Basics of Surveillance for IPAC
Objectives

- Discuss basic principles and methodology for Healthcare-Associated Infection (HAI) surveillance

- Review basic surveillance practices: data collection, analysis, interpretation, and communication of surveillance findings

- Review basic statistical terms and processes and how they relate to surveillance process and outcome measures for infection prevention
Surveillance

Defined as

• Surveillance is the systematic, ongoing collection, collation and analysis of data with timely dissemination of information to those who require this information in order to take action.

• The actions usually relate to improvements in prevention or control of the condition.

Surveillance

- A surveillance system is an **information** loop or cycle
- Starts and ends with communication and action

**Flow of Surveillance Data**

- **Collection**
- **Dissemination and utilization**
- **Collation and recording (reporting)**
- **Analysis and interpretation**
Why perform surveillance?

- There is conclusive evidence to show that the establishment of a surveillance system for HAIs is associated with reductions in infection rates.
- Surveillance is also useful in monitoring the effectiveness of preventive and infection control programs.
- Surveillance is required for patient safety and some mandatory reporting requirements in Saskatchewan (e.g. CDI, SSI).

- Objective: determine the extent of infections and the risk of disease transmission, so that prevention and control measures can be applied both effectively and efficiently to minimize the burden of illness.
Pop Quiz Hot Shot...

- Your CEO requests that your RHA begins HAI surveillance and the results are to be reported back to senior leadership and the board.

What do you do?
Steps to Planning a Surveillance System

1. Assess the Population to be Surveyed
2. Select the Outcomes for Surveillance
3. Use Established Case Definitions for Infection
4. Collect the Surveillance Data
5. Calculate and Analyze Surveillance Rates
6. Apply Risk Stratification Methodology
7. Interpret Infection Rates
8. Communicate and Use Surveillance Information to Improve Practice
9. Evaluate the Surveillance System
Recommended Practices for Surveillance

Surveillance Planning
Types of Surveillance

**Active surveillance:** Going out and looking for the disease
- provides the most accurate and timely information, but it is also expensive.
- E.g. breast cancer screening program

**Passive Surveillance:** Sitting back and waiting for the disease to be noticed
- relatively inexpensive and provides critical information for monitoring health.
- data quality and timeliness are difficult to control.
- E.g. notifiable diseases registry
Assess the population

Initial assessment should include:

- Who is at risk in this setting?
- What medical procedures or interventions occur in this setting?
- What is the frequency of particular types of infections?
- What is the impact of the infection?
- What is the preventability of the infection?
- What are we required to report? (e.g., antibiotic-resistant organisms).
Types of Infection Risk

- Procedure-associated risk
- Device-associated risk
- Patient or Care-level risk
Procedure-associated Risk

• Infection risk varies by type of procedure

Table 22. SSI rates* by operative procedure and risk index category, PA module, 2006 through 2007

