Not many years ago, geographer Jeffrey Wilson watched the painful experience of a family member fighting off secondary infections in the hospital while recovering from a serious accident. Little did Wilson know that he would soon contribute his geographic information system (GIS) skills to efforts to reveal patterns in the occurrence of hospital secondary infections. The resulting GIS analysis of person-to-person contact over space and time provided compelling evidence used to educate hospital workers and improve preventive measures.

Wilson’s relative had a nosocomial infection—one caused during his stay in the hospital, not by his initial injury. One such infection, fairly common, is methicillin-resistant *Staphylococcus aureus* (MRSA), which is a bacterium that is resistant to certain antibiotics including methicillin. An estimated 90,000 nosocomial-related deaths are reported in the United States annually. In a hospital, the main mode of infection transmission to other patients is thought to be through human hands, especially health care workers’ hands.

“There’s still a lot of controversy out there as to what the means are by which bacteria are transmitted within hospitals and the effective ways to stop that transmission,” says Abel Kho, M.D., an affiliated scientist at Regenstrief Institute, Inc., in Indianapolis. As a researcher, Kho was concerned with shedding more light on MRSA transmission and developing effective prevention methods.

Kho had read about using GIS for health applications and recognized that his challenge involved tracking the location and movement of patients and staff within a defined space. He contacted Wilson, chair of the Geography Department at Indiana University-Purdue University, for help. The department’s GIS group frequently works with the university’s School of Medicine on GIS health applications for environmental health risk assessment.

Wilson and then graduate student Kelly Johnston responded by creating a GIS model to visualize the data spatially and over time. Since the information they were tracking occurred inside the hospital, they used ArcGIS Desktop to import the building’s computer-aided design (CAD) plans and create a basemap representation of the building.

Kho pulled together a number of disparate data sources, thanks in part to the close working relationship between Regenstrief Institute and Wishard Memorial Hospital in Indianapolis. Kho extracted microbiology and laboratory data along with admission/discharge/transfer (ADT) data commonly used to identify where patients are in the hospital at any given time. But the pivotal data was from the automated vital signs system, a bedside system used by nurses and nurse’s aides to log in their identification and date/time stamps whenever they check a patient’s vital signs. “That was the key point to allow us to reconstruct movement patterns of staff through different patient care areas,” says Kho.

To ensure anonymity of both patients and staff, Kho deidentified the data to protect patient and staff privacy and then passed it on to Wilson and Johnston for geocoding. The sample spanned activity over a three-month period and provided a large volume of data to work with (44,485 logins). Using ArcGIS Desktop and the ArcGIS Tracking Analyst extension, they superimposed patient bed assignment, contact isolation status, MRSA status, and nursing staff movements onto the floor plans to create time sequence animations. ESRI’s ArcGIS 3D Analyst extension served as a visualization tool to look at infection data across multi-
An Exercise in Decision Support

Analyzing Health Data

Approximately 3,000 local public health departments work every day in the United States to protect the health of communities. Employees in these departments continually analyze health data to make program resource allocation decisions and respond to community concerns. Often, the analysis of existing health data is done at the ZIP Code level. But if source data at the ZIP Code level is flawed, it can lead to inaccurate conclusions that result in poor decisions about where to conduct public health interventions.

Geocoding addresses and visualizing data through GIS can improve the accuracy of source data, which leads to better decision making. In the following examples from the San Bernardino County Department of Public Health, consider how GIS could benefit data analysis:

1. Routine vital statistics reports for the county health officer indicate an extremely high teen birth rate in a particular ZIP Code. Is it likely that the high teen birth rate is a real phenomenon or an artifact of the data?

2. In response to a request from community leaders regarding health concerns in their unincorporated area, data analysts are preparing a community needs assessment survey. To inform the survey development, analysts examine census data and vital records data (birth and death records) for the unincorporated area.

In the first example, the accuracy of a high teen birth rate for a particular ZIP Code was in question. Therefore, data analysts geocoded the addresses for all birth records for the particular ZIP Code. After doing so, they found 19 of the 43 teen births (44 percent) actually belonged to another ZIP Code. The resulting teen birth rate based on the geocoded addresses was significantly lower than the teen birth rate based on the ZIP Codes listed on birth certificates.

