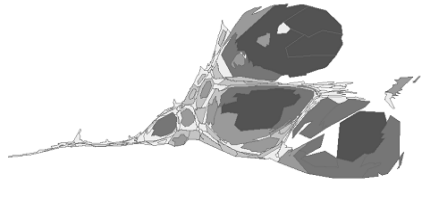


Introduction to GIS & Public Health

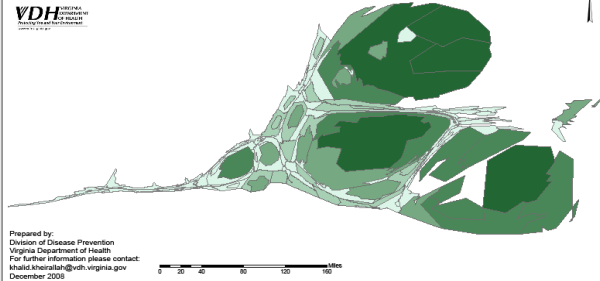
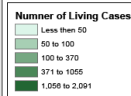


Jeff Stover
Director, Health Informatics & Integrated Surveillance Systems
Division of Disease Prevention
Virginia Department of Health

EPID-600
September 14, 2009



Virginia Counties sized by the Number of People Living with HIV/AIDS. Data as of December 2007.



Prepared by:
Division of Disease Prevention
Virginia Department of Health
For further information please contact:
Haidi Shen at haidi@vdh.virginia.gov
December 2008

Overview

- GIS defined
- The geographic foundation for PH
- Public Health GIS history and use
 - visualization
- Geocoding & Data Management
- GIS & Privacy

What is GIS?

A geographic information system is an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes.¹

A computer-assisted system for the capture, storage, retrieval, analysis and display of spatial data.²

Computer-based systems for integrating and analyzing geographic data.³

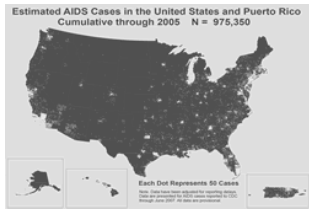
1 A to Z GIS. ESRI Press.
2 Clarke, 1986, p. 175
3 Cromeey and McCallery, 2002

"[GIS] requires rethinking and reorganizing the way that data are collected, used and displayed."

Clarke et al. On Epidemiology and Geographic Information Systems: A Review and Discussion of Future Directions. Emerging Infectious Diseases. Vol 2, No 2, April-June 1996

The Geographic Foundation for Public Health

- Answers the basic question... "where?"
 - Where do people live?
 - Where are the agents of disease or specific health-related events?
 - Where can we intervene to eliminate/reduce risks or to improve health service delivery?
- People and the factors that cause disease are dispersed, often unevenly, across communities and regions.

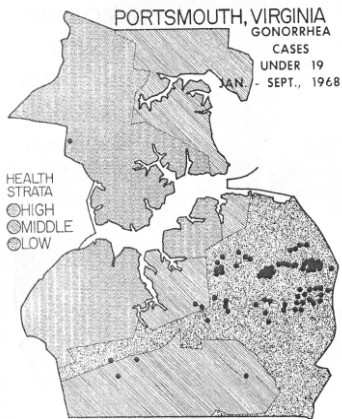


• <http://www.cdc.gov/hiv/topics/surveillance/resources/slides/dot/slides/AIDSmaps.ppt>

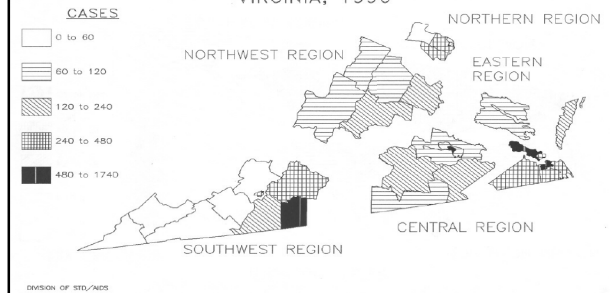
GIS at VDH

- Beginnings
 - 1970's
 - Internal reports
- Late 1990's
 - ODW
- OASIS
 - HIV/STD
- Office of Epidemiology
 - Fish advisories
 - Environmental Epi
- Enterprise GIS
 - EP&R
- H1N1

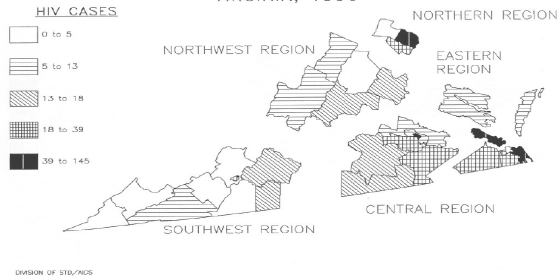
Figure 4



GONORRHEA CASES VIRGINIA, 1996

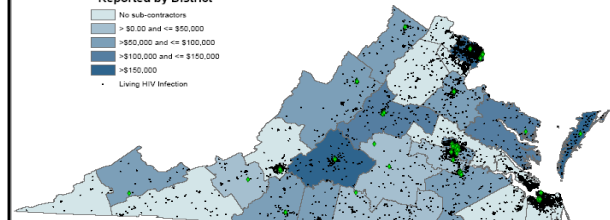


REPORTED HIV CASES VIRGINIA, 1996



2003 Ryan White Sub-Contractors Living HIV Infection (HIV and AIDS Unduplicated*)

Amount of Awards to Sub-Contractors Reported by District



* Virginia regulations require reporting of HIV and AIDS separately, therefore, an individual may be reported once as an HIV case and once as an AIDS case. This table presents the total number of people who have either HIV or AIDS. People reported as both an HIV case and an AIDS case are counted only once.



VDH
Division of HIV/STD

HealthMap
Global Disease Alert Map

EN English | ES Español | FR Français | PT Português | AR العربية | RU Русский

Home | About | Contact | News | Alerts | Settings | Help | Feedback

Now available as an iPhone App!

