Pseudomonas aeruginosa on inflatables and foam teaching aids in swimming pools

Ciska Schets, Ruben Baan, Harold van den Berg, Ana Maria de Roda Husman


*Pseudomonas aeruginosa* in swimming pools

- grows in the warm and humid swimming pool environment
- accumulates in biofilms
- introduced by swimmers through the bare-feet floors
- opportunistic pathogen
  - attacks at low resistance / weak immunity
  - causes ear, skin, eye, wound and urinary track infections
- resistant to a broad range of commonly used antibiotics
  - low natural susceptibility
  - easily acquires resistance
- pool infections often associated with
  - poor disinfection
  - poor cleaning
  - overcrowding
aim and set-up

- test whether inflatables and foam teaching aids in Dutch swimming pools were colonized by *P. aeruginosa*
- enrolment of swimming pools in Utrecht and Leiden region
  - 2011 and 2012
  - 24 swimming pools
- pool visits included
  - administration of questionnaire to pool manager
    - age, origin, cleaning, storage, frequency of use of inflatables and teaching aids
  - selection of most frequently used teaching aids with body contact
  - sampling of inflatables, teaching aids and mats
selection of the sampled equipment
sampling

- 10 x 10 cm square
- EnviroSwab 3M
- foam teaching aids
  - 1 sample per object
  - 2-4 objects per swimming pool
- inflatables and mats
  - 3-5 samples per object
  - 1 object per swimming pool
- recording of ‘wet/dry’
- recording of room temperature
Pseudomonas aeruginosa detection

- EnviroSwabs washed in peptone-saline
  - membrane filtration, CN-agar & mPA-B
  - Pseudalert quantitray (IDEXX)
  - swab in Pseudalert presence/absence test

- confirmation
  - King’s B agar
  - API20E and/or API20NE
  - growth at 42 °C
  - acetamide-test
  - pigment production

- antibiotic susceptibility test (Sensi-Disc)
  - 12 clinically relevant antibiotics
equipment tested

- 175 objects tested
  - 125 (71%) of foam
  - 50 (29%) of vinyl-canvas
- 230 samples taken
  - 127 (55%) from foam teaching aids
  - 103 (45%) from vinyl-canvas objects
  - 121 samples (53%) from dry objects
  - 109 (47%) from wet objects
**P. aeruginosa** positive samples

- *P. aeruginosa* contaminated objects in 19 of 24 pools (79%)
- 63 of 230 samples positive (27%) with at least 1 method
  - 25 positive samples from foam objects
    - 20% of the objects positive
  - 38 positive samples from vinyl-canvas objects
    - 44% of the objects positive
- 43% of ‘wet’ samples positive
- 12% of ‘dry’ samples positive
**P. aeruginosa on foam teaching aids**

<table>
<thead>
<tr>
<th></th>
<th># total</th>
<th>%</th>
<th># dry</th>
<th>%</th>
<th># wet</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>aqua belt</td>
<td>2/13</td>
<td>15</td>
<td>2/10</td>
<td>20</td>
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<td>0</td>
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<tr>
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<td>1/8</td>
<td>13</td>
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<td>17</td>
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<td>31</td>
<td>1/15</td>
<td>7</td>
<td>12/27</td>
<td>44</td>
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<tr>
<td>noodle</td>
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<td>21</td>
<td>2/11</td>
<td>18</td>
<td>2/8</td>
<td>25</td>
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<tr>
<td>swim belt</td>
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<td>9</td>
<td>1/22</td>
<td>5</td>
<td>2/13</td>
<td>15</td>
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<tr>
<td>bricks</td>
<td>1/4</td>
<td>25</td>
<td>1/3</td>
<td>33</td>
<td>0/1</td>
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<tr>
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<td>20</td>
<td>8/69</td>
<td>12</td>
<td>17/58</td>
<td>29</td>
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</table>

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### P. aeruginosa on vinyl-canvas objects

<table>
<thead>
<tr>
<th></th>
<th># total</th>
<th>%</th>
<th># dry</th>
<th>%</th>
<th># wet</th>
<th>%</th>
<th># objects</th>
<th>%</th>
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</thead>
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<td>0</td>
<td>0/0</td>
<td>0</td>
<td>0/2</td>
<td>0</td>
<td>0/1</td>
<td>0</td>
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<tr>
<td>animal</td>
<td>4/18</td>
<td>22</td>
<td>0/11</td>
<td>0</td>
<td>4/7</td>
<td>57</td>
<td>3/9</td>
<td>33</td>
</tr>
<tr>
<td>obstacle course</td>
<td>17/34</td>
<td>50</td>
<td>3/14</td>
<td>21</td>
<td>14/20</td>
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<tr>
<td>float</td>
<td>7/15</td>
<td>47</td>
<td>1/8</td>
<td>13</td>
<td>6/7</td>
<td>86</td>
<td>6/11</td>
<td>55</td>
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<tr>
<td>mat</td>
<td>7/30</td>
<td>23</td>
<td>3/18</td>
<td>17</td>
<td>4/12</td>
<td>33</td>
<td>6/18</td>
<td>33</td>
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<tr>
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<td>1/1</td>
<td>100</td>
<td>2/3</td>
<td>67</td>
<td>2/3</td>
<td>67</td>
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<tr>
<td><strong>total</strong></td>
<td>38/103</td>
<td>37</td>
<td>8/52</td>
<td>15</td>
<td>30/51</td>
<td>59</td>
<td>22/50</td>
<td>44</td>
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</table>
methods & concentrations

