Infection control methods for cancer patients undergoing treatment:
Infection control measures for prevention of fungal infections in neutropenic patients
Petra Gastmeier
2010: 300 years Charité hospital Berlin

- 3200 beds
- largest university hospital in Germany
- 3 haematology/oncology departments
2010: 125 years Institute for Hygiene
Charité University Hospital Berlin

Institute of Hygiene = National Reference Center for Surveillance of nosocomial infections supported by the German Ministry of Health
Endpoints

Primary BSI cases
Primary BSI rate = \frac{\text{number of cases}}{\text{neutropenia days}} \times 1000

Pneumonia cases
Pneumonia rate = \frac{\text{number of cases}}{\text{neutropenia days}} \times 1000

- Autologous transplant patients, 25 departments
- Allogenic transplant patients, 19 departments
- Participation is voluntary, confidential data feedback
- www.nrz-hygiene.de
# Distribution of infection rates 2006-2010

## Autologous transplant patients

<table>
<thead>
<tr>
<th>Infection rate</th>
<th>Patients</th>
<th>Infections</th>
<th>Median</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary BSI / 1000 neutroenic days</td>
<td>2658</td>
<td>373</td>
<td>14.3</td>
<td>19.0</td>
</tr>
<tr>
<td>Pneumonia cases / 1000 neutropenic days</td>
<td>2658</td>
<td>99</td>
<td>2.4</td>
<td>5.2</td>
</tr>
</tbody>
</table>

## Allogenic transplant patients

<table>
<thead>
<tr>
<th>Infection rate</th>
<th>Patients</th>
<th>Infections</th>
<th>Median</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary BSI / 1000 neutroenic days</td>
<td>3719</td>
<td>619</td>
<td>19.8</td>
<td>23.0</td>
</tr>
<tr>
<td>Pneumonia cases / 1000 neutropenic days</td>
<td>3719</td>
<td>333</td>
<td>8.7</td>
<td>18.2</td>
</tr>
</tbody>
</table>
ONKO-KISS – Krankenhaus-Infektions-Surveillance-System auf Knochenmark- und Blutstammzell-Transplantationsabteilungen
Berechnungszeitraum: Juli 2003 bis Juni 2008

Referenzdaten für Knochenmark- und Blutstammzell-Transplantationsabteilungen
Allogene Transplantationen

<table>
<thead>
<tr>
<th>Anzahl Kliniken:</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anzahl Abteilungen:</td>
<td>20</td>
</tr>
<tr>
<td>Anzahl Patienten:</td>
<td>3.189</td>
</tr>
<tr>
<td>Anzahl Neutropenietage:</td>
<td>60.665</td>
</tr>
<tr>
<td>Anzahl Patienten mit NI:</td>
<td>778</td>
</tr>
</tbody>
</table>

Verteilung Neutropeniedauer

<table>
<thead>
<tr>
<th></th>
<th>Neutropeniedauer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gepoolt</td>
</tr>
<tr>
<td></td>
<td>19,0</td>
</tr>
</tbody>
</table>

Inzidenzdichten über alle Patienten mit allogener Transplantation

<table>
<thead>
<tr>
<th>Art der Infektion</th>
<th>Anzahl Infektionen</th>
<th>Anzahl Patienten</th>
<th>Inzidenzdichte</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gepoolt</td>
<td>25%-Quantil</td>
</tr>
<tr>
<td>Sepsis</td>
<td>525</td>
<td></td>
<td>8,7</td>
</tr>
<tr>
<td>Pneumonie</td>
<td>363</td>
<td></td>
<td>6,0</td>
</tr>
</tbody>
</table>

Inzidenzdichte = Anzahl Infektionen / Anzahl Neutropenie-Tage x 1000
BSI cases

Autologous transplant patients

Incidence: 8/2658 = 0.3%

Allogeneic transplant patients

Incidence: 31/3719 = 0.8%

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. krusei</td>
<td>8</td>
</tr>
<tr>
<td>C. albicans</td>
<td>5</td>
</tr>
<tr>
<td>C. tropicalis</td>
<td>3</td>
</tr>
<tr>
<td>C. glabrata</td>
<td>1</td>
</tr>
<tr>
<td>C. guiellermondi</td>
<td>1</td>
</tr>
<tr>
<td>C. parapsilosis</td>
<td>1</td>
</tr>
<tr>
<td>Candida spp.</td>
<td>15</td>
</tr>
</tbody>
</table>
Candida spp. are often endogenous infections following the selection following broad spectrum antibiotic usage, but also transmission via hands of HCW.
In general the same prevention measures as used for bacterial infections
Only during neutropenic period!

**Autologous transplant patients**

Incidence: 0/2658 = 0 %

**Allogenic transplant patients**

Incidence: 11/3719 = 0.3 %

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. fumigatus</td>
<td>1</td>
</tr>
<tr>
<td>A. flavus</td>
<td>1</td>
</tr>
<tr>
<td>Aspergillus spp.</td>
<td>8</td>
</tr>
<tr>
<td>Absidia spp</td>
<td>1</td>
</tr>
</tbody>
</table>

Pneumonia cases

Molds
1. Surveillance

Hospitals caring for neutropenic patients should establish ongoing surveillance of IFI to detect increases in incidence.

Aspergillosis cases

It is necessary to perform a regular review of microbiological and pathology reports suggestive of infection.
1. Surveillance

EORTC/MSG defined 3 levels of diagnostic probabilities
  „proven“
  „probable“
  „possible“

These criteria were designed for clinical research, but can also be applied to infection control surveillance.

De Pauw B et al. CID 2008; 46:1813-21
1. Surveillance

- it is not possible to reliably distinguish community-acquired from nosocomial cases
- arbitrary cut-off of 7 days has been used by some experts as an incubation period
- also nosocomial when 14 days post discharge

Partridge-Hinckley K et al. Mycopathologia 2009; 168: 329-37
1. Surveillance

DENOMINATORs:
A. Surveillance for the hematology/oncology department
   - per number of patients with neutropenia/
     at least 10 days of neutropenia
   - all patient days
   - stratified according to type of therapy

B. Surveillance for the whole hospital
   - per 100 patients/ - per 1000 patient days
## Example: Surveillance

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of cases</th>
<th>Patient days</th>
<th>Incidence density (per 100 000 patient days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>32</td>
<td>391 445</td>
<td>24</td>
</tr>
<tr>
<td>2004</td>
<td>16</td>
<td>407 007</td>
<td>15</td>
</tr>
<tr>
<td>2005</td>
<td>15</td>
<td>407 644</td>
<td>6</td>
</tr>
<tr>
<td>2006</td>
<td>7</td>
<td>415 980</td>
<td>5</td>
</tr>
<tr>
<td>2007</td>
<td>11</td>
<td>431.954</td>
<td>4</td>
</tr>
</tbody>
</table>

Graf K et al. BMC Infect Dis; in press
Example: Surveillance

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>proven</td>
<td>56</td>
</tr>
<tr>
<td>probable</td>
<td>25</td>
</tr>
<tr>
<td>possible</td>
<td>133</td>
</tr>
</tbody>
</table>

Graf K et al. BMC Infect Dis in press

- 37 Solid organ transplantation
- 8 Bone marrow transplantation
- 10 Malignant tumors
- 26 Chronical organ diseases
2. Protective environment
2. Protective environment

- Positive airflow relative to the corridor
- High number of air changes per hour (> 12 ACH)
- Minimal leakage of air into the room
2. Protective environment

Central or point-of-use high-efficacy particulate air (HEPA) filters with 99.97% efficacy for removing particles 0.3 µm or larger

Aspergillus conidia (2.5-3.0 µm diameter)
2. Protective environment

Filter efficiency

<table>
<thead>
<tr>
<th>Filters</th>
<th>Efficiency</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Low</td>
<td>20-40 %</td>
</tr>
<tr>
<td>2nd</td>
<td>Medium</td>
<td>90 %</td>
</tr>
<tr>
<td>3rd = HEPA*</td>
<td>High</td>
<td>99.97 % for removing particles &gt;0.3 μm in diameter.</td>
</tr>
</tbody>
</table>

HEPA = high-efficiency particulate air
The evidence for HEPA filtration to prevent IFI: Our review

The Influence of High-Efficiency Particulate Air Filtration on Mortality and Fungal Infection among Highly Immunosuppressed Patients: A Systematic Review

Tim Eckmanns,¹ Henning Rüden,¹ and Petra Gastmeier²
¹Institute of Hygiene and Environmental Medicine, Charité–University Medicine Berlin, Berlin, and ²Institute of Microbiology and Hospital Hygiene, Medical University Hanover, Hanover, Germany

Eckmanns et al. JID 2006; 193:1408–18
Method

- 923 articles screened
- Two groups of studies: RCTs and non-RCTs (16 trials included; 8+8)
- Two endpoints: mortality (9) and fungal infection rate (10)
Table 3. Results of meta-analyses of studies with death as the outcome.

<table>
<thead>
<tr>
<th>Authors, year of publication [reference]</th>
<th>Patients in rooms with HEPA/LAF ventilation, no.</th>
<th>Patients in rooms with no ventilation system, no.</th>
<th>Total patients, no.</th>
<th>RR (95% CI)</th>
<th>Mortality rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Who died</td>
<td>Who survived</td>
<td>Who died</td>
<td>Who survived</td>
<td></td>
</tr>
<tr>
<td>RCTs with death as the outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yates et al., 1973 [26]</td>
<td>11</td>
<td>24</td>
<td>17</td>
<td>35</td>
<td>87</td>
</tr>
<tr>
<td>Levine et al., 1973 [27]</td>
<td>1</td>
<td>21</td>
<td>9</td>
<td>29</td>
<td>60</td>
</tr>
<tr>
<td>Buckner et al., 1978 [24]</td>
<td>23</td>
<td>6</td>
<td>25</td>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>Storb et al., 1983 [25]</td>
<td>5</td>
<td>34</td>
<td>28</td>
<td>63</td>
<td>130</td>
</tr>
<tr>
<td>Petersen et al., 1987 [29]</td>
<td>13</td>
<td>36</td>
<td>12</td>
<td>38</td>
<td>99</td>
</tr>
<tr>
<td>Petersen et al., 1988 [28]</td>
<td>13</td>
<td>128</td>
<td>15</td>
<td>186</td>
<td>342</td>
</tr>
<tr>
<td>All</td>
<td>66</td>
<td>249</td>
<td>106</td>
<td>353</td>
<td>774</td>
</tr>
<tr>
<td>Non-RCTs with death as the outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rodriguez et al., 1978 [24]</td>
<td>39</td>
<td>24</td>
<td>69</td>
<td>13</td>
<td>145</td>
</tr>
<tr>
<td>Schmeiser et al., 1988 [30]</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>15</td>
<td>41</td>
</tr>
<tr>
<td>Gamillscheg et al., 1991 [31]</td>
<td>16</td>
<td>9</td>
<td>11</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>All</td>
<td>56</td>
<td>58</td>
<td>80</td>
<td>37</td>
<td>231</td>
</tr>
</tbody>
</table>

**NOTE.** CI, confidence interval; HEPA, high-efficiency particulate air; LAF, laminar airflow; non-RCT, nonrandomized controlled trial; RCT, randomized controlled trial; RR, relative risk.

* Pooled RR determined by the DerSimonian and Laird method.
### Table 4. Results of meta-analyses of studies with fungal infection as the outcome.

<table>
<thead>
<tr>
<th>Authors, year of publication [reference]</th>
<th>Patients in rooms with HEPA/LAF ventilation, no.</th>
<th>Patients in rooms with no ventilation system, no.</th>
<th>Total patients, no.</th>
<th>RR (95% CI)</th>
<th>HEPA/LAF ventilation</th>
<th>Without ventilation</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RCTs with fungal infection as the outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Levine et al., 1973 [27]</td>
<td>0</td>
<td>22</td>
<td>3</td>
<td>35</td>
<td>60</td>
<td>0.24 (0.013–4.48)</td>
<td>0</td>
</tr>
<tr>
<td>Schimff et al., 1975 [21]</td>
<td>0</td>
<td>24</td>
<td>1</td>
<td>18</td>
<td>43</td>
<td>0.27 (0.011–6.20)</td>
<td>0</td>
</tr>
<tr>
<td>Buckner et al., 1978 [24]</td>
<td>0</td>
<td>46</td>
<td>3</td>
<td>41</td>
<td>90</td>
<td>0.14 (0.0073–2.57)</td>
<td>0</td>
</tr>
<tr>
<td>Lohner et al., 1979 [32]</td>
<td>5</td>
<td>19</td>
<td>2</td>
<td>19</td>
<td>45</td>
<td>2.19 (0.47–10.1)</td>
<td>21</td>
</tr>
<tr>
<td><strong>All</strong></td>
<td>5</td>
<td>111</td>
<td>9</td>
<td>113</td>
<td>238</td>
<td>0.57* (0.13–2.53)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Non-RCTs with fungal infection as the outcome</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rodriguez et al., 1978 [23]</td>
<td>3</td>
<td>60</td>
<td>9</td>
<td>73</td>
<td>145</td>
<td>0.43 (0.12–1.54)</td>
<td>5</td>
</tr>
<tr>
<td>Navari et al., 1984 [33]</td>
<td>0</td>
<td>36</td>
<td>1</td>
<td>30</td>
<td>67</td>
<td>0.29 (0.012–6.83)</td>
<td>0</td>
</tr>
<tr>
<td>Rham et al., 1984 [34]</td>
<td>9</td>
<td>158</td>
<td>12</td>
<td>55</td>
<td>234</td>
<td>0.30 (0.13–0.68)</td>
<td>5</td>
</tr>
<tr>
<td>Sherertz et al., 1987 [35]</td>
<td>0</td>
<td>39</td>
<td>14</td>
<td>74</td>
<td>127</td>
<td>0.077 (0.0047–1.25)</td>
<td>0</td>
</tr>
<tr>
<td>Withington et al., 1998 [36]</td>
<td>0</td>
<td>51</td>
<td>1</td>
<td>63</td>
<td>115</td>
<td>0.41 (0.017–10.0)</td>
<td>0</td>
</tr>
<tr>
<td>Oren et al., 2001 [37]</td>
<td>0</td>
<td>26</td>
<td>13</td>
<td>32</td>
<td>71</td>
<td>0.063 (0.0039–1.02)</td>
<td>0</td>
</tr>
<tr>
<td><strong>All</strong></td>
<td>12</td>
<td>370</td>
<td>50</td>
<td>327</td>
<td>759</td>
<td>0.29* (0.15–0.54)</td>
<td>3</td>
</tr>
</tbody>
</table>

**NOTE.** CI, confidence interval; HEPA, high-efficiency particulate air; LAF, laminar airflow; non-RCT, nonrandomized controlled trial; RCT, randomized controlled trial; RR, relative risk.

* Pooled RR, determined by the DerSimonian and Laird method.
Limitations

- Statistical homogeneity was considerable, huge differences in rates of infection and death
- Studies performed over a very long period included (28 years)
- Follow-up periods differed significantly
- Severity and duration of neutropenia?
- 3 studies used decontamination (with oral antibiotics)
- 2 studies used HEPA filtration only, the others in combination with LAF
- No study was blinded

Eckmanns et al. JID 2006; 193:1408–18
The Influence of High-Efficiency Particulate Air Filtration on Mortality and Fungal Infection among Highly Immunosuppressed Patients: A Systematic Review

Tim Eckmanns, Henning Rüden, and Petra Gastmeier

Institute of Hygiene and Environmental Medicine, Charité–University Medicine Berlin, Berlin, and Institute of Microbiology and Hospital Hygiene, Medical University Hanover, Hanover, Germany

Conclusion

• Patients with BMT receive some benefit if they are placed in a protected environment
• Nevertheless the evidence is still somewhat ambiguous
• No final conclusion can be drawn from the data available

Eckmanns et al. JID 2006; 193:1408–18
The evidence for HEPA filtration to prevent IFI: A new systematic review

Infection-control interventions for cancer patients after chemotherapy: a systematic review and meta-analysis

Method

- Broader approach: “protective isolation” =
  - air quality control
  - prophylactic antibiotics
  - and barrier isolation

- Also RCTs and non-RCTs included

- mortality at day 30
- mortality at the longest follow-up
Conclusion

"Air quality control, using HEPA filtration with or without other control measures, had only a modest effect on invasive mould infections and survival that did not reach significance.

Its use should be probably reserved for patients at highest risk for invasive mould infections and for endemic or outbreak settings.

What patients should be hospitalized in protected rooms?

Patients
• with allogenic transplants of haematopoietic stem cells or
• with severe neutropenia (< 100 cells/mm\(^3\)) of more than 1 week’s duration

Ruiz-Camps I et al. Clin Micro Infect 2011; 17 (suppl 2), 1-24
HEPA FILTRATION

WITH OR WITHOUT LAF

(= laminar airflow)
Laminar airflow (LAF)

**PRO:**
- involves much greater air changes
- helps to minimize opportunities for microorganism proliferation

**CON:**
- much higher expense
- inconvenience to the patient due to noise and draughts
Positive-pressure isolation and the prevention of invasive aspergillosis. What is the evidence?

On balance, the additional expense and inconvenience of LAF does not appear to be justified.

H. Humphreys, J Hosp Infect 2004; 56: 93-100
A survey in 180 centers 1999
(European Group for Bone and Marrow Transplantation; EBMT)

<table>
<thead>
<tr>
<th></th>
<th>HEPA</th>
<th>LAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allogenic HSCT</td>
<td>61 %</td>
<td>42 %</td>
</tr>
<tr>
<td>Autologous HSCT</td>
<td>47 %</td>
<td>24 %</td>
</tr>
</tbody>
</table>


A survey in 30 centers in Germany 2005
(ONKO-KISS group)

<table>
<thead>
<tr>
<th></th>
<th>HEPA</th>
<th>LAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allogenic HSCT</td>
<td>83 %</td>
<td>54 %</td>
</tr>
<tr>
<td>Autologous HSCT</td>
<td>53 %</td>
<td>28 %</td>
</tr>
</tbody>
</table>

Conrad et al. ECCMID 2006, Nice
Portable HEPA units are available that can filter air at a rate of 300–800 ft$^3$/min.

Portable HEPA filters are used temporarily in rooms with no general ventilation or to augment systems that cannot provide adequate airflow.

They should achieve the equivalent of ