major public health problem in Louisiana

Background

- Goals
  - Assist the National Cancer Institute in working with geospatial experts to assess and improve the use of geospatial analysis in cancer registries.
  - Utilize LTR's population based data to map the occurrence of late-stage colorectal cancer within Louisiana's (LA) 64 Parishes
  - Combine Louisiana's cancer resources to analyze and identify target areas for screening intervention.

ADDRESS CLEANING

The Precision of Geospatial Analysis is Dependent on the Quality of GIS Coordinates

- Project highlighted
  - Inconsistencies in address documentation
  - Changes in data collection over time

GIS Quality Score

- When an address is geocoded, it is assigned a GIS quality score, Indicating the coordinates' degree of geographic precision
- ***00-05*** – Coordinates are from house number and street, street intersection, or mid-point of street segments
- ***06-12*** – Coordinates are from an Address zip, Post Office Box, or zipcode or county centroid
- ***98-99*** - Coordinate quality unknown or unassigned

Precisely Capturing the Cancer Burden Contingent on the Accuracy of LTR's Data

Began by looking at cases of colorectal cancer (CC) diagnosed in LA from 2007 to 2014

- Out of 19,845 CC cases dx, 5,784 had a GIS quality score ≥ 05
- Resulting in roughly 29% of the cases being censored out of GIS mapping
- The problem grows when we restrict results to GIS scores of 01

Not Limited

LTR processes a little over 26,000 new cases of cancer a year

5% have a PO Box or Rural Route as the address at diagnosis

An additional **2%** have an address unrecognized by the AGGIE Geocoder

- **Typos** – Missing digits, Misspelled words, etc.
- **Data Entry Errors** – Wrong zip, Abbreviations

Standard Setters?

- The CoC and NAACCR have guidelines on how to capture the address at diagnosis that mirror address reporting for the U.S. Census Bureau
  - "the place where he or she lives and sleeps most of the time or the place the person considers to be his or her usual home."
- In 2008, NAACCR published **A Geocoding Best Practices Guide**
- Unable to locate a standard for retrospectively cleaning address at diagnosis

The lack of available resources prompted LTR to develop a process to improve GIS coordinates for older cases

Solution

- LTR proposed best practice guidelines to standardize the process of retrospectively cleaning address at diagnosis.
- Guidelines aimed to resolve the following issues:
  - PO Box at diagnosis but no street level address
  - Street-level address that are not recognized by the AGGIE Geocoder

Highlighted the importance of reporting the correct city and zip code as well as the spelling of street names and accurate reporting of street numbers

Guidelines

- The following resources were used to choose the most accurate address or verify the existing address:
  - Accurint People Search Software – Voter Registration
  - United States Postal Service
  - Death Certificates
    - Requires some detective work
    - Patient expired within 1 year of diagnosis and the address on the death certificate coincides with the voting address from the time period of diagnosis

Address Cleaning: Results and Conclusion

- Guidelines developed while cleaning the addresses for the colorectal cancer project
- We assessed the effectiveness of the new procedure by systematically applying the steps to breast cancer cases diagnosed in Louisiana from 2009-2014
  - **1067** breast cancer cases (2009-2014) with poor quality GIS coordinates and/or census tract values
  - **520** breast cancer cases **(49%)** were adjusted using the new guidelines resulting in good quality coordinates
  - **352** breast cancer cases **(33%)** were added to the analysis using diagnosis years 2010-2014
  - Altered the statistically significant clusters in the analysis

METHODS

Approach

- **Implementation:**
  - Map Generation
  - SatScan Cluster Detection
- **Measures:**
  - Incidence Rate
  - Late-stage Incidence Rate
  - Late-stage Proportion

Map Generation

- Louisiana has 1148 census tracts
  - Many have cancer case counts below the threshold for analysis
- Solution
  - Combined each census tract with its surrounding tracts according to their Euclidean distances to reach a population size of at least 20,000 and 21 cases
- Thus, an aggregated and stable age-adjusted incidence rate for that census tract could be calculated.
  - Socioeconomic status was not taken into consideration, a limitation.

