Air supply in operating theatres – the German view

Differences and similarities in infection prevention in European countries

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Knowing more. Thinking ahead.
Surgical site infections

- SSI are the most frequent hospital infection in Germany (ca. 225,000) (Gastmeier, Dtsch med Wochenschr. 2008; 133(21))
- reasons are multicausal
- 30 % – 55 % der SSI are avoidable (Gastmeier, Dtsch med Wochenschr. 2010; 135 (3), DGKH Hygiene-Tipp (02/2012))
- Influence of the air is an unsolved question in Germany (rki; Epidemiologisches Bulletin 04/2010)
Surgical site infections - reasons

- Endogenous factors (90 %)
  - Microbiological colonization within the wound area (95 %)
  - Microbiological colonization outside the wound area (5 %)
- Exogenous factors (10%)
  - Surgical staff and ventilation (99 %)
  - Environment (1%)

(Swissnoso Bulletin, Postoperative Wundinfektionen: eine Übersicht, 03/1996)
## KRINKO-Guideline: Prevention of SSI

### Anteil der bei Wundinfektionen gewonnenen Isolate (%) je nach Fachgebiet

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Allgemein-und Thoraxchirurgie (2527)</th>
<th>Traumatologie/Orthopädie (1631)</th>
<th>Herzchirurgie (714)</th>
<th>Gefäßchirurgie (431)</th>
<th>Geburtshilfe (653)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
<td>11,4</td>
<td>42,7</td>
<td>39,6</td>
<td>39,0</td>
<td>19,8</td>
</tr>
<tr>
<td>Enterokokken</td>
<td>12,9</td>
<td>10,9</td>
<td>8,7</td>
<td>10,7</td>
<td>6,9</td>
</tr>
<tr>
<td>E. coli</td>
<td>22,6</td>
<td>4,1</td>
<td>2,7</td>
<td>6,7</td>
<td>4,4</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>3,8</td>
<td>3,2</td>
<td>3,6</td>
<td>2,6</td>
<td>0,5</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>3,7</td>
<td>1,2</td>
<td>0,8</td>
<td>3,0</td>
<td>0,5</td>
</tr>
<tr>
<td>Koagulase neg. Staphylokokken</td>
<td>4,2</td>
<td>19,4</td>
<td>21,1</td>
<td>9,3</td>
<td>8,7</td>
</tr>
<tr>
<td>Enterobacter spp.</td>
<td>12,9</td>
<td>2,4</td>
<td>4,3</td>
<td>3,3</td>
<td>0,3</td>
</tr>
<tr>
<td>Streptokokken</td>
<td>4,8</td>
<td>4,8</td>
<td>1,5</td>
<td>5,3</td>
<td>6,4</td>
</tr>
<tr>
<td>Candida</td>
<td>1,4</td>
<td>0,2</td>
<td>0,5</td>
<td>0,2</td>
<td>0,1</td>
</tr>
</tbody>
</table>

Bundesgesundheitsbl - Gesundheitsforsch - Gesundheitsschutz 2007 · 50:377–393
Tasks of the ventilation system

- Removal of thermal load
- Removal of micro-organisms
- Removal of harmful substances
- External loads
- Internal loads

Source: Dr. Peter Lüderitz
Technical standard

- E-VDI 2167: 2004
- E-DIN 1946-4: 2005
- E-DIN 1946-4: 2007
- VDI 2167-1: 2007

DIN 1946-4: 2008-12
Hygienic requirements of the ventilation system depend on kind of surgery

- The requirements depending on:
  - Implantation of extraneous material
  - Size of the wound area
  - Time of surgery
  - Blood circulation
Room classes according to DIN 1946-4

- Room classes
- OR: Room class Ia
  - Total endoprothetic, transplantations, thorax surgery
- OR: Room class Ib
  - “common” surgery, colon, micro invasive surgery
- Room class II
  - All peripheral rooms
Room class 1a

- 3-stage supply-air filtration
- (F7/ F9 ventilation unit) and terminal HEPA filters (H13)
- Plenum-type laminar-airflow-style diffusers
- Size: 3.2 m x 3.2 m
- Supply-air velocities LAF: 0.22 – 0.25 m\(^3\)/s
- Outdoor air flow rate min. 1,200 m\(^3\)/h,
- Whole amount of air: 9,000 – 10,000 m\(^3\)/h
- Positive pressure
Room class Ia
Differential flow

- Supply-air diffuser is the same
- Air volume flow is the same
- Supply-air velocities in the center is faster than in the boundaries
  - Center: 0.40 m*s\(^{-1}\), boundaries: 0.20 m*s\(^{-1}\)
- Smaller lee areas behind lamps
Differential flow
Poor ventilation
Good ventilation
Room class Ib

- 3-stage supply-air filtration
- (F7/ F9 ventilation unit) and terminal HEPA filters (H13)
- Small supply-air diffusers or simple filter outlets
- Turbulent air distribution
- Outdoor air flow rate min. 1,200 m³/h
- Whole amount of air: 3,000 – 4,000 m³/h
- Positive pressure
Room class Ib
Room class II

- 2-stage supply-air filtration (F7/F9)
- Filter outlets or overspill air from theatre
- Turbulent air distribution
- Outdoor air flow 40 m³/ person
- All peripheral rooms in the surgical suite belong to room class II
Room class II: intervention room
Influence of different ventilation systems upon the contamination of medical device

Turbulent ventilation

under laminar-airflow  outside the LAF
Results

Table 3: Comparison of contamination levels on sedimentation plates and Crile clamps, of an equivalent size surface area, for the different ventilation systems.

<table>
<thead>
<tr>
<th></th>
<th>la-OR protected area</th>
<th>la-OR outside protected area</th>
<th>Ib-OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedimentation plates [cfu/50 cm²]</td>
<td>0.4</td>
<td>2.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Crile clamps [cfu/50 cm²]</td>
<td>1.6</td>
<td>7.0</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Table 4: Individual results for Crile clamp contamination levels with the different ventilation systems.

<table>
<thead>
<tr>
<th></th>
<th>la-OR protected area</th>
<th>la-OR outside protected area</th>
<th>Ib-OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of clamps</td>
<td>48</td>
<td>49</td>
<td>50</td>
</tr>
<tr>
<td>Clamps with 0 cfu</td>
<td>33</td>
<td>26</td>
<td>17</td>
</tr>
<tr>
<td>Proportion of contaminated clamps</td>
<td>31%</td>
<td>47%</td>
<td>66%</td>
</tr>
<tr>
<td>Mean value [cfu]</td>
<td>0.7</td>
<td>2.8</td>
<td>3.6</td>
</tr>
<tr>
<td>Maximum value [cfu]</td>
<td>7.4</td>
<td>64.0</td>
<td>44.3</td>
</tr>
</tbody>
</table>

Benen T., Wille F, Clausdorff, L. Influence of different ventilation systems upon the contamination of medical device. HygMed 2013; 38-4:
overnight shutdown of the ventilation system in the OR

- Ventilation runs 24 h, 365 d per year and costs a lot of energy
- DIN 1946-4: 2008 for the peripheral rooms possible
  - point 6.9: shutdown room class II possible
  - roomclass I: reversal of positiv pressure should be avoided
- OENORM H 6020: 2007
  - point 5.9.1: shutdown for OR-ventilation possible
  - default: lead time from 30 min before the start of use
Hygienic review of overnight shutdown

- no patients in the OR ➔ no risk
- no stuff in the OR ➔ no risk
- nobody in the OR ➔ no comfort requirements
- entry of particles and germs during the out of the use time is low
- by lead time the sufficient purging of the room is ensured
Conclusions

- Ventilation is just one part to avoid surgical site infections
- The importance of the ventilation system in infection control is unsure but cannot be denied
- German standard: DIN 1946-4: 2008
- 3 room classes: Ia LAF, Ib turbulent for OR, II “normal” rooms
- Intersurgical contamination of medical devices depends on the ventilation system
- Overnight shutdown of the ventilation is possible
Thank you for your attention!
Any questions?

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