Spatial distribution of opioid overdoses, as represented by EMS naloxone use

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Background

- opioids, heroin, and overdose
- naloxone and its utility as an indicator of opioid overdose
- the Susquehanna Emergency Medical Services Region (SREMS)
- the SREMS electronic patient care report (ePCR) database

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- Areal or lattice data versus point pattern data
- Research question: does the spatial point pattern of EMS calls involving naloxone administration demonstrate aggregation or clustering, over and above the aggregation to be expected of EMS calls in general?
- This was a study of clustering, not a search for clusters

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- Assessment strategies
  - G function: nearest-neighbor distances
  - F function: empty-space distances
  - K and L functions: number of events within distance r of an event
  - others

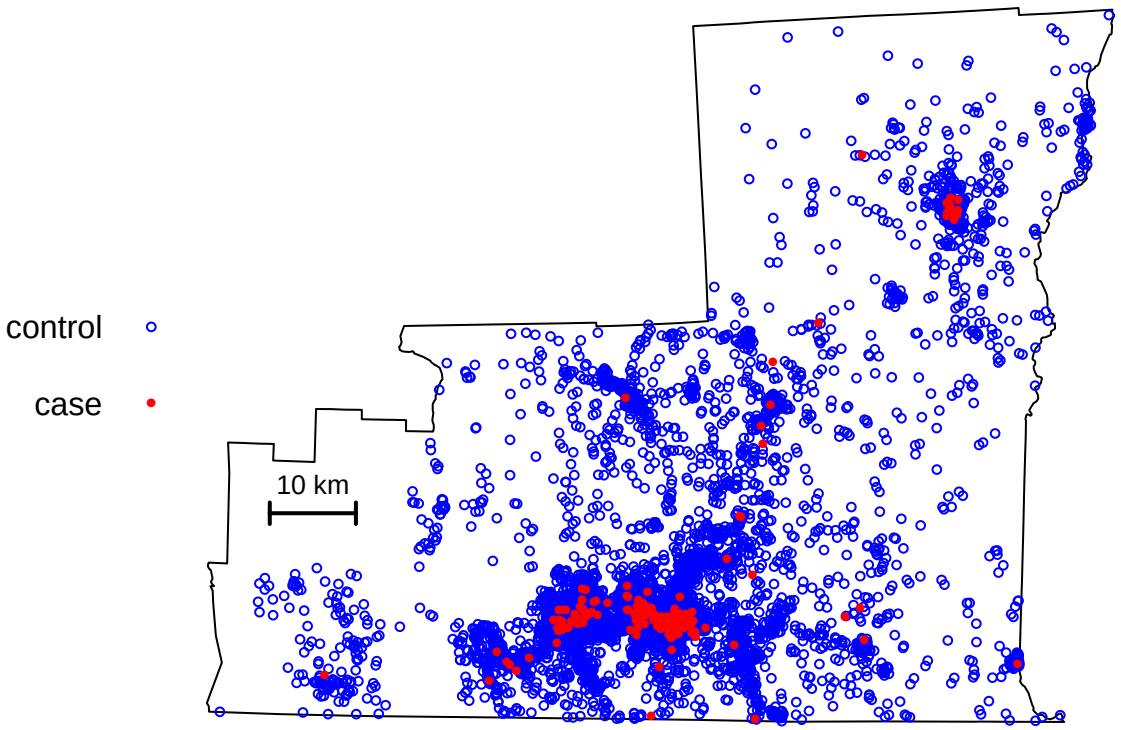
Methods

- 63 EMS agencies were invited to participate
  - agencies with fewer than 50 total calls during the study period were excluded
  - 13 agencies participated, including all the largest and most active
- study period: 9 September 2012 to 9 February 2014
- incident locations were geocoded in ArcGIS 10.3
  - TIGERline street address files for the three counties
  - county boundaries shapefile from CUGIR
  - projected in UTM 18 N with NAD 1983, distances in meters
  - match accuracy set at 79%, with no further manual matching
  - duplicate locations eliminated
- statistical analysis done in `R` with `spatstat` package

Summary description of the analytical dataset

	cases	controls	sum
matched	198	34571	34769
tied	4	1449	1453
unmatched	45	8671	8716
unique matched	183	10643	10826