Search: 0/1000

- PROHEB Alert
- PROHEB HESIS
- PROHEB East Africa
- World Health Organization
- World Map, by Area-weight
- BioSurveillance
- Google Maps
- Research Technologies
- WHO Disease Hotspot
- HealthMap Community
- HealthMap Community

Category

- International Significance
- New & Ongoing Outbreaks
- Outbreaks

Historical Alert History

- Search: 0/1000 Alerts
- Cholera (241)
- Salmonella (4332)
- Highly Pathogenic Avian Influenza (HPAI)
- Sexually Transmitted Infection (STI)
- Chagas Fever (133)
- Cholera (241)
- Poliovirus (106)
- Fever (87)
- epidemic (84)
- Polio (24)

World Map

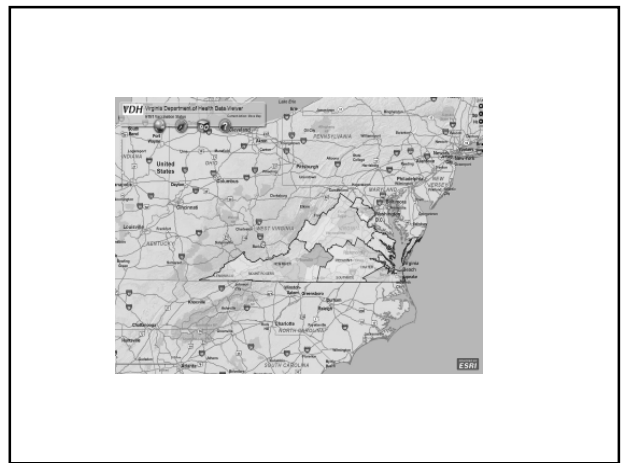
Report: 61287 Pertussis, 6424, Hep. 606100 Enteric Technology, 10799, 2100

Date Range: 14 Sep - 14 Sep

Outbreak missing from the map? Help us by adding it:

http://URL_of_Disease_Outbreak_Report

<http://www.healthmap.org/en>



Counties by Selected City/County, 2001 vs. 2002

County	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TOTAL	% DIFF (2001)	% CHANGE (2012)
WOODRUFF	2	2	0	0	0	0	0	0	0	0	0	0	2	-100	-100
2002	1	3	4	2	0	3							13		
ALEXANDRIA	14	8	3	6	5	9	12	10	10	17	7	21	122	+135	+174.8
2002	9	13	10	17	15	7							88		
ARLINGTON	6	6	15	6	13	4	18	16	5	11	3	6	93	-12	-24.9
2002	4	17	7	1	3								38		
CHARLOTTESVILLE	9	4	4	2	4	2	10	13	6	6	1	7	67	-120	-83.3
2002	2	6	13	10	2	9							64		
CHESAPEAKE	24	22	10	32	24	21	51	47	23	37	18	40	361	+26	+18.2
2002	21	31	32	28	28	32							269		
CHESTERFIELD	6	6	11	7	12	7	37	17	11	20	22	5	102	+10	+26.9
2002	17	8	12	11	7								69		
DANVILLE/STEVENS	18	13	12	18	23	24	56	37	29	43	9	38	332	+161	+232.2
2002	24	32	29	27	26	16							154		
FAIRFAX CO	23	6	14	14	9	12	13	22	4	12	4	17	190	-2	-2.7
2002	14	6	13	20	6	7							75		
FRANKLIN CITY	4	3	0	1	7	13	1	3	5	0	2	40	113	+108.0	
2002	7	4	3	2	5								26		
FRYBOROUGH	2	2	4	0	1	2	10	8	1	4	3	4	43	-26	-206.4
2002	2	4	11	4	7								37		
HAMPTON	41	26	32	44	28	33	194	20	40	27	43	484	-3	-1.9	
2002	28	36	30	31	29	42							318		
HANOVER	2	2	1	1	0	1	3	4	0	0	0	3	24	-22	-114.3
2002	1	1	1	1	1	4							11		
HERNDON	9	29	4	12	27	21	13	36	1	23	24	24	205	-61	-16.8
2002	2	25	22	11	21								104		
LYNCHBURG	16	16	19	14	13	13	29	42	27	26	11	20	268	+27	+22.9
2002	14	28	18	6	12	15							131		

Revised Jan 6/10/2002

S.A.M.
Strategic Action Monitoring

Weekly Reporting by District

Select a map

Interactive Database

Reports

Weekly

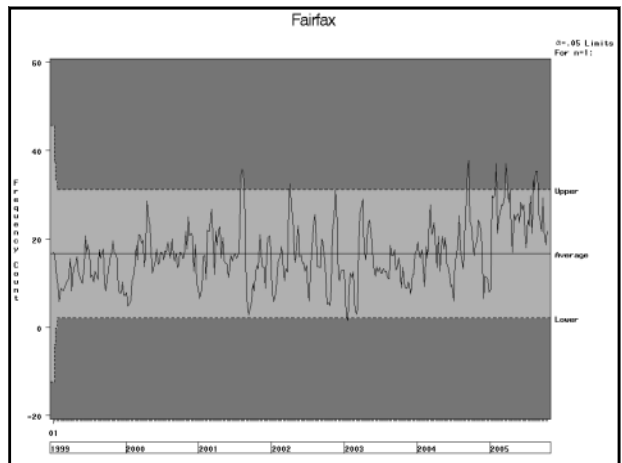
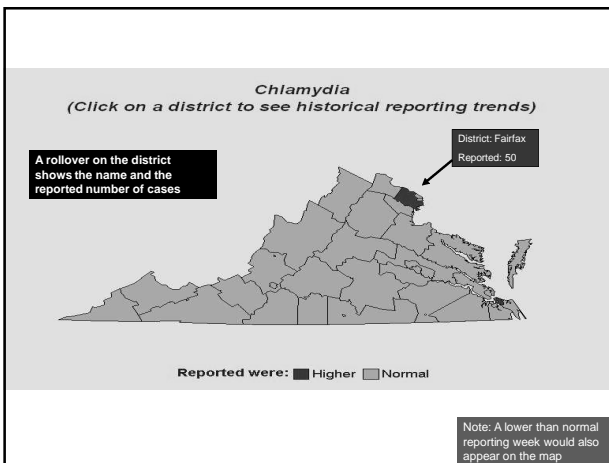
Monthly