Map Generation

- The Standardized Incidence Ratio (SIR) was then calculated as the incidence rate of the census tract relative to the state-wide rate
- The SIRs are illustrated on the maps by 7 percentile levels
  - <=11th percentile
  - <=22nd percentile
  - <=33rd percentile
  - 34-66th percentile
  - >=67th percentile
  - >=78th percentile
  - >=89th percentile

Map Generation

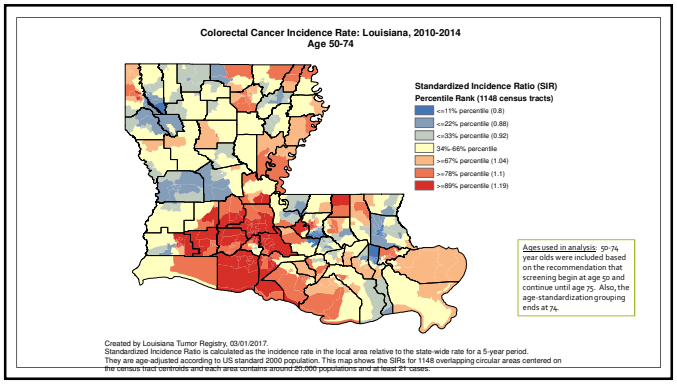
- For late-stage proportions, we applied a similar strategy.
- We combined each census tract with its surrounding areas to reach at least 100 cancer cases and 21 late-stage cancer cases in order to calculate the aggregated late-stage proportion for that census tract
- The Standardized Proportion Ratio (SPR) was then calculated as the proportion of late stage of the census tract relative to the state-wide late stage proportion

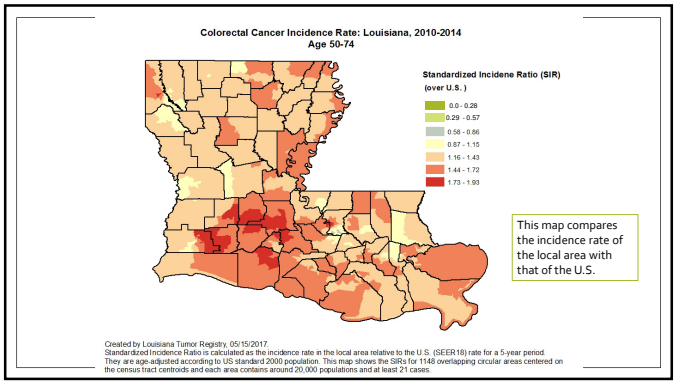
SaTScan Software

- SaTScan is a free software that analyzes spatial, temporal and space-time data using the spatial, temporal, or space-time scan statistics.
- It can perform geographical surveillance of disease to detect spatial disease clusters and determine if they are statistically significant.
- The clusters are designed to be in the shape of circles or ellipsoids.
- We used a discrete Poisson-based model to detect the clusters with high incidence rates, where the number of events in a geographical location is the incidence at the census tract level. The model adjusted for the age inhomogeneity of the underlying population at risk.
- For the late-stage proportions, we used a Bernoulli model, with the late-stages (regional & distant) as the case, and early stages (In Situ and Localized) as the control.

RESULTS

INCIDENCE RATE



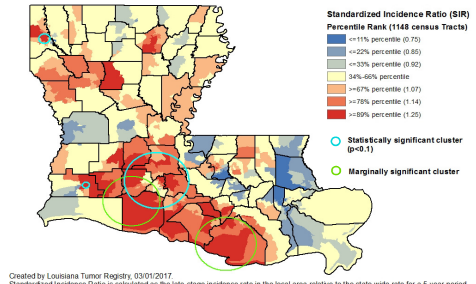


LATE-STAGE INCIDENCE RATE

How is late-stage incidence rate calculated?