Again, in the second example, examining the accuracy of teen birth rate data as it relates to survey development highlights the advantage of using GIS. Prior to geocoding, the data analysts found less than five teen births in the unincorporated area. After geocoding addresses from birth records, data analysts found 40 teen births in the unincorporated area—more than eight times as many. This increased teen birth rate in the unincorporated area indicates that the community needs assessment survey should include a focus on teen pregnancy prevention.

Accurate data is critical for making public health program decisions. Local health officials are encouraged to consider how address geocoding and visualization of data can improve decision support in their departments. Some state health departments are already geocoding vital records data at the point of data collection—a promising practice.

Lance Miller, M.A. (lmiller@dph.sbcounty.gov), and Andrea Rodriguez, M.S. (arodriguez@dph.sbcounty.gov), statistical analysts with the San Bernardino County Department of Public Health, contributed to this article.
GIS: Helping Shape Global Health One Nation at a Time, Part I

The use of GIS is rapidly spreading across the world as one of the most important technologies that helps nations address their most serious health goals including reducing disparity, improving access to services, and preventing the spread of disease. Striving for ubiquitous health could mean health everywhere, anytime. I acknowledge that health is on a continuum—one does not arrive at “good health” accidentally. Personal health begins before birth and continues throughout a person’s life. Access to health and human services has become one of the major determinants of the degree of health attained. Multiply one person’s health by billions and this brings us to global health.

The strength of modern GIS technology extends well beyond geographically relevant data analysis and powerful data visualization. It excels as a medium that helps inform, organize, and deliver health and human services. GIS supports every Web-based service locator, every directions-finding Web site, and every consumer-facing information and referral service sponsored by health organizations.

As nations strive to protect their citizens from the threat of infectious diseases, such as Legionella, dengue fever, West Nile virus, tuberculosis, or avian influenza, GIS has become an important technology for adding intelligence to existing disease surveillance systems at the local, regional, and national levels. GIS technology’s ability to author, publish, and share critical information about the spatial dynamics of disease makes it, without exception, the technology of choice for accelerating the detection and identification of disease clusters. GIS technology’s capacity to reach beyond geopolitical boundaries makes it highly desirable in public health emergencies and responses.

As every person is different, so is every community and nation. However, the varied ways that information technology is used seem fundamentally parallel. The way GIS is used by health and human service organizations and the professionals who lead these organizations is more similar than dissimilar; therefore, one of the greatest promises of GIS is its ability to speak a common language.

In my opinion, developing a common language about health and human services helps nations move forward, and when we move forward, everyone everywhere has a better chance to attain the ubiquitous health that is so needed in this world.

As always, I encourage your second opinion.

Regards,

Bill

Submit Your Article to HealthyGIS
Share your knowledge and innovative ideas about real-world GIS solutions in health and human services research, analysis, and delivery by submitting an article to HealthyGIS. Broaden your professional experience and stimulate discussion among your peers. For more information, visit www.esri.com/health and click “HealthyGIS Newsletter” or contact the editors, Peggy Harper (e-mail pharper@esri.com) or Susan Harp (e-mail sharp@esri.com).
**Spatiotemporal Analysis of Syphilis Case Distribution**

**SYPHILIS PATTERNS AMONG MALES AND FEMALES IN HOUSTON - A SPATIOTEMPORAL ANALYSIS**

**STEPHEN, Riju, MS; KUBALA, Amanda, MPH; MGBERE, Osaro, PhD; MUKKAVILLI, Sreevidya, MPH; PERRY, Mark, MPH**

Office of Surveillance and Public Health Preparedness, Houston Department of Health and Human Services

**INTRODUCTION**

Syphilis strikes populations in a disproportionate manner, with substantially higher infection rates found in urban areas. The number of syphilis cases reported in the Houston area has been increasing steadily over the past six years, as also seen nationwide. According to the CDC, there is an estimated 2- to 5-fold increased risk of acquiring HIV infection when syphilis is present. Distinctive spatial patterns emerge in the male and female cases when we analyze syphilis in Houston using Geographic Information Systems (GIS). The trends in the spatial patterns lead us to hypothesize that the mode of transmission of syphilis may change among males and females. The spatial patterns suggest that homosexual behavior among males is an emerging concern to be addressed in order to prevent an outbreak in the affected communities. It also indicates that the males and females may have a different set of significant underlying risk factors which favors transmission among them.