<table>
<thead>
<tr>
<th>Procedure code</th>
<th>Operative procedure description</th>
<th>Duration cut point (min)</th>
<th>Risk index category</th>
<th>No. of procedures</th>
<th>No. of SSI</th>
<th>Pooled mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Abdominal aortic aneurysm repair</td>
<td>225</td>
<td>0,1</td>
<td>881</td>
<td>16</td>
<td>1.82</td>
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<tr>
<td>AAA</td>
<td>Abdominal aortic aneurysm repair</td>
<td>225</td>
<td>2,3</td>
<td>288</td>
<td>15</td>
<td>5.21</td>
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<td>APPY</td>
<td>Appendix surgery</td>
<td>81</td>
<td>0,1</td>
<td>2691</td>
<td>40</td>
<td>1.49</td>
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<tr>
<td>APPY</td>
<td>Appendix surgery</td>
<td>81</td>
<td>2,3</td>
<td>372</td>
<td>13</td>
<td>3.49</td>
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<tr>
<td>AVSD</td>
<td>Arteriovenostomy for renal dialysis</td>
<td>111</td>
<td>0,1,2,3</td>
<td>606</td>
<td>6</td>
<td>0.99</td>
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<tr>
<td>BILI</td>
<td>Bile duct, liver or pancreatic surgery</td>
<td>330</td>
<td>0,1</td>
<td>422</td>
<td>37</td>
<td>8.77</td>
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<tr>
<td>BILI</td>
<td>Bile duct, liver or pancreatic surgery</td>
<td>330</td>
<td>2,3</td>
<td>202</td>
<td>33</td>
<td>16.34</td>
</tr>
<tr>
<td>BRST</td>
<td>Breast surgery</td>
<td>202</td>
<td>0</td>
<td>997</td>
<td>8</td>
<td>0.80</td>
</tr>
<tr>
<td>BRST</td>
<td>Breast surgery</td>
<td>202</td>
<td>1</td>
<td>914</td>
<td>25</td>
<td>2.74</td>
</tr>
<tr>
<td>CARD</td>
<td>Cardiac surgery</td>
<td>300</td>
<td>0,1</td>
<td>10,382</td>
<td>121</td>
<td>1.17</td>
</tr>
<tr>
<td>CARD</td>
<td>Cardiac surgery</td>
<td>300</td>
<td>2,3</td>
<td>3396</td>
<td>58</td>
<td>1.71</td>
</tr>
<tr>
<td>CBGB</td>
<td>Coronary bypass w/chest and donor incision</td>
<td>300</td>
<td>0</td>
<td>1003</td>
<td>3</td>
<td>0.30</td>
</tr>
<tr>
<td>CBGB</td>
<td>Coronary bypass w/chest and donor incision</td>
<td>300</td>
<td>1</td>
<td>47,296</td>
<td>1399</td>
<td>2.96</td>
</tr>
<tr>
<td>CBGB</td>
<td>Coronary bypass w/chest and donor incision</td>
<td>300</td>
<td>2,3</td>
<td>15,706</td>
<td>767</td>
<td>4.88</td>
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<tr>
<td>CBGC</td>
<td>Coronary bypass graft with chest incision</td>
<td>285</td>
<td>0,1</td>
<td>3495</td>
<td>57</td>
<td>1.63</td>
</tr>
<tr>
<td>CBGC</td>
<td>Coronary bypass graft with chest incision</td>
<td>285</td>
<td>2,3</td>
<td>1,147</td>
<td>33</td>
<td>2.88</td>
</tr>
<tr>
<td>CEA</td>
<td>Carotid endarterectomy</td>
<td>133</td>
<td>0,1,2,3</td>
<td>2615</td>
<td>11</td>
<td>0.42</td>
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<tr>
<td>CHOL</td>
<td>Gallbladder surgery</td>
<td>121</td>
<td>0,1,2,3</td>
<td>3337</td>
<td>23</td>
<td>0.69</td>
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<tr>
<td>COLO</td>
<td>Colon surgery</td>
<td>188</td>
<td>0</td>
<td>2638</td>
<td>250</td>
<td>4.18</td>
</tr>
</tbody>
</table>
Device-associated Risk

- Infection risk increases with use of invasive devices
  - Higher risk with longer duration
Patient- or Care-level Risk

- Infection risk varies by patient-specific risk factors
- Infection rates vary by patient care unit

NHSN 2009 Data Summary, published 2011
Outcomes vs. Process Measures

- **Outcome Measure** - the result of care or performance
  - Infection rate
  - Mortality rate
  - Length of stay
  - Patient satisfaction

- **Process Measure** - series of steps that result in an outcome; adherence to polices and recommended practices
  - Immunization
  - Central line insertion practices
  - Hand hygiene
Outcome Measures

• Examples:
  • CAUTI per 1000 Foley catheter days (or patient days)
  • CLABSI per 1000 central line days
  • VAP per 1000 ventilator days
  • CDI per 10,000 patient days
Process Measures

