Surveillance for Healthcare-Associated Infections Among Long-Term Care Facilities: The Basics

Gwen Borlaug, CIC, MPH

September 19, 2013

Content

This presentation will include an overview of the basic principles and terms used in the practice of surveillance and epidemiology. It will provide the foundation for developing and implementing surveillance programs in LTC facilities.
Surveillance is…

... a comprehensive method of measuring outcomes and related processes of care, analyzing data, and providing information to members of the healthcare team to assist in improving those outcomes.

…the first step in prevention. It describes the “who, what, where, when” of disease occurrence, which informs and directs prevention measures.

Terms

- **Outcome**
  - Result of care or performance
  - May be negative (e.g., __________)
  - May be positive (e.g., __________)

- **Process**
  - Steps taken to achieve an outcome
  - Examples: _________________
Goals of Surveillance

- Prevent infections among residents
- Prevent infections among healthcare personnel
- Achieve above in the most cost-efficient manner possible

Purposes of Surveillance

- Determine endemic rates of disease occurrence
- Detect and investigate clusters or outbreaks
- Assess prevention/control measures
- Identify potential risk factors
Purposes of Surveillance

- Target performance improvement efforts
- Monitor compliance with process measures
- Detect and report notifiable diseases to public health
- Identify epidemiologically important pathogens (e.g. TB, multidrug-resistant organisms)

Terms

- Cluster— an observation of an unusual number of events grouped together in time and space, with no immediate recognized cause
- Outbreak—an incident in which two or more epidemiologically-linked cases of a similar disease occur
- Risk factor—variable associated with an increased chance of developing disease or infection
Terms

- **Endemic**—the usual presence of a disease or condition in a specific population or geographic area
- **Epidemic**—the occurrence of more cases of a disease than expected in a given area or among a specific population during a specified time period

Surveillance Steps

- Assess the population
- Select the outcome or process to be measured
- Use surveillance definitions
- Collect surveillance data
- Calculate and analyze the data
- Apply risk stratification
- Report and use data for improvement
Use Surveillance Definitions

- Define all data elements (outcome/process, the at-risk population, risk factors).
- Use standardized case definitions to ensure consistent, accurate, reproducible data.
- Use the same definitions and methods if data are compared over time.
- Indicate clearly any changes in definitions when reporting data.

Example

As the infection preventionist at a long-term care facility, you decide to conduct surveillance for primary bloodstream infections associated with use of central lines. Residents who are admitted with a central intravascular catheter will be included in this surveillance process.

http://qhr.knowledgebase.co/article/central-venous-access-procedures.html
Example

Identify
- The outcome being measured
- Items that require a definition
- The population at risk
- Risk factors
- Potential sources of standardized definitions

Collect Surveillance Data
- Train personnel in data collection methods.
- Use information technology expertise and resources when possible.
- Consider use of software to filter data and electronic patient records to improve efficiency.
- Collect data from a variety of sources.
- Conduct active, prospective surveillance when possible.
Terms

- Active surveillance—intentional collection of data to identify residents with conditions of interest. A designated individual systematically and routinely reviews data sources.
- Passive surveillance—data sources are not routinely reviewed. The data collector waits for reports of possible events and does not actively seek out information.

Terms

- Prospective surveillance—monitor for events during admission/when resident is at risk
- Retrospective—review charts after discharge/when resident no longer at risk

The National Healthcare Safety Network (NHSN) requires active, prospective surveillance conducted by a trained healthcare professional.
Practice Question

What is your favorite infectious disease?
1. Tuberculosis
2. Norovirus
3. Influenza
4. Coccidioidomycosis

Quiz Time

- As part of conducting HAI infection surveillance in your facility, you review pharmacy reports every Monday and Wednesday to identify residents receiving antibiotic therapy. This is an example of
  1. Active, retrospective surveillance
  2. Active, prospective surveillance
  3. Passive, retrospective surveillance
  4. Passive, prospective surveillance
Calculate Rates

- Rates, ratios, and proportions are used to measure the frequency of an event in a specific population during a given time period.
- Calculating frequency of an event requires a numerator and a denominator.

Terms

- Numerator—the number of cases or events in a specific population during a specified time period
- Denominator—the population at risk during the same specified time period
Rates

- Most commonly used rates in HAI surveillance
  - Incidence
  - Prevalence
  - Incidence density

Rates

- Incidence
  - Measures the occurrence of new cases or events in a specific population during a given time period
  - Formula
    \[
    \text{number of new cases} \times 10^n \over \text{number in the population at risk}
    \]
Quiz Time

During January 2013, an IP at a long-term care facility identified 7 new cases of influenza-like illness among the 35 residents living in the dementia unit. What is the incidence of ILI on this unit during January 2013?

1. 2 %
2. 20 %
3. 7 per 100 admissions
4. Not enough information to calculate incidence

Rates

- Prevalence
  - Measures existing cases of a disease or condition in a population during a given time period
  - Used mainly with chronic diseases or colonization with multidrug-resistant organisms
  - Formula
    \[
    \frac{\text{number of individuals with a given condition}}{\text{number in the population}} \times 10^n
    \]
A LTC facility determined prevalence of MRSA among its 150 residents during April 2013. Staff conducted a medical records review to identify residents with histories of MRSA colonization or infection during Jan–March, and obtained nares cultures during April from residents with no documented history of MRSA colonization or infection. The medical records review identified 10 residents with histories of MRSA, and nares cultures identified 15 residents with MRSA colonization. What is the prevalence of MRSA colonization/infection during April 2013 among residents of this facility?

1. 16.7%
2. 10%
3. 6.7%
4. 16.7 per 100 admissions
Rates

- Incidence density
  - Expression of incidence in which the denominator is person-time units (e.g. ventilator days)
  - Accounts for the variation in exposure time, and therefore risk, in the population (a resident with an indwelling urinary catheter in place for two days does not have the same risk of infection as a resident who has it in place for 30 days)
  - Used to calculate device-associated HAIs

Rates

- Incidence density
  - Formula
    \[
    \frac{\text{number of device-associated infections}}{\text{number of device days}} \times 1,000
    \]
  - To obtain device days per month, the number of residents with a device is obtained at the same time each day, and the total for all days is calculated at the end of the month.
Quiz Time

During April 2013 at Happy Times Nursing Home, 3 residents had an indwelling catheter in place for 3 days, 5 residents for 2 days, and 1 resident for 4 days. How many catheter days are counted for April?
1. 12 catheter days
2. 18 catheter days
3. 9 catheter days
4. 23 catheter days

Quiz Time

One of the residents with indwelling urinary catheters was determined to have a catheter-associated urinary tract infection (CAUTI) that same month. What is the incidence density of CAUTI for April 2013?
1. 4.35 per 1,000 catheter days
2. 43.5 per 1,000 catheter days
3. 11% of residents with catheters
4. None of the above
Ratios

- Ratios—fractions in which the values in the numerator may or may not be in the denominator
- Example of ratio with independent numerator and denominator
  - Among 100 adults attending a conference, 40 are male and 60 are female. The ratio of male to female adults is 2:3.

Proportion—a ratio in which the numerator is a subset of the denominator

- Example
  - Among 100 adults attending a conference, 40 are male. The proportion of males in this group is 40/100, or 2/5. Expressed as a per cent, 40% of the conference attendees are male.
Device Utilization Ratio

- Measure of how much devices are used among a population of residents
- Formula
  \[
  \frac{\text{number of device days}}{\text{number of resident days}}
  \]

Quiz Time

In addition to the number of urinary catheter days at Happy Times Nursing Home during April, you also note that a total of 10 residents were present in the facility for all 30 days of April. What is the urinary catheter device utilization ratio for this facility during April 2013?

1. 90%  
2. 23  
3. 0.08  
4. 0.08 catheter days/resident
Mean

- Mathematical average of a set of data
- Example:
  - The mean (or average) number of emails you receive per month is 75.
  - What do you need to know to calculate this?

Quiz Time

Calculate the average monthly CAUTI rate during the following 6 months at Happy Times Nursing Home

<table>
<thead>
<tr>
<th>Month</th>
<th>Number CAUTI</th>
<th>Number Catheter Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>February</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>March</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>April</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>May</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>June</td>
<td>4</td>
<td>30</td>
</tr>
</tbody>
</table>
Quiz Time

The mean monthly CAUTI rate during the first half of 2012 among residents of this nursing home is

1. 73/1,000 catheter days per month.
2. 73/1,000 patient days per month.
3. 70/1,000 catheter days per month.
4. 70/1,000 patient days per month.

NHSN Rate Table

<table>
<thead>
<tr>
<th>Location</th>
<th>Yr./Month</th>
<th>No. CAUTI</th>
<th>Urinary Catheter Days</th>
<th>CAUTI Rate</th>
<th>NHSN CAUTI Pooled Mean</th>
<th>Incidence Density p-value</th>
<th>Incidence Density Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 North</td>
<td>2013M02</td>
<td>0</td>
<td>198</td>
<td>0.000</td>
<td>1.6</td>
<td>0.7329</td>
<td>25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Days</th>
<th>Cath Util Ratio</th>
<th>CathDU_Mean</th>
<th>Proportion p-value</th>
<th>Proportion Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>236</td>
<td>0.839</td>
<td>0.67</td>
<td>0.0000</td>
<td>80</td>
</tr>
</tbody>
</table>
A p-value is associated with a statistical test that determines the probability that a sample group is different from a standard population.

A probability of 95%, or a p-value of 0.05 or less is usually used to determine statistical differences between sample and standard populations.

The smaller the p-value, the greater the probability the two values represent differences between the two groups.

Suppose the CAUTI rate for nursing home A during 2012 was 1.2 infections per 1,000 catheter days, and the national pooled rate for similar types of nursing homes was 3.1 during that same time period. The p-value for these data is 0.08. What does this mean?
2012 Nursing Home A CAUTI Rate Table
Unit 1

<table>
<thead>
<tr>
<th>CAUTI Count</th>
<th>Urinary Catheter Days</th>
<th>CAUTI Rate</th>
<th>NHSN CAUTI Pooled Mean</th>
<th>Incidence Density p-value</th>
<th>Incidence Density Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1918</td>
<td>0.521</td>
<td>4.1</td>
<td>0.0035</td>
<td>30</td>
</tr>
</tbody>
</table>

Patient Days Cath Util Ratio CathDU Mean Proportion p-value Proportion Percentile

| 3841        | 0.499                  | 0.50       | 0.3755                 | 56                        |

Rate Table

- How many CAUTI were identified on this unit during 2012?
- How many urinary catheter days were recorded among residents in this unit?
- What was the CAUTI incidence density for this unit during 2012?
- What was the national mean CAUTI incidence density during 2012?
Rate Table

- Is incidence of CAUTI in this unit different from the national incidence? Why or why not?
- Is that good or bad?
- What is the urinary catheter device utilization ratio for this unit during 2012?
- Is this ratio different from the national utilization ratio? Why or why not?

<table>
<thead>
<tr>
<th>CAUTI Count</th>
<th>Urinary Catheter Days</th>
<th>CAUTI Rate</th>
<th>NHSN CAUTI Rate Pooled Mean</th>
<th>Incidence Density p-value</th>
<th>Incidence Density Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1918</td>
<td>0.521</td>
<td>4.1</td>
<td>0.0035</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Days</th>
<th>Cath Util Ratio</th>
<th>CathDU Mean</th>
<th>Proportion p-value</th>
<th>Proportion Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>3841</td>
<td>0.499</td>
<td>0.50</td>
<td>0.3755</td>
<td>56</td>
</tr>
</tbody>
</table>
Percentile

- Used to compare values in sets of data
- Values from 0 to 99 that identify the percentage of the group with values less than yours
- Example: If CAUTI incidence in your facility is in the 75th percentile, this means 75% of all facilities in the database have lower CAUTI rates than your facility.
In what percentile is this nursing home, comparing its CAUTI rate to the national rate? What does this mean? Is this good or bad?

<table>
<thead>
<tr>
<th>CAUTI Count</th>
<th>Urinary Catheter Days</th>
<th>CAUTI Rate</th>
<th>NHSN CAUTI Pooled Mean</th>
<th>Incidence Density p-value</th>
<th>Incidence Density Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1918</td>
<td>0.521</td>
<td>4.1</td>
<td>0.0035</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Days</th>
<th>Cath Util Ratio</th>
<th>CathDU Mean</th>
<th>Proportion p-value</th>
<th>Proportion Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>3841</td>
<td>0.499</td>
<td>0.50</td>
<td>0.3755</td>
<td>56</td>
</tr>
</tbody>
</table>

2011–12 Nursing Home Employee Influenza Vaccination Rates at Key Percentiles, Wisconsin n = 279

<table>
<thead>
<tr>
<th>Percentile</th>
<th>EIVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th</td>
<td>50%</td>
</tr>
<tr>
<td>25th</td>
<td>65%</td>
</tr>
<tr>
<td>50th</td>
<td>82%</td>
</tr>
<tr>
<td>75th</td>
<td>91%</td>
</tr>
<tr>
<td>90th</td>
<td>97%</td>
</tr>
</tbody>
</table>
Quiz Time

How many reporting nursing homes achieved employee influenza vaccination rates of 50% or less during 2011–12?

1. 10
2. 50
3. 97
4. 28

Quiz Time

Your nursing home has a total of 120 employees. How many do you need to vaccinate for your facility to fall into the 10th percentile?

1. 60 or fewer
2. 97 or fewer
3. 65 or fewer
4. 120 or fewer
Median

The point at which half of the values in a data set are above and half are below. It is the middle point, or 50th percentile, and may have a different value from the mean. The median is less influenced by outliers than is the mean.

Back to the data set on slide 45: n = 10

Mean CAUTI rate = 3.5 infections/1,000 catheter days (35/10)

1.0
2.0
2.0
3.0
4.0
4.0
4.0
5.0
5.0
5.0

Median (50th percentile) = 4.0 infections/1,000 catheter days
Quiz Time

What was the median nursing home employee influenza vaccination rate during 2011—12?
1. 50%
2. 97%
3. 82%
4. Not sufficient information

Let’s review…

- Rates, ratios, and proportions are fractions.
- The numerator is the event of interest (e.g. infection, fall, pressure ulcer).
- The denominator is a measurement of the population at risk for the particular event under surveillance (e.g. all residents with a urinary catheter).
- Use of statistical probability methods (p-value) determines whether differences in rates are meaningful.
Risk Stratification

- Not all individuals within a resident population have the same risk.
- Differences in risk may occur due to age, sex, severity of illness, or other factors.
- Stratification is the process of subdividing the population into groups, based on a risk factor or characteristic.
- Risk stratification helps identify populations with highest risk, areas of most need for intervention.

Risk Stratification

- Example: Calculation of incidence of fall injuries among three groups of residents
  - The ambulatory elderly
  - Residents with Alzheimer’s disease
  - Residents with neuromuscular disorders
- Three rates would be calculated, one for each group, using different denominators (number of residents in each group).
During 2012, you conducted surveillance for incidence of fall injuries among the 100 residents in your facility, and observed that 20 such injuries occurred during that time period. If incidence by unit is as follows, in which unit would you begin a prevention program?

1. Ambulatory elderly unit
2. Alzheimer’s unit
3. Neuromuscular unit

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number of falls injuries</th>
<th>Number of residents/unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambulatory elderly</td>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td>Alzheimer’s</td>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>Neuromuscular disorders</td>
<td>2</td>
<td>10</td>
</tr>
</tbody>
</table>
Risk Stratification

- Additional examples
  - Stratifying by dwell time of urinary catheter
  - Monitoring healthcare personnel influenza vaccination rates by job classification
  - Uptake of a particular vaccine by residents, stratifying by payor source

Use of Data for Improvement

- Data are powerful when shared.
- Heightened awareness improves performance.
- Distribution of data should be part of the annual surveillance plan.
- Data should be reported in a systematic and timely fashion.
Use of Data for Improvement

- External data/inter-facility comparisons are valid only if:
  - Surveillance intensity is the same among all data sources.
  - Data collection methods are similar.
  - All contributors use the same surveillance definitions.
  - Differences in population are accounted for.

Prevalence of MRSA and CDI among Reporting Wisconsin Hospitals 2011—2012

Number of patients with MRSA or CDI/100 admissions 

- MRSA
- CDI

2011
2012
Frequency of surgical site infections associated with hip or knee replacement procedures, by infection type and primary pathogen, Wisconsin hospitals, 2011.

<table>
<thead>
<tr>
<th></th>
<th>Hip Replacement Procedures</th>
<th>Knee Replacement Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of reporting hospitals</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Number of infections/number of procedures (%)</td>
<td>81/4,964 (1.6%)</td>
<td>74/8,395 (0.88%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Types of infection</th>
<th>Number (%)</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep incisional</td>
<td>47 (58%)</td>
<td>29 (39%)</td>
</tr>
<tr>
<td>Superficial incisional</td>
<td>21 (26%)</td>
<td>26 (35%)</td>
</tr>
<tr>
<td>Joint</td>
<td>12 (15%)</td>
<td>18 (24%)</td>
</tr>
<tr>
<td>Bone</td>
<td>1 (1%)</td>
<td>1 (1%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Top primary pathogens isolated</th>
<th>Number (%)</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>29 (36%)</td>
<td>37 (50%)</td>
</tr>
<tr>
<td>Methicillin-resistant S. aureus (MRSA)</td>
<td>12 (15%)</td>
<td>8 (11%)</td>
</tr>
<tr>
<td>Coagulase negative staphylococcus</td>
<td>14 (17%)</td>
<td>13 (18%)</td>
</tr>
<tr>
<td>Streptococci</td>
<td>7 (9%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>E. coli</td>
<td>0 (0%)</td>
<td>4 (5%)</td>
</tr>
</tbody>
</table>

CAUTI Graph

How would you label this graph?
Summary

- HAI surveillance should be active, prospective, systematic and consistent.
- Surveillance provides outcome as well as process data for action toward improved resident care and safety.
- Sharing data with those who can change outcomes and processes supports quality improvement initiatives.

"Good surveillance does not necessarily ensure the making of the right decisions, but it reduces the chances of wrong ones."

--Alexander D. Langmuir, MD, MPH
Founder, CDC Epidemic Intelligence Service
References


“Dig Deeper”

- Chapters 5 and 6 of the APIC online text
  - Use of statistics
  - Statistical process control
  - Use of standardized infection ratio (SIR) as a method of risk adjustment
Gwen Borlaug, CIC, MPH
Coordinator, DPH HAI Prevention Program
1 West Wilson Street Room 272
Madison, Wisconsin 53702
608-267-7711

ghan.borlaug@wi.gov