- Late-Stage is defined as cancers diagnosed at a regional or distant stage
- For a specified time period,
  - Late-Stage Age-Adjusted Incidence Rate= $\frac{\#\ of\ New\ Cases\ of\ Late-Stage\ CRC}{Person-years\ in\ the\ total\ population\ for\ the\ specified\ age\ group}$
  - Standardized Age-Adjusted Incidence Rate (SIR)= $\frac{incidence\ rate\ in\ the\ local\ area}{state-wide\ incidence\ rate}$

Colorectal Cancer Late-Stage Incidence Rate: Louisiana, 2010-2014
Age 50-74, with Overlapped SaTScan Clusters

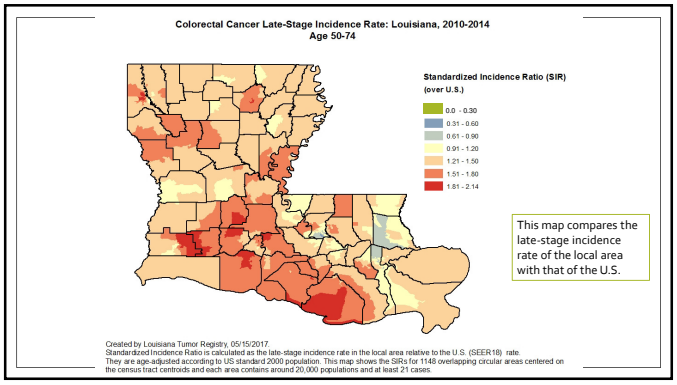


Created by Louisiana Tumor Registry, 03/01/2017.
Standardized Incidence Ratio is calculated as the late-stage incidence rate in the local area relative to the state-wide rate for a 5-year period. They are age-adjusted according to US standard 2000 population. This map shows the SIRs for 1148 overlapping circular areas centered on the census tract centroids and each area contains around 20,000 populations and at least 21 cases.
The circles show clusters detected by SaTScan software which are statistically significant at 0.1 level.

Comparisons of Demographics and Other Characteristics between the Clusters and the State, Late-Stage Incidence Rate

	Cluster 1 RR*: 2.06, p: 0.0007	Cluster 2 RR*: 1.25, p: 0.014	Cluster 3 RR*: 1.58, p: 0.038	
	Southwest Louisiana	South Central Louisiana	Northwest Louisiana	State-wide
Demographics and SES Characteristics	11 census tracts 108 CRC cases 69 late-stage cases	155 census tracts 1,412 CRC cases 792 late-stage cases	25 census tracts 167 CRC cases 111 late-stage cases	1,148 census tracts 7,269 CRC cases 3,997 late-stage cases
White	↓ 27.5%	69.6%	↓ 18.8%	63.9%
Black	↑ 71.3%	27.3%	↑ 80.4%	32.8%
Hispanic	2.1%	3.1%	1.7%	4.2%
Male among age 50-74	47.9%	48.2%	45.6%	47.8%
Poverty among age 45-74	↑ 21.4%	14.5%	↑ 25.3%	13.5%
Education under high school diploma among age 45+	↑ 28.3%	↑ 24.7%	↑ 23.1%	19.0%
Unemployed among age 45-74	↑ 9.3%	4.6%	6.5%	5.4%
No health insurance among age 45-74	↑ 18.3%	14.8%	↑ 22.4%	14.6%

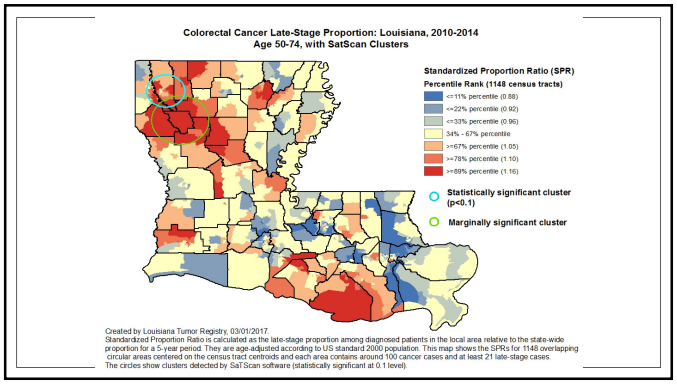
*RR (Relative Risk): the estimated risk within the cluster divided by the estimated risk outside the cluster.



LATE-STAGE PROPORTION

What is late-stage proportion?