**ANALYSIS**

Syphilis Surveillance data from Houston Department of Health & Human Services (HDHHS) was used for this study. The data comprised of 2763 cases (Primary, Secondary and Early latent cases) reported to HDHHS and covers the period from 1999 through 2006. There were 2012 male cases and 751 female cases reported during this period. The address locations of patients were converted into density maps using the kernel density function of the Spatial Analyst extension of ESRI’s ArcGIS 9.2. In order to understand the dynamics of the disease transmission among males and females, thirteen risk factors have been identified in the population during the study period. Five most prominent risk factors have been selected for analysis. These are 'condom use sometimes' (CUS), oral sex (OS), men having sex with men (MSM), rectal intercourse (RI) and anonymous sex (AS). Descriptive and inferential analyses were carried out using the SPSS (version 11.0).

**RESULTS**

The number of reported cases increased significantly (P<0.05) from 2001 to 2006, except in 1999 and 2000. The significant risk factors identified in the population included not always using condoms (P<0.001), oral sex (P<0.001), men having sex with men (MSM) (P<0.001), rectal intercourse (P<0.001), and anonymous sex (P<0.001). The MSMs increased from 7.6% in 1999 to 48.3% in 2006, peaking at 60.0% in 2004. The males were always using condoms (P<0.001), oral sex (P<0.001), men having sex with men (MSM) (P<0.001), rectal intercourse (P<0.001), and anonymous sex (P<0.001). The MSMs increased from 7.6% in 1999 to 48.3% in 2006, peaking at 60.0% in 2004. The males were found to be significantly more at risk (P<0.001) compared to females. The number of reported cases was the highest in Blacks followed by Whites.

**DISCUSSION**

The spatial patterns between male and female cases gradually change from similar ones in 1999 to strikingly dissimilar ones towards 2006. There develops a distinct epicenter of disease concentration among males while for females the concentrations are not pronounced. This is indicative of either a changing risk behavior or a changing demographic profile in the epicenter of the disease in Houston towards the end of the eight year period. Another reason could be that if women are more aware of safer sexual practices, they might insist on using protective measures in a heterosexual relation which reduces the chances of heterosexual mode of transmission compared to homosexual.

There could be other underlying factors that are causing the distinct pattern among males and females in Houston towards the end of the eight year period. Migration of certain groups of people to the inner city areas during the course of time could be one of the reasons. The spatial patterns between male and female cases gradually change from similar ones in 1999 to strikingly dissimilar ones towards 2006. There develops a distinct epicenter of disease concentration among males while for females the concentrations are not pronounced. This is indicative of either a changing risk behavior or a changing demographic profile in the epicenter of the disease in Houston towards the end of the eight year period. Another reason could be that if women are more aware of safer sexual practices, they might insist on using protective measures in a heterosexual relation which reduces the chances of heterosexual mode of transmission compared to homosexual.

**CONCLUSION**

Geospatial patterns, population trends and demographic changes may reveal patterns not readily detected by traditional surveillance and epidemiological methods and raise hypotheses about not only geographic concentrations are not pronounced. This is indicative of either a changing risk behavior or a changing demographic profile in the epicenter of the disease in Houston towards the end of the eight year period. Further analysis of risk factors would indicate a better picture. Further analysis of risk factors would indicate a better picture.

This poster on spatiotemporal analysis of syphilis case distribution won the People’s Choice Award during the 2007 Health GIS Conference. For more information, write Riju Stephen at riju.stephen@cityofhouston.net.
Workshop Probes GIS Tools for Analysis and Fieldwork

ESRI and Loma Linda University (LLU) School of Public Health (SPH) hosted a GIS workshop for health professionals in March at the LLU Geoinformatics Resource Center. The workshop included a mix of health GIS presentations and hands-on exercises. Dr. Carlos Castillo-Salgado, area manager of health analysis and information systems, Pan American Health Organization, discussed using GIS as a tool for analysis and problem solving in epidemiology and public health practice. Workshop participants tested a new mobile GIS vector control application developed by LLU SPH for a local health agency. Attendees also enjoyed tours of LLU Medical Center’s Emergency Department (home to the Advanced Emergency GIS application) and the nearby ESRI campus.

