Cost-Effectiveness of GIS-Based Targeted *Chlamydia trachomatis* Interventions

Wiley D, Jenkins, PhD, MPH
Southern Illinois University School of Medicine
Department of Family and Community Medicine

American Public Health Association Annual Meeting
November 6, 2007

Introduction

- *Chlamydia trachomatis* (CT) is the most commonly reported infectious disease in the United States (976,445 reported cases in 2005).
- State case rates range from 141.7 to 732.6 per 100,000. There were 50,559 reported cases in Illinois in 2005.
- Greater than 70% of CT cases are asymptomatic and long-term morbidity may include pelvic inflammatory disease (PID), ectopic pregnancies and infertility.
- Infection with CT may also increase risk of HIV infection.
- Chlamydia incidence has increased in Illinois each of the past nine years.
- Screening is the primary means of intervention, but is often consumed by those at low risk (est. at >30% of all tests in Illinois).

Objective

- To determine if a model of state-local health department cooperation for the provision of technical data and guidance for targeted interventions is effective and cost-effective in reducing local chlamydia incidence.
  - If the state health department provides this technical assistance, can the local health department use it to reduce local incidence?
  - If local incidence is reduced, is the reduction sufficient for the model to be cost-effective?

Background

- Multiple studies have shown that gonorrhea and chlamydia geographically cluster to varying degrees.
- While gonorrhea is usually more geographically concentrated, chlamydia can cluster according to subtype.
- Researchers have seen that STD endemic levels depend upon a small group of people, the “core”, who are frequently infected.
- Mathematical modeling indicates that minor epidemics are more likely to be sustainable within small sections of a population.
- Interventions targeted to specific geographic locations can be effective, and useful complements to traditional methods.

Background (cont.)

- Literature searches for the cost of pelvic inflammatory disease (PID) and further morbidity returned a wide range of estimations.
- For this study, we utilized the values and ranges published by Yeh et al (2003). Advantages include the use of the societal perspective, a lifetime time horizon and a state-transition model.
- For a projected cohort of women, the average lifetime cost (versus literature range of values):
  - of PID is $2,150 (vs $1,900-$5,329)
  - infertility is $1,270 (vs $971-$4,221)
  - chronic pelvic pain at $6,350 (vs $777-$6,382)
  - ectopic pregnancy at $6,840 ($812-$6,840).
- Sensitivity analysis shows that the costs are sensitive to rates of complications, costs of treatment and data source. Average lifetime costs can from Yeh range from $1,060 to $3,180.

Background (cont.)

- Local health department (LHD) STD staff currently rely on both local and Illinois Department of Public Health (IDPH)-supplied case data and other advice.
- Case information contains various demographic variables (e.g. race, age, gender, address).
- The proposed model would add:
  - Geospatially mapped local case data
  - US Census Bureau data associated with the census block groups (CBG) where case concentrations reside;
- The proposed model would present very specific data in very specific geographic areas where targeted interventions might have the greatest impact.

Methods

- Case studies of both the state and multiple local health departments were performed to collect current policy data.
- The state-level intervention and control activities can be grouped into three broad categories: direct services, indirect services and data management.
- STD staff in 13 LHDs were interviewed. They were asked to discuss: staffing; intervention efforts; collaborations; materials and literature utilized; interactions with ISTD; outbreak response actions.
- In IL, LHDs are autonomous entities. Interventions beyond screening are largely dependent upon local KSAs and budget.
- The state has resources available that are beyond the reach of the local level.
- We theorized that the provision of otherwise unavailable data to the LHD would enable them to target limited resources more effectively than they would on their own.

Participating counties

- Selection criteria (2005 data):
  - the presence of one relatively large city (pop. of 24,875 to 153,628)
  - relative geographic isolation (minimum of 25 miles to another city)
  - a relatively high incidence rate.
- Based on convenience and expected requirements.
- Matching based on increasing rate, though other factors considered.

Cases			Controls		
County	Annual Count	Annual Rate	County	Annual Count	Annual Rate
McLean	493	327.7	Adams	122	178.7
Vermilion	368	438.5	Kankakee	483	465.2
Winnebago	1,522	546.7	Sangamon	958	507.0
Champaign	1,133	630.6	Macon	613	534.4
Peoria	1,292	704.3	Jackson	405	679.4

Geocoding

- Case addresses were geocoded using ArcGIS 9.0. Not all cases were successfully located by the software as many had either invalid addresses or an unknown location.

Geocoded vs. non-geocoded cases by county	Champaign	McLean	Peoria	Vermilion	Winnebago
Total 2005 cases (preliminary data)	1050	458	1158	318	1366
Geocoded (%)	850 (81)	324 (71)	1030 (89)	290 (91)	1251 (92)
Non-Geocoded (%)	200 (19)	134 (29)	128 (11)	28 (9)	115 (8)

Geocoding (cont.)

- Data are compared to determine if there were any biases in which cases were geocoded and which were not. There were three demographic factors which are relevant here:
- Age – *t*-test for equality of means showed that the only county to have a significant difference is Peoria. (22.8-non versus 21.4).
- Gender – the *t*-test for equality of means showed there is no significant difference in gender for any county.
- Race – chi-square analyses showed that three counties had significant differences between racial geocoding success, with Blacks more likely to be located and Unknowns less likely. This may cause bias in terms of segregation and concentration.