<table>
<thead>
<tr>
<th></th>
<th>CN-agar*</th>
<th>mPA-B-agar*</th>
<th>Pseudalert**</th>
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<tbody>
<tr>
<td></td>
<td>foam</td>
<td>vinyl-canv</td>
<td>foam</td>
</tr>
<tr>
<td># samples</td>
<td>23 (8)</td>
<td>36 (10)</td>
<td>4 (3)</td>
</tr>
<tr>
<td>positive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>range</td>
<td>0.4-38</td>
<td>0.2-90</td>
<td>0.2-20</td>
</tr>
<tr>
<td>mean</td>
<td>10.1</td>
<td>19.7</td>
<td>8.3</td>
</tr>
<tr>
<td>median</td>
<td>5.9</td>
<td>2.7</td>
<td>4.8</td>
</tr>
</tbody>
</table>

* concentrations in cfu/ml
** concentrations in mpn/ml
**P. aeruginosa concentrations**

- variable concentrations
- on average higher concentrations on inflatables than on foam teaching aids
- concentrations were method dependent
- detected concentrations give indication of ‘true’ concentrations
  - small part of objects swabbed
    - no test for homogeneity / representativeness of samples
  - recovery of swab procedure unknown
    - washing procedure standardized, however variation possible
    - positive presence / absence tests of washed swabs indicate that bacteria stay behind in swabs (19%)
# Use and Maintenance of Equipment

<table>
<thead>
<tr>
<th></th>
<th>Vinyl-Canvas</th>
<th>Foam</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>frequent</td>
<td>frequent</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>1-10 years</td>
<td>1-3 years</td>
</tr>
<tr>
<td><strong>Frequency of Use</strong></td>
<td>daily</td>
<td>daily</td>
</tr>
<tr>
<td></td>
<td>weekly</td>
<td>weekly</td>
</tr>
<tr>
<td><strong>Duration of Use</strong></td>
<td>60-240 min</td>
<td>30-240 min</td>
</tr>
<tr>
<td></td>
<td>60-120 min</td>
<td>60-120 min</td>
</tr>
<tr>
<td><strong>Cleaning after Use</strong></td>
<td>yes 1/15#</td>
<td>yes 5/24</td>
</tr>
<tr>
<td></td>
<td>yes 2/16*</td>
<td></td>
</tr>
<tr>
<td><strong>Cleaning/drying</strong></td>
<td>yes 7/15#</td>
<td>none</td>
</tr>
<tr>
<td>Before Storage</td>
<td>yes 5/16*</td>
<td></td>
</tr>
<tr>
<td><strong>Storage Location</strong></td>
<td>dry place in building</td>
<td>in swim hall</td>
</tr>
</tbody>
</table>

*: inflatables
#: mats
health conditions

- swimming pool managers
  - seldomly notified of skin conditions
  - mentioned occasional cases of skin rash
    - children used inflatable slides or obstacle courses
    - attributed this to scraping of skin on inflatables

- probable underestimation of cases
  - large number of people use inflatables
  - high level of contaminated objects
  - appearance of *P. aeruginosa* folliculitis is not unique
  - mild infection: no medical attention required
antibiotic resistance

- 193 isolates were confirmed *P. aeruginosa*
- 40/193 (21%) isolates were (intermediate) resistant
  - 28 isolates resistant to 1 antibiotic
  - 12 isolates resistant to 2-5 antibiotics
  - no multi-drug resistance
    > ≥1 antibiotic in ≥3 antibiotic classes
- antibiotic resistant isolates from 11 different objects
  - 4 foam objects
  - 7 vinyl-canvas objects
- most observed resistance against
  - carbapenems → imipenem
  - monobactams → aztreonam
summary

- *P. aeruginosa* was present on inflatables and foam teaching aids in Dutch swimming pools
- 21% of the isolated strains was (intermediate) resistant to one or more of the tested clinically relevant antibiotics
- large inflatables more often contaminated than foam aids
  - storage
  - frequency of use
  - type of material
  - shape
- wet objects more often contaminated than dry objects
  - biofilms clearly noticeable on vinyl-canvas objects
conclusions

• wet storage of inflatables and teaching aids enhances growth of *P. aeruginosa*
• the effect of cleaning before storage seems minimal in case of wet storage
• the effect of cleaning and drying before storage seems preventive
• the effect of cleaning, drying or disinfection on growth, re-growth or removal of *P. aeruginosa* needs further study
• presence of (antibiotic resistant) *P. aeruginosa* is unwanted
acknowledgements

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- Michelle Pereira
- Tonny de Vos
- Jolanda van Schie
- Annelies van Goor
questions?

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