Outbreaks of Health care Associated Infections

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Tallinn, Estonia
Content

• HAI outbreaks
  – Characteristics
  – Detection
  – Investigation
Patients at risk

- Underlying disease
- Age
- Medical interventions
- Patient density
- Immunosuppressive treatment

- Environmental factors
- Food
- Facilities
- Others
<table>
<thead>
<tr>
<th>#</th>
<th>Searches</th>
<th>Results</th>
<th>Search Type</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Infection controlS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
<td>24025</td>
<td>Advanced</td>
<td>Display</td>
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<tr>
<td>2</td>
<td>cross infectionS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
<td>40426</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>3</td>
<td>1 or 2</td>
<td>56120</td>
<td>Advanced</td>
<td>Display</td>
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<td>4</td>
<td>hospitalS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
<td>907668</td>
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<td>5</td>
<td>health care institutionS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
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<td>Delete</td>
</tr>
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<td>6</td>
<td>health care facilityS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
<td>873</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>7</td>
<td>4 or 5 or 6</td>
<td>908134</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>8</td>
<td>3 and 7</td>
<td>26713</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>9</td>
<td>outbreakS.mp. [mp-title, original title, abstract, name of substance word, subject heading word, unique identifier]</td>
<td>77581</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>10</td>
<td>8 and 9</td>
<td>4288</td>
<td>Advanced</td>
<td>Display</td>
</tr>
<tr>
<td>11</td>
<td>limit 10 to (english language and humans and yr=&quot;2005 -Current&quot;)</td>
<td>1098</td>
<td>Advanced</td>
<td>Display</td>
</tr>
</tbody>
</table>
Hospital outbreak control requires joint efforts from hospital management, microbiology and infection control


- An outbreak of multidrug-resistant *Klebsiella pneumoniae* producing the extended-spectrum β-lactamase CTX-M15 affected 247 mainly elderly patients in more than 30 wards in a 1000-bedded Swedish teaching hospital between May 2005 and August 2007.
  - Faecal screening identified twice as many cases as cultures from clinical samples.
  - Transmission occurred by direct and indirect patient-to-patient contact, facilitated by patient overcrowding.
  - Interventions included formation of a steering group with economic power, increased bed numbers, better compliance with alcohol hand disinfection and hospital dress code, better hand hygiene for patients and improved cleaning.
  - The cost of the interventions was estimated to be €3 million
Local Hospital Perspective on a Nationwide Outbreak of Pseudomonas aeruginosa Infection in Norway


• During the winter of 2001–2002 in Norway, there was a national monoclonal nosocomial outbreak of *Pseudomonas aeruginosa* infection mainly affecting patients in intensive care units.

• The use of SPC at one of the affected hospitals would have detected this outbreak several weeks before the alert from the Norwegian National Public Health Institute (NIPH).

Conclusion

• The plotting of rare events, such as an outbreak of nosocomial infection, with a g chart may be used for early detection of a process out of control.
Characteristics of HAI outbreaks

- Location
- Type of infection
- Pathogens
- Source
- Mode of transmission
- Preventive/control measures

Gastmeier et al. Infect Control Hosp Epidemiology; 2005 26(4);357-361
Location

• Hospital – 83% (50% in intensive care units)
• Outpatient care – 12%
• Nursing home – 5%

• Special challenges:
  – Unskilled personnel in general and in specific in infection control
  – Work in several health care facilities

Gastmeier et al.
Type of infection

- Bloodstream – 37%
- Gastrointestinal – 29% (Probable underreporting)
- Pneumonia – 23%
- Urinary tract – 14%
- Surgical site – 12%
- Other lower respiratory – 10%
- Central nervous system – 8%
- Skin and soft tissue – 7%