Examples:

• CAUTI prevention: % foley catheters with appropriate indication
• CLABSI prevention: % adherence to prevention bundle (all or none)
• CDI prevention: % adherence to appropriate environmental cleaning practices
Use Surveillance Definitions

- Always refer to **written definitions** to ensure accuracy of applying case definitions
  - Use standardized, published, validated definitions where available
  - Where not available, prepare written definitions to ensure intra-facility standardization
- For accurate and valid comparisons, use the **same Definitions and case finding methodology**
  - If definitions/methodologies change, the comparability of rates over time will be compromised
NHSN Infection Surveillance Definitions

CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting

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BACKGROUND

Since 1988, the Centers for Disease Control and Prevention (CDC) has published 2 articles in which nosocomial infection and criteria for specific types of nosocomial infection for surveillance purposes for use in acute care settings have been defined.1,2 This document population for which clinical sepsis is used has been restricted to patients ≤1 year old. Another example is that incisional SSI descriptions have been expanded to specify whether an SSI affects the primary or a secondary incision following operative procedures in which more than 1 incision is made. For additional information about how these criteria are used for NHSN surveillance, refer
Alternative Surveillance Definitions

Surveillance definitions also exist for settings that may not yet be covered by NHSN definitions:

- Home care
- Clinics
- Dental offices

PHAC - Canadian Nosocomial Infection Surveillance Program
Recommended Practices for Surveillance

Data Collection
Collecting Surveillance Data

• Data collectors should include IPAC staff *and others* with responsibility or interest
• Limit collection to only what is needed
• Be involved in efforts that advance the electronic health record
Prospective vs. Retrospective

• Concurrent or prospective surveillance
  - Initiated when patient is still under the care

Advantages

• ability to capture information in real time
• interview caregivers
• observe findings not recorded in patient record
Prospective vs. Retrospective

• **Retrospective surveillance**
  - Closed record review after patient has been discharged or is deceased.

**Advantages:**
• allows for comprehensive review of sequential events
• efficient

**Disadvantage:**
• does not allow for prompt intervention

**NOTE:** Avoid reliance on administrative data, i.e. abstracted billing; may be useful for identifying possible HAIs but not reliable or valid for HAI surveillance.
<table>
<thead>
<tr>
<th>Incidence</th>
<th>Measure of new infections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons in a population who develop a disease or condition within a specified period of time</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prevalence</th>
<th>Measure of infections that are present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of persons in a population who have a disease or condition at a given point in time</td>
<td></td>
</tr>
</tbody>
</table>
Incidence and Prevalence

- **Incidence:** number of new cases of a disease that occur during a specified period of time in a population at risk for developing the disease
- Measures RISK in specific groups of people (sex, age, occupation, ethnic background)
- Denominator includes population at risk
- Time must be specific and all individuals in the denominator must be at risk during that time period
- Time is arbitrary and depends on the disease (e.g. week, month, quarter, etc.)
- Can be expressed as a % or as a rate per 1,000 people or in person-time (e.g. person-years)
Incidence

- In general, incidence is:
  \[ A = \text{number of new cases} \]
  \[ P = \text{population at risk} \]

Given over a specific time period

e.g. # of SSIs following C-section in Q3

# of women who had a C-section in Q3
Cumulative Incidence vs. Incidence Density

- Cumulative Incidence (AKA Incidence Proportion)
  - Calculated using a period of time during which ALL of the individuals are considered to be at risk for the disease (i.e. when following an entire population)

- Incidence Density
  - Calculated by including in the denominator the sum of time during which EACH individual was at risk (person-years) (i.e. when following a group of individuals who have been observed for different durations each)

\[
A = \text{number of new cases} \\
PT = \text{Population at risk (P) x duration of risk (T)}
\]
Example: Figure above shows 5 people, 2 of which developed HIV in the five-year follow-up period of the study.