- Late-Stage is defined as cancers diagnosed at a regional or distant stage
- Total # of CRC Cases includes in situ, localized, regional, and distant
- % of late-stage CRC cases = $\frac{\#\ of\ Late\text{–}Stage\ CRC\ Cases}{Total\ \#\ of\ CRC\ Cases} \times 100$
- Standardized Proportion Ratio = $\frac{Late\text{-}stage\ proportion\ among\ diagnosed\ patients\ in\ the\ local\ area}{Statewide\ Late\text{-}Stage\ proportion}$



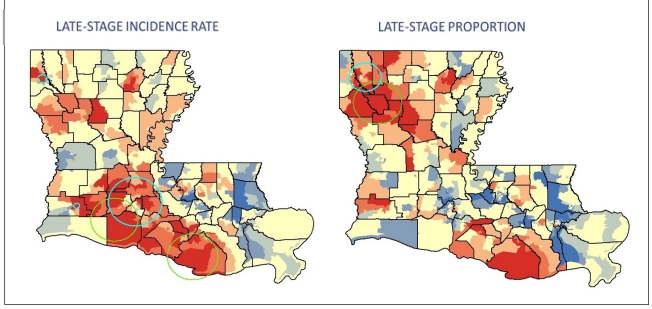
Comparisons of Demographics and Other Characteristics between the Clusters and the State, Late-Stage Proportion

Demographics and Other Characteristics	Cluster 1 (RR*:1.21, p: 0.014) Northwest Louisiana 102 census tracts 693 colorectal cancer cases 443 late-stage cases	State-wide 1,148 census tracts 7,269 CRC cases 3,997 late-stage cases
White	58.7%	63.9%
Black	39.1%	32.8%
Hispanic	3.1%	4.2%
Male among age 50-74	47.0%	47.8%
poverty among age 45-74	13.8%	13.5%
Education under high school diploma among age 45+	⇩ 16.2%	19.0%
Unemployed among age 45-74	4.4%	5.4%
No health insurance among age 45-74	15.0%	14.6%

*RR (Relative Risk): the estimated risk within the cluster divided by the estimated risk outside the cluster.

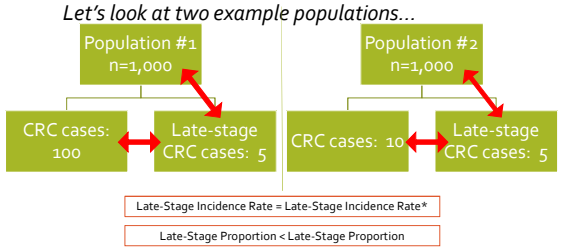
LATE-STAGE INCIDENCE VS. LATE-STAGE PROPORTION

Louisiana (2010-2014, Age 50-74)



Why do these two approaches highlight different areas?

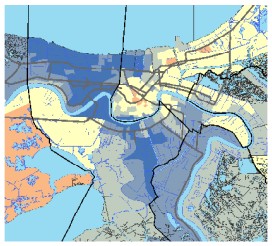
Let's look at two example populations…



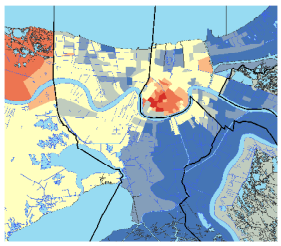
AREA-LEVEL MAPS

New Orleans (2010-2014, Age 50-74)

Late-Stage Incidence Rate

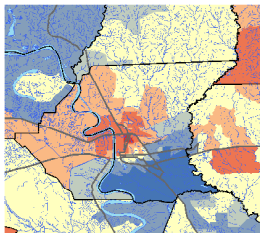


Late-Stage Proportion

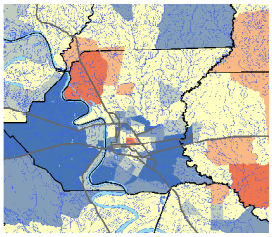


Baton Rouge (2010-2014, Age 50-74)

Late-Stage Incidence Rate

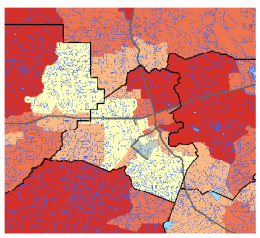


Late-Stage Proportion

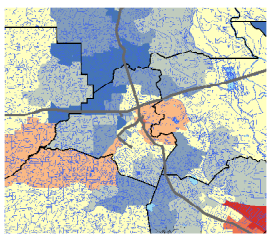


Lafayette (2010-2014, Age 50-74)