New Select

Select Month

Select Month

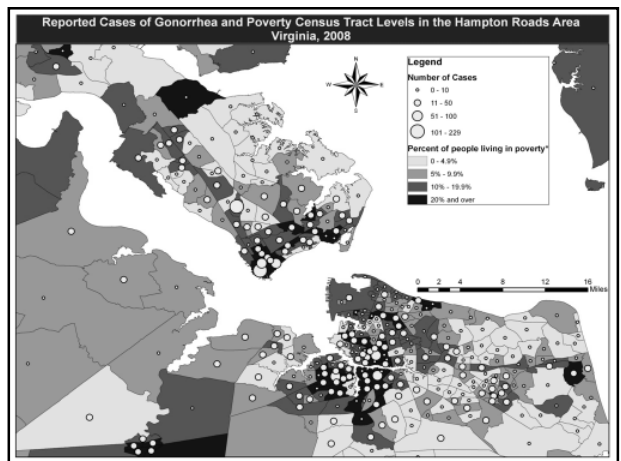
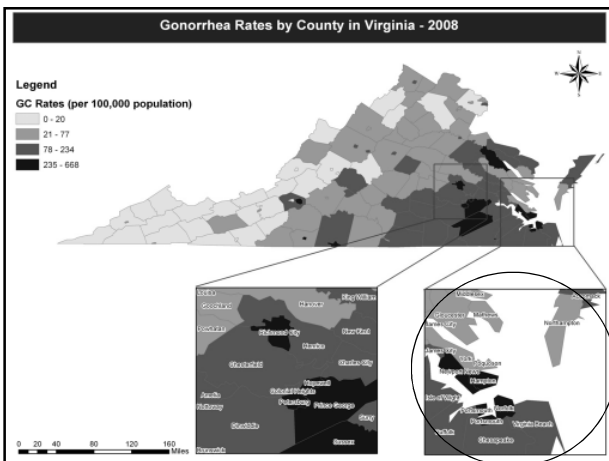
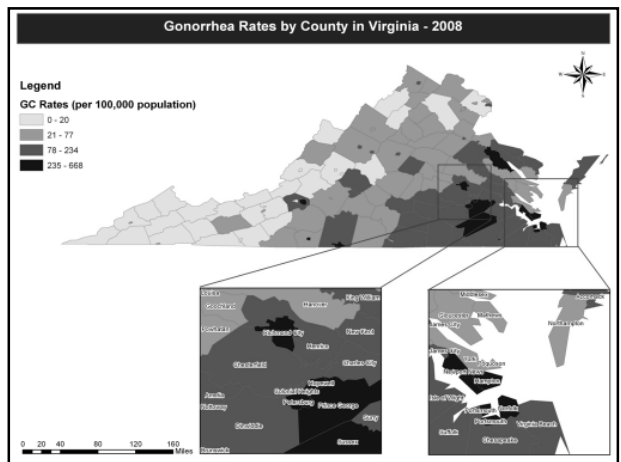
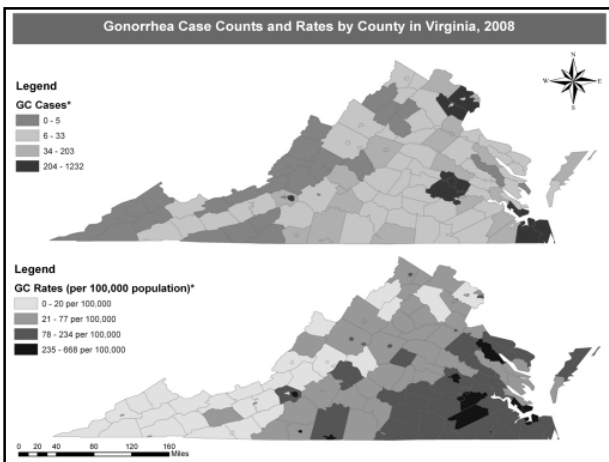
Strategic Maps

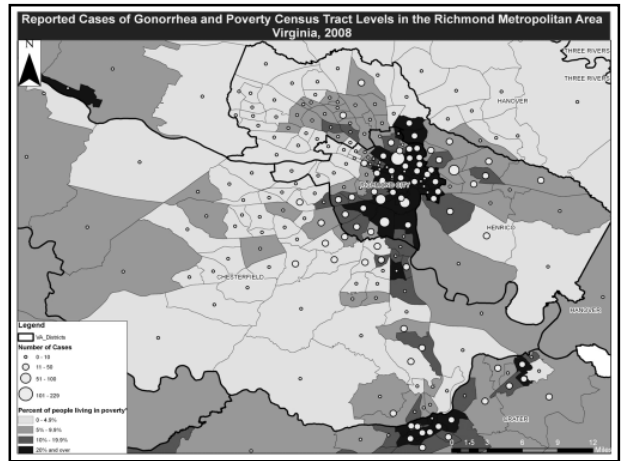
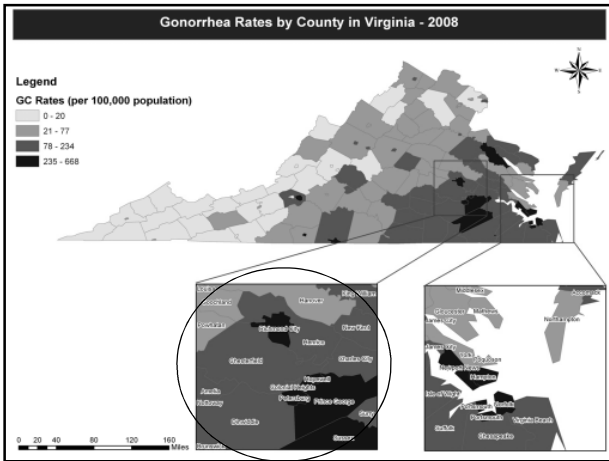


Does GIS provide “added value”?

Is GIS more than just maps
 (“eye candy”)?

GIS is a tool for understanding
 how spatial relationships can
 and/or do affect an outcome
 [e.g., public health].





VDH **Spatial Analysis of Gonorrhea Incidence in Richmond, Virginia, 2000-2007**
Glan Zhang, Dana Vastis, Chris Deitcher, Jeff Stover

Summary
Richmond, Virginia, has been historically recognized as a locality with one of the highest gonorrhea rates in the country. The aim of this presented population-based study on gonorrhea is to identify statistically significant geographic clusters. **Methods:** We analyzed reported gonorrhea diagnoses (n=8,643) between 2000 and 2007 in the city of Richmond, Virginia. Gonorrhea cases were geocoded and mapped to block groups (n=163). Gonorrhea incidence rates for each block group were calculated. A spatial scan statistics is conducted to identify core areas with elevated rates. **Results:** The average yearly incidence rate of gonorrhea in Richmond was 681 per 100,000. Of the total number of cases, 85.9% were under the age of 35, and 84.9% were Black. Seven clusters with higher-than-expected rates (p=0.0001) were identified. The most likely cluster was located on the northeastern part of the City, with an annual incidence rate of 1449.4 per 100,000. Cases occurred in this cluster represented 21 percent (1084 cases) of the total number of gonorrhea cases in Richmond, Virginia, between 2000 and 2007.

Introduction
Gonorrhea is a sexually transmitted infection (STI) caused by the bacterium Neisseria gonorrhoeae. It is one of the most common STIs in the United States. In 2007, there were approximately 1.1 million new cases of gonorrhea reported in the United States. The Centers for Disease Control and Prevention (CDC) estimates that approximately 10% of these cases are reported, meaning that there are actually about 11 million new cases each year. Gonorrhea is a major cause of pelvic inflammatory disease (PID) in women, which can lead to infertility and other complications. In men, gonorrhea can cause pain and swelling of the testicles and urethritis. It can also be transmitted to the eyes, throat, and rectum. Gonorrhea is preventable through the use of condoms and regular testing. Treatment is available and effective, but it is important to seek medical attention as soon as possible to avoid complications.

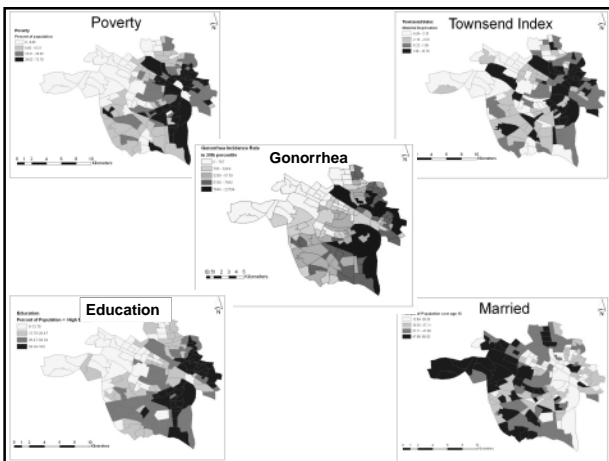
Materials & Methods
This study was a population-based study of gonorrhea incidence in Richmond, Virginia, from 2000 to 2007. Data on gonorrhea diagnoses were obtained from the Virginia Department of Health (VDH) and geocoded to the census tract level. Census tracts were then classified into four categories based on the percentage of the population living in poverty: 0-4%, 5-9.9%, 10-19.9%, and 20% and over. The spatial scan statistics method was used to identify geographic clusters of gonorrhea cases. The method involves scanning the geographic area with a circular window of varying sizes and shapes to identify areas with a higher-than-expected number of cases. The most likely cluster was identified as the area with the highest relative risk (RR) and the lowest p-value.

Results
The average yearly incidence rate of gonorrhea in Richmond was 681 per 100,000. Of the total number of cases, 85.9% were under the age of 35, and 84.9% were Black. Seven clusters with higher-than-expected rates (p=0.0001) were identified. The most likely cluster was located on the northeastern part of the City, with an annual incidence rate of 1449.4 per 100,000. Cases occurred in this cluster represented 21 percent (1084 cases) of the total number of gonorrhea cases in Richmond, Virginia, between 2000 and 2007.

Demographics
The study population was divided into four age groups: 0-14, 15-24, 25-34, and 35-64. The majority of cases (85.9%) were in the 0-34 age group. The majority of cases (84.9%) were in the Black population.

Spatial Analysis of Gonorrhea Incidence in Richmond, Virginia, 2000-2007

- **Summary**
 - **Introduction:** In Virginia, Richmond city has been historically recognized as a locality with one of the highest gonorrhea rates in the country. The aim of this presented population-based study on gonorrhea is to identify statistically significant geographic clusters. **Methods:** We analyzed reported gonorrhea diagnoses (n=8,643) between 2000 and 2007 in the city of Richmond, Virginia. Gonorrhea cases were geocoded and mapped to block groups (n=163). Gonorrhea incidence rates for each block group were calculated. A spatial scan statistics is conducted to identify core areas with elevated rates. **Results:** The average yearly incidence rate of gonorrhea in Richmond was 681 per 100,000. Of the total number of cases, 85.9% were under the age of 35, and 84.9% were Black. Seven clusters with higher-than-expected rates (p=0.0001) were identified. The most likely cluster was located on the northeastern part of the City, with an annual incidence rate of 1449.4 per 100,000. Cases occurred in this cluster represented 21 percent (1084 cases) of the total number of gonorrhea cases in Richmond, Virginia, between 2000 and 2007.



Clusters identified by spatial scan statistics using SaTScan

	Blocks	Population	Observed Cases	Expected Cases	RR	LLR*	p value
Most Likely Clusters	15	15,288	1840	778	2.67	560.85	0.0001
	26	17,347	1668	843	2.21	368.86	0.0001
Secondary Clusters	4	4,807	476	262	1.86	72.57	0.0001
	22	22,538	1048	823	1.31	31.43	0.0001
	1	1,759	162	87	1.88	26.03	0.0001

Spatial Analysis of Gonorrhea Incidence in Richmond, Virginia, 2000-2007



FIGURE 2. Reported gonorrhea incidence rates per 100,000 per census block group, Richmond City, Virginia, 2000-2007

Geocoding & Data Management

Healthy People 2010:

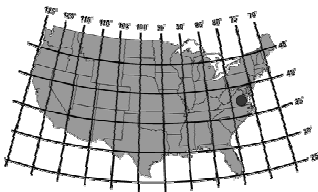
Increase the proportion of all major national, state, and local health data systems that use geocoding to promote nationwide use of geographic information systems (GIS) at all levels.

