Cleaning in the 21st Century
The Dark Ages?

Dr. Ina (L.E. Willemsen)
Consultant Infection Control
Amphia hospital
The Netherlands
March 15th 2017
Amphia hospital

- Large teaching hospital
- ± 45,000 admissions per day
- 3 hospital locations

- 235 people housekeeping employees, working across 3 locations
- Department of infection control with 10 infection control practitioners
The importance of cleaning in a hospital

- Increase in life expectancy
- Increase in chronic diseases
- Increase in the complexity of care
- Increase in antimicrobial resistance
The importance of cleaning in a hospital

Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings

Jonathan A. Otter PhD a,b,*, Saber Yezli PhD b, James A.G. Salkeld BSc b, Gary L. French MD, FRCPa

a Centre for Clinical Infection and Diagnostics Research (CIDR), Department of Infectious Diseases, King’s College London & Guy’s and St. Thomas’ NHS Foundation Trust, London, UK
b Bioquell, Andover, Hampshire, UK
Increased risk from the prior room occupant
«the room lotto»

Patient with a pathogen (e.g. C. difficile, MRSA, VRE, A.baumanii of P. auruginosa)

Patient is discharged
Room is cleaned & disinfecte

The next room occupant is at an increased risk of acquiring the pathogen
Increased risk from the prior room occupant

Figure: increased risk associated with the prior room occupant
* VRE in the two weeks prior to admission
# immediate prior room occupant was VRE positive

Routes of transmission – Hands & Instruments

Patient environment → Hands & Instruments → Next patient
The importance of cleaning in a hospital

<table>
<thead>
<tr>
<th>Direct patient contact</th>
<th>Contact with environmental surfaces only</th>
</tr>
</thead>
<tbody>
<tr>
<td>45% of 50 HCP acquired MRSA on their gloved hands</td>
<td>52% of 44 HCP acquired VRE on their hands or glove</td>
</tr>
<tr>
<td>50% of 30 HCP acquired <em>Clostridium difficile</em> on their gloved hand</td>
<td>40% of 50 HCP acquired MRSA on their gloved hands</td>
</tr>
<tr>
<td>50% of 30 HCP acquired <em>Clostridium difficile</em> on their gloved hand</td>
<td>50% of 30 HCP acquired <em>C difficile</em> on their gloved hands</td>
</tr>
</tbody>
</table>

*Compliance with hand hygiene: 80%*                                               *Compliance with hand hygiene: 50%*

Otter et al. Evidence that contaminated surfaces contribute to the transmission of …… AJIC May 2013
In the absence of clear cleaning policy for dect telephones and stethoscopes a study was performed to culture these items.

- Physicians and residents were asked to participate
- Items were sampled according to a standardized method
- Agar plate were cultured overnight at 35-37 gr C.

<table>
<thead>
<tr>
<th></th>
<th>Day 0</th>
<th>Day 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dect phone</td>
<td>8% carried <em>S. aureus</em></td>
<td>5% carried <em>S. aureus</em></td>
</tr>
<tr>
<td>Stethoscope</td>
<td>12% carried <em>S. aureus</em></td>
<td>12% carried <em>S. aureus</em></td>
</tr>
</tbody>
</table>
Routes of transmission – droplet / airborne

- Large droplets travel ballistically through the air.
- Small droplets travel as a cloud through the air.

Droplet/airborne transmission causes very heavy contamination of environment, items, and equipment.

3 feet to 6 feet
Examples of High-touch items and surfaces in the patient environment:

- Door Handle
- Call Bell
- Light Switch
- Commode
- Bedpan

- Patient Room
- Patient Bathroom
Examples of High-touch items and surfaces outside the patient environment.
## Surface survival

