

Reinventing Public Health Preparedness Through Innovation

Kansas City Health Department automates disease outbreak and alert system

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One week after the devastating Sept. 11 attacks, a letter containing anthrax arrived at a television news studio in New York City. More tainted letters followed, addressed to the media and politicians, resulting in more than 20 people infected with anthrax spores. Bioterrorism, a new wave of terror, washed across the county and served as a catalyst for changing how Kansas City's public health department tracks and responds to disease outbreaks.

The Kansas City, Mo. Department of Health (KCHD) is part of the U.S. public health system that has improved the health of Americans for the past century. In the early 1900s, innovative programs by the public health system eradicated many deadly epidemics by improving sanitation, such as separating sewage from drinking water, implementing food inspections and recommending immunizations.

While seemingly simple ideas today, these entrepreneurial initiatives of the time eliminated much of the fear around diseases such as polio, smallpox, the plague, cholera and typhoid.

Because of past public health initiatives such as these, people live approximately 30 years longer today than they did in 1900. Five of these 30 years are attributed to better medical care while the remaining 25 years are credited to preventing or delaying disease through a better public health system. Despite the public health system's early influence on the health of Americans, the financial support of the public health departments has eroded over the past few decades, perhaps a victim of its own achievements.

People don't usually think about their local public health department when they purchase food or drink a clean glass of



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tap water and this attitude is reflected in the distribution of healthcare dollars. For example, only 9 percent of all healthcare expenditures were distributed to public health initiatives, including the National Institutes of Health and the Centers for Disease Control and Prevention (CDC), according to an article in the *American Medical News* published shortly after the anthrax attacks in 2001.

The investment in prevention has been neglected in favor of the perception that medicine will always have a cure.

The opportunity

Despite budgetary concerns or levels of disease outbreak, the KCHD’s mission is to “promote, preserve and protect the health of citizens in a healthy Kansas City.” We lose more lives from infectious diseases in Kansas City than we do from all motor vehicle crashes, burns, drownings, falls and homicides, combined. The KCHD is just as essential a public safety agency as the police or the fire departments.

To this end, our mission is carried out through the KCHD’s core functions of assessment, policy development and assurance by a number of programs, such as air quality, food protection, communicable disease prevention and public health preparedness.

Reporting specific health conditions is the civic responsibility of health professionals around the nation. At the KCHD, our communicable disease prevention program is the largest single initiative within the department and is responsible for the detection, control and prevention of communicable diseases and bioterrorism among Kansas City residents and visitors.

We accomplish this by monitoring the occurrences of those legally mandated reportable diseases and other diseases of public health concern. The City Council dictates that certain diseases must be reported by physicians, laboratories and others, within specific time frames. This mandate results in hundreds of physicians, laboratory technicians and clinicians submitting health information about the 441,500 residents that live in the 318-square mile, four-county Kansas City, Mo.-area to the department every day.

Because this information came from a variety of sources and locations, it was often convoluted and disparate. In Kansas City, details sent from one location were often missing from another one and vice versa. The information arrived at the department in various formats such as phone calls, e-mails, faxes and letters.

This information had to be entered into a surveillance system manually, which was a time-consuming process that elevated the risk for error. Delayed and under reporting were also problems. These delays also impacted how quickly we forwarded required information on to the Missouri state health department, who in turn, relayed the information to the CDC. With unorganized and late information, it was difficult to take the appropriate action to stop the spread of disease or biohazard.

Kansas City’s problems with health data collection were typical of other cities. Just two years before the anthrax attack, there was significant evidence that the U.S. public health system was unprepared for such an incident. In 1999, the CDC and National Association of County and City Health Officials tested how quickly local health departments could be notified of a health threat or bioterrorism emergency. The results were not promising:

- Only 35 percent of e-mail sent by the CDC to the local health departments was successfully delivered
- Only 20 percent of local health departments had e-mail capacity
- Less than 50 percent of the local health departments had high-speed continuous access to the Internet

Fast Facts

With 441,500 residents, Kansas City, Mo. is the nation’s 36th largest city per population.