Address:
920 Main St.
Richmond, VA 23220

Longitude (X3): **-77.451723**
 Latitude (Y3): **37.550164**

Street Database

905 Main St.	X1, Y1
910 Main St.	X2, Y2
920 Main St.	X3, Y3
930 Main St.	X4, Y4
940 Main St.	X5, Y5



MAIL THE TOP TWO COPIES TO YOUR LOCAL HEALTH DEPARTMENT

VIRGINIA DEPARTMENT OF HEALTH
 Confidential Morbidity Report

Patient's Name (Last, First, Middle Initial): _____ DOB: _____

Patient's Address (Street, City or Town, State, Zip Code): _____ City or County of Residence: _____

Date of Birth: _____ Age: _____ Race (do not check more than one): _____ Hispanic Origin: _____ Sex: _____

DISEASE OR CONDITION: _____ Date of Onset: _____

Date of Diagnosis: _____ Date of Report: _____

Physician's Name: _____

Address: _____

Reported by (Last, First, Middle Initial): _____ Date of Report: _____

Other Information: _____

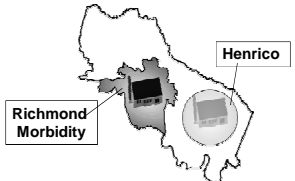
Please complete as much of this form as possible.

John Snow
 0139 Vibrio cholerae Dr.
 Richmond, VA, 23231

Reporting Form

Reporting Form

Address:
0139 Vibrio Cholerae Dr.
Richmond, VA, 23231



Independent cities

- In Virginia, under state constitutional changes after the American Civil War (1861-1865), beginning in 1871, cities became politically independent of the counties. For many practical purposes, an independent city in Virginia since then has been comparable to a county. Many agencies of the U.S. Government consider Virginia's independent cities to be county-equivalents.

http://en.wikipedia.org/wiki/List_of_counties%2C_cities%2C_and_towns_of_Virginia#Independent_cities

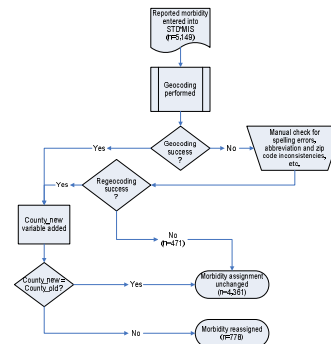
- Virginia is divided into independent cities and counties, which function in the same manner. According to the US Census Bureau, independent cities are considered county-equivalent. [58] Under Virginia law, all municipalities incorporated as cities are independent of any county. As of 2006, thirty-nine of the forty-two independent cities in the United States are in Virginia. Virginia does not have any political subdivisions, such as villages or townships, for areas of counties that are not within the boundaries of incorporated towns. There are hundreds of other unincorporated communities in Virginia, sometimes informally called towns. [59]

http://en.wikipedia.org/wiki/Virginia#Cities_and_towns

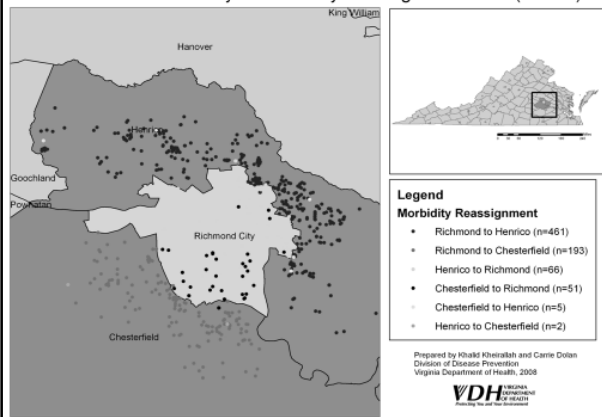
Name	Street	City	County	St	Zip
A Movable Feast	1318 E Cary St	Richmond	Richmond City	VA	23219
Azalea Food Market & Deli	211 Azalea Ave.	Richmond	Richmond City	VA	23227
Blimpie	13969 Raised Anter	Midlothian	Richmond City	VA	23112
Bogey's Bagels	13520 Midlothian Trnprk	Midlothian	Richmond City	VA	23113
Boychiks Deli	4024-B Cox Rd	Richmond	Richmond City	VA	23233
Café 1602	1602 Rolling Hill Dr	Richmond	Richmond City	VA	23229
Carla's Kitchen	920 W Grace St	Richmond	Richmond City	VA	23220

Street_new	City_new	St	Zip_new	Longitude	Latitude	Census Block	FPS	County_new	Code
1318 E CARY ST	RICHMOND	VA	23219-4155	-77.432889	37.534887	517600350010 95	51760	RICHMOND CITY	580 A50
211 AZALEA AVE	RICHMOND	VA	23227-3621	-77.424551	37.602463	510872000430 00	51087	HENRICO	580 A50
13969 RAISED ANTLER CR	MIDLOTHIAN	VA	23112-2005	-77.563553	37.402642	510411010010 24	51041	CHESTERFIELD	580 A50
13520 MIDLOTHIAN TRPK	MIDLOTHIAN	VA	23113-4214	-77.649450	37.503059	5104110001510 16	51041	CHESTERFIELD	580 A50
4024-B COX RD	RICHMOND	VA	23233	-77.619700	37.624400	51087200115	51087	HENRICO	ES22CSX
1602 ROLLING HILLS DR	RICHMOND	VA	23229-5012	-77.546885	37.613115	5108720010430 22	51087	HENRICO	580 A50
920 W GRACE ST	RICHMOND	VA	23220-4125	-77.451723	37.550164	517600430010 03	51760	RICHMOND CITY	580 A50

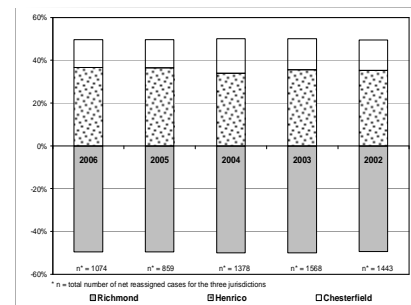
Business Process Flowchart for Geocoding STD Morbidity: City of Richmond, Chesterfield County and Henrico County, Virginia – 2006.



