Behind the Cascade: Analyzing Spatial Patterns Along the HIV Care Continuum

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Disclosures

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Background

- **The HIV care continuum is an effective framework for improving the health of people living with HIV**

- **Limited data exist on how geographic factors impact access to care, retention in care, ARV treatment and suppression of viral load.**

- **Geographic information system (GIS) technology**
  - **allows for mapping and geographic analyses**
  - **able to identify geographic foci or hot spots of disease**
  - **has been effectively used to map the burden of tuberculosis, syphilis, and HIV infection in communities**

- **Spatial analysis may be useful for monitoring HIV care by identifying geographic areas with poor outcomes**

Objective

- **Using GIS analytic strategies, we sought to identify areas associated with:**

  - not linking to care

  - not linking to care within 90 days

  - not retaining in care

  - not achieving viral suppression after HIV diagnosis

Data Source and Study Population

Philadelphia's Enhanced HIV/AIDS Reporting System (eHARS)

- **Name-based case reporting of all new HIV infections in the City**
- **Reporting of all CD4 <350 cell/mm3 and all HIV RNA results**
- **Medical record abstraction for all patients linked to care**
- **All laboratory results are assigned a unique identifier**

All adults (≥18 years old) with a new HIV diagnosis (+ Western blot) with a Philadelphia address at the time of diagnosis between 2008 and 2009; follow-up through 2011

Persons with an invalid address or with a prison address at the time of their diagnosis were excluded

Outcomes

Linkage to Care
- Defined as documentation of >1 CD4 or viral load test results after the diagnosis

Linkage to Care in 90 days
- Defined as documentation of >1 CD4 or viral load test results within 90 days of HIV diagnosis

Retention in Care
- Defined by NQF Medical Visit Frequency Measure
- Completing at least 1 medical visit with a provider with prescribing privileges in each 6-month interval of the 24-month measurement period, with a minimum of 60 days between medical visits.
  - Date of first linkage defined the start of the 24 month measurement period.
  - We used CD4 and/or viral load as a proxy for HIV medical care visits

Viral Suppression
- Defined as evidence of HIV-1 RNA <200 copies closest to the end of the 24 month measurement period

Variables of Interest

Predictors (at time of diagnosis): age, sex at birth race/ethnicity, HIV transmission risk, insurance status at the time of diagnosis, incarceration, multiple care providers, distance to nearest HIV medical care site

Spatial Analyses – K functions
- Analyze a spatial point process
- Multiple distance scales
    - e.g. clustered at small distances yet dispersed at large distances
- Complete spatial randomness (CSR)
- Utilizes all points in a given area
- Compare to multiple simulated random processes