<table>
<thead>
<tr>
<th>Organism</th>
<th>Survival time</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clostridium difficile</em> (spore)</td>
<td>&gt; 5 months</td>
</tr>
<tr>
<td><em>Acinetobacter spp</em></td>
<td>3 days to 11 months</td>
</tr>
<tr>
<td><em>Enterococcus spp</em> (incl. VRE)</td>
<td>5 days to &gt; 46 months</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>6 hours to 16 months</td>
</tr>
<tr>
<td><em>Klebsiella spp</em></td>
<td>2 hours to &gt; 12 months</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em> (incl. MRSA)</td>
<td>7 days to &gt; 12 months</td>
</tr>
<tr>
<td>Norovirus</td>
<td>8 hours to &gt; 2 weeks</td>
</tr>
</tbody>
</table>

**NOTE.** Adapted from Kramer et al. BMC Infect Dis 2006;6:130
Survival of ESBL producing *Escherichia coli* in three different suspension fluids

How long can extended-spectrum β-lactamase (ESBL)-producing *E. coli* survive on dry inanimate surface in water, saline and sheep blood

- *E. coli* ST131 and *E. coli* ST10
- Bacterial survival on the glasses was determined hourly during the first day, daily during following 6 days, and once weekly from day 7 up to 100 days.

V. Weterings et al. Submitted for publication
Survival of ESBL producing *Escherichia coli* in three different suspension fluids

A biphasic survival curve for all materials was observed, whereby there was a rapid decrease in the number of viable bacteria in the first six hours, followed by a much slower decrease in the subsequent days.

![Graph showing survival of ESBL producing *Escherichia coli* in three different suspension fluids.](image)

*Observed (circle ST10; triangle ST131) and predicted survival of ST10 (solid line) or ST131 (dotted line) in water, saline and sheep blood in the first 6h (I) and total study period (II).*
Survival of ESBL producing *Escherichia coli* in three different suspension fluids

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Survival of ESBL producing *Escherichia coli* in three different suspension fluids

This study shows that ESBL-producing *E. coli* ST10 and ST131 can survive on dry inanimate surfaces for long periods of time, even up to 71 days.

*In the first 6h of the experiment:*  
- **Increased survival of ST131** as compared to ST10.  
- The proportion surviving per hour was substantially higher in **sheep blood** than in the other media.

*After the first 6h of the experiment*  
- No difference between suspension fluids and ST-type.

V. Weterings et al. Under submission
"OK, you made your point...." cleaning is important!
Cleaning techniques

Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals

John M. Boyce

- Personnel-related issues
- Issues related to disinfection protocols and practices
- Monitoring housekeeping practices
- New liquid disinfectants
- Self-disinfecting surfaces
- No-touch room decontamination methods (e.g. hydrogen peroxide; ultraviolet)
Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals

John M. Boyce

- Personnel-related issues
- Issues related to disinfection protocols and practices
- Monitoring housekeeping practices
- New liquid disinfectants
- Self-disinfecting surfaces (e.g. coatings)
- No-touch room decontamination methods - Xenex
Self disinfecting surfaces - coatings

Titanium dioxide (TiO$_2$) + UV light $\rightarrow$ Reactive Oxigen Species ($\cdot$OH)

ROS damages the bacterial cell wall and membrane

We tested the influence of two TiO$_2$-based coating on the survival of Escherichia coli ST131 in the environment?
Self disinfecting surfaces - coatings

Figure 1: method survival experiment.

Coating A: Environ-X
Coating B: Produsafe-QX
### Self disinfecting surfaces - coatings

<table>
<thead>
<tr>
<th>Coating A</th>
<th>reduction</th>
<th>Max effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E.coli</em> in sterile saline</td>
<td>1.55 log reduction</td>
<td>7 hour</td>
</tr>
<tr>
<td><em>E.coli</em> in sheep blood</td>
<td>no reduction</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coating B</th>
<th>reduction</th>
<th>Max effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E.coli</em> in sterile saline</td>
<td>3.15 log reduction</td>
<td>5 hour</td>
</tr>
<tr>
<td><em>E.coli</em> in sheep blood</td>
<td>no reduction</td>
<td>-</td>
</tr>
</tbody>
</table>

J.Stohr et al. Posterpresentation at ECCMID 2016
Self disinfecting surfaces - coatings

This study shows that TiO$_2$-based coatings reduce bacterial survival in sterile saline in an in vitro setting.