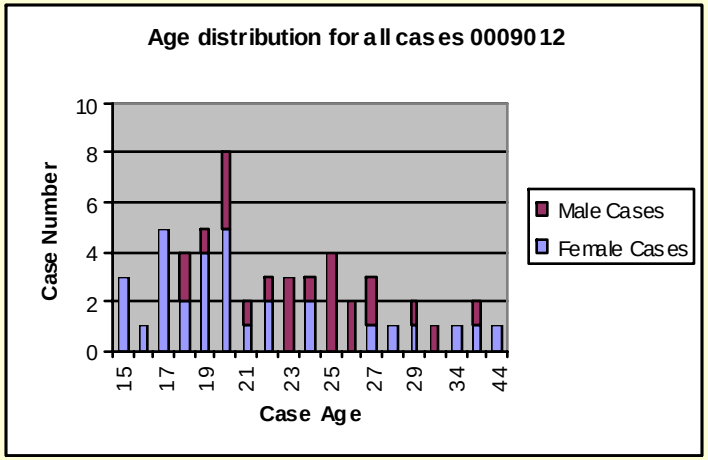
Mapping

- Cases were located into census block groups (CBG) which were then stratified into five levels by both total case number and case concentration. Stratification levels were determined by the Jenk's method.
- Map sets for each participating county were then produced. Each set included
  - multiple views of the county,
  - closer views of the major metropolitan center,
  - street-level views of targeted CBGs.
- The purpose was not necessarily a statistically significant geographical cluster (e.g. SatScan), but a useful tool to target resources and enlist partners.

Case data summaries

- Local case data was summarized and broken down into tables and charts as an aid to intervention development.
- Census Bureau data on population, income and education for the county and selected CBGs were collected and provided.

	Champaign County		Tract 9.01 Block Group 2	
	Males	Females	Males	Females
Total Cases	314	740	23	31
Am. Indian	0	1	0	0
Asian-PI	4	20	0	0
Black	191	360	20	23
White	70	237	0	5
Other	9	32	0	0
Unknown	42	90	3	3



County interventions

- Participants were given 10 weeks to implement and complete their interventions.
- McLean and Winnebago counties had staff go “door-to-door” in target areas with information.
- Champaign county advertised and utilized a mobile health van in target areas.
- Peoria county performed much more extensive partner notification and tracing for those in the target areas.
- Vermilion county created display boards and materials and placed in public places (housing authority lobby and local clinic).
- All performed without supplemental funding.

ARIMA modeling

- *Auto**R**egression **I**ntegrated **M**oving **A**verage* used to look for an intervention effect in subsequent local incidence.
- Model acceptance criteria consisted of the following items:
  - All model parameters had to be significant.
  - All Box-Ljung chi-square statistics for the model residuals had to be insignificant to 12 lags.
  - The residual's partial autocorrelation could not display a trend.
- High monthly variance contributed to models with poor predictive ability (MAPE range of 15.3% - 58.8%).
- CI quite wide and encompassed all observed counts.
- Bottom line, for this application, very low utility.

Chi-square and *t*-test analyses

- Observed case data post-intervention were compared to data pre-intervention and the same time period the previous year at 4- and 8-month time spans.
- Done to examine before-and-after and historical effects.

Chi-square

- No chi-square analysis for cases or controls were significantly different for any time span.

t-test

- No case county experienced any significant decrease in incidence for any time span.
- One control county (Sangamon) experienced significant differences. May be due to county-city health department merger in 2006.

Cost-effectiveness

- Costs data utilized included:
  - Direct costs of each intervention type – this included number/cost of man-hours expended, materials and other literature, mileage and supplies.
  - Indirect costs – this included pro-rated employee retirement and pro-rated administrative.
  - Costs of chlamydia and its complications – these were taken from the literature and those with a societal perspective utilized.
- Wages/personnel time was the greatest cost for each LHD.
- Total costs range: $726 - $10,111

Cost-effectiveness (cont.)

- Minimum change required for cost-effectiveness utilizing low-to-high values of disease progression and lifetime cost

County		Champaign	McLean	Peoria	Vermilion	Winnebago
Intervention costs		$1,680	$1,892	$10,564	$1,179	$7,448
2005 total cases		1,133	493	1,292	368	1,522
Number of averted cases required for CE (progression; cost)	10%; $1,060	20	20	100	20	80
	25%; $2,150	4	4	20	4	16
	50%; $3,180	2	2	8	2	6
Percent decrease from 2005 for CE (progression; cost)	10%; $1,060	1.8%	4.1%	7.7%	5.4%	5.3%
	25%; $2,150	<1.0%	<1.0%	1.5%	1.1%	1.1%
	50%; $3,180	<1.0%	<1.0%	<1.0%	<1.0%	<1.0%

Limitations

- Sample size
- Selection of cases
- Case/control matching
- Geocoding not equivalent between counties
- Intervention
  - duration
  - intensity
  - consistency/generalizability
- Forecasting and sample variance

Discussion

- There is solid basis for the theory that a targeted intervention can be effective.
- Targeting resources to a specific area, versus the more common community-wide methods, should be less cost-intensive and more easily accomplished with minimal local budgets.
- Due to economies of scale, the state has resources and technology beyond the reach of local departments.
- The utilization of existing resources to assist local efforts should be a cost-effective method for decreasing local incidence.

More to explore…

- How to make an annual incidence decrease of 1% statistically significant?
- Evaluate interventions for implementation effectiveness.
- Standardize local test interventions to compare results.
- Subsidize interventions to make greater impact and duration.

Contact information

Wiley D. Jenkins

wjenkins@siumed.edu

217-545-8717