Practice of Communicable Disease Surveillance in North Carolina
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SLIDE 1 TITLE

SLIDE 2 Practice of Communicable Disease Surveillance in North Carolina

SLIDE 3
At the end of this presentation, you should be able to:
1. Describe the network of surveillance partnerships for communicable disease in North Carolina
2. Interpret reported data as an indicator of disease incidence within the community
3. List 4 public health uses of communicable disease surveillance

SLIDE 4
Before getting into some examples, let me begin by acknowledging our partners in public health practice. From a collaborating and coordinating perspective at the state level, our primary partners are the 85 local departments, most of these with an area of jurisdiction that coincides with the county where they are located, and some grouping a few counties as District Health Departments.

Next, we depend on the active involvement of clinicians and laboratories as the source of information on communicable disease occurrence. While recently we've worked hard to automate some aspects of disease surveillance, reporting clinicians and laboratories, together with the local health departments form the foundations of a network of health professionals involved in the collection and use of surveillance data.

And our others public health partners are:
- The 9 hospital based public health epidemiologists, who form a network of dedicated public health partners who are employees in the largest hospital systems in the state
- The 8 regional immunization consultants, primarily working on childhood vaccine preventable diseases
- Disease Intervention Specialists also regionally based, primarily working on tracing and contacting contacts of persons reported with sexually transmitted diseases, and on some occasions also in responses to other diseases
- And the 4 regional teams working on public health preparedness and response.

SLIDE 5
Epidemiologists from our Communicable Disease Branch frequently consult national experts at the Centers for Disease Control and Prevention about reported cases, outbreak investigations

and control measures, about trends observed in disease incidence, and for building standardized surveillance systems.
At the state level, other groups within the Epidemiology Section or Division of Public Health are sometimes a better match to find the needed expertise for some of the issues brought to the attention of our Communicable Disease Branch. Most commonly, we consult with the Occupational and Environmental Epidemiology Branch and the Office of Public Health Preparedness and Response, as well as with the State Laboratory of Public Health and the Office of the Chief Medical Examiner.

SLIDE 6
This diagram summarizes the flow of communicable disease surveillance data in North Carolina. Physicians report cases of reportable diseases to the local health departments, where data are entered into the NC Electronic Disease Surveillance System, or NC-EDSS.

Laboratories can also report directly into this electronic system. While attractive from the perspective of timeliness, comprehensiveness and efficiency, setting up Electronic Laboratory Reporting of reportable lab results is complex and labor-intensive. Two very important laboratories, the State Laboratory of Public Health and LabCorp have been reporting by ELR since late in 2008. As of January, 2014, a total of 15 laboratories are reporting in production mode, and many more (58) are in the process of developing ELR with IT and business staff from the Division of Public Health.
Other laboratories still send their reportable results to us by secure fax, encrypted email or regular mail.

The system allows two-way communication between local health department in charge of communicable disease control and Subject Matter Experts of the Communicable Disease Branch at the State level.

Lastly, this system is used to notify CDC of reportable communicable disease data in a format that does not identify patients.

SLIDE 7
The public health collection of disease data through reportable disease requirements does not provide us with an exact count of disease incidence in the community. While we would like for cases of reportable disease to be reported close to 100% of the time, we have to recognize that the resulting picture is rather an indicator of disease incidence in the community. Let's look at the graph shown on this slide to illustrate and explain this.

You can see on this pyramid where the base is the general population, that of the subset of persons ill in the community, a gradually reduced fraction consults a physician, had a specimen collected to confirm the diagnosis with a test intended to detect the causative organism, not all of whom have a positive result, and even fewer getting reported. So the information that eventually reaches public health professionals is carefully considered, with the knowledge that it may be the tip of a larger occurrence of illness in the community.

SLIDE 8

Another analogy often used to illustrate this concept is that of the “Tip of the Iceberg.” Of all infected cases, only a subset will consult their health provider, as shown here in a slide used to talk about influenza surveillance.

SLIDE 9

In the traditional model of disease surveillance, information that reaches public health professionals is fragmentary and not timely. As shown on this graph, just one or a few case may be reported to the local health department, and after a delay that can sometimes be prolonged.