Questions remain with respect to the efficacy of TiO2 based coatings in clinical settings, as

- the antibacterial effect was absent in the presence of blood;
- the presence of UV-light is a prerequisite for the antibacterial effect;
- data on the long-term persistence of the antibacterial effect of TiO2 coatings are lacking

* Environ-X and Produsafe QX supplied the coated cover glasses, but didn’t participate in the study design, the interpretation of results, or the decision to publish the data.
The Xenex Pulsed Xenon lamps produce a flash of full spectrum germicidal light that irreversibly damages micro-organisms.

1. **Photohydration** (pulling water molecules into the DNA that prevents transcription)
2. **Photosplitting** (breaking the backbone of the DNA)
3. **Photodimerization** (improper fusing of DNA bases)
4. **Photo crosslinking** (cell wall damage and cell lysis)

**Easy in use**
No need to seal room vents or doors
No penetration through glass or plastic
What is the influence of PX-UV, after variable time-intervals, on the survival time of *K. pneumoniae* Sequence Type (ST) 258, a pandemic strain.
Before PX-UV

After PX-UV

T=3.5 h serie:

Before PX-UV

After PX-UV

T=0 h serie:

1.9 log reduction

4.7 log reduction

Vertical bars represent 95% CI of mean 10LogCFU/ml

Legenda:

T=0 h serie: Before PX-UV

T=3.5 h serie: Before PX-UV

After PX-UV

After PX-UV

h. after inoculation
Pulsed Xenon Ultraviolet light

This study shows that PX-UV effectively reduces bacterial counts in the environment. However, the effect was much stronger after 3.5 hours. This is probably due to the evaporation of water, exposing the bacteria to the direct effect of UV-light.

The PX-UV is a promising technique to control environmental contamination with highly-resistant microorganisms. This should be studied in a clinical setting.

* REV Desinfectie Robots supplied the Xenex Germ-Zapping Robot, but didn’t participate in the study design, the interpretation of results, or the decision to publish the data.
Laboratory versus clinical setting

What is clean?
## Measuring environmental contamination

<table>
<thead>
<tr>
<th>Method</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection</td>
<td>Simple</td>
<td>Does not provide reliable assessment of cleanliness</td>
</tr>
<tr>
<td>Fluorescent marker system</td>
<td>Inexpensive Minimal equipment needed</td>
<td>Must mark surfaces before cleaning, and check them after cleaning</td>
</tr>
<tr>
<td>Aerobic colony counts</td>
<td>Relatively simple Detects presence of pathogens</td>
<td>More expensive Results not available after 48 hrs</td>
</tr>
<tr>
<td>ATP bioluminescence assay systems</td>
<td>Provides quantitative measure of cleanliness Quick results</td>
<td>More expensive Requires special equipment</td>
</tr>
</tbody>
</table>
Measuring environmental contamination

ATP (Adenosine Tri-Phosphate) = Organic matter (debris, food, bacteria)
The presence of ATP is indicative for insufficient cleaning

The more light (= RLU), the more contamination

Advantage:
• Standardized
• Objective
• Quantitative
• Real time feedback
• Useful for education purposes and feedback

## Interpretation ATP measurement

### Immediately after cleaning

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>&gt; 250</td>
</tr>
</tbody>
</table>

### During the day

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>&gt; 1500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>INTERMEDIATE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt; 3000 RLU</td>
</tr>
</tbody>
</table>

**Interpretation ATP measurement**

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>GREY ZONE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt;3000 RLU</td>
</tr>
</tbody>
</table>

Computer keyboard in our laboratory

2.603 RLU
Interpretation ATP measurement

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>GREY ZONE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt; 3000 RLU</td>
</tr>
</tbody>
</table>

Computer keyboard in our laboratory after cleaning

639 RLU
# Interpretation ATP measurement

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>GREY ZONE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt; 3000 RLU</td>
</tr>
</tbody>
</table>

Table in the canteen, with food rest!  

9,194 RLU
Interpretation ATP measurement

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>GREY ZONE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt; 3000 RLU</td>
</tr>
</tbody>
</table>

Table in the canteen, with food rest, **after cleaning**

329 RLU
# Interpretation ATP measurement

<table>
<thead>
<tr>
<th>CLEAN</th>
<th>GREY ZONE</th>
<th>CONTAMINATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1500 RLU</td>
<td>1500 – 3000 RLU</td>
<td>&gt; 3000 RLU</td>
</tr>
</tbody>
</table>

Body fluid !!
one small droplet

97,074 RLU
Measuring environmental contamination

Which items should be tested?

1. Frequently touched by patients

2. Frequently touched by healthcare workers

3. Medical devices
   - Glucose meter
   - Thermometer

4. Sanitary items
   - Toilet seat
   - Potty chair
<table>
<thead>
<tr>
<th>locatie</th>
<th>ward A (I)</th>
<th>ward A (II)</th>
<th>ward A (III)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bed rail</td>
<td>1858</td>
<td>1841</td>
<td>2158</td>
</tr>
<tr>
<td>bed rail</td>
<td>5683</td>
<td>1759</td>
<td>776</td>
</tr>
<tr>
<td>overbed table (surface top)</td>
<td>2816</td>
<td>638</td>
<td>435</td>
</tr>
<tr>
<td>washstand</td>
<td>397</td>
<td>134</td>
<td>109</td>
</tr>
<tr>
<td>shower chair</td>
<td>1068</td>
<td>3097</td>
<td>179</td>
</tr>
<tr>
<td>support bar in the toilet room</td>
<td>1870</td>
<td>569</td>
<td>828</td>
</tr>
<tr>
<td>toilet seat (upper-side)</td>
<td>12131</td>
<td>3579</td>
<td>6339</td>
</tr>
<tr>
<td>door handle nursing office</td>
<td>3195</td>
<td>1138</td>
<td>962</td>
</tr>
<tr>
<td>patient alarm bell</td>
<td>3443</td>
<td>11411</td>
<td>1535</td>
</tr>
<tr>
<td>i.v. pole (most frequently touched part)</td>
<td>3954</td>
<td>1069</td>
<td>1271</td>
</tr>
<tr>
<td>keyboard PC in the nursing office</td>
<td>6370</td>
<td>3611</td>
<td>2400</td>
</tr>
<tr>
<td>ward telephone (inside nursing office)</td>
<td>2536</td>
<td>4766</td>
<td>822</td>
</tr>
<tr>
<td>control panel bedpan washer</td>
<td>400</td>
<td>198</td>
<td>99</td>
</tr>
<tr>
<td>bedside commode (bedpan-chair)</td>
<td>968</td>
<td>757</td>
<td>4193</td>
</tr>
<tr>
<td>cabinet for medical supply &amp; bandages (hand grip)</td>
<td>1652</td>
<td>1876</td>
<td>357</td>
</tr>
<tr>
<td>blood pressure cuff</td>
<td>1148</td>
<td>1187</td>
<td>578</td>
</tr>
<tr>
<td>ear thermometer</td>
<td>1701</td>
<td>1390</td>
<td>553</td>
</tr>
<tr>
<td>blood glucose meter</td>
<td>1541</td>
<td>881</td>
<td>844</td>
</tr>
<tr>
<td>work surface of the bench for drug preparation</td>
<td>833</td>
<td>55</td>
<td>193</td>
</tr>
<tr>
<td>keyboard Computer On Wheels (COW)</td>
<td>8209</td>
<td>983</td>
<td>1814</td>
</tr>
</tbody>
</table>
RESULTS nursing home (example NH A)
# RESULTS nursing home

*(example NH A and B)*

<table>
<thead>
<tr>
<th>Item</th>
<th>Nh A</th>
<th>Nh B</th>
<th>Nh C</th>
<th>Nh D</th>
</tr>
</thead>
<tbody>
<tr>
<td>bed rail</td>
<td>3.373</td>
<td>1566</td>
<td>926</td>
<td>233</td>
</tr>
<tr>
<td>overbed table</td>
<td>9.689</td>
<td>3044</td>
<td>1119</td>
<td>80</td>
</tr>
<tr>
<td>toilet seat</td>
<td>938</td>
<td>3981</td>
<td>1407</td>
<td>233</td>
</tr>
<tr>
<td>bedside commode</td>
<td>3.196</td>
<td>3535</td>
<td>1239</td>
<td>1299</td>
</tr>
<tr>
<td>washstand</td>
<td>36.560</td>
<td>261</td>
<td>1329</td>
<td>1040</td>
</tr>
<tr>
<td>support bar toilet</td>
<td>38.846</td>
<td>8164</td>
<td>1198</td>
<td>2096</td>
</tr>
<tr>
<td>table livingroom</td>
<td>3.446</td>
<td>282</td>
<td>1608</td>
<td>233</td>
</tr>
<tr>
<td>doorknob livingroom</td>
<td>6.552</td>
<td>7091</td>
<td>7113</td>
<td>1237</td>
</tr>
<tr>
<td>keyboard computer</td>
<td>706</td>
<td>3492</td>
<td>1030</td>
<td>521</td>
</tr>
<tr>
<td>telephone</td>
<td>1.703</td>
<td>4804</td>
<td>2975</td>
<td>1476</td>
</tr>
<tr>
<td>medicine supply</td>
<td>1.181</td>
<td>2061</td>
<td>439</td>
<td>287</td>
</tr>
<tr>
<td>cabinet for medical supplies &amp; band</td>
<td>215</td>
<td>3607</td>
<td>5451</td>
<td>55</td>
</tr>
<tr>
<td>ear thermometre</td>
<td>895</td>
<td>3142</td>
<td>296</td>
<td>672</td>
</tr>
<tr>
<td>glood glucose meter</td>
<td>2.393</td>
<td>3391</td>
<td>190</td>
<td>302</td>
</tr>
<tr>
<td>patient lift handle</td>
<td>221.269</td>
<td>22.132</td>
<td>1149</td>
<td>9590</td>
</tr>
</tbody>
</table>
Bundle approach

“a collection of things, tied or wrapped up together”
Infection Risk Scan = IRIS

Measurement of both patient and ward-related variables.

Standardised Objective Bundle approach

Outcome or process values are compared to reference data (breakpoints) and classified in risk categories: high, intermediate, low risk (traffic light colors)

Results are visualised in a risk profile and an improvement plot
Infection Risk Scan = IRIS

RISK PROFILE
Patient-related risks

IMPROVEMENT PLOT
Variables that can be influenced by HCWs
Infection Risk Scan = IRIS

RISK PROFILE

- **ESBL-rectal carriage (%):**
  - 0%
  - 25%
  - 56%

- **Medical devices (%):**
  - 0%
  - 4%
  - 25%

- **Antimicrobial use (%):**
  - 0%
  - 4%
  - 56%

- **McCabe score (comorbidity):**
  - niet fataal
  - uiteindelijk fataal
  - snel fataal
  - onbekend
  - 77
  - 23

IMPROVEMENT PLOT

1= transmission of ESBL (%);
2= inappropriate use of med.devices (%);
3= inappropriate use of antibiotics (%);
4= environmental contamination (RLU);
5= handhygiëne non-compliance (%);
6= personal hygiene HCW
7= preconditions infection control

High risk
Intermediate risk
Low risk
IRIS
Infection Risk Scan = IRIS

1 = transmission of ESBL (%);
2 = Inappropriate use of med.devices (%);
3 = inappropriate use of antibiotics (%);
4 = environmental contamination (RLU);
5 = handhygiène non-compliance (%);
6 = personal hygiene HCW
7 = preconditions infection control
To provide relevant and easy to understand information, showing an overall view of the current infection control practice.

Based on the results a targeted quality improvement program is implemented.
Figure: improvement plots from 5 hospital wards of different medical specialties. IRIS was performed three times with an interval of 6-8 months.

1 = transmission of ESBL (%);
2 = inappropriate use of med. devices (%);
3 = inappropriate use of antibiotics (%);
4 = environmental contamination (RLU);
5 = hand hygiene non-compliance (%);
6 = personal hygiene HCW
7 = preconditions infection control

* Willemsen & Kluytmans. De Infectierisicoscan in de praktijk, Verbetering van infectiepreventie en antibiotica gebruik door transparantie. NTvG. 2016
Environmental contamination

High level of contamination of:
- Keyboard Computer on wheels (COW)
- Potty-chairs
- “orphan” objects
- Better agreements on responsibilities
- Dedicated cleaning staff
- Monitoring cleaning practices
- Monitoring cleaning performed by nursing staff

→ Significant reduction in ATP level (p<0.0001)
HANDHYGIENE

- Education program Hand hygiene (performed by nurses)
- Hand disinfectants at the bed-side
- Peer review feedback
- Increase in compliance from 43% to 66%
  (over 1000 observations per IRIS, p<0.000)

![Graph showing overall HHC (IRIS 1 and 3)]
Infection RISK Scan – Nursing Homes

- Residential setting
- More interaction between residents
- Lower awareness about hygiene among residents
- Difficult instruction opportunities among residents
**Infection Risk Scan – Nursing Homes (NH)**

Setting: 9 Nursing Homes within one organisation

Inclusion: 774 residents (range 14-189 per NH)

No significant difference in population between the 9 NHs.

An IRIS scan was performed. Results were expressed in an IRIS-plot for each NH

*Willemsen et al. Measuring the quality of infection control in Dutch nursing homes using the IRIS. Antimicrob Resist and Inf Control. 2014*
Infection Risk Scan – Nursing Homes (NH)

NH 1  NH 2  NH 3

NH 4  NH 5  NH 9

A = local guidelines not available; B = shortcomings in constraints; C = healthcare associated infections; D = use of medical devices; E = environmental contamination; F = antimicrobial use; G = ESBL carriage

All axis are scaled from 0 up to 100% of the total population of tested subjects/objects

*Willemsen et al. Measuring the quality of infection control in Dutch nursing homes using the IRIS. Antimicrob Resist and Inf Control. 2014*
Infection Risk Scan – Nursing Homes (NH)

NH1

NH5

*Willemsen et al. Measuring the quality of infection control in Dutch nursing homes using the IRIS. Antimicrob Resist and Inf Control. 2014*
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Antimicrobial resistance in the NH

643 out of 774 residents were screened → 70/643 (10.9%) ESBL carriage
E. coli / Breda
E. coli ST131 is a “highly transmissable” and virulent outbreak strain.

- Long term carriage
- “Super clone”
- Virulent
- Resistent

Escherichia coli Sequence Type 131 Is a Dominant, Antimicrobial-Resistant Clonal Group Associated with Healthcare and Elderly Hosts

Ritu Banerjee, MD, PhD; Brian Johnston, BS; Christine Lohse, MS; Stephen B. Porter, BS; Connie Clabots, BS; James R. Johnson, MD
Current situation in this NH

%Tot

Cleaning in the 21th century

THE DARK AGES?
IT DOESN'T HURT TO BE OPTIMISTIC. YOU CAN ALWAYS CRY LATER.

LUCIMAR SANTOS DE LIMA

PICTUREQUOTES.com
**i-4-1-health project (Netherland – Belgium)**

**Goal:** to obtain insight in the presence and transmission of antimicrobial resistance in
- Hospitals
- Nursing homes
- Schools and kindergardens
- Veterinary farms

by using the IRIS method

The ultimate goal is to control and reduce resistance in the border area.
Acknowledgements

Amphia ziekenhuis
- Esther Weterings
- Carlo Verhulst
- Gonny Moen
- Jan Kluymans
- Kees Verduin
- Miranda van Rijen
- Marjolein Kluymans
- Sanny Nijssen
- Tineke de Goede
- Veronica Weterings
- Wouter Blox
- Yvonne Hendriks

Elisabeth Tweesteden ziekenhuis
- Jacobien Veenemans
- Joep Stohr

Jolande Nelson
Thebe
- Ans Mulder
- Sandrien Verhoef

Rhode Island Hospital
- Julie Jefferson
- Leonard Mermel

Universitair Ziekenhuis Leuven
- Annette Schuermans
- Martine Verelst
- Veroniek Saegemans