Gonorrhea and Chlamydia Morbidity Reassignment 2006 (N=778)



Net Gonorrhea and Chlamydia Morbidity Reassignment Percentages: City of Richmond, Chesterfield County and Henrico County: 2002-2006



Distribution of Gonorrhea and Chlamydia Based on Geocoded Morbidity Assignments in the Tri-city/county Richmond Area[^], 2006

Morbidity	City/County			Total
	Richmond	Chesterfield	Henrico	
Reported Cases	3625	802	722	5,149
Redistributed Cases [†]	3088	941	1120	5,149
Gained (+)	117 (3%)	195 (24%)	466 (64%)	778
Lost (-)	654 (18%)	56 (7%)	68 (9%)	778
Total	771	251	534	
Net Change	-537 (-15%)	+139 (17%)	+398 (55%)	0

[†]Non-geocodable cases (n=471) were retained within the city/county of initial morbidity report and are included in the redistributed case counts for each city/county above. Hence, the total Reported Cases and Redistributed Cases are equal.
[^]The Tri-City/County Richmond Area is comprised of the city of Richmond and the counties of Chesterfield and Henrico.

Ranking of Richmond, VA, based on National Summary of Gonorrhea and Chlamydia Rates among Cities >200,000 Population: 1992-2004*

YEAR	GONORRHEA		CHLAMYDIA	
	RANK	RATE (x10 ⁵)	RANK	RATE (x10 ⁵)
1992 [†]		1805.9	6	598.4
1993 [†]	6	991.4	7	504.7
1994 [†]	2	1280.7	10	485.7
1995 ^{††}	2	1195.8	1	1083.9
1996	3	876.0	1	1026.8
1997	8	739.4	1	1100.0
1998	5	793.7	4	841.5
1999	2	940.9	1	1015.6
2000	1	923.6	1	1175.5
2001		1066.3	1	1057.6

* Data in this table was extracted from annual CDC Sexually Transmitted Disease Surveillance reports 9-21
[†] Data from 1992-1995 for chlamydia rankings is based on raw rank tables requiring manual calculation
^{††} The Virginia Department of Health initiated increased chlamydia screening criteria (6/7/1996)
[‡] Geocoding was implemented for all data beginning in January 2002

Check it out!

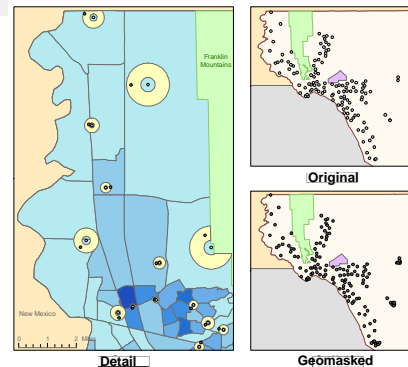
Stover, J., Kheirallah, K., Delcher, C., Dolan, C., Johnson, L.
Improving Surveillance of Sexually Transmitted Diseases Through Geocoded Morbidity Assignment
 Public Health Reports - OASIS Suppl. Nov/Dec 2009. Vol 124. No. 5.

GIS & Privacy

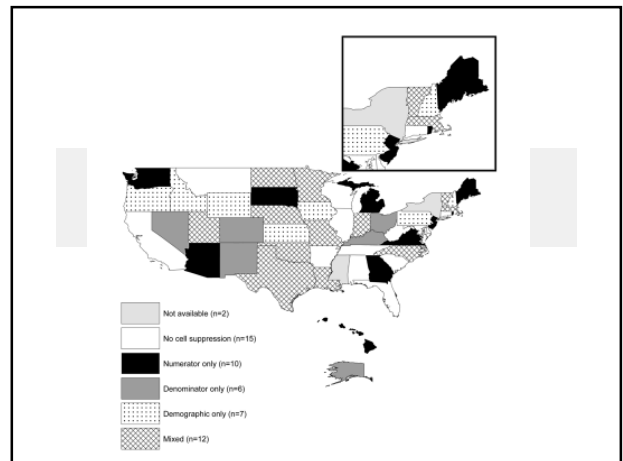
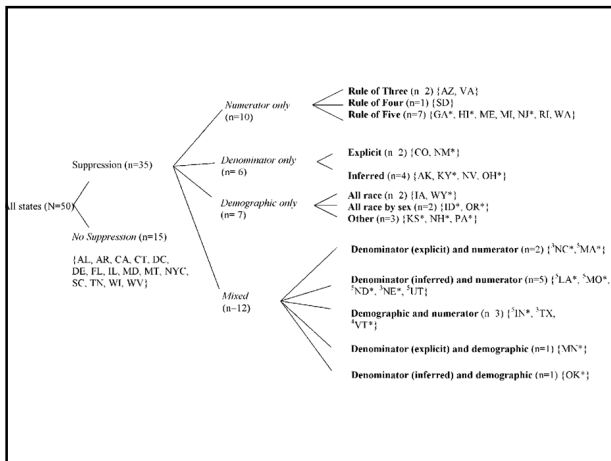
Data Confidentiality

- Geo-masking
 - moving the point locations
 - Transformations:
 - Translation: shift all points a fixed distance and direction
 - Scale: expand or contract all points by a scaling factor
 - Rotation: rotate all points by a fixed angle about a pivot point
- Random perturbation:
 - Relocate randomly from original
 - Most commonly used method
 - Maps for public release – equivalent visual pattern
 - Where is the point?
 - Is it now in a lake?
 - Urban vs rural
- Aggregation
 - Loss of geographic information
 - Artificial boundaries
 - Assumed homogeneity
- Reverse geocoding
 - 432 of 550 (79%) patients in Boston
 - Brownstein et al. NEJM 2006

Random Perturbation in a GIS



Stinchcomb, D.