Late-Stage Incidence Rate

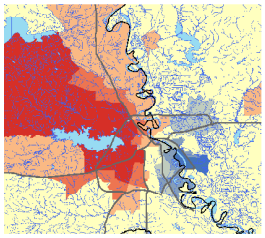


Late-Stage Proportion



Shreveport (2010-2014, Age 50-74)

Late-Stage Incidence Rate



Late-Stage Proportion

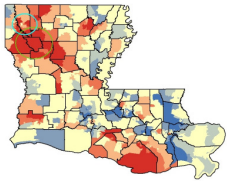
Feedback from LCCRT Summit

- Suggestion to compare the incidence rate (or late-stage proportion) in the local area to the national incidence rate (or late-stage proportion).
  - These maps were included above. Comparing the local rates to the state-wide rate allows cancer control programs to focus efforts in the areas of highest need.
- Perplexing that there are hotspots/clusters in Shreveport given that there are so many GIs in that area.
- Suggestion to add GI locations and Federally Qualified Health Centers to the maps.
  - You will see these side-by-side comparisons next.
- Replace the term 'Cluster' with 'Hotspot.'
- Remove clusters that are not statistically significant.

SIDE-BY-SIDE COMPARISONS

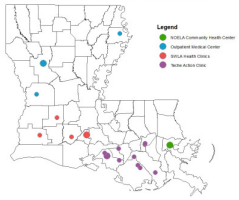
Late-Stage Proportion and FQHCs

Late-Stage Proportion



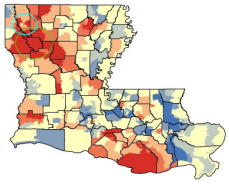
Federally qualified health centers

Louisiana Colorectal Health Program (LCHP) Partners

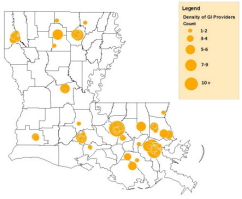


Late-Stage Proportion and GIs

Late-Stage Proportion

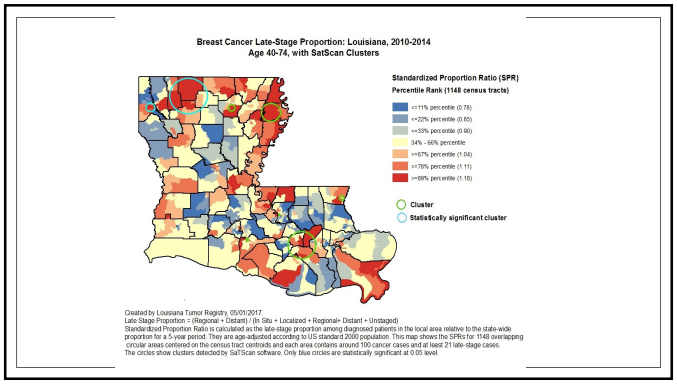


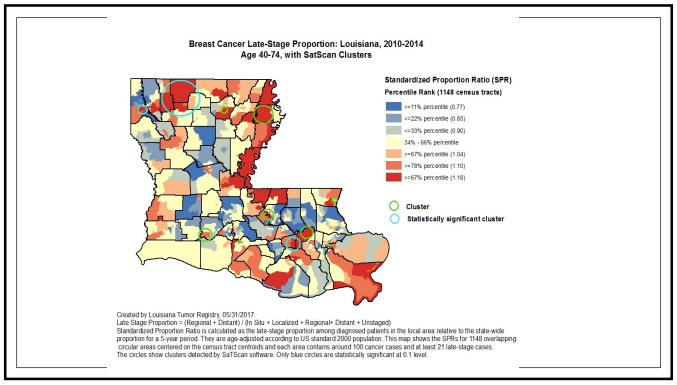