Dot Density Map of New HIV Diagnoses,

Philadelphia, PA 2008-2009

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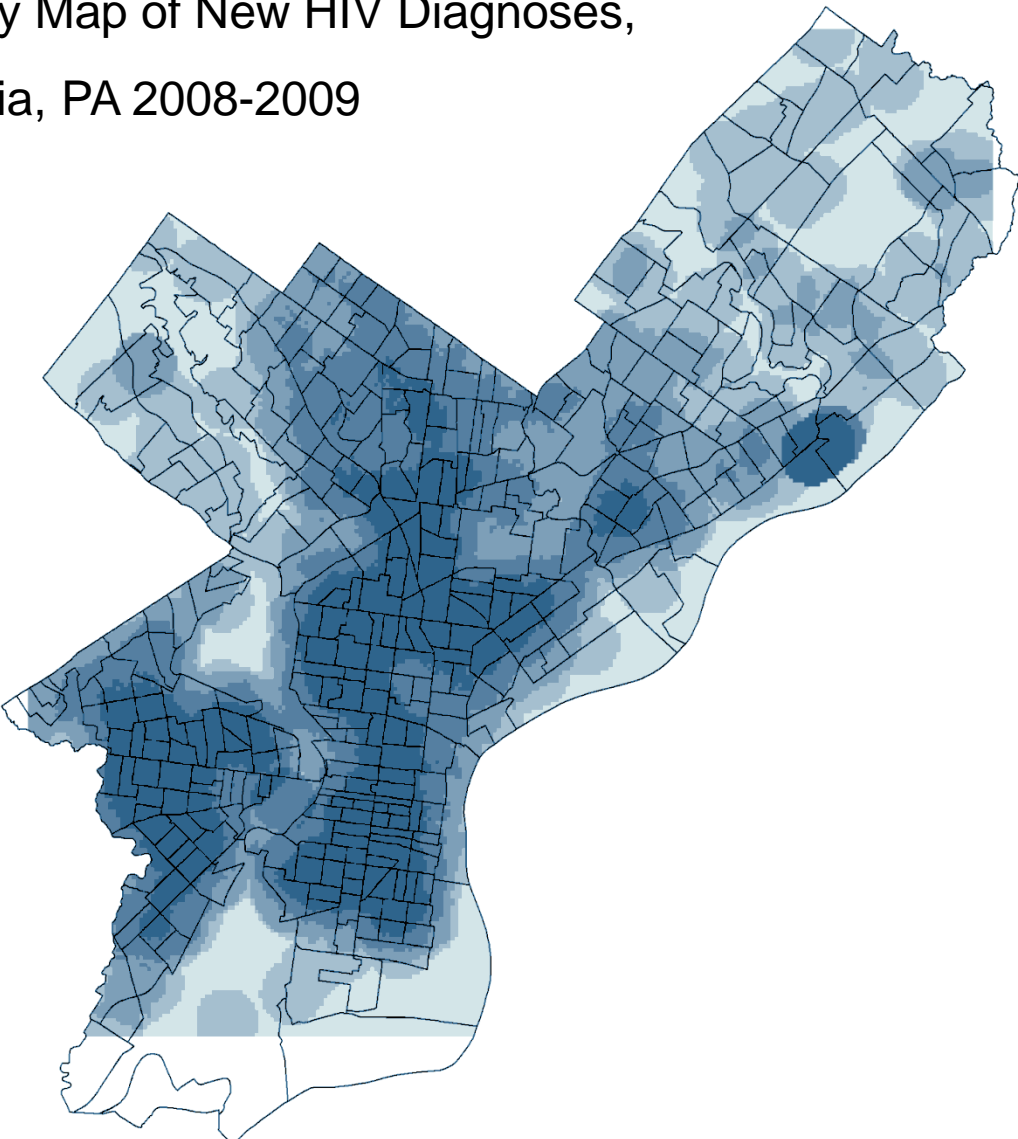
Cross-K functions

- Analyze marked spatial point process
  - 2 patterns within 1 population
- Multiple distance scales
  - e.g. clustered at small distances yet dispersed at large distances
- Spatial Indistinguishability Hypothesis
- Compares distribution of pop 1 to that of pop1+pop2

Radial Distances

- Determined by research
- Average nearest neighbor
- Direct observation
- Some combination
- Average of 5 nn distances for each cases
  - Mean = 990 (1000)
  - Max nn dist for 99% cases 5000 ft
  - 2500 for 3rd distance

Local Cross K function

- P value calculated for each point in marked pattern 1
- Exact because all points are known, and no simulation is required
- P-values imported to ArcMAP, plotted at x,y coordinates and spline interpolated to raster surface

Analyses

**Univariate statistics** were used to describe the dataset.

Multivariable logistic regression was used to assess relationships between predictors and outcomes.
- Models were adjusted for age, sex at birth, race/ethnicity, HIV transmission risk, and insurance status at the time of diagnosis, as well as incarceration status, visits to multiple care sites, and proximity to nearest HIV medical provider
- Geographic hotspots were included in the final model
- Persons were considered to be within a hotspot if the calculated distance was <5,000 feet
- Persons were assigned as residing inside or outside of the hot spot for each of the four outcomes
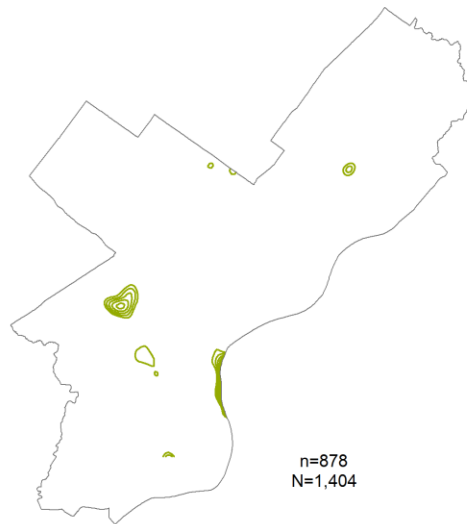
Geographic Pattern Analysis of HIV Medical Care Engagement,
2008-2009 Diagnoses (excluding prison cases), Philadelphia, PA