Confidentiality

- GIS is fairly new to STD surveillance
- Technology has outpaced confidentiality standards
- Is geocoded and/or mapped data easily identifiable?
 - Use of rates, ranges, etc.
 - Randomization of points, offsets
- Need to establish guidance for users and recipients
 - Data sharing agreements

“Mapping communicable diseases at detailed geographic scales raises significant concerns about privacy and confidentiality.”

Cronky and McLafferty, Guilford Press 2002.

- “CDC recommends that data be released in the form that is closest to microdata and that still preserves confidentiality.”

CDC/ATSDR Policy on Releasing and Sharing Data

- “Protected Health Information...[means] any information, whether oral, written, electronic, visual, pictorial, physical, or any other form, that related to an individual's past, present, or future...condition, treatment, services...which reveals the identity of the individual...or where there is a reasonable basis to believe such information could be utilized to reveal the identity of that individual....this definition should be interpreted broadly.”

Model State Public Health Privacy Act

CDC Comments on Disclosure of Confidential Information

"Those assessing the risk that confidential information will be disclosed should recommend the statistical methods to be used for disclosure protection (e.g. suppression, random perturbations, recoding, top- or bottom-coding.) The recommended methods should balance the risk of disclosure against the possibility that reducing the risk of disclosure will also reduce the usefulness of the data for public health practice and research."

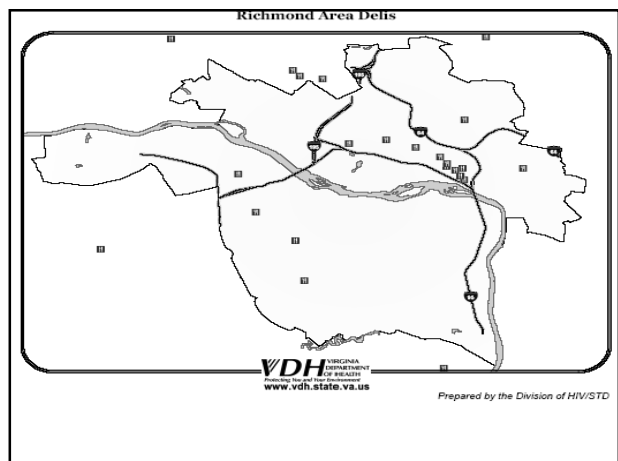
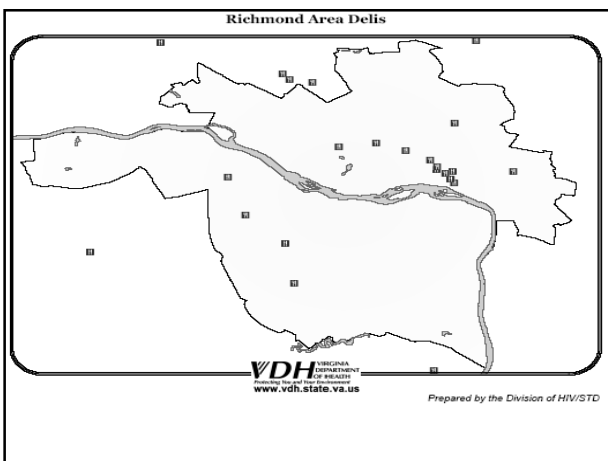
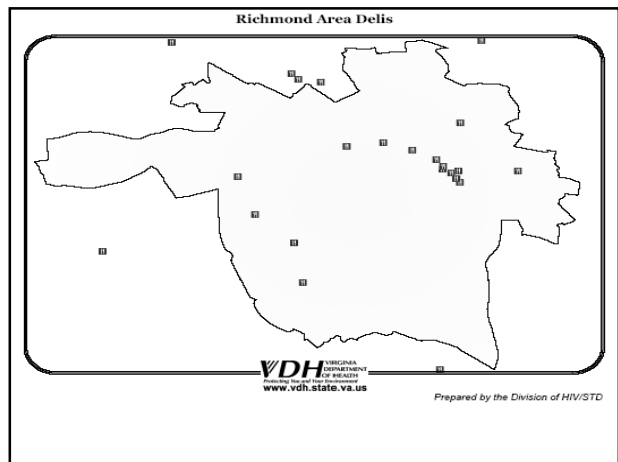
This requires staff trained to assess such risks.

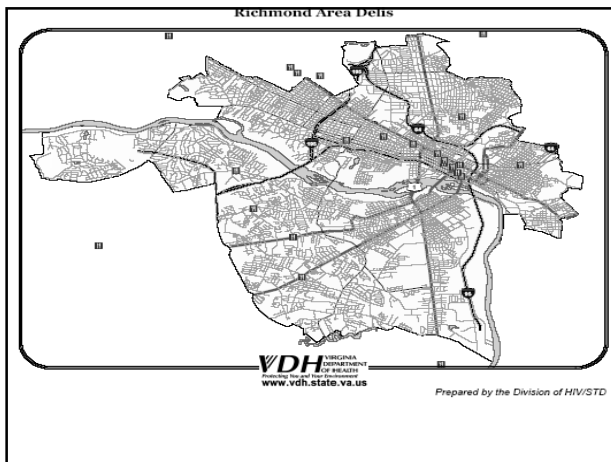
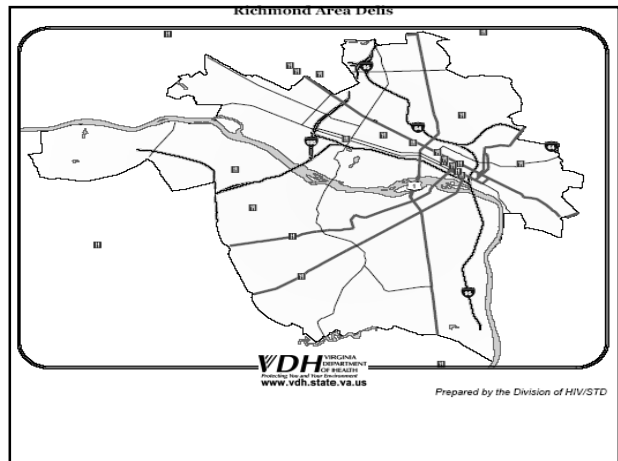
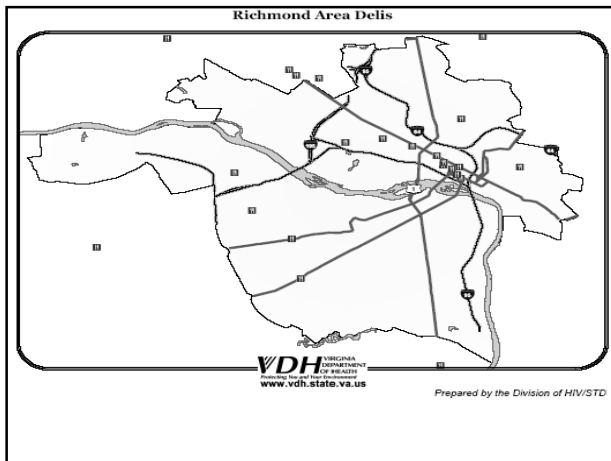
From CDC Guidelines for HIV/AIDS Surveillance, Appendix C: Security and Confidentiality