Approximate non-duplicated locations of EMS calls



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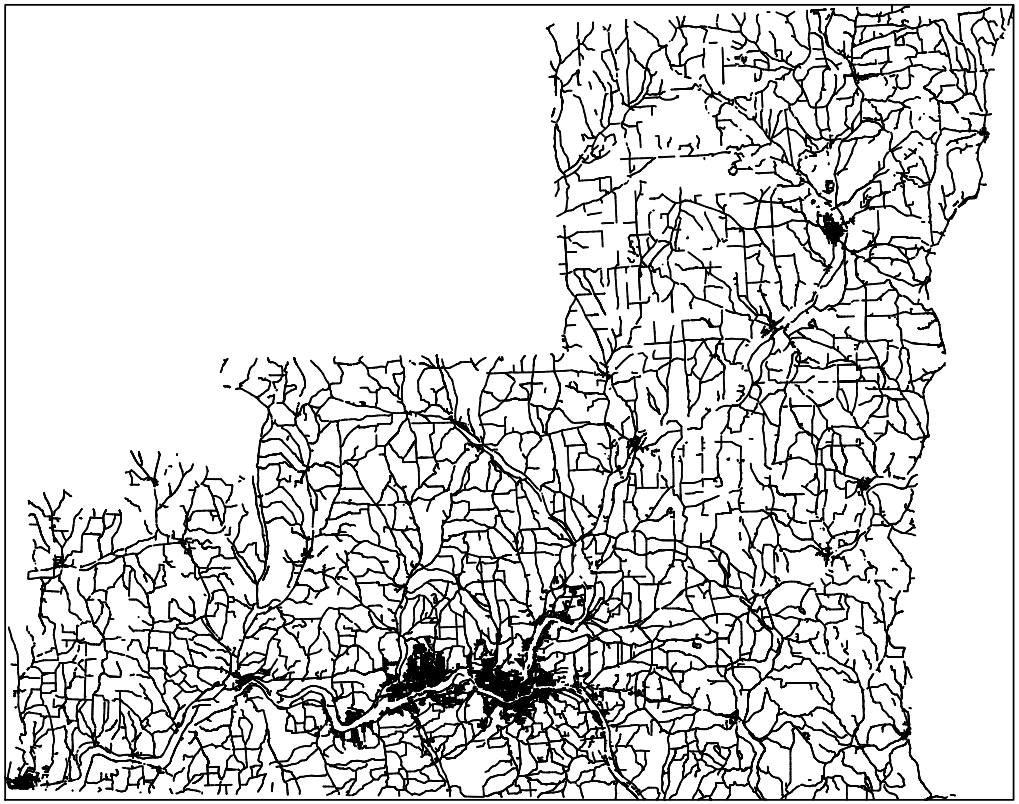

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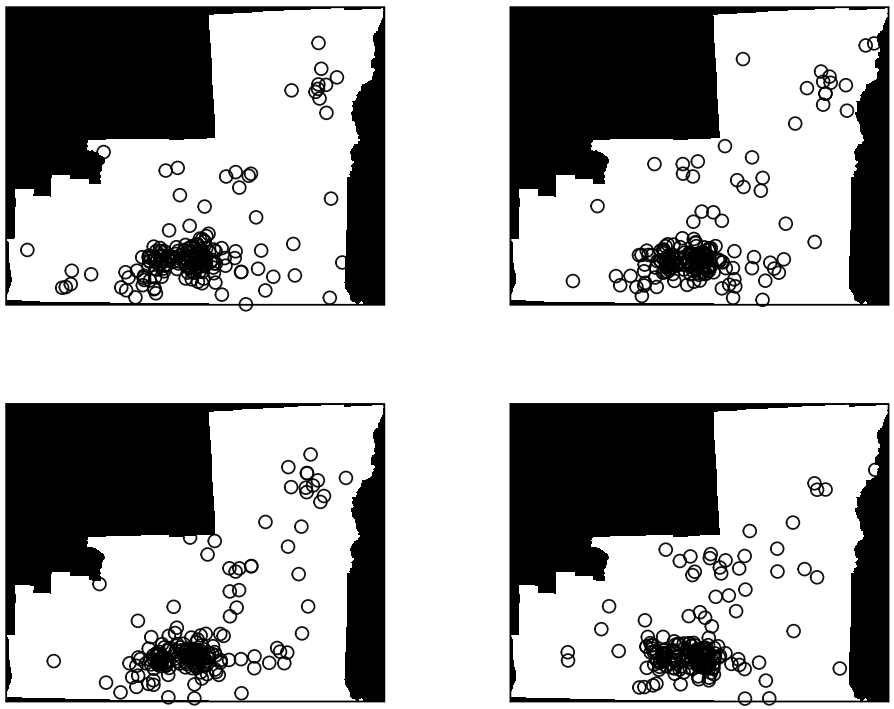