n=313
N=1,716
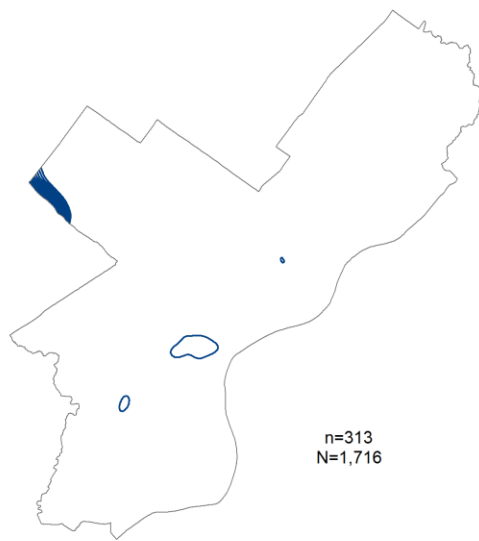
A1. Persons Not Linked to Care

n=345
N=1,404
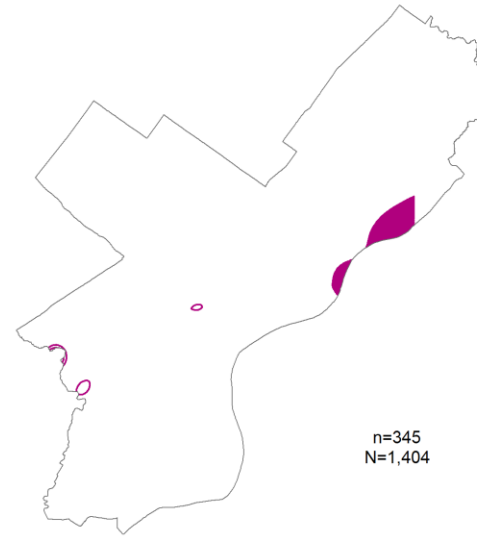
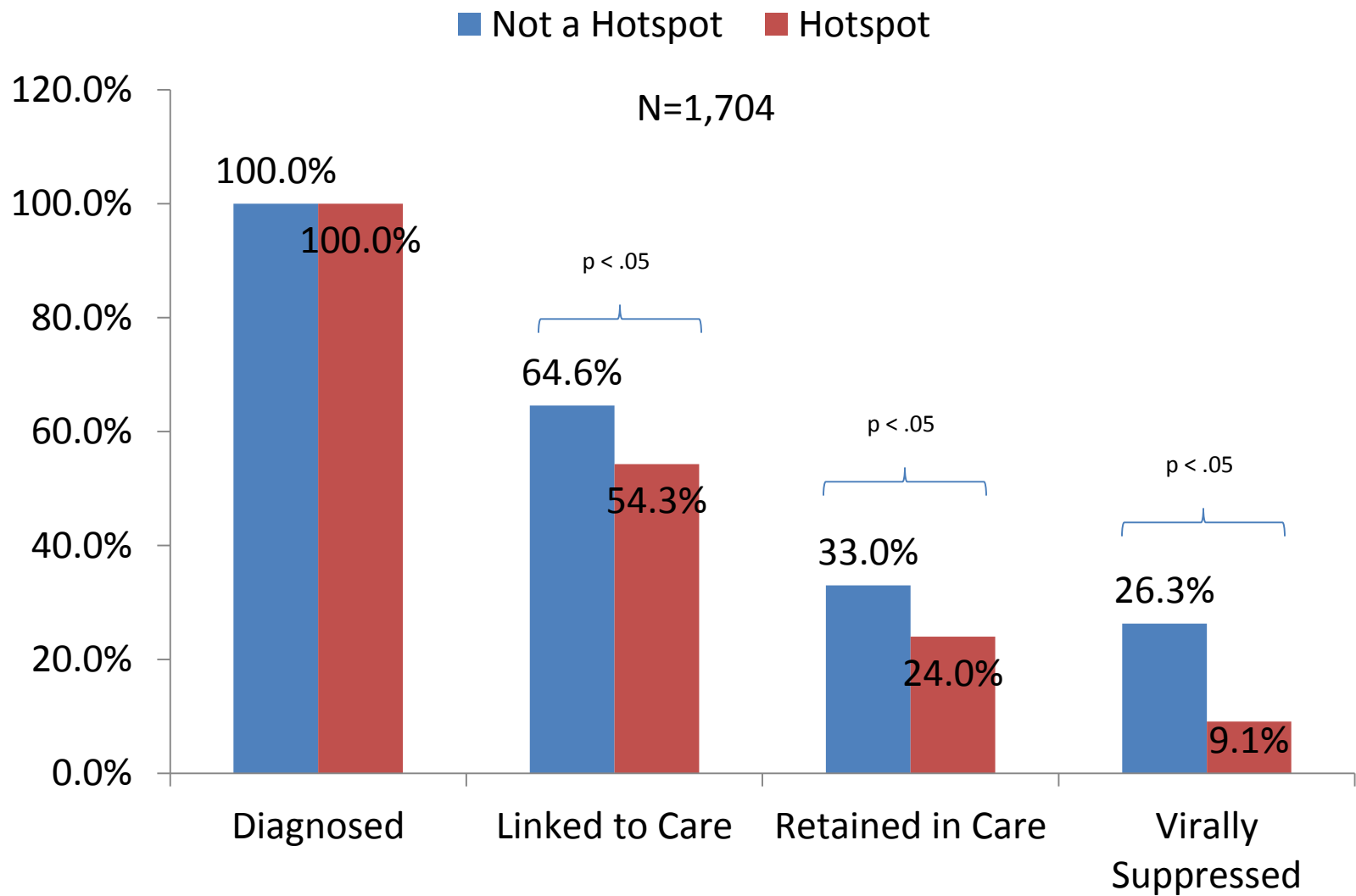A2. Persons Not Linked to Care w/in 90 Days