- "Geographic information systems (GIS) allow for relatively accurate dot-mapping. Care must be taken that graphic (like numeric) presentation of data cannot permit the identification of any individual by noting pinpoint observations of HIV cases at, for example, the county, ZIP code, or census tract level."
- "Generally speaking, only aggregated HIV/AIDS surveillance data should be released outside the HIV/AIDS surveillance unit through published reports, grant applications, grant progress or planning reports, correspondence, newsletters, public meeting, or press releases."

From CDC Guidelines for HIV/AIDS Surveillance, Appendix C: Security and Confidentiality

- "In developing a data release policy, state and local HIV/AIDS surveillance programs should be mindful that, given the location of a particular case-patient, less obvious data elements could be linked together to identify an individual. For example, when releasing data on a community with relatively few members of a racial/ethnic group or age group, surveillance staff should be careful that release of aggregate data on the distribution of HIV-infected individuals by these categories could not suggest the identity of an individual."
- "As a rule, CDC will not release aggregated data in tables when cell size is three or less (on a national level.)"





No Place to Hide — Reverse Identification of Patients from Published Maps

between 2004 and 2005, we identified 19 articles (including 5 in the Journal) that included maps with the addresses of patients plotted as individual dots or symbols. In these articles, more than 19,000 such addresses were plotted on maps. Given the potential implications for the privacy of patients, we investigated whether we could use these published maps to reidentify the patients. We created a simulated map of 550 geographically coded addresses of patients in Boston, using the minimum feature resolution required for publication in the Journal (Fig. 1A). We then used standard GIS techniques to determine the street pairs with which such addresses can be identified (Fig. 1B). The reverse-identification method precisely identified 432 of the addresses (79%) and identified 67% of the addresses within 1/4 of the correct address (Fig. 1B).

The publication of maps of Boston with precise locations of patients jeopardizes patients' privacy. Guidelines for the display or publication of health data are needed to guarantee patients' anonymity. A common approach has been to map according to administrative unit rather than home address. However, the aggregation of data in this manner places constraints on the visualization of disease patterns. Another method is spatial aliasing, or randomly relocating patients' addresses within a given distance of their true location. Aliasing can allow a visualization that obscures the necessary information while preserv-

ing patients' privacy. Such aggregation and shuffling are common and reliable means of de-identifying data that are for sale, in terms of protecting identifiable health information, than simply reducing the resolution of a map. Editors of journals and textbooks should consider implementing such practices to guide the safe reporting of spatial data.

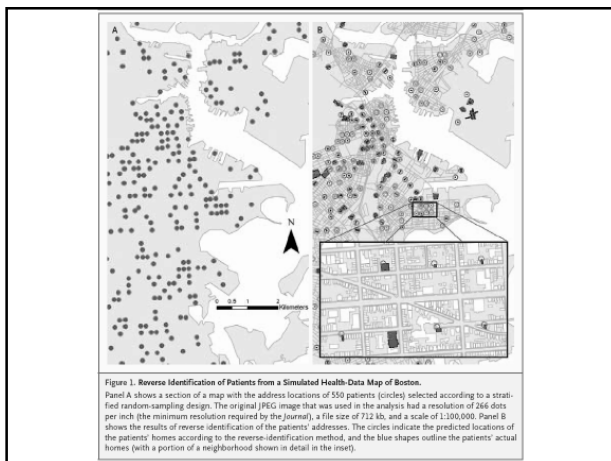
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1. Glass, C.A., Spang, J., Stevens, H., Gough, H. Geographic information systems (GIS) use geographic information system (GIS) data to analyze and display spatial data. In: Encyclopedia of GIS, 2nd ed. McGraw-Hill, 2001, pp. 100-110.

2. Himmelfarb, J., Glass, C., Rubin, D., et al. Reverse-geocoding: reverse-geocoding (reverse-geocoding) is the display of geographic health data using the geographic information system (GIS) data. In: Encyclopedia of GIS, 2nd ed. McGraw-Hill, 2001, pp. 100-110.

3. Glass, C.A., Spang, J., Stevens, H., Gough, H. A reverse-geocoding approach to analyzing spatial health data. In: Encyclopedia of GIS, 2nd ed. McGraw-Hill, 2001, pp. 100-110.

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No Place to Hide

- human health and map integration are now widespread, due to GIS availability
- GIS-related research has grown by ~26% annually (4x more than human health research in general)
- 19 articles from 5 journals w/ >19,000 addresses
- Reverse identification resulted in:

No Place to Hide

- Reverse identification resulted in:
 - Identification of 432 of 550 (79%) geographically coded addresses
 - All addresses identified within 14m of correct address
- Guidelines needed to guarantee patient anonymity
- Aggregation of data, spatial skewing should become part of journal requirements

Your public health career...

- be open to new tools
- be flexible
- be “cutting edge”
- be visionary
- be an opportunist

“The best way to predict the future is to create it”

Jeff Stover, MPH

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