How to improve reliability in HAI surveillance?
Local opportunities

Gabriel Birgand
NIHR Health Protection Research Unit in Healthcare Associated Infections and Antimicrobial Resistance

@Gbirgand
Questions

1. What may affect the reliability?
2. In reality, are surveillance data reliable?
3. How can we improve the reliability?
4. What to do in practice?
5. Perspectives
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1. What may affect the reliability?
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What may affect the reliability?

Human frailty

• Judge and be judged
  - Implement interventions & assess outcomes
  - Preconceived opinion: attribution bias
What may affect the reliability?

Human frailty

- The framing effects
  - “The context in which options are presented directly impacts our selection”
    - IPC climate of “getting to zero”
      → Unrealistic expectations from public & administrators
  - Public reporting, financial consequences
    → “Improving rates rather than results”

Distortion of IC specialists’ minds toward unrealistic low level
What may affect the reliability?

Human frailty

- Altruistic vs individualistic behaviour
What may affect the reliability?
Human frailty

• Altruistic vs individualistic behaviour

Cooperators
Altruistic behaviour

Benefit for their future patient populations

Accurate rates

contribution
What may affect the reliability?

Human frailty

- Altruistic vs individualistic behaviour

Cooperators
Altruistic behaviour

Free-riders
Individual behaviour

Benefit for their future patient populations

Accurate rates

Benefit for others facilities

Contribution
What may affect the reliability?
Human frailty

- Altruistic vs individualistic behaviour

Cooperators
Altruistic behaviour

Benefit for their future patient populations
Contribution
Accurate rates

Free-riders
Individual behaviour

Benefit for others facilities
Contribution
Underreporting of HCAIs

Benefit for their lack of cooperation

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What may affect the reliability?

Technical factors

• **A binary assessment**
  - Yes or No for complex scenario
  - Least sure IP: certain in 20% of cases
  - Most sure IP: certain in 97% of cases
  - Median: sure in 58% of cases

Hofstede model: uncertainty avoidance
  - High specificity raters
  - High sensitivity raters
What may affect the reliability?

Technical factors

- Impact of definitions

  - SSI diagnosis using four common definitions
    » 5804 surgical wounds in 4773 patients assessed

<table>
<thead>
<tr>
<th></th>
<th>Mean % of wound infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC definition</td>
<td>19.2% (18.1% - 20.4%)</td>
</tr>
<tr>
<td>NNISS version</td>
<td>14.6% (13.6% - 15.6%)</td>
</tr>
<tr>
<td>Pus alone</td>
<td>12.3% (11.4% - 13.2%)</td>
</tr>
<tr>
<td>ASEPSIS score &gt; 20</td>
<td>6.8% (6.1% - 7.5%)</td>
</tr>
</tbody>
</table>

» Subjective criteria → Lack of clear definitions

Wilson BMJ 2004
What may affect the reliability?

Technical factors

• Impact of definitions
  - Lack of clear definition → Opportunity to mislead rates
  - How to lower ventilator-associated pneumonia rates?

« The Klompas recipe »:

1. Interpret clinical signs as strictly as possible.
2. Interpret chest radiographs as strictly as possible.
3. Require consensus between two or more infection preventionists.
4. Seek endorsement of intensivists before "certifying" suspected cases as VAP.
5. Require bronchoalveolar lavage for diagnosis.
6. Set quantitative growth thresholds for endotracheal aspirate and BAL cultures.
7. Transfer patients who require prolonged mechanical ventilation.
8. Expand surveillance to include uncomplicated postoperative patients.
Questions

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3. How can we improve the reliability?

4. What to do in practice?

5. Perspectives
Are surveillance data reliable?

- Method for inter-observer assessment without gold-standard
Are surveillance data reliable?

- **Inter-observer variability and agreement in classifying Healthcare associated infections**

<table>
<thead>
<tr>
<th></th>
<th>VAP</th>
<th>SSI</th>
<th>BSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>Klompas AJIC 2009</td>
<td>Birgand Pone 2013</td>
<td>Mayer CID 2012</td>
</tr>
<tr>
<td>Number of assessors</td>
<td>3 ICP</td>
<td>100 IPC + 76 Surgeons</td>
<td>18 IPC</td>
</tr>
<tr>
<td>Number of case-vignettes</td>
<td>50</td>
<td>20</td>
<td>114</td>
</tr>
<tr>
<td>Agreement (k coefficient)</td>
<td>0.35 - 0.5</td>
<td>0.24 – 0.55</td>
<td>0.42 – 0.55</td>
</tr>
</tbody>
</table>

- **Kappa coefficient**
  - < 0.40 = poor agreement
  - 0.41-0.60 = fair agreement
  - 0.61-0.80 = good agreement
  - > 0.81 = excellent agreement
Questions

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4. What to do in practice?
5. Perspectives
How to improve the reliability?