n=878
N=1,404

A3. Persons Not Retained in Care

n=147
N=526
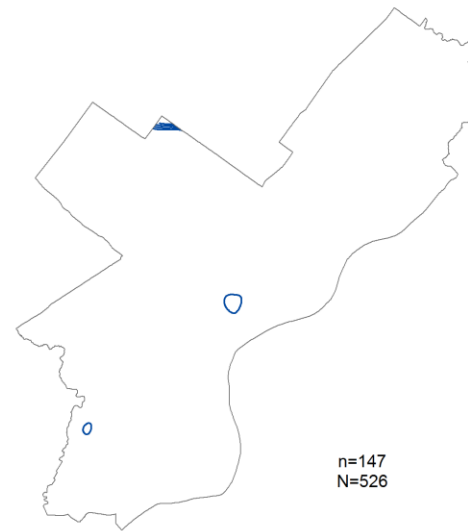
A4. Persons Not Virally Suppressed

HIV CARE CONTINUUM BY RESIDENCE IN GEOGRAPHIC HOTSPOTS

Sample Characteristics,

Characteristics	Included N=1,704 (%)	Excluded N=157 (%)	P value

Sample Characteristics

Characteristics	Included N=1,704 (%)	Excluded N=157 (%)	P value
Age (years)			0.03
<25	398 (23%)	24 (15%)	
25-44	797 (47%)	71 (45%)	
45+	509 (29.9%)	59 (38%)	
Unknown	0 (0.0%)	3 (2%)	
Sex			0.24
Female	509 (30%)	39 (25%)	
Male	1,195 (70%)	115 (73%)	
Unknown	0 (0.0%)	3 (2%)	
Race/ethnicity			0.07
White	258 (15%)	31 (20%)	
Black	1,078 (63%)	81 (52%)	
Hispanic	293 (17%)	11 (7%)	
Other/unknown	75 (5%)	34 (21%)	

Sample Characteristics

Characteristics	Included N=1,704 (%)	Excluded N=157 (%)	P value
HIV Risk			<0.0001
Heterosexual	683 (40%)	45 (29%)	
MSM	619 (36%)	51 (32%)	
IDU	175 (10%)	35 (22%)	
Other/NIR	227 (4%)	26 (17%)	
Insurance			<0.0001
Private	338 (20%)	19 (12%)	
Medicaid	487 (28%)	26 (16%)	
Medicare	169 (10%)	20 (13%)	
Uninsured	285 (17%)	26 (16%)	
Other/unknown	425 (25%)	66 (42%)	

Sample Characteristics

Characteristics	Included N=1,704 (%)	Excluded N=157 (%)	P value
Prison Stay			<0.0001
No	1,606 (94%)	19 (12%)	
Yes	98 (6%)	150 (32%)	
Proximity to Care*			
No	742 (44%)	N/A	
Yes	962 (56%)		