Nearly 2 million people live in the greater Kansas City metropolitan area, which straddles the Missouri-Kansas state line and includes more than 176 cities and 15 counties.

Spanning 318 square miles, Kansas City, Mo. is the 13th largest city in the U.S. per land area.

- Less than 50 percent of local health departments had the capability to send fax alerts to multiple recipients such as state health agencies, the CDC and physicians
- Nationwide tracking for chronic disease, which is responsible for 70 percent of all U.S. deaths, was nonexistent

The innovation

Based on this data and deficiencies, clearly something had to be done to improve biosurveillance—the monitoring of information sources to detect an emerging epidemic, whether naturally occurring or the result of bioterrorism. A definitive tool for biosurveillance is the electronic reporting of diagnostic results to confirm the presence of a dangerous pathogen.

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One deadly pathogen that created fear across the country in 2001 was anthrax. Locally, the anthrax scare tangentially touched Kansas City when a community postal facility received a shipment of stamps from the Brentwood post office in Washington, D.C., where two postal workers were killed after handling two letters containing anthrax spores on their way to Capitol Hill in October 2001. Although no one in Kansas City was infected with anthrax, it definitely made us all think, “*Could it happen here? Are we adequately prepared to handle it?*”

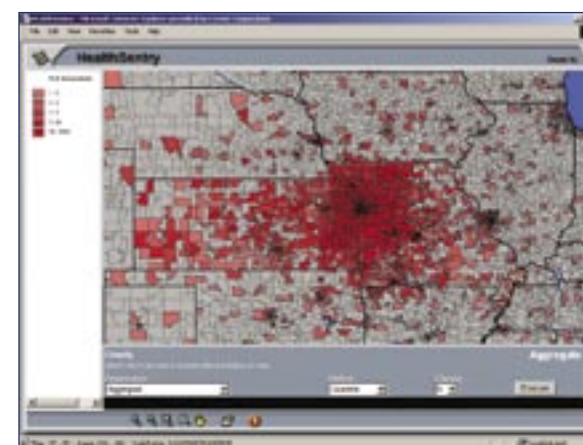
As the anthrax incidents unfolded, the KCHD saw the need for change and partnered with Cerner to create an innovative program to protect the health and safety of Kansas Citians. By developing a timely and sensitive, electronic reporting tool, we could quickly improve our biosurveillance. Together, we created an early warning computer system called *HealthSentry™* to alert health authorities to possible bioterrorist attacks or disease outbreaks in the area. In its simplest form, the system was the public health equivalent to a burglar alarm, designed to alert the appropriate authorities and trigger an immediate response.

HealthSentry provided a sorely needed, secure connection between health organizations’ laboratory systems and the KCHD through a data network. We launched *HealthSentry* as a pilot in April 2002, with development and roll outs scheduled through 2007. Cerner invested approximately \$2 million into the development of the system and provided the necessary software to area healthcare providers. The providers securely sent their laboratory information to Cerner, which used encryption processes to keep the identity of the patients confidential.

The data was then analyzed and released in a series of reports and regional maps. This information was made available to local health departments the next morning, enabling public health officials to log onto a secure Web site to view what diseases were reported in the previous 24 hours.

In addition to the analysis of laboratory data, *HealthSentry’s* integrated decision support system allowed us to define alerting criteria and then alert designated recipients. For example, the presence of even one occurrence of anthrax in the area could automatically trigger an e-mail, page or fax notification to on-call health officials.

Public health officials also customized Web-based reports, exported data for further analysis and viewed graphical maps generated from the secure Web-based access to the system. This feature offered the ability to select a pathogen of interest for electronic display or printing. The system also enabled quick identification of disease clusters that could be quickly shaded and displayed based on ZIP codes or county lines.



Map of Kansas and Missouri with color-coded number of potential reportable events per ZIP code.

Data and timing were the core elements of *HealthSentry*. Laboratory orders provided early warning of an undiagnosed disease, as an increase in the type of tests administered provided public health officials a clue to potentially dangerous disease outbreaks within a certain geographic area. Rapid access to this comprehensive data allowed KCHD to monitor, identify and analyze disease

outbreaks in a way that was previously unrealistic. More importantly, we finally had the ability to alert the public faster.

The process

The electronic reporting system consisted of four, nonaffiliated healthcare organizations of varying size; Cerner, as the data clearinghouse; and the KCHD as the recipient of the data. The healthcare organizations ranged from a regional care center with 49 beds to an urban hospital with 650 beds. *HealthSentry* collected clinical microbiology results from the providers and laboratory order-trending information. *HealthSentry* was the first reported system to provide laboratory order-trending information to public health organizations, which can provide the earliest warning that a disease outbreak has occurred.

Because of this exchange of patient information, we established agreements to ensure security within the system. Surveillance data reported to public health organizations are exempt from HIPAA. Legal agreements designating the supplier of the clearinghouse system as a business associate with full reporting capability were established with the participating organizations. These agreements, combined with: stringent access controls (physical and procedural security measures); encryption of identifiable information; and a virtual private network (VPN), ensured secure communications and protection of confidentiality.

Cerner extracted information daily at each healthcare provider, including new laboratory test orders, laboratory results and patient demographic information. The data was checked for errors/duplication and mapped. For example, microbiologic results identifying reportable pathogens were automatically mapped to a common nomenclature to standardize the varying names between the participating providers. Typical procedure orders, such as a stool culture, deemed relevant to the detection of an infectious disease outbreak, were also mapped to a common nomenclature.

After this process was complete, the results were used to build reports that were delivered through a secure Internet connection to the KCHD. For example, one report provided trending information on orderable procedures and another provided results from positive, reportable laboratory tests.

Disease reporting in Kansas City requires that public health officials know the name of the testing facility and the patient's age, date of birth, race, sex, address and telephone number. We evaluated reports received through both traditional (phone, fax, mail) and electronic reporting between March 29 and Sept. 2, 2002, for data completeness and timeliness. As each type of traditional or electronic report was received, we documented whether each required data element was provided and the date on which conventional reports were received.

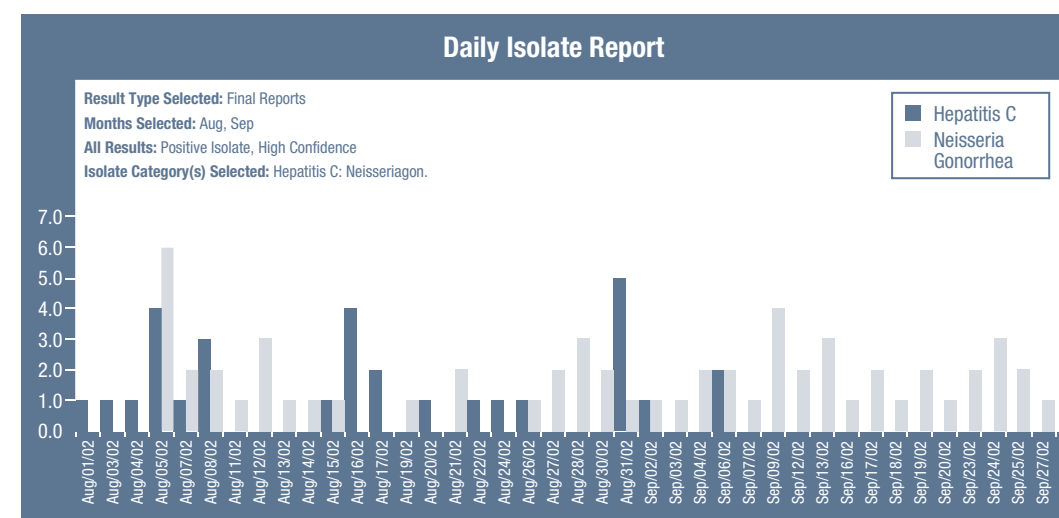
The results

HealthSentry monitored more than 50 reportable diseases, and automating the process greatly increased disease reporting numbers. For example, after 258 days of collecting data in 2002, we saw a 400 percent increase in the number of hepatitis C cases reported. Improvements in the reporting of Chlamydia, invasive group streptococcal infections and Salmonella were statistically significant. For example, one Chlamydia case arrived at the KCHD 20 days earlier.