Gastmeier et al.
Most frequently reported HAI pathogens

<table>
<thead>
<tr>
<th>HAI infection</th>
<th>HAI outbreaks</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td><em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>Enterococci</td>
<td><em>Pseudomonas aeruginosa</em></td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td><em>Klebsiella pneumoniae</em></td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td><em>Serratia marcescens</em></td>
</tr>
<tr>
<td>Streptococci</td>
<td><em>Hepatitis B, C virus</em></td>
</tr>
<tr>
<td><em>Enterobacter</em> spp.</td>
<td><em>Legionella pneumophila</em></td>
</tr>
</tbody>
</table>

*Probable underreporting: *Salmonella* spp., *Campylobacter* spp., norovirus, rotavirus, respiratory viral infections

Gastmeier et al.
### Source of HCA outbreaks

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>26%</td>
</tr>
<tr>
<td>Medical equipment / device</td>
<td>12%</td>
</tr>
<tr>
<td>Environment</td>
<td>12%</td>
</tr>
<tr>
<td>Medical personnel</td>
<td>11%</td>
</tr>
<tr>
<td>Contaminated drug</td>
<td>4%</td>
</tr>
<tr>
<td>Contaminated food</td>
<td>3%</td>
</tr>
<tr>
<td>Care equipment</td>
<td>3%</td>
</tr>
<tr>
<td>Unclear source</td>
<td>37%</td>
</tr>
</tbody>
</table>

*Gastmeier et al.*
Mode of transmission

- Contact – 45%
- Invasive technique – 16%
- Inhalation – 15% (droplet, airborne)
- Ingestion – 4%
- Unclear mode of transmission – 28%

Gastmeier et al.
Detection of outbreaks

• Surveillance
  – Specific infection types
    • Point prevalence
    • Incidence
  – Alert microorganisms
    • Rare microorganisms
    • Increased frequency

• Statistical Process Control (SPC)
  – Application of statistical methods to monitoring and control of a process to ensure that it operates at its full potential to produce conforming product.
SPC - Example

- number of days between observations
- average number of days between observations

observation number

number of days between observations: 30

EpiNorth
# Reported outbreaks in health care facilities in Norway 2005 – 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Outbreaks</th>
<th>Number of cases</th>
<th>Microorganism</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>47</td>
<td>622</td>
<td>Norovirus</td>
<td>82%</td>
</tr>
<tr>
<td>2006</td>
<td>74</td>
<td>1784</td>
<td>Norovirus</td>
<td>95%</td>
</tr>
<tr>
<td>2007</td>
<td>88</td>
<td>2253</td>
<td>Norovirus</td>
<td>93%</td>
</tr>
<tr>
<td>2008</td>
<td>105</td>
<td>1817</td>
<td>Norovirus</td>
<td>82%</td>
</tr>
<tr>
<td>2009</td>
<td>99</td>
<td>1660</td>
<td>Norovirus</td>
<td>82%</td>
</tr>
</tbody>
</table>

[http://www.fhi.no/eway/default.aspx?pid=233&trg=MainArea_5661&MainArea_5661=5631:0:15,4689:1:0:0:::0:0](http://www.fhi.no/eway/default.aspx?pid=233&trg=MainArea_5661&MainArea_5661=5631:0:15,4689:1:0:0:::0:0)
Problems with detecting outbreaks

- No detection
  - 2-3 patients with pneumonia in intensive care unit
- Detection → No investigation
  - Nursing homes
- Detection → Investigation → No reporting
  - If sanctions against reporting doctors, nurses
- False detection: pseudo-epidemics (artefacts)
  - E.g. consequent laboratory contamination
  - May lead to unnecessary antibiotic treatment
The outbreak investigation
Why outbreak investigation?

• Objectives
  – Describe the outbreak
  – Identify the source
  – Prevent further cases
  – Make recommendations for future prevention
  – Learning…
Steps of an outbreak investigation

- Have an outbreak control plan
- Confirm outbreak and diagnosis
- Form Outbreak Control Team – multidisciplinary
- Define a case
- Identify cases and obtain information
- Descriptive data collection and analysis
- Develop hypothesis
- Analytical studies to test hypothesis
- Other studies: microbiological and environmental
- Communication: during and after
Three parallel activities

- Epidemiological investigations
  - Analytical
  - Descriptive

- Microbiological investigations
  - Diagnostics
  - Characterisation

- Environmental investigations
  - Inspection
  - Sampling

Control Measures
The case definition

- Time, place, person
- Clinical symptoms
- Microbiological results

"A person in Sweden who developed pneumonia within 14 days after returning from travel abroad and tested positive by urinary antigen test for *Legionella pneumophila* sg.1"

**Graded case definition:** confirmed, probable, possible
Specificity versus sensitivity
How do you find more cases?

• Contact health care staff in the hospital, in other wards, in other hospitals
  – Medical records
• Contact laboratories
  – Lab reports
• Look into surveillance data if available
• Ask patients if they know other who are ill
Descriptive epidemiology

What → What happens? Diagnosis, pathogen

Who → Who is involved? Age, gender

Where → Where does the outbreak occur?

When → When did the outbreak start?
Initial study

• Trawling questionnaires
  – Early cases
  – Generate hypotheses

• All relevant exposures
  – Standardised questionnaire
  – Look also for unusual, exotic exposures

➢ Don’t withdraw possible hypotheses now!
Describe cases

- **Place**
  - Mapping

- **Person**
  - Age, gender

- **Time**
  - Epicurve

### Table: Age Distribution

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>5-19</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>20-49</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>50-69</td>
<td>53</td>
<td>29</td>
</tr>
<tr>
<td>70-79</td>
<td>37</td>
<td>18</td>
</tr>
<tr>
<td>80-94</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>140</td>
<td>91</td>
</tr>
</tbody>
</table>

Age Percentages:
- 0-4: 60% Men, 40% Women
- 5-19: 67% Men, 33% Women
- 20-49: 49% Men, 51% Women
- 50-69: 65% Men, 35% Women
- 70-79: 67% Men, 33% Women
- 80-94: 55% Men, 45% Women
- Total: 61% Men, 39% Women
The Epicurve

Point source outbreak

Number of cases

Days in May 2010
The Epicurve

Continuous source outbreak

Number of cases

December 2009
Outbreak in a hospital

Date and time of onset

- 27 August
- 28 August
- 29 August
- 30 August

Cases:
- 1 case patient
- 1 case staff member
Generate hypotheses

Descriptive epidemiology → Hypothesis 1
Trawling questionnaires → Hypothesis 2
General knowledge →...

Other information about the outbreak:
- Environmental inv.
- Microbiological inv.
Test your hypothesis – 2 strategies

Analytical epidemiology
• Case control or Cohort
• Short questionnaire
• Based on hypothesis
• Cases and controls
• Comparison
• Statistical analysis
• Risk factors identified?

Microbiological testing
• Sample patients and suspected sources
• Analyse for presence of pathogens
• Genomic characterisation – comparison

Complementary, but not always possible…
Environmental investigation

• Inspection and sampling of relevant areas
  – Evaluate hygienic standard and risk
  – Is infection control in place?

• Do you suspect a specific product?
  – Can you trace it back?
  – When and where was it produced?
  – Batch number?

• Is transmission likely to occur from the environment?
Control measures

• Short term: stop the outbreak
  – Information and advice to patients, public
  – Hygienic measures and infection control
  – Staff allocation

• Long term: prevent outbreaks in the future
  – Infection control routines
  – Training, information, regulations

• The balance: To early or too late….?
Control measures in HAI outbreaks

• Standard precautions
• Isolation containment
• Hand hygiene (disinfection)
• Decontamination
• Choice of treatment (antibiotic therapy)
• Allocation of personnel/work restriction
• Screening, surveillance
• Vaccination
Communication

• Inform early those who need to know!
• Be open – don’t try to hide anything
• During the investigation
  – Web updates
  – News letters for health care workers
  – Pres releases, interviews for the public
• When the investigation is finished
  – Outbreak report for all involved stakeholders
  – Scientific publication?
Investigation of HAI outbreaks?