Participants in the recent Health GIS workshop at Loma Linda University, pictured here, came from several public health agencies from Southern California, the Pan American Health Organization (World Health Organization Regional Office for the Americas), and universities in Mexico and India.

Notable Links

- [www.cdc.gov/nchs/about/otheract/gis/gis_publichealthinfo.htm](http://www.cdc.gov/nchs/about/otheract/gis/gis_publichealthinfo.htm)
The National Center for Health Statistics produces Public Health GIS News and Information, a bimonthly online report. The report includes information on the use of GIS for disease control and prevention, notifications of events, and GIS-related Web links and literature.

- [msc.fema.gov](http://msc.fema.gov)
The Federal Emergency Management Agency (FEMA) Map Service Center offers the latest as well as historical flood maps and free map viewers for downloading. The historical flood maps are digital raster images of flood hazard boundary maps (FHBMs) and flood insurance rate maps (FIRMs). The Q3 Digital Flood Data and Coastal Barrier Resource Area product contains FIRM data and is GIS ready.

Medical Information System provides daily alert statistics for the European Union, updated every 10 minutes around the clock. The site includes data for many diseases and information on bioterrorism, vaccines, and medicines. News searches can be made in 22 languages.

- [gis.esri.com/esripress/display/index.cfm](http://gis.esri.com/esripress/display/index.cfm)
ESRI Press offers a wide variety of books on GIS, cartography, and spatial analysis. Books cover both the private and public sectors across many industries. Check out the site to see the latest releases, view the catalog, and place orders.

- [www.esri.com/podcasts](http://www.esri.com/podcasts)
The ESRI podcast page links you to the latest Instructional and Speaker series podcasts, such as Understanding the ArcGIS Desktop Applications: What Is ArcMap?

- [www.esri.com/arcgiserplorerblog](http://www.esri.com/arcgiserplorerblog)
The Web log (blog) maintained by the ESRI ArcGIS Explorer team presents useful information, tips, tricks, examples, and best practices. You can download the latest version of ArcGIS Explorer and find links to content and the ArcGIS Explorer forum and ArcScripts pages.

- [blogs.esri.com/arcgisserver](http://blogs.esri.com/arcgisserver)
This blog is written by the ArcGIS Server development team. Online discussion presents tips and best practices for effectively using ArcGIS Server.
ArcGIS Tracking Analyst Visualizes and Analyzes Change over Time

ArcGIS Tracking Analyst provides tools for playback and analysis of time series data. Tracking Analyst helps visualize complex time series and spatial patterns and interactions while integrating with all other GIS data within the ArcGIS system. ArcGIS Tracking Analyst also integrates with Tracking Server to allow you to support the display, management, and broadcast of real-time data over the Internet.

With ArcGIS Tracking Analyst, you can explore, visualize, and analyze change relative to time and location. ArcGIS Tracking Analyst provides capabilities for the sophisticated visualization and analysis of time-related data by defining temporal events that consist of the following information:

- **Time**—The date and time of the event
- **Position**—The geographic location of the event
- **Attributes**—Object-specific characteristics and properties

ArcGIS Tracking Analyst allows you to use data with a time stamp field and view those features in a sequence. You can also view a time sequence between data layers that individually represent specific points in time. In this way, ArcGIS Tracking Analyst allows you to leverage your existing data for time series visualization.

The extension allows for complete customization by writing macros in Visual Basic for Applications (included with ArcGIS Desktop) or creating extensions for ArcGIS Desktop developed in standard development environments. The extension includes a toolset for system integrators and advanced users with more than 50 ArcObjects components.

With ArcGIS Tracking Analyst, you can:

- Visualize change over time using standard attributes of GIS data.
- Visualize change over time using different data layers that represent specific points in time.
- Symbolize time by color, size, or shape to show the aging of data.
- Interactively play back time-related data.
- Apply actions to individual layers in a time sequence based on attributes, location, or a combination of the two: Highlight, Suppress, or Filter.
- Set temporal offsets for comparisons of temporal events.
- Create animation files for AVI output.
- Create a data clock temporal chart for additional analysis.

For more information and to request a free 60-day trial of ArcGIS Tracking Analyst, visit www.esri.com/trackinganalyst. Information on Tracking Server is available at www.esri.com/tracking-server.