**Robust HAI definitions**

<table>
<thead>
<tr>
<th>Arthroplasty</th>
<th>Kappa value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purulent drainage</td>
<td>1</td>
</tr>
<tr>
<td>Pain</td>
<td>0.777</td>
</tr>
<tr>
<td>Tenderness</td>
<td>0.062</td>
</tr>
<tr>
<td>Localised swelling</td>
<td>0.184</td>
</tr>
<tr>
<td>Redness</td>
<td>0.343</td>
</tr>
<tr>
<td>Heat</td>
<td>0.137</td>
</tr>
<tr>
<td><strong>Incisional spontaneous dehiscence, or opened by a surgeon</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Clinical diagnosis of SSI</strong></td>
<td>0.812</td>
</tr>
<tr>
<td><strong>Fever (temperature &gt; 38°C)</strong></td>
<td>1</td>
</tr>
</tbody>
</table>

→ Robustness of criteria for severe infection
How to improve the reliability?

**Surveillance definitions for VAP**

**Conventional definition**
- New onset of purulent sputum,
- +/- Change in character of sputum,
- +/- Increased respiratory secretions,
- +/- Increased suctioning requirements

**Worsening gas exchange**
(eg desaturation, increased oxygen requirements, or increased ventilator demand)

**Rale or bronchial breath sounds**
How to improve the reliability?

**Surveillance definitions for VAP**

**Conventional definition**
- New onset of purulent sputum, +/- Change in character of sputum,
- +/- Increased respiratory secretions,
- +/- Increased suctioning requirements
- **Worsening gas exchange**
  (e.g., desaturation, increased oxygen requirements, or increased ventilator demand)
- **Rale or bronchial breath sounds**

**Streamlined definition**
- ≥ 25 neutrophils per low field on Gram stain of endotracheal aspirate
- +/- bronchoalveolar lavage specimen
- ≥ 2 days of stable or decreasing daily minimum PEEP followed by a rise in daily minimum PEEP of ≥ 2.5 cm H2O, sustained for ≥ 2 calendar days; or ≥ 2 days of stable or decreasing daily minimum FiO2 of ≥ 0.15 points, sustained for ≥ 2 calendar days
How to improve the reliability?

- No subjectivity
- Data sources standardised
- Time-saving
  → Automated surveillance
How to improve the reliability?

- No subjectivity
- Data sources standardised
- Time-saving
  → Automated surveillance

- Quality outcome indicator
- Difficult to build VAP prevention strategies

**Conventional definition**
- New onset of purulent sputum,
  +/- Change in character of sputum,
  +/- Increased respiratory secretions,
  +/- Increased suctioning requirements

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How to improve the reliability?

• Improve the accuracy by training
  - German national HCAI surveillance system (KISS)
  - 10 case-vignettes sent to surveillance persons

Higher diagnostic accuracy for:
- higher levels of education
- external status
- more surveillance experience
How to improve the reliability?

• Improve the accuracy by training
  - German national HCAI surveillance system (KISS)
  - 10 case-vignettes sent to surveillance persons

Case vignette education: sensitive tool for validating the accuracy of HCAI diagnostics

Higher diagnostic accuracy for:
- higher levels of education
- external status
- more surveillance experience
How to improve the reliability?

• Assess cases independently
  - Separate surveillance and intervention roles

SSI after cardiac surgery

<table>
<thead>
<tr>
<th>Routine surveillance</th>
<th>Independent committee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Infection</td>
</tr>
<tr>
<td>Infection</td>
<td>15</td>
</tr>
<tr>
<td>No infection</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
</tr>
</tbody>
</table>

- 3 cases after discharge
- 1 misclassified
- 3 treated / no other CDC/NHSN criteria
- 1 case not meet any of the criteria
How to improve the reliability?

• Improving SSI diagnostic using wound photography?

• By Improving the post-discharge surveillance?
  • Many PDS methods, stakeholder engagement issues
    → High variability → unreliability?

• By involving patients?
How to improve the reliability?