Cumulative incidence = 2 cases/5 individuals over 5 year period
= 0.4 over a 5 year period
= 0.08 over a 1 year period
= 8 per 100 over a 1 year period

Incidence Density = 2 cases/16.5 person years
= 12.1/100 person years of observation
Incidence

Example:
- A total of 5031 patients were observed for a total period of 127,859 patient-days
- 596 patients developed a nosocomial infection
- What is the incidence rate of nosocomial infection in the hospital (per 1000 patient days)?

\[
\frac{596 \text{ new cases} \times 1000}{127,859 \text{ pt days}} = 4.7 \text{ cases/1000 patient days}
\]

Is this cumulative incidence or incidence density?

CUMULATIVE INCIDENCE
Incidence

Another Example:

- Between 1996 and 2000, 2957 women were newly diagnosed with acute myelocytic leukemia in a geographic area in the US covered by a National Cancer Institute registry.
- An estimated 19,185,836 women lived in these areas on average during this 5 year period.
- First, what is the total number of woman-years for this period?
  \[ 19,185,836 \text{ women} \times 5 \text{ years} = 95,929,180 \text{ woman-years} \]
- What is the incidence rate for leukemia for this period for this population?
  \[ IR = \frac{A}{PT} = \frac{2957}{95,929,180} = 0.03 \text{ cases per 1000 woman-years} \]
Prevalence

- Number of people with the disease at a specific time divided by the number of people in the population at that time.
- Measures burden of disease (diseases with long morbidity have higher prevalence)

**Point Prevalence:** The proportion of people in a population who have a disease at a particular time, such as a particular date (a “snapshot”)

Point Prevalence = \( \frac{\text{# of all cases on a specific date}}{\text{# of people at risk on that date}} \)

**Period Prevalence:** The proportion of people in a population who have a disease over a specific period of time (i.e. a season, or a year)

Period Prevalence = \( \frac{\text{# of all cases in that period}}{\text{# of people at risk during that period}} \)
Prevalence

Examples:
23% of this class is left handed

In 2008, 28% of Americans were clinically obese

<table>
<thead>
<tr>
<th>Interview Question</th>
<th>Type of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Do you currently have asthma?&quot;</td>
<td>Point prevalence</td>
</tr>
<tr>
<td>&quot;Have you had asthma during the last ((n)) years?&quot;</td>
<td>Period prevalence</td>
</tr>
<tr>
<td>&quot;Have you ever had asthma?&quot;</td>
<td>Cumulative incidence</td>
</tr>
</tbody>
</table>
Recommended Practices for Surveillance

Calculation and analysis of infection rates
Measures of Disease Frequency

- Common frequency measures are:
  - Ratios
  - Proportions, and
  - Rates.

All three frequency measures have the same basic form:

\[
\frac{\text{Numerator}}{\text{Denominator}} \times 10^n
\]
Numerator Data

Numerator = the “Event” being measured

Example:

- # of HAIs identified through active or passive surveillance: CLABSI, CAUTI, SSI, VAP, CDI
Denominator Data

• Denominator = Population at risk or total of all possible events

# of patient who develop cervical cancer
# of women in study

• Denominator data collection may involve collection of risk factor data necessary for risk adjustment
  • e.g. age, birthweight, ASA score
Pick a denominator... any denominator?

Scenario: You are interested in calculating the incidence rate of surgical site infections following C-Section procedures in your hospital from Apr-Jun 2016.

Which of the following would be an appropriate denominator for your calculation?

a) The total number of surgeries performed from Apr-Jun 2016
b) The number of women who had a C-Section from Apr-Jun 2015
c) The number of women who had a C-Section from Apr-Jun 2016
d) The number of women who had surgery from Apr-Jun 2016
Ratios, Proportions and Rates

1) Ratio
- Obtained by dividing one quantity by another. These quantities may be related or may be totally independent.

