Practical statistics for the ICP

Helen K Crouch, MPH, CIC
Objectives

1. Discuss the role of basic statistics in infection prevention Programs

2. Provide an overview of calculations and use of frequency measures, rates and ratios used in epidemiology
Why Bother?

- Aids in organizing and summarizing data
- To make inferences about data without proving anything
- To communicate findings clearly and meaningfully to others
Overview

- Measures of Central Tendency
- Measure of Variability
- Pictorial Statistics
- Appropriate uses of rates & ratios
- Quality Control Charts
Measures of Central Tendency

**Mean = sum of** \( x \) (value of each observation/n (number of observations))

- average
- affected by outliers especially when n is low

Example: Average length of stay in the 7 surgical patients that were infected on the orthopedic floor.

<table>
<thead>
<tr>
<th>Patient</th>
<th># days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 days</td>
</tr>
<tr>
<td>2</td>
<td>3 days</td>
</tr>
<tr>
<td>3</td>
<td>6 days</td>
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<tr>
<td>4</td>
<td>4 days</td>
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<tr>
<td>5</td>
<td>5 days</td>
</tr>
<tr>
<td>6</td>
<td>9 days</td>
</tr>
<tr>
<td>7</td>
<td>6 days</td>
</tr>
</tbody>
</table>

What is the mean?
Median: the point at which 50% of the values fall below the mean and 50% of values occur above mean

- 2, 3, 4, 5, 6, 6, 9
- 4 + 5 = 9
- 9/2 = 4.5

Mode: observations that occur most frequently
Measure of Variability

- **Range:** provides a value that represents the difference between the highest and lowest values in a data set.

- **Deviation:** measures the spread of each individual value from the mean of the data set.
  - Negative deviation (<mean)
  - Positive deviation (>mean)
  - No deviation (same as mean)
Standard Deviation: measure of dispersion that reflects the variability in values around the mean

- Indicates how small the variability among observations
Standard Deviations

- 68.3%
- 95.5%
- 99.7%
Percentiles
**Percentiles**: If you were in the 80\textsuperscript{th} percentile…….

**Percentage**: then you **would be in the top 20\%**

The median is a specialized case of a quantile, defined as the 50\textsuperscript{th} percentile.
Hospital X hospital acquired infections

- SSI: 40%
- Blood: 34%
- Urine: 6%
- Pneumonia: 20%
Salmonella outbreak (Histogram)
Cases of ESBL E coli

- Total: 10
- June: 1
- May: 2
- April: 2
- March: 2
- February: 1
- January: 1
Appropriate uses of rates

- Basic rate = \( \frac{x}{y} \times K \)

- Incidence Rate: a measure of the frequency with which an event occurs in a population over a specified period of time
- $K$ is a constant.

- Used to transform the result of division into a uniform quantity so that it can be compared with other, similar quantities.

- Proportions, $k$ is 100.

- Device day rates $k$ is 1000 (not a %).

Rate$= \frac{x}{y} \times k$. 
During 1997 a total of 30 patients in hospital A developed SSI-CABG. The hospital had 200 CABGS for the year.

What is the annual incidence of SSI per 100 CABG procedures?
Device Associated Rate
(Incidence Density Rate)

Nosocomial infections in a given period \( \times K \)
Device days in a given period
Or patient days
Device associated infection rate (Incidence density Rate)

- It involves calculating a rate in which the numerator *is not* included in the denominator.
<table>
<thead>
<tr>
<th>Date</th>
<th># of patients</th>
<th>Indwelling urinary catheter</th>
<th>SICU Central line(s)</th>
<th>Ventilator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>2</td>
<td>3</td>
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<td>16</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<tr>
<td>...</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>28</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>TOTAL</td>
<td>87</td>
<td>64</td>
<td>50</td>
<td>42</td>
</tr>
</tbody>
</table>
Number of device associated infections identified
1. Urinary catheter-associated UTIs - 2
2. Central line associated BSI - 2
3. Ventilator associated PNEU - 1

UTI’s = 2/64 x 1000 = xx UTI’s per 1000 Foley days

BSI’s = 2/50 x 1000 = xx BSI’s per 1000 central line days

VAP = the denominator is less than 50. Do not calculate
Device Associated Rate (Incidence density)

Nosocomial infections in a given period \( X \ k \)  
Patient days in a given period /device days

5 VAPs in surgical ICU in march  
342 ventilator days in march

QUESTION: what is the device associated rate for VAP in the surgical ICU for the month of march?
2 South Trauma/Surgical ICU
CL-BSI

2 South NNIS median
Device Utilization (ratio)

- **Device days/patient days**
  - This measures the utilization of the particular device.

- **< 50 patients the ratio may not be a good estimate of the true device utilization ratio**
Device Utilization (ratio)

- 50 CL days/87 patient days = 0.57
- Compare with NHSN 2006
  - Surgical ICU D/U for CL pooled mean is 0.62
  - Mean is 0.63 (or 50th percentile)
  - 25th percentile is 0.46
  - Refer to the AJIC to compare with the NHSN Summary 2006
Prevalence (point prevalence)

Is the proportion of persons in a population with a particular disease/attribute at a specific point in time (point prevalence) or over a specified time period (period prevalence)

*NOT A TRUE RATE*
Prevalence

- On a specified day the ICP identifies 6 patients with VRE colonization on 9c. On the day of the study the unit had 40 patients.

- What is the prevalence of VREs per 100 patients?
Attack rate (same as incidence rate)

- It is the proportion of persons at risk who become infected over an entire period of exposure or measure of the risk/probability of becoming a case.
- Used for epidemics/outbreaks where a specific population is exposed.
- expressed as a percentage.
Quality Control Charts

- SPC: Statistical Process Control
  - Developed in industry to concurrently monitor the production process
  - Main obj is to ensure that the process is performed consistently within predetermined parameters
Quality Control Charts

- Monitor outcomes (rates and frequency of healthcare associated infection) or to monitor the process of care
- Quickly identify variations in practice or outcomes,
  - determine if and when interventions are necessary
  - measures impact of any interventions
Quality Control Charts

- Variation in process is a key concept in SPC.
- Efforts to decrease variation lead to improved quality.
- SPC focuses on monitoring processes and outcomes to minimize or decrease variation.
Quality Control Charts

- Selecting a type of chart
  - The types of data and frequency of events determine type of control chart: Most common with infection control
  - c Chart: stable
  - u chart: Sample size variable (device rates, MDRO rates)
  - p chart: Surgical site infection rates
Quality Control Charts

Out of control if 1 of the following occurs

- One point falls above the UCL or below the LCL
- Two of three consecutive points >2 SDs but < 3 SDs on one side of the mean
- 4 of 5 consecutive points >1 SDs but <2 SDs on one side of mean
- 9 consecutive pts on one side of mean
- 6 consecutive pts increasing or decreasing
- 14 consecutive pts alternating up and down
- 15 consecutive pts within 1 SD above or below mean
Quality Control Charts: Caveats

- The fact a described process is in control does not mean that the process does not need improvement.
- Sample size important. These charts should not be used for very infrequent events or for small denominator samples.
- Manufacture standards different than applying to humans.
Quality Control Charts

MRSA initial isolates HA definition

Less ISR and surveillance cultures

Sigma level: 2

per 10,000 OBD
Summary

- Measures of Central Tendency
- Measure of Variability
- Pictorial Statistics
- Appropriate uses of rates & ratios
- Quality Control Charts
References

1. The Use of Statistical Process Control Charts in Hospital Epidemiology: Inf Contr and Hosp Epi Vol.14 No.11; 1993 pp 649-656
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