(Courtesy of the Metropolitan Airport Commission Aviation and Satellite Program, Minneapolis-St. Paul International Airport.)

Conference Examines Shaping Global Health with GIS

September 28–October 1, 2008—The ESRI Health GIS Conference provides a forum for you to gain insight from industry leaders on the most recent thinking about geospatial data and analysis applied to community health, health care delivery, information sharing, and emergency preparedness and response.

Health and human services professionals will meet at the 2008 ESRI Health GIS Conference, September 28–October 1, 2008, in Washington, D.C., at the Renaissance Washington, DC Hotel. This year’s theme, Shaping Global Health, puts a focus on sharing and discussing successful approaches to using geography to improve research, management, policy decisions, public health and hospital preparedness, and health care delivery worldwide.

Invited speakers include Stephen W. Corbett, chief medical informatics officer for the Loma Linda University Adventist Health Sciences Center, speaking on the center’s Web-based hospital emergency situation awareness system; Carlos Castillo-Salgado, senior advisor for the Pan American Health Organization (PAHO), speaking on PAHO programs for promoting public health GIS in the Americas; and Yasushi Ohkusa, chief researcher for the Infectious Disease Surveillance Center, National Institute of Infectious Diseases in Japan, speaking on spatial modeling of health scenarios in a GIS environment.

In addition to attending speaker and paper sessions, attendees can participate in ESRI-sponsored workshops on Sunday, September 28. Kristen Kurland, professor at the H. John Heinz III School of Public Policy and Management, will give an executive overview of the value of GIS to health organizations; Katie Clift, ESRI technical analyst, will explain how ArcGIS Desktop users can utilize ModelBuilder tools to design workflow automation and spatial analysis tasks; and Lauren Scott, ESRI geoprocessing spatial statistics product engineer, will review new ArcGIS 9 spatial statistical methods that are useful for epidemiological analyses.
ESRI UC Returns to San Diego in August

The ESRI International User Conference (ESRI UC) is unlike any other event. As the largest GIS conference in the world, this annual gathering offers innovation at its best. Users from more than 120 countries come to learn new skills; share information; and discover best practices, tips, and tricks.

This year’s ESRI UC includes one- and two-day preconference seminars, with more than 40 topics including analysis, development, enterprise GIS, fundamentals, industry focus, mobile and server GIS, and visualization and cartography. Meet us at the San Diego Convention Center, August 4–8, 2008, to be part of this extraordinary experience.

Register online at www.esri.com/uc.

GIS Uncovers Hospital Infection Transmission Clues

Extending this work, Kho has developed, with Agency for Healthcare Research and Quality funding, an electronic network to track known MRSA patients whenever they are admitted to a hospital within Indianapolis and track some of the environmental factors that might be leading to infections and the frequency of the patients’ visits to health centers.

Kho currently holds dual posts as an assistant professor at Northwestern University in Chicago and affiliated scientist at Regenstrief Institute in Indianapolis. For more information, contact him by e-mail at abel.kho@nmmf.org.

Important ESRI UC Deadlines
San Diego, CA

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<th>Event</th>
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<tr>
<td>Early Bird registration</td>
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<tr>
<td>Standard registration</td>
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<tr>
<td>On-Site registration</td>
<td>September 28, 2008</td>
<td>$449</td>
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Register online at www.esri.com/events/health.

Note: Complimentary registrations based on software maintenance do not apply for the ESRI Health GIS Conference. Deadline for special group-rate hotel room reservations is September 5, 2008.

About Regenstrief Institute, Inc.

Regenstrief Institute, Inc., is an internationally recognized informatics and health care research organization dedicated to the improvement of health through research that enhances the quality and cost-effectiveness of health care.

For 30 years, Regenstrief’s research scientists have developed the Regenstrief Medical Records System (RMRS), one of the nation’s first electronic medical record systems and the keystone of many institute activities. RMRS serves as the day-to-day electronic medical records system at Indianapolis Wishard Memorial Hospital, among others.

In fall 2007, the U.S. Department of Health and Human Services awarded the Indiana University School of Medicine a contract to begin, through Regenstrief Institute, a trial implementation of a Nationwide Health Information Network (NHIN) in collaboration with eight other organizations.

For more information, visit www.regenstrief.org.