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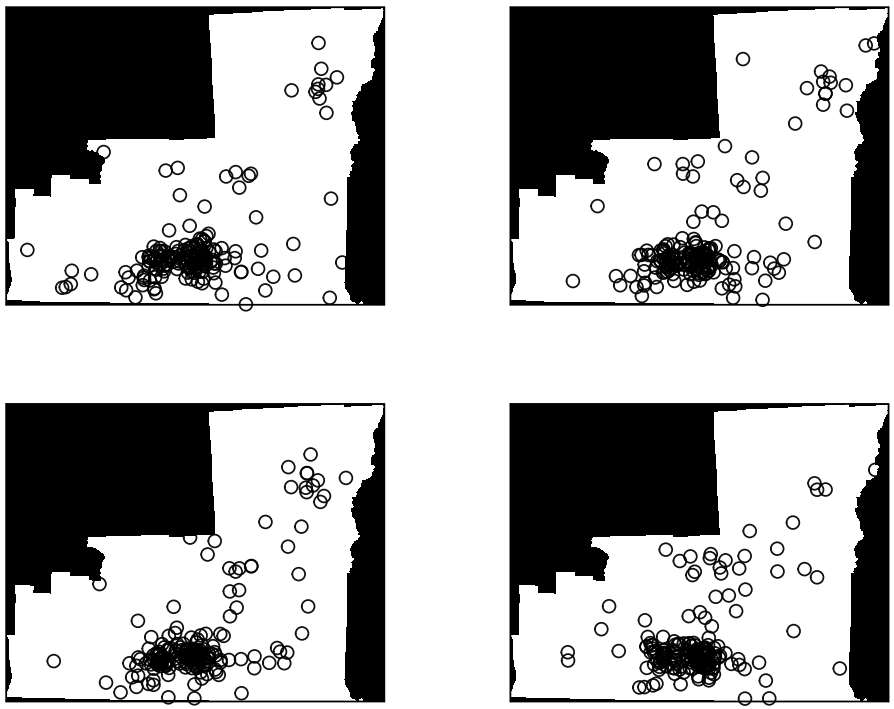

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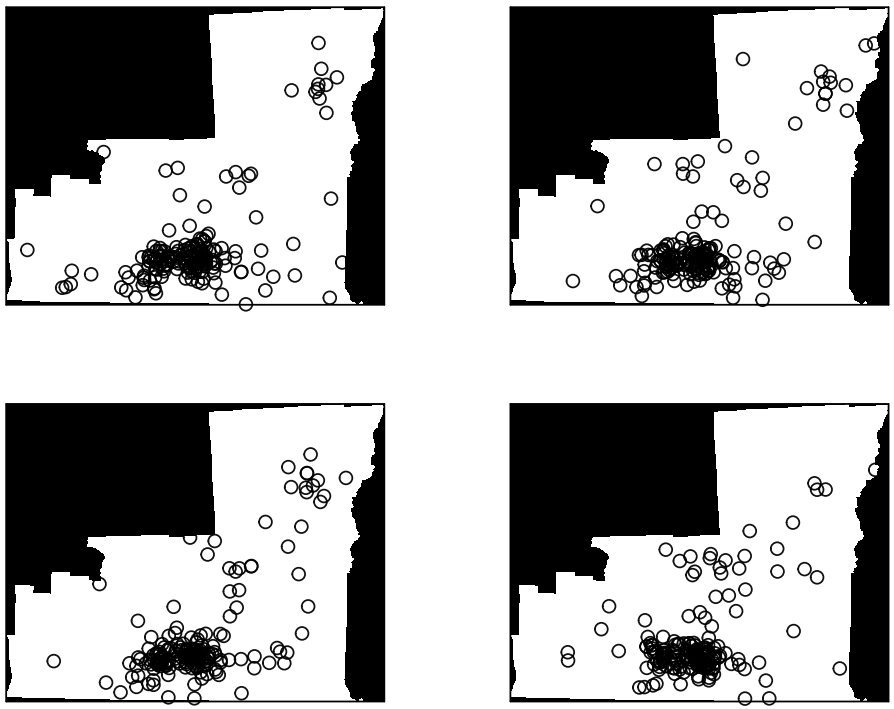
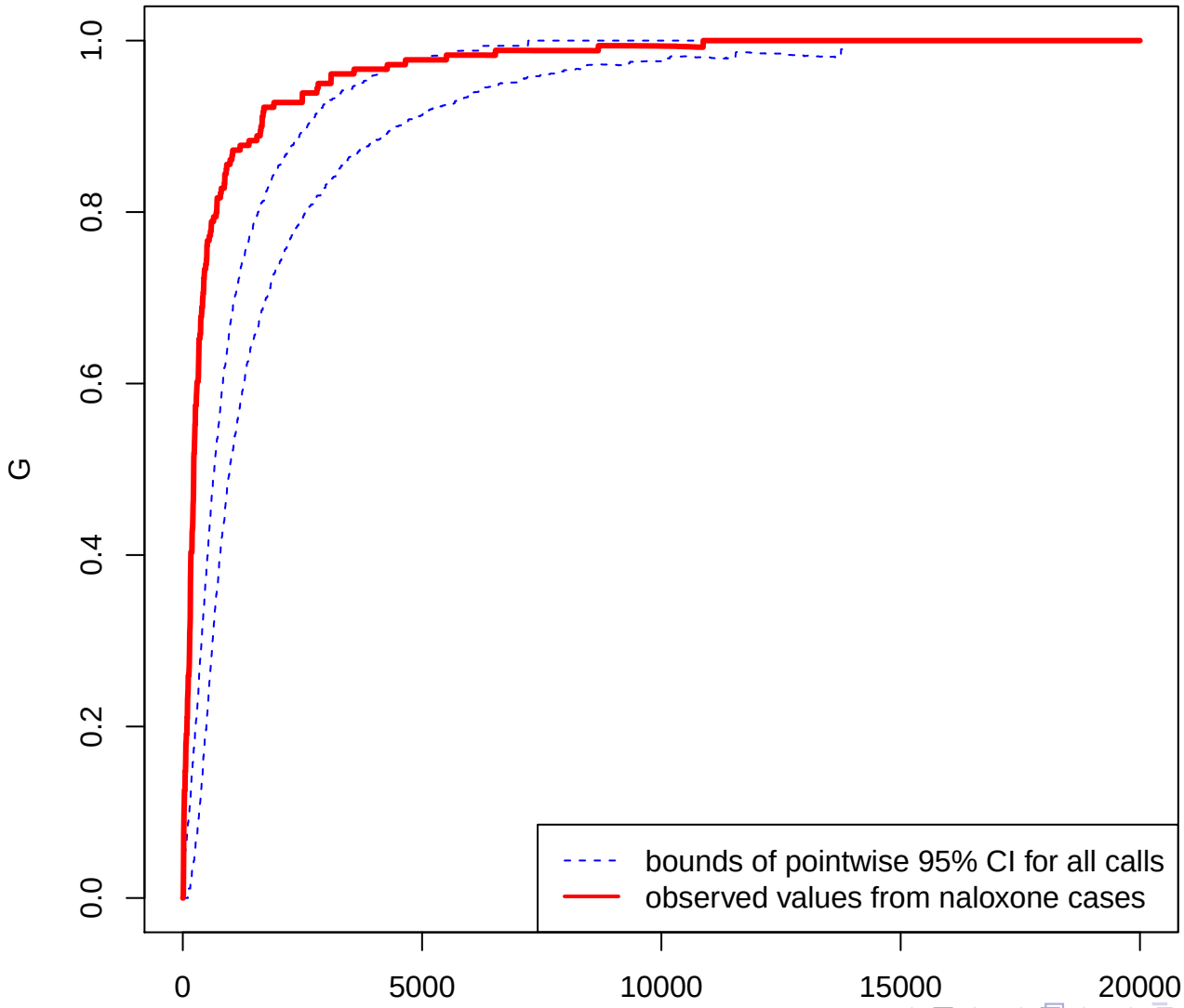
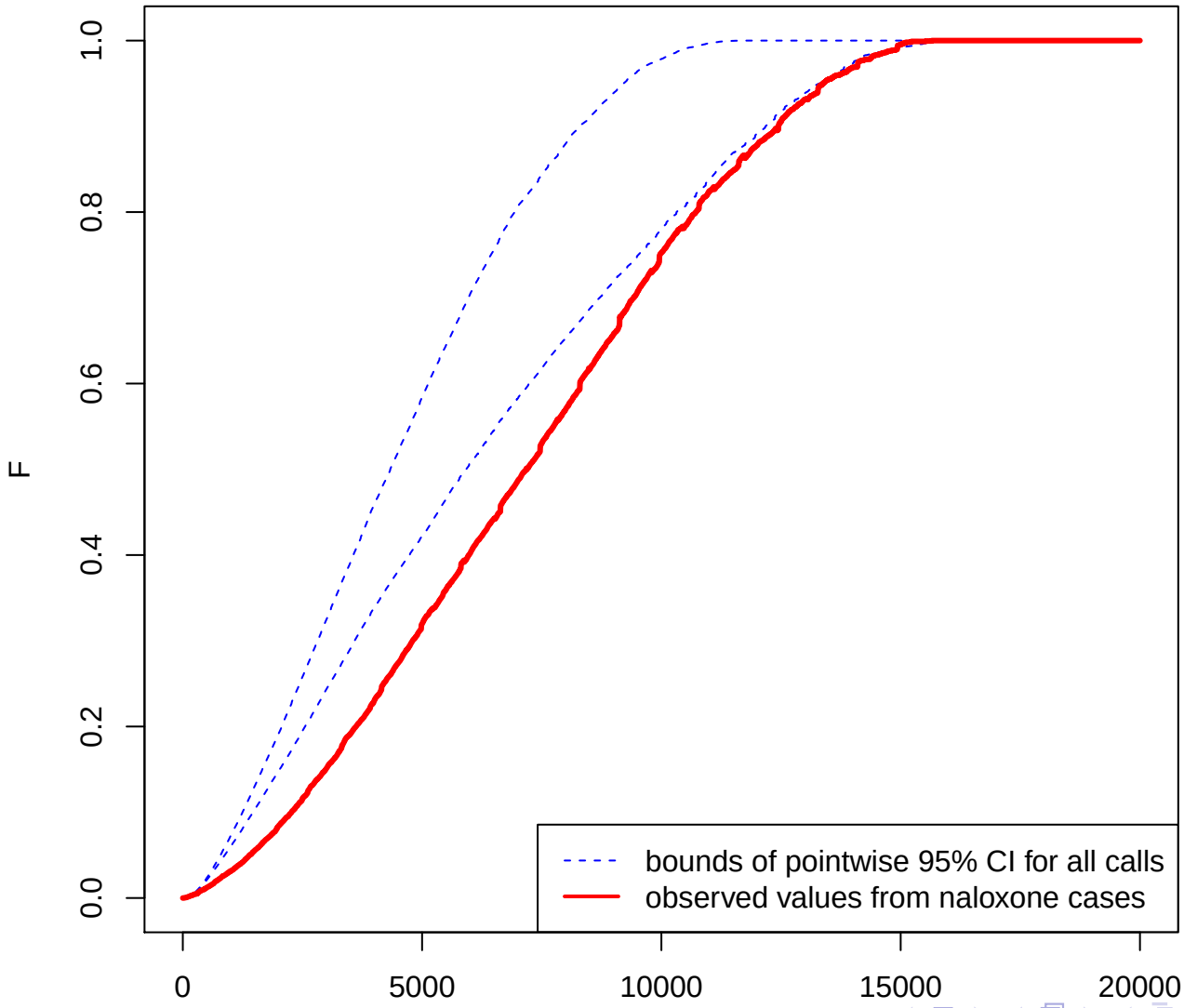
- the 500 replications of each test statistic (function) served as its null sampling distribution