• What facilitates it
  – Diagnosis can usually be made rapidly
  – Direct access to medical care, laboratory
  – Patient’s records are available
  – Easy cohorting of cases

• What makes it difficult
  – Multidrug-resistant pathogens
  – Complex environment
  – Intra- and interhospital transfer of patients
  – Temporary staff, working in shifts
Multidisciplinary collaboration

- Different needs and priorities
- Multicenter approach
- National or international

- Pressure and stress
- Keep calm and think systematic
Remember…

• What is happening?                   Assessment
• Who is involved?                     Description
• What is the source?                  Analysis
• What needs to be done?               Interventions
References and Resources

Article Summaries

- Unpasteurized Milk Articles

Foodborne Diseases Surveillance and Outbreak Investigation Toolkit

- Guide to Confirming a Diagnosis in Foodborne Disease
- Guidelines for Specimen Collection
- *Listeriosis Case Form* [PDF 385KB]
- *Cholera and Other Vibrio Illnesses Report Form* [PDF 2.72MB]
- *EFORS Form* [PDF 165KB]
- *Guidelines for Completing EFORS Form* [PDF 19KB]
- *Standard Questionnaires* [PDF 38KB]
- *Standard Questionnaires* [DOC 219KB]
- *Oregon Questionnaire* [PDF 148KB]
- *Oregon Questionnaire* [DOC 108KB]
- Public Health Training Network
- Epi Info

Government Links

- Food and Drug Administration (FDA)*
- United States Department of Agriculture*

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Microsoft Word

Description: Microsoft Word is a word processing program used to create and edit text documents. Text in Word documents can be easily modified or copied for use in other applications.

http://www.cdc.gov/outbreaknet/references_resources/
Epi Info™

Latest Version: Epi Info™ Version 3.5.1
Release Date: August 18, 2008

Get It Now!

What is Epi Info™?
Physicians, nurses, epidemiologists, and other public health workers needing a background in information technology often have a need for simple tools that allow the rapid creation of data collection instruments and data analysis, visualization, and reporting using epidemiologic methods.

Epi Info™, a suite of lightweight software tools, delivers core ad-hoc epidemiologic functionality without the complexity or expense of large, enterprise applications.

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More than one million users are estimated.

EDUCATION
Epi Info™ is a key component in public health education at colleges, universities, and other schools of public health around the world.

COLLABORATION
Epi Info™ encourages collaboration between local, national, and international partners using Epi Info™ state and territorial.

How is Epi Info™ Used?
Epi Info™ is used worldwide for the rapid assessment of disease outbreaks; for the development of small to mid-sized disease surveillance systems; as ad hoc components integrated with other large scale or enterprise-wide public health information systems; and in the continuous education of public health professionals learning the science of epidemiology, tools, and techniques.

The MakeView module of Epi Info™ allows users to create questionnaires and data entry forms called Views in Epi Info™. With MakeView, users place questions and data entry fields on one or many pages of a View and tailor the data entry process with conditional skip patterns, data validation, and custom calculations programmed by the user using MakeView’s Check Code.

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Monday-Friday, 8:30 a.m. - 4:30 p.m. (Eastern Standard Time)
epiinfo@cdc.gov

http://www.cdc.gov/epiinfo/
Summary HAI outbreaks

• Characteristics
  – Population at risk

• Outbreak detection
  – Effective surveillance systems
  – Vigilant hospital personnel

• Outbreak investigation
  – Have a plan and work systematically
  – Skilled hospital infection control practitioner, epidemiologist, microbiologist, more…?

• Prevention and control measures
The ultimate goal: patient safety