Understanding the Opioid Crisis in a surgical setting in Iowa through Data

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Background: The Opioid Epidemic

- Opioid deaths rising since the 1990's
- Opioid overdose surpasses motor vehicle accident as leading cause of death in United States
 - ~115 deaths/day due to opioid overdose in US [3]
- \$78.5 billion dollars/year economic burden [3]
- In Iowa:
 - Concern in both urban and rural areas
 - Prescription opioid deaths account for majority of opioidrelated deaths [2]
 - Prescription opioid deaths have quadrupled in past 20 years [2]

Background: Morphine Milligram Equivalents (MME)

- Compares different prescription opioid types to a standardized morphine equivalent
- Total or MME per day
- MME per day can range anywhere from around 20 MME/day to >200 MME/day
- Higher dose does not show greater benefits than lower doses [4]
- Doses at or above 50 MME/day increase risk of overdose by at least twice that of 20 MME/day dose [4]

What are the spatial patterns of high dosage prescriptions following surgeries in the state of lowa?

Data

- De-identified medical insurance claims from large, private insurer: 2003-2016
- Variables of interest:
 - MME/day and MME total prescribed
 - Category of surgery
 - Member city
 - Socioeconomic variables
 - Population size, sex, age, income

Data Cleaning

Started with >272 million claims

• Surgeries, prescriptions, inpatient, etc.

Cleaning:

- People who live in Iowa
- Use surgical codes (ICD-9 & CPT) to categorize surgeries into 12 groups (by collaborators)
- Prescription claims filled in a 30 day window following a surgery
- Fix city misspellings and take out claims for which no city is specified in order to plot longitude and latitude
- Biologically plausible MME (<1000)

Final: 72,481 observations (persons)



Location Map

- Dots represent 1 unique observation
- Added random noise
 - N(0, 0.01*SD)
- Spread all over Iowa

Methods: Bayesian Kriging

Geostatistical interpolation method on a continuous surface

Interpolated values modeled using Gaussian process

Gives prediction based on a weighted average with neighboring spatial observations

 Based on normal distribution model with spatial covariance structure.

Gives a spatial pattern of statistics

Mean or standard deviation

Fit via INLA (R package):

- Integrated nested Laplace approximation
- Alternative approach to Bayesian MCMC method of inference
 - Fast and accurate for certain models
 - Latent Gaussian Models (unobserved)
- Adjusts for demographics/socioeconomic covariates

Results: Surgery category differences

Catg	mean	median	sd
Thoracic	74.04526	66.66667	62.98084
Breast	71.99395	50.00000	64.66078
Gynecol	71.53206	50.00000	60.39886
Neuro	68.30666	60.00000	46.05430
Urology	67.69006	50.00000	56.58744
Cardiac	64.80163	60.00000	40.56894
Vascular	62.68947	46.87500	59.49588
Endocrine	62.35229	50.00000	49.67786
General	59.65282	46.87500	50.72415
Obstetrics	58.38783	50.00000	42.79412
Opthal	51.72996	37.50000	50.59101
Otolar	35.03598	25.00000	33.89418

Average MME Per Day by Surgery Category



Results: Surgery category differences



Square Root MME per day total

T test results

T-test comparing MME per day rates

- Benjamini Hochberg Yekutieli procedure to controls the FDR at 0.05
 - Does not assume independence
 - If difference between one pair of surgeries then likely different pairs of surgeries
- *Asterisk represents adjusted p-value < 0.05

T test for surgical types (p-values)

	Breast	Cardiac	Endocrine	General	Gynecol	Neuro	Obstetrics	Opthal	Otolar	Thoracic	Urology	Vascular
Breast		٠	*	*			*	*	*		*	*
Cardiac	*			*	*		*	*	*	*		
Endocrine	*				*	*		*	*	*	*	
General	*	*			*	*		*	*	*	*	
Gynecol		٠	*	*		*	*	*	*		*	*
Neuro			*	*	*		*	*	*			*
Obstetrics	*	٠			*	*		*	*	*	*	*
Opthal	*	٠	*	*	*	*	*		*	*	*	*
Otolar	*	٠	*	*	*	*	*	*		*	*	*
Thoracic		٠	*	*			*	*	*			*
Jrology	*		*	*	*		*	*	*			*
/ascular	•				*	*	*	*	*	*	*	

Results: Interpolated Intensity Surface

INTERPOLATED MME PER DAY

UNADJUSTED AND ADJUSTING FOR POPULATION SIZE, INCOME, AGE, AND SEX

Unadjusted Intensity Surface





Thoracic Surgery

SAMPLE SIZE = 396

Unadjusted Intensity Surface



General Surgery

SAMPLE SIZE = 24,590



Total MME Maps

POSSIBLY DUE TO MISSING DISTANCE COVARIATE

Conclusion/ Limitations

Conclusions:

- Spatial variability in MME/day is attributed to covariates
- There still exists variability in total MME that is not explained by covariates

Limitations:

Not randomized

Only PrivateInsurance

- Representative?
 - Private insurer
 - No medicare/medicaid
 - SES and older population

Member location used

- Physician location may answer a different question
- Future: adjust for distance between member and provider

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References

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Unadjusted Intensity Surface



Otolaryngology Surgery

SAMPLE SIZE = 19,279



Unadjusted Intensity Surface



Breast Surgery

SAMPLE SIZE = 1,661







Gynocology Surgery

SAMPLE SIZE = 4,204