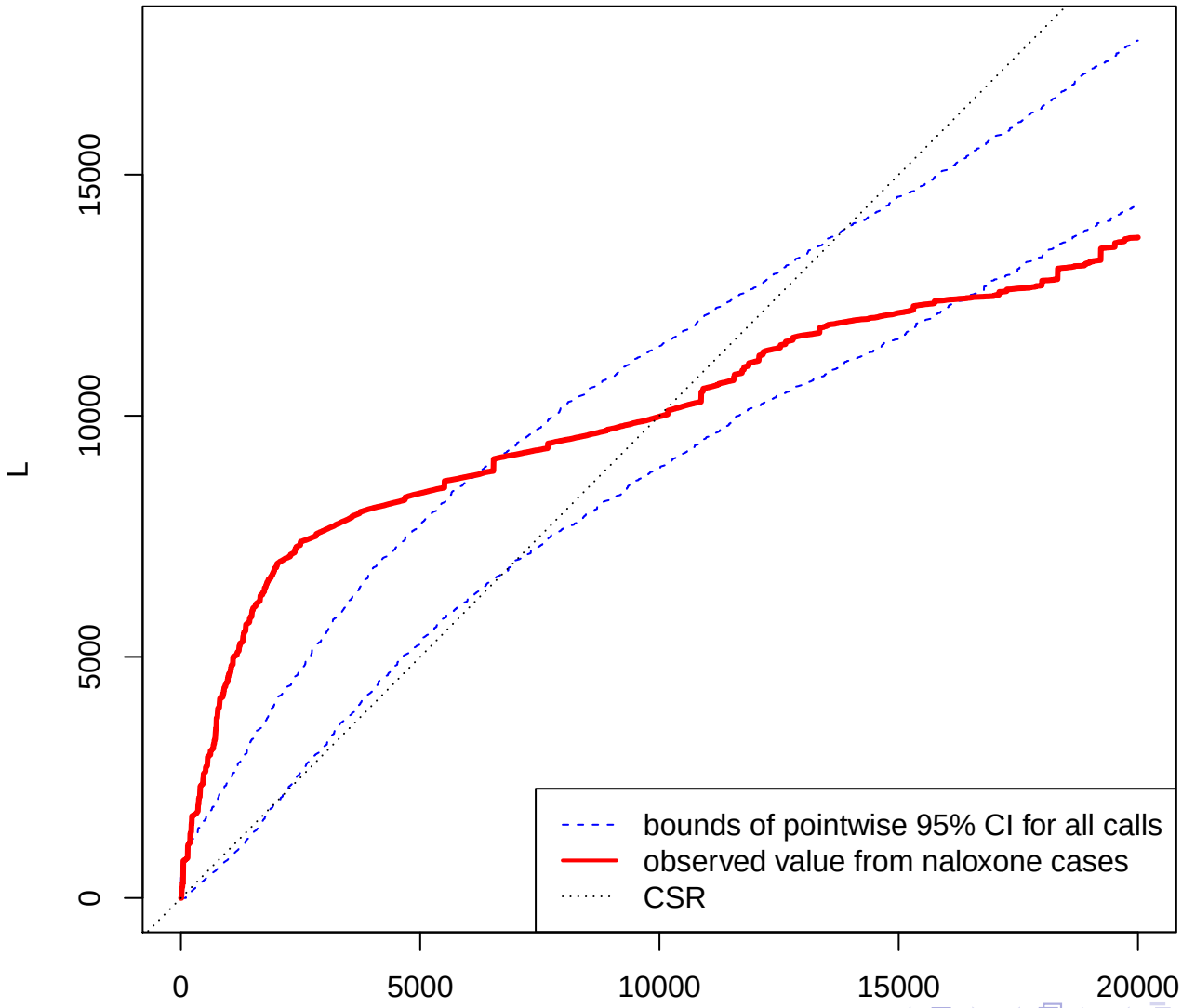
Results: nearest neighbor distance



Results: empty space function



Results: L function from inhomogeneous K function



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  - naloxone EMS calls appear more highly clustered than expected if they were merely a random sample of all call locations
- Limitations
  - Naloxone administration is a useful but imperfect indicator of opioid overdose
  - Participation by EMS agencies was not universal
  - Duplicate locations
  - Geocoding was imperfect and incomplete
  - The point patterns were highly inhomogeneous

Further questions

- If indeed the naloxone cases are spatially aggregated—why?
- What is the pattern-generating spatial process?
  - first-order versus second-order phenomena
  - likely both
- What are the predictors of a naloxone occurrence in a particular location?
- What is the spatial relationship between incident location and home location?

Acknowledgements

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