Avoid human interpretation

Manual surveillance
- Surveillance datasheet completed for each patient
- Manual medical record review

Semi-automated surveillance
- Classification algorithm
  - Regression model
  - Proc > Micro > ICD-10 > Pharm

Designated, trained personnel
Multidisciplinary assessment

Van Mourik CID 2013
How to improve the reliability?
Avoid human interpretation

**Manual surveillance**
- Surveillance datasheet completed for each patient
- Manual medical record review

**Semi-automated surveillance**
- Classification algorithm
- Regression model

**Automated surveillance**
- Classification algorithm
- Regression model

- Probability of HCAI
  - 0%
  - 50%
  - 90%

- Van Mourik CID 2013
- Multidisciplinary assessment
- Designated, trained personnel
How to improve the reliability?
Pragmatic syndromic surveillance

Algorithm: Daily assessment

Flagging

Clinical value:
Early diagnosis

Epidemiological value:
Inclusion for follow-up alert

Multidisciplinary assessment
Designated, trained personnel

King J of Inf. 2013
How to improve the reliability?
Avoid human interpretation

<table>
<thead>
<tr>
<th>Disadvantages</th>
<th>Manual</th>
<th>Semi-automated</th>
<th>Syndromic</th>
<th>Automated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective input, non-blinded assessment</td>
<td></td>
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<tr>
<td>Intentional underreporting</td>
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<tr>
<td>Subjectivity in definitions</td>
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<tr>
<td>Dichotomous determination</td>
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<td>Attentivity, staffing</td>
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<tr>
<td>Memory bias</td>
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<td>Clinical sense</td>
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<tr>
<td>PPV</td>
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<tr>
<td>NPV</td>
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</table>

Legend:
- Strong link
- Mild link
- No link

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Questions

1. What may affect the reliability?
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What to do in practice?

• Make key people your best friends
  • For perspectives of improvement: Surgeons, Intensivists, Microbiologists, nurses, patient safety leaders, QI departments, administrators...
  • For data management: IT, Data warehouse, Pharmacists...

• Implement in the right way
  • Co-production: Involve end-users in the conception + foster sense of ownership of the data
  • Make process and measures embedded and sustained
  • Active engagement: intra- and interprofessional dialogue
What to do in practice?

• Choose the right method
  - Adapted to local capacities
    • Resources for testing or surveillance
    • E.g. Contact >80% patients in case of post-discharge surveillance

• Choose the right definition
  - All infections or only severe infections?
    - Medical and economic impact, clinical meaning, patients perception
    - Fully quantitative or quanti/qualy?
What to do in practice?

• Convert data into accurate information
  - Quality indicator vs performance monitoring
    → Reliable over time
  - Not only focus on what to measure and how reliable those measures are
    → Highlight opportunities for improvement
  - Combining with cost in feedback

• Share Your Good News
  “discussing positive experiences leads to heightened well-being, increased overall life satisfaction and even more energy”
  → Newsletter, hospital website, social media...
Questions

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Perspectives

• Develop intelligent clinical decision support systems
  - Artificial intelligence/machine learning algorithm
    → Provide advanced, intelligent decision support for diagnosis and surveillance
  - Population models to provide assessment for individual patients
  - Combination of human creativity & power of computing.
Case vignettes:
A tool to assess the agreement among healthcare professionals.

Gabriel Birgand
NIHR Health Protection Research Unit in Healthcare Associated Infections and Antimicrobial Resistance

@Gbirgand
Agreement among healthcare professionals in diagnosing case vignette-based surgical site infections in 10 European countries.


Birgand et al, Plos one 2013
20 vignettes

20 x 4 = 80 readings per specialty

10 Surgeons x 8 vignettes = 80 readings
10 ICPs x 8 vignettes = 80 readings

160 readings per country

1600 readings

x10 countries

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Clinical case 1

Surgical intervention

• Patient of 78 years old

• Patient
  ASA score : 2

• Intervention: **Total right knee replacement**
  Date : 17/11/2010
  Duration of intervention : 2h05min
  Altemeier classification : 1
  Emergency : no
  Endoscopic technic: no

• NNIS risk Score : 0
Prevention
Skin preparation
Preoperative shower:
The day before intervention: yes (polyvidon iodine soap)
The day of the intervention: yes (polyvidon iodine soap)
Surgery site disinfection: yes (polyvidon with alcohol)

Antibioprophylaxis
Drug: Cefazoline 2 g 30 minutes before incision and kept during 24 hours after intervention
Clinical case 1

Surgical intervention

- Immediate operative follow-up
  - Stay in the postoperative ward 5 hours after the intervention
  - Clean scar, No associated infection signs, Apyretic patient

- Day 1 to day 6:
  - Apyretic, No pain, clean scar, Healing without problem, Radiography normal

- Hospital discharge the 23 of November in physiotherapy center
Rehospitalised the 28th of November (D10)

Discharge of the right knee scar, Apyretic, Right knee a bit painful, Oedema of the right knee, Inflammatory scar and serous discharge