Gastroenterologists in LA in 2016

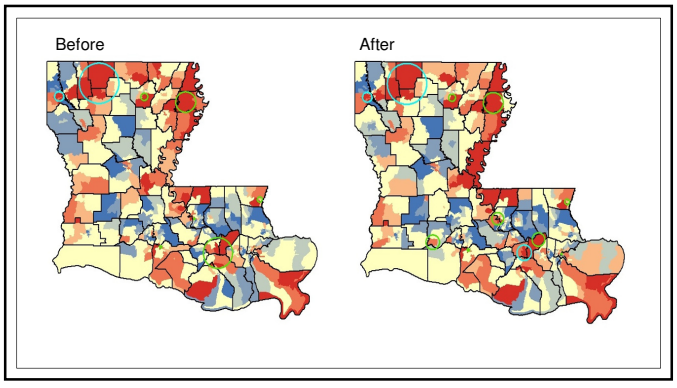


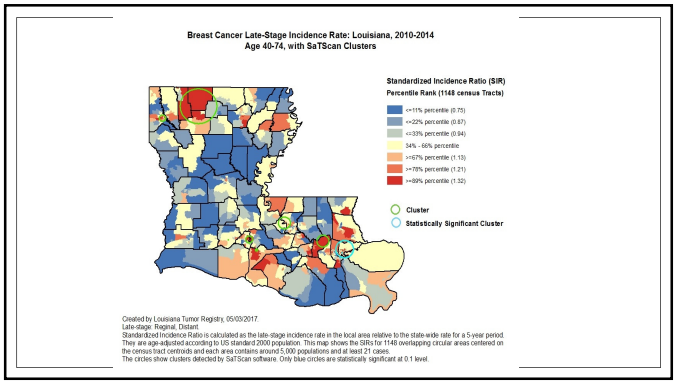
BUT WAIT!

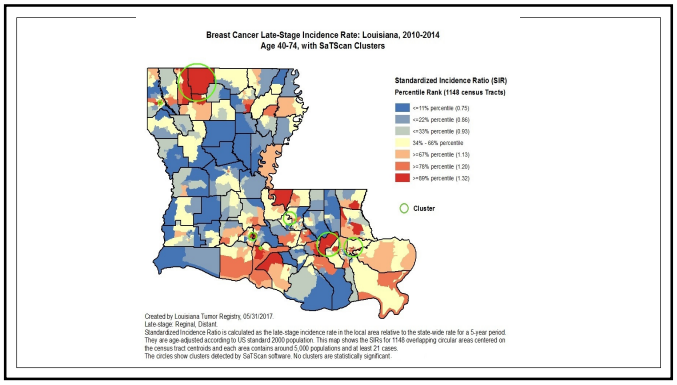
Remember the breast analysis that I said was altered by the results of address cleaning?

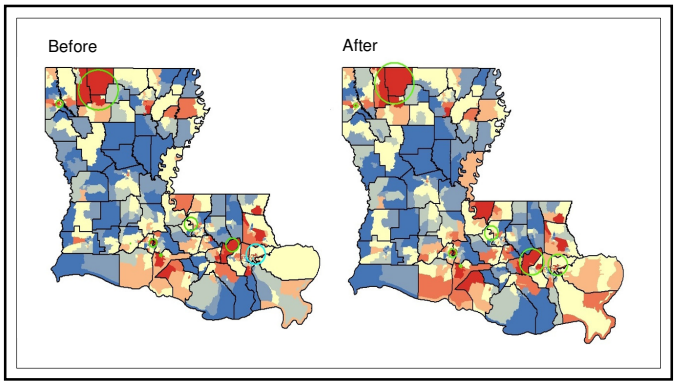

Breast Cancer Late-Stage Proportion: Louisiana, 2010-2014
Age 40-74, with SatScan Clusters
Standardized Proportion Ratio (SPR)
Percentile Rank (1148 census tracts)
<=11% percentile (0.78)
<=22% percentile (0.85)
<=33% percentile (0.90)
34% - 66% percentile
>=67% percentile (1.04)
>=78% percentile (1.11)
>=89% percentile (1.18)
Cluster
Statistically significant cluster
Created by Louisiana Tumor Registry, 05/01/2017.
Late Stage Proportion = (Regional + Distant) / (In Situ + Localized + Regional+ Distant + Unstaged)
Standardized Proportion Ratio is calculated as the late-stage proportion among diagnosed patients in the local area relative to the state-wide proportion for a 5-year period. They are age-adjusted according to US standard 2000 population. This map shows the SPRs for 1148 overlapping circular areas centered on the census tract centroids and each area contains around 100 cancer cases and at least 21 late-stage cases.
The circles show clusters detected by SaTScan software. Only blue circles are statistically significant at 0.05 level.