*Proximity to care indicates < average distance to nearest care site

Factors Associated with Failure to Link and Link Timely

Characteristics	Not Linked AOR (95% CI)	Not Linked <90 Days AOR (95% CI)
Sex		
Female	1 [Reference]	1 [Reference]
Male	1.46 (1.05-2.02)	1.04 (0.75-1.44)
Race/Ethnicity		
White	1 [Reference]	1 [Reference]
Black	2.12 (1.37-1.61)	1.08 (0.74-1.58)
Hispanic	0.93 (0.54-1.61)	1.03 (0.66-1.60)
Other/Unknown	2.00 (0.97-4.12)	1.43 (0.74-2.75)
HIV Risk Factor		
HET	1 [Reference]	1 [Reference]
MSM	0.58 (0.40-0.84)	0.85 (0.59-1.21)
IDU	2.20 (1.42-3.41)	0.95 (0.59-1.52)
Other/NIR	1.44 (0.98-2.13)	0.74 (0.49-1.12)
Insurance		
Private	1 [Reference]	1 [Reference]
Medicaid	1.08 (0.68-1.69)	1.45 (0.98-2.13)
Medicare	2.15 (1.26-3.66)	0.94 (0.54-1.64)
Uninsured	1.88 (1.18-3.01)	1.79 (1.18-2.73)
Other/unknown	2.47 (1.61-3.79)	2.17 (1.47-3.19)
Geographic Area		
No	1 [Reference]	1 [Reference]
Yes	1.76 (1.30-2.40)	1.49 (1.12-1.99)

Factors Associated with Failure to Be Retained and Virally Suppressed

Characteristics	Not Linked AOR (95% CI)	Not Linked <90 Days AOR (95% CI)
Age at Diagnosis		
45+	1 [Reference]	1 [Reference]
25-44	1.11 (0.85-1.45)1.81	1.36 (0.84-2.21)
<25	(1.29-2.53)	1.45 (0.78-2.71)
Race/Ethnicity		
White	1 [Reference]	1 [Reference]
Black	1.76 (1.26-2.44)	0.96 (0.55-1.67)
Hispanic	1.92 (1.30-2.85)	0.97 (0.49-1.94)
Other/Unknown	1.87 (1.00-3.49)	1.88 (0.66-5.32)
Proximity to Care		
No	1 [Reference]	1 [Reference]
Yes	1.18 (0.94-1.49	0.63 (0.42-0.95)
Multiple Care Sites		
No	1 [Reference]	1 [Reference]
Yes	0.47 (0.37-0.60)	0.99 (0.64-1.52)
Geographic Area		
No	1 [Reference]	1 [Reference]
Yes	1.84 (1.39-2.43)	3.23 (1.87-5.59)

Multivariate Regression Models for Involvement in Continuum of Care

Characteristic	Not Linked to Care	Not Linked <90 Days	Not Retained in Care	Not Virally Suppressed
Age at Dx			<25	
Sex at birth	Male			
Race/ ethnicity	Black		Black Hispanic	
Risk Group	IDU			
Insurance	Medicare Uninsured	Uninsured		
Geographic Area	Yes	Yes	Yes	Yes
Prison stay				
Proximity to care				Yes
Multiple care sites			Yes	

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Summary

- Geographic clustering was independently associated with poor outcomes at each step along the HIV Care Continuum

- Geographic clusters identified were unique with no geographic overlap between steps in the Continuum

- Geographic clusters identified have a greater burden of HIV disease compared to other neighborhoods

- Proximity to HIV medical care was not associated with linkage to care, linkage in <90 days or retention in care

Conclusions

- Community factors related to poverty and community socioeconomic status may impact HIV treatment outcomes for individuals in living in geographic clusters
- We hypothesize:
  - Community norms and social disorder may have a greater effect on linkage to care;
  - Access to public transportation and social services may have a greater effect on retention in care;
  - And access to pharmacies may have a greater effect on viral suppression.
- Differences in community factors that influence each step of the cascade may explain the lack of overlap in hot spots.

Limitations

1. Statistical differences in demographic characteristics for age, mode of transmission and insurance status between those in the cohort and those excluded

2. Excluded persons diagnosed in the jail

3. Use of routine HIV surveillance laboratory data to define outcomes, may underestimate linkage and retention if labs were not ordered at every visit and/or if underreporting of labs occurred

4. Unable to account for outmigration, may underestimate outcomes

5. Did not assess the impact of density of general medical facilities, hospitals and pharmacies, access to public transportation, social services and housing stability

Implications & Future Studies

- **Better understanding of the characteristics of places that influence access to HIV medical care and treatment outcomes—mixed methods strategies**
- **Consistent with CDC's High Impact Prevention program, identification of geographic clusters could help to specifically target separate linkage, retention, and adherence interventions in the areas identified with the greatest need**
  - **Philadelphia's CDC CoRECT application – selected medical providers in the geographic cluster identified for retention**
- **Develop new strategies for intervention based upon ecological factors of the distinct clusters**

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