- Puncture of the knee: positive by PCR to Staphylococcus coagulase negative, incubation in an bloodculture broth positive in 14 hours with Staphylococcus coagulase negative
- Treatment: vancomycin + Gentamycin 29-11 to 1-12
  - 2nd puncture the 29th of November negative
Evolution of body constants

Clinical case 1

C-reactive protein dosage

Polynuclear count

Temperature
Certainly not SSI

Please, precise the deep of the surgical site infection ticking the value you think the more adapted according to the following scale:

- [ ] □ 1 Superficial
- [ ] □ 2 Uncertain between 1 and 3
- [ ] □ 3 Deep or organ /space

Certainly SSI
Clinical case 1

Postoperative evolution

Picture of the scar 10 days after the intervention
Certainly not SSI

Please, precise the depth of the surgical site infection ticking the value you think the more adapted according to the following scale:

- **1** Superficial
- **2** Uncertain between 1 and 3
- **3** Deep or organ /space

Certainly SSI
<table>
<thead>
<tr>
<th>SUPERFICIAL</th>
<th>DEEP</th>
<th>ORGAN/SPACE</th>
</tr>
</thead>
</table>
| Infection occurs within 30 days after the operation and infection involves only skin and subcutaneous tissue of the incision and at least one of the following:  
  **Case 1.** Purulent drainage, from the superficial incision.  
  **Case 2.** Organisms isolated from fluid or tissue from the superficial incision.  
  **Case 3.** At least one of the following signs: pain or tenderness, localized swelling, redness, or heat and superficial incision is deliberately opened by surgeon, unless incision is culture-negative.  
  **Case 4.** Diagnosis of superficial incisional SSI by the surgeon or attending physician. | Infection occurs within 30 days after the operation if no implant† is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and infection involves deep soft tissues (e.g., fascial and muscle layers) of the incision and at least one of the following:  
  **Case 1.** Purulent drainage from the deep incision but not from the organ/space component of the surgical site.  
  **Case 2.** A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever (>38°C), localized pain, or tenderness, unless site is culture-negative.  
  **Case 3.** An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.  
  **Case 4.** Diagnosis of a deep incisional SSI by a surgeon or attending physician. | Infection occurs within 30 days after the operation if no implant† is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and infection involves any part of the anatomy (e.g., organs or spaces), other than the incision, which was opened or manipulated during an operation and at least one of the following:  
  **Case 1.** Purulent drainage from a drain that is placed through a stab wound‡ into the organ/space.  
  **Case 2.** Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.  
  **Case 3.** An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination.  
  **Case 4.** Diagnosis of an organ/space SSI by a surgeon or attending physician. |
Certainly not SSI

Please, precise the deep of the surgical site infection ticking the value you think the more adapted according to the following scale:

- 1 Superficial
- 2 Uncertain between 1 and 3
- 3 Deep or organ /space

Certainly SSI
## Methods

### Existence of SSI

**Intra-class correlation coefficient (ICC) with 95%CI**

<table>
<thead>
<tr>
<th>SSI certainly absent</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>SSI certainly present</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No SSI</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>SSI</td>
<td>8</td>
<td>17</td>
<td>12</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1 (12)</th>
<th>2 (25)</th>
<th>3 (18)</th>
<th>4 (7)</th>
<th>5 (6)</th>
<th>6 (9)</th>
<th>15 (22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC specialists (n=36)</td>
<td>7 (19)</td>
<td>10 (28)</td>
<td>6 (17)</td>
<td>3 (8)</td>
<td>2 (6)</td>
<td>4 (11)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Surgeons (n=31)</td>
<td>1 (3)</td>
<td>7 (23)</td>
<td>6 (19)</td>
<td>2 (6)</td>
<td>2 (6)</td>
<td>2 (6)</td>
<td>11 (35)</td>
</tr>
<tr>
<td>Total (n=67)</td>
<td>8 (12)</td>
<td>17 (25)</td>
<td>12 (18)</td>
<td>5 (7)</td>
<td>4 (6)</td>
<td>6 (9)</td>
<td>15 (22)</td>
</tr>
</tbody>
</table>
## Methods

### Depth of SSI

**kappa coefficient (kC) with 95%CI**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC specialists (n=13)</td>
<td>8 (62)</td>
<td>1 (8)</td>
<td>4 (31)</td>
</tr>
<tr>
<td>Surgeons (n=17)</td>
<td>9 (53)</td>
<td>6 (35)</td>
<td>2 (12)</td>
</tr>
<tr>
<td>Total (n=30)</td>
<td>17 (57)</td>
<td>7 (23)</td>
<td>6 (20)</td>
</tr>
</tbody>
</table>
Thank you for your attention

Acknowledgements: A. Holmes, B. Cookson, C. Suetens, JC Lucet, R. Troughton

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