Example: Number of stillbirths per thousand live births.

\[
\frac{\text{# of stillbirths}}{\text{# of live births}} \times 1000
\]

“Ratio” is a general term that includes Rates and Proportions.
Ratios, Proportions and Rates

2) Proportion

- A ratio that compares a part to the whole (i.e. the numerator is included in the denominator)

Example: The number of HA-CDI cases out of the total number of CDI cases.

\[
\frac{\text{# of HA-CDI cases}}{\text{# of CA-CDI + HA-CDI cases}} \times 100
\]

- May be expressed as a decimal, a fraction or a percentage.
Ratios, Proportions and Rates

3) Rate

- A ratio in which an event occurs in a defined population in a defined time. Therefore, a rate is a measure of risk!

Example: The number of HA-CDI cases in a healthcare facility per 10,000 patient days.

\[
\text{# of HA-CDI cases} \times 10,000 \\
\text{# of patient days}
\]
Rate or Proportion??

Commonly Used Rate:
- **Incidence Rate**: the ratio of the number of new cases to the total time the population is *at risk* of disease (e.g. # of new HA-CDI/# of patient days)

Commonly Used Proportions:
- **Attack Rate**: the proportion of the population that develops illness during an outbreak (e.g. # of staff ill during outbreak/# of staff working during outbreak)
- **Case-Fatality Rate**: the proportion of persons with the disease who die from it (# of fatalities due to CDI/# of CDI cases)

**NOTE**: Despite often being called a rate, these are actually proportions because they are not expressed per UNITS OF TIME.
Recommended Practices for Surveillance

Interpret surveillance information
NHSN (or other) published data can provide a benchmark for your data


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This report is a summary of Device-Associated (DA) and Procedure-Associated (PA) module data collected and reported by hospitals and ambulatory surgical centers participating in the National Healthcare Safety Network (NHSN) from January 2006 through December 2008 as reported to the Centers for Disease Control and Prevention (CDC) by July 6, 2009. This report updates previously pub-
• Compare your **CLABSI rate** to pooled mean rate of same unit type
• Goal to have your reported rates less than benchmark rate.

A word of caution...
Recommended Practices for Surveillance

Report and use surveillance information
Reporting and Using Surveillance Data

“The demonstrable power of surveillance is in sharing findings with those who need to know and who can act on the findings to improve patient safety.”

AJIC Am J Infect Control 2007; 35:427-40

- Plan for distribution of findings
- Distribute report to those that are most able to impact patient care and considers the target audience
- Report in a manner to stimulate process improvement
- Use visual displays of data
  - charts, graphs, tables, or other graphics data
Recommended Practices for Surveillance

Evaluate Surveillance System
Endpoint of HAI Surveillance?

Data that demonstrate progress in **HAI Prevention!**

**CLABSI, 2009-2011**
Quality HAI Surveillance

Key tenets

• A **written plan** should serve as the foundation
• The **intensity** of surveillance needs to be maintained over time (i.e. active vs. passive)
• Stay **consistent** over time; apply same surveillance definitions and case finding methodology
And the board members rejoice!!
What else can be done with surveillance data?
• After collecting infection rates for your own facility/RHA, what else can be done with the information?
  ❖ Inferential Statistics (hypothesis testing)…a topic for another day!

Real world example: Researchers want to know the rate of new HA-CDI cases reported in their facility or RHA and whether it is significantly different from the rate reported overall by the province or in other published data.
Basically... p-values

Are my infection rates significantly different (higher or lower) than the rates somewhere else (assuming they used the same definition and case finding methods)?

P-value < 0.05 means the difference between groups is statistically SIGNIFICANT
Basically... confidence intervals (CI)

Significant differences between infection rates can be demonstrated graphically using confidence intervals:

The difference is considered statistically significant if the 95% confidence intervals of the two rates, proportions, percentages, or means DO NOT overlap.
Questions?