Breast Cancer Late-Stage Proportion: Louisiana, 2010-2014
Age 40-74, with SatScan Clusters
Standardized Proportion Ratio (SPR)
Percentile Rank (1148 census tracts)
<=11% percentile (0.77)
<=22% percentile (0.85)
<=33% percentile (0.90)
34% - 66% percentile
>=67% percentile (1.04)
>=78% percentile (1.10)
>=67% percentile (1.18)
Cluster
Statistically significant cluster
Created by Louisiana Tumor Registry, 05/31/2017.
Late Stage Proportion = (Regional + Distant) / (In Situ + Localized + Regional+ Distant + Unstaged)
Standardized Proportion Ratio is calculated as the late-stage proportion among diagnosed patients in the local area relative to the state-wide proportion for a 5-year period. They are age-adjusted according to US standard 2000 population. This map shows the SPRs for 1148 overlapping circular areas centered on the census tract centroids and each area contains around 100 cancer cases and at least 21 late-stage cases.
The circles show clusters detected by SaTScan software. Only blue circles are statistically significant at 0.1 level.


Before
After


Breast Cancer Late-Stage Incidence Rate: Louisiana, 2010-2014
Age 40-74, with SaTScan Clusters
Standardized Incidence Ratio (SIR)
Percentile Rank (1148 census Tracts)
<=11% percentile (0.75)
<=22% percentile (0.87)
<=33% percentile (0.94)
34% - 66% percentile
>=67% percentile (1.13)
>=78% percentile (1.21)
>=89% percentile (1.32)
Cluster
Statistically Significant Cluster
Created by Louisiana Tumor Registry, 05/03/2017.
Late-stage: Reginal, Distant
Standardized Incidence Ratio is calculated as the late-stage incidence rate in the local area relative to the state-wide rate for a 5-year period.
They are age-adjusted according to US standard 2000 population. This map shows the SIRs for 1148 overlapping circular areas centered on
the census tract centroids and each area contains around 5,000 populations and at least 21 cases.
The circles show clusters detected by SaTScan software. Only blue circles are statistically significant at 0.1 level.


Breast Cancer Late-Stage Incidence Rate: Louisiana, 2010-2014
Age 40-74, with SaTScan Clusters
Standardized Incidence Ratio (SIR)
Percentile Rank (1148 census Tracts)
<=11% percentile (0.75)
<=22% percentile (0.86)
<=33% percentile (0.93)
34% - 66% percentile
>=67% percentile (1.13)
>=78% percentile (1.20)
>=89% percentile (1.32)
Cluster
Created by Louisiana Tumor Registry, 05/31/2017.
Late-stage: Reginal, Distant
Standardized Incidence Ratio is calculated as the late-stage incidence rate in the local area relative to the state-wide rate for a 5-year period.
They are age-adjusted according to US standard 2000 population. This map shows the SIRs for 1148 overlapping circular areas centered on
the census tract centroids and each area contains around 5,000 populations and at least 21 cases.
The circles show clusters detected by SaTScan software. No clusters are statistically significant.


Before
After

Implementation

- We are currently working with the LCCRT to implement these maps. Given that the LCCRT is an unfunded mandate of the state legislature, much of the implementation focuses on provider education.
- Compose written interpretations of these maps to prevent misunderstanding when they are distributed.
- Share these maps with providers: How is your area performing? How are you promoting colorectal cancer screening in your practice?
  - Via Louisiana Family Doctor, the Official Publication of the Louisiana Academy of Family Physicians

Acknowledgements

- Lauren Maniscalco, MPH, LTR Registry Liaison
- Yong Yi, PhD, MS, LTR Data Manager
- Kevin Henry, PhD, MA, Associate Professor at Temple University
- David Stinchcomb, PhD, Westat

THANK YOU!

Questions?