In this example of an outbreak of shigellosis --a disease that is easily transmitted from child-to-child-- in a child care facility, the better use of surveillance data is for the public health person receiving the first reported case(s) to immediately pick up the telephone and verify with the patient or his/her parents or guardians if this reported case is associated with attendance at a child care facility, then further contacts the facility to learn whether there is an outbreak in the facility.

In other words, public health surveillance does not rely only on passive accumulation of information, but on the active (or reactive) use that is made of the available data.

SLIDE 10

Next, let me remind you of some of the uses we can make of surveillance data, as already introduced in the lecture by Dr. Fleischauer in Unit 3 of this course.

Here are 4 public health uses of surveillance data:

- Count cases and measure trends
- Identify risk factors associated with certain diseases
- Verify that control measures have an effect on disease incidence
- And document the need to allocate resources

SLIDE 11

In most of this presentation, I will use data reported by clinicians and laboratories. But before we get to this, here is a graph that uses two other types of data sources, to illustrate that disease surveillance is a dynamic process and methods can vary to monitor the health status of the population in North Carolina.

This graph shows the surveillance of Influenza-Like Illness as a proportion of 2 patient populations: Hospital Emergency Department visits in the blue line, and outpatients seen at a network of volunteer practice offices (also called ILINet) in the purple line.

Even though the magnitude of data point is not identical in the two systems (the patient population is not exactly the same, and the case definition also may differ slightly), we clearly are following the same type of event with these two systems.

The increase seen in early May 2009, on the left side, is contemporary of the recognition of a novel influenza virus in North America, the one that caused the pandemic influenza of 2009, and the more than tripling of incidence seen in September occurred when schools reopened after the summer.

SLIDE 12
We will now look at several examples of interpretation of surveillance data.
A changes in incidence may be expected or not, and may reflect trends.
And because we are <u>epidemiologists studying the distribution and determinants of disease frequency</u> in human population, we <u>analyze the data in terms of time, place and persons</u>.

SLIDE 13
And while a change in disease frequency may reflect a true change in disease incidence, we must carefully rule out other possible explanations before rushing to conclusion. We want to verify that changes are not consequent to reasons such as:

- Population change
- Changes in the reporting procedure
- Changes in personnel which may affect increases or decreases depending with how systematic and thorough different persons may be
- Scientific progress, with for example the availability of new tests, or their use extending from research to commercial availability.

If observed changes are not a result of these types of changes, then we may consider that they reflect true changes in disease incidence in the community.

SLIDE 14
This graph showing the incidence of salmonellosis in the United States in the 1970s and 1980s. It is relatively old but remains interesting as it combines several patterns of incidence: annual seasonality peaking each summer, overall increasing trend across two decades, and a marked peak superimposed over the seasonal incidence in 1985, reflecting a large outbreak with over 16,000 confirmed cases that was associated with a faulty pasteurization process of milk distributed in a large metropolitan area.

SLIDE 15
Here is the trend of tuberculosis incidence in the US in the 1980's and early 1990's. Starting in 1985, there is a departure from the expected decreasing trend based of the experience in the early 80's. One of the definitions of an outbreak is having more cases observed than expected.

This is what happened as a result of the spreading AIDS epidemic, with tuberculosis being a frequent opportunistic infection in AIDS patients.

SLIDE 16

Following investigation and modification of tuberculosis control policies and practices, the pre-existing trend was restored and the decreasing slope resumed, parallel to what it had been prior to the first years of the AIDS epidemic.

SLIDE 17

As another example of trend accompanying efficient control measures, this trend documents how the Haemophilus influenzae B vaccine effectively prevented numerous cases of this infection.

SLIDE 18

Another success story is seen with the surveillance of acute hepatitis B, concurrent with universal hepatitis B vaccination at birth.

SLIDE 19

In children aged less than 20, a 91% decline in incidence was observed between 1991 and 2005. In adults, the decline was 75%.

The 6 Graders vaccination campaigns were organized to shorten the lag time before the benefit of vaccination would become evident. As most cases of hepatitis B are the result of sexual transmission, vaccination of all birth cohorts alone, started in 1994, would have resulted in having to wait until this birth cohort would reach an age where sexual activity would start. Vaccinating older children shortened this lag time.