In addition, cases of disease that were previously not reported, under reported, misreported or reported late, were suddenly more accurate. In particular, giardiasis and hepatitis C were underreported. Sexually transmitted diseases, including Chlamydia, gonorrhea, and syphilis, were also underreported.

Analysis of the system adds to the evidence that electronic reporting of disease can offer substantial benefits to public health. Notably, *HealthSentry* attained a significant improvement in timelines to detection for salmonella spp., as well as an improvement in underreporting of this pathogen. Salmonella and other pathogens tracked by the clearinghouse, including shigella, *E. coli* 0157:H7, giardia lamblia and cryptosporidium parvum are classified by the CDC as class B bioterrorism agents for food or water safety threats.

In comparing the completeness of the data delivered by electronic reporting to data delivered by traditional means, we discovered improvement for every



Example of a pathogen-trending report showing the trends for a user-selected set of pathogens.

data element. The conclusion was that greater completeness of data delivered by electronic reports is a tangible benefit for both healthcare providers and public health workers as it's more accurate, timely and reduces follow-up requests for additional information.¹

The future

While Kansas City now enjoys added protection through *HealthSentry*, there is much work to be done at the national level. A report released by the Trust For America's Health (TFAH) in December 2004, found that despite incremental progress, three years after the anthrax attacks, there is still a long way to go to protect the American people from bioterrorist attack. For example:

- Only five public health laboratories report sufficient capabilities

(facilities, technology, and/or equipment) to fully respond to a chemical terrorism threat, and only one-third of states report sufficient bioterrorism lab response capabilities

- Two-thirds of states do not electronically track disease outbreak information by national standards, causing serious delays in reporting, making early warning of disease threats difficult
- Nearly one-third of states cut their public health budgets between fiscal year 2003 and 2004, and federal bioterrorism budgets decreased by more than \$1 million per state in 2004
- Shifting federal priorities and programs are distracting from improvement efforts, and there is little, if any, accountability to the public

¹Archer, R, Hoffman MA, Wilkinson TH, Bush A, Myers W, Griffin RG, Hoff GL, Multijurisdictional approach to biosurveillance, Kansas City. Emerg Infect Dis [serial online] 2003 Oct [2005 July]. Available from: URL: <http://www.cdc.gov/ncidod/EID/vol9no10/03-0060.htm>

“Public health organizations can only implement effective prevention and control measures to protect the public if they have the ability to continuously monitor events, rapidly identify an outbreak, effectively analyze the data, immediately alert authorities and have the necessary resources to respond.”

Despite these findings above, some progress is being made. President Bush signed Project BioShield into law in July 2004, which provided new tools to improve medical countermeasures protecting Americans against chemical, biological, radiological or nuclear attack. However, the potential protection provided through BioShield strongly depends on how early we detect the outbreak or intentional attack and whether we have sufficient resources to respond.

The CDC’s BioSense initiative promotes greater and timelier acquisition of relevant data and will enhance the consistency of public health surveillance nationally. Furthermore, a strong “bio response” foundation is crucial for local and state health departments to be able to contain and prevent further spread of disease.

Comparison of reporting times between conventional and electronic reporting and evaluation of reporting coverage					
Pathogen	Average days earlier ^a	Electronic & traditional ^b	Electronic only ^c	Total reports	Reporting improvement (%) ^d
<i>Campylobacter</i> sp.	0.6	10	7	17	70
<i>Chlamydia trachomatis</i>	2.2 ^e	29	81	110	279
<i>Cryptosporidium parvum</i>	0.0	1	—	1	—
<i>Escherichia coli</i> O157:H7	0.0	1	2	3	200
<i>Giardia lamblia</i>	0.0	1	12	13	1,200
<i>Neisseria gonorrhoeae</i>	0.3	50	48	98	96
<i>Haemophilus influenzae</i> (invasive)	3.0	3	3	6	100
Hepatitis A	0.0	1	—	1	—
Hepatitis B	0.5	4	3	7	75
Hepatitis C	3.6	5	22	27	440
Influenza	1.2	5	3	8	60
Group A streptococcal infections (invasive)	2.3 ^f	7	1	8	14
<i>Borrelia burgdorferi</i>	1.3	4	3	7	75
<i>Salmonella</i> sp.	2.7 ^g	14	6	20	43
<i>Shigella</i> sp.	0.0	2	1	3	50
<i>Streptococcus pneumoniae</i> (invasive, drug-resistant)	8.0	1	—	1	—
<i>Treponema pallidum</i>	0.4	5	21	26	420
<i>Yersinia</i> sp.	0.0	1	—	1	—

^aAverage days earlier electronic report was received. Only cases received by both means were used to calculate this value.

^bAll reports received through traditional reporting were also received by the data clearinghouse.

^cElectronic only and traditional means column.

^dReceived electronically only/received through both means x 100.


^eSignificant as determined by Student t test (p<0.05).

^fSignificant as determined by Wilcoxon signed rank (p<0.05).

Lists specific pathogens and average improvement timeliness for each with electronic reporting.

As we found in Kansas City, whether facing a natural disease outbreak or a bioterrorist attack, public health organizations can only implement effective prevention and control measures to protect the public if they have the ability to continuously monitor events, rapidly identify an outbreak, effectively analyze the data, immediately alert authorities and have the necessary resources to respond. The KCHD, like many public health departments, was not fully prepared to take such actions before Sept. 11, 2001. Through innovation and partnership with our neighboring healthcare organizations, we used information technology to increase the effectiveness and capabilities of the public health department. Though we may now be better prepared to detect a large-scale outbreak or intentional attack, we still lack many of the vital resources necessary for an appropriate response. Without this additional infrastructure, we risk having many of the alarms go unanswered.

Innovative technological tools such as *HealthSentry*, coupled with increased funding to further restore public health infrastructure will help to protect and improve the health of the public.

Following the example of the early 20th century, public health departments made a huge difference in health and lives of Americans by reducing risks. Based on that model of prevention and innovation, public health systems can do the same with the health threats of today. 



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Rex Archer, M.D., MPH is the director of health for Kansas City, Mo., and president of the National Association of County & City Health Officials (NACCHO)

He is responsible for safeguarding the public health of nearly 500,000 residents and a daytime population of more than 1 million people.

The Kansas City Health Department (KCHD) has been most recently recognized as the first fully accredited public health agency in the state of Missouri and the first west of the Mississippi. The KCHD has also been recognized by the Centers for Disease Control and Prevention (CDC) as one of the first 11 local health departments in the U.S. to meet the criteria for public health ready.

Archer is an acknowledged authority on civilian bio-defense with more than 25 years of protecting the public’s health. Archer testified on the need to provide a better level of protection against infectious diseases and bioterrorism threats for the U.S. Senate Appropriations subcommittee of the Labor Health & Education on Oct. 3, 2001 (the first inhalation anthrax case occurred one day later on Oct. 4).

Archer has served as a senior advisor to the U.S. Department of Health and Human Services Agency for Health Care Research and Quality and the CDC, and has been widely quoted by national media including *The Boston Herald*, *The New York Times*, *The Wall Street Journal*, *The Washington Post*, MSNBC and CBS.

Prior to his present position in Kansas City, Dr. Archer completed his medical degree with the University of Kansas, his general preventive medicine public health residency and master’s degree in public health degree at the University of Michigan and is recognized as a Public Health Leadership Institute Scholar by UCLA/CDC. He has served as Physician in Charge—Employee Health Programs at the Ford Motor Company and local and state health positions in Maryland.