SLIDE 20

Here is the trend of hepatitis A incidence in North Carolina in the 2nd half of the 1900's. (It matched the national trend closely.) Outbreak peaks were cyclical; coming back every few years, and in the more recent years the magnitude of these peaks has declined and the interspace between peaks is longer. These changes are contemporary of improvements in hygiene and food preparation, better understanding of the risks and of the measures available to control the spread of hepatitis A, such as the post exposure administration Immune Globulin or hepatitis A vaccine.

SLIDE 21

Concentrating our attention on recent years, one can see the outbreak of 1988-1990, followed by years that appear to show a relative steady state of about 200 cases or less reported in NC in most years.

SLIDE 22

Let's drill down now, and analyze the data by person characteristics. (Remember, epidemiologists analyze data in terms of time person and place.) Stratifying by gender, we notice that males exceed females most years, and this differential is most obvious in 2001, 2002 and 2003 where over half of reported cases were males.

SLIDE 23

Now, further stratifying these surveillance data, we can see that most cases were young adult males. While hepatitis A is largely known to be a foodborne disease, which can also be transmitted from person-to-person, these observations were documenting an ongoing outbreak of hepatitis A among the gay community, and we targeted risk communication to this community.

SLIDE 24

Analyzing surveillance data by "place," we can map cases by the county of residence of reported patients. In the summer of 2001, there was noticeable clustering of cases of Salmonella enteritidis infection in the area around Charlotte. Careful investigation through a case-control study revealed that these cases were associated with egg consumption, with eggs that came from a farm in proximity to that area that had been associated with a prison outbreak six months earlier.

SLIDE 25

On this map, you can see the distribution of reported cases of LaCrosse encephalitis according to their county of residence over the 14 years between 1998 and 2011. LaCrosse encephalitis is an infection resulting from the bite of mosquitoes carrying the responsible virus, and the geographical location of these cases follows in part that of habitat of the mosquito vector, the "tree hole mosquito."

SLIDE 26

As some of the counties in the western part of the state are sparsely populated, the distribution of counties with highest incidence rate, relative to population, is slightly different that that showing cases in the previous slide.

SLIDE 27

The trend of Rocky Mountain Spotted Fever cases reported in NC over the past two decades includes a steady increase starting in the year 1998. This is the year positive laboratory results indicative of this infection were made reportable. Laboratories became aware of this requirement, possibly gradually. Also, dedicated and tenacious public health staff reviewed these reports, and pursued all reports until it was known whether each case met the case definition or not. So, while true increased incidence over these years may have occurred, we can reasonably suspect that artifacts contribute to the direction of the trend. In addition, less than 5% of these case reports included sufficient laboratory data to meet the case definition as confirmed cases of RMSF, which requires retesting during convalescence, generally after weeks.

SLIDE 28
With a finer time distribution of close to 3,000 reported cases of RMSF, by month of onset of illness instead of by year, a seasonal pattern that is concomitant of tick activity is recognizable.

SLIDE 29
Here is a test. Looking at the distribution by age group of reported cases for this disease, what kind of inference could you make regarding its mode of transmission?

It is noticeable that reported cases are mostly among young adults, in the 20 to 34 year old age group, and to a lesser degree in the 35-64 year olds.

SLIDE 30
Sexual transmission is the predominant mode of transmission of hepatitis B, and this is reflected in the age distribution of reported cases.

SLIDE 31
Here is an interesting distinction observed in tuberculosis surveillance data. Tuberculosis among the US-borne population is steadily decreasing, while it is not in the foreign-born population. So, with regards to tuberculosis incidence, we are seeing a different impact among these populations.

SLIDE 32
Measles surveillance provides us with another opportunity to analyze data by person characteristics. Typically, the expected baseline of measles incidence is about zero case per year, with occasionally imported cases being identified.

In 1989, over 180 cases were reported in North Carolina. While measles is generally known as a childhood disease, almost 80% of the reported cases were aged 10 to 24 years. A loosely enforced vaccination policy using a single dose of vaccine resulted over the years in a significant pool of susceptible individuals in the community. When a case or a few cases of measles, which is highly transmissible, were introduced in this population, all exposed susceptibles were infected.

In terms of using surveillance for guiding actions, this resulted in policy changes: measles vaccination now consists of the administration of two doses of vaccine, as opposed to one in the past, and immunization requirements for admission to schools and universities is now strictly enforced.

SLIDE 33

Continuing with measles surveillance, in 2013 a person returned to NC from attending an event in India, where he was exposed to measles. That person belonged to a community that was poorly vaccinated, resulting in 23 cases before this outbreak could be brought under control.

SLIDE 34

Surveillance of another vaccine preventable disease, pertussis, or whooping cough, shows recent increased incidence in North Carolina, as observed in other states. This calls to maintain or increase the rate of immunization on the population. It appears to also suggest that the vaccine currently in use, while causing less adverse reactions, may also have lowered the herd immunity in the population, in part as a result of waning immunity that occurred faster than with the older vaccine.

SLIDE 35

In the recent past, major improvements were made in the conduct of surveillance for communicable diseases.
Electronic reporting was implemented, mostly as a result of dedicated federal funding
e.g., NC-EDSS (for case reports and laboratory results),
NC DETECT for near-real time reporting (hospital E. Depts., Poison Center, EMS)

The Reporting of events providing earlier warning was added to the traditional surveillance of diagnosed cases. Examples include:
- Electronic reporting of laboratory results, and
- Syndromic surveillance – rather than surveillance of diagnosed cases – as is done in North Carolina with mandatory reporting of hospital Emergency Department visits.
- Public Health use of non-traditional sources of data: Ambulance runs, Poison Control Center calls, School absenteeism, Pharmaceutical drug sales, etc.

Also recently, Healthcare-Associated Infection became the focus of national debate, and public health officials in North Carolina and other states are working on collaborative approaches to prevent these infections from occurring, and they are also building new surveillance systems to monitor the incidence of these infections.

SLIDE 36

Following the anthrax outbreak of 2001, the concept of syndromic surveillance gained traction as a possible counter-measure against bioterrorism. On the upper part of this slide, traditional surveillance is represented with the blue line, showing that it takes several days for information on diagnosed cases to reach public health officials. Syndromic surveillance (shown in red), on the other hand, can provide an early warning, early enough to administer effective post-exposure prophylaxis to exposed persons, such as antibiotics, in time to avoid a fatal outcome in many of them, as shown on the lower part of the slide.

SLIDE 37

The syndromic surveillance system is called NC DETECT. (Disease Event Tracking and Epidemiologic Collection Tool.) The syndromic surveillance epidemiologists monitoring data in DETECT rely primarily on hospital emergency department (ED) visits and Poison Center data (CPC for Carolinas Poison Center).

SLIDE 38
In North Carolina, when a decision to build a syndromic surveillance system was made, it was decided to build a statewide system, and partner collaboration with the NC Hospital Association was crucial to make a minimum dataset from all Emergency Department visit reportable by law.

SLIDE 39
To end on a good note, this slide represents hospital participation to the national BioSense surveillance system for Emergency Department visits. The excellent level of coverage reached in North Carolina is evident on the national map of non-Department of Defense reporting hospitals, where statewide coverage provides population health data.

SLIDE 40
Updated map as of February, 2014 shows the distribution of hospitals has not changed dramatically, although the statewide nature of hospital ED surveillance is obvious in a few states, including NC.

SLIDE 41
Lastly, here is a pictorial representation of the systems in use in North Carolina to conduct surveillance of communicable diseases and of the communication channels associated with them. On the right side is the "traditional surveillance system" into which reports are received from clinicians and from laboratories, and on the left is the more recent syndromic surveillance system. As disease surveillance is conducted for action, as a tool used in the control of these diseases, data from multiple sources are fed into the system and significant information derived from analysis is shared with public health partners through the Health Alert Network.

I hope you find your work in conducting surveillance for communicable disease as much of a passion as it is for many of the speakers invited to participate in the recording of this series of lectures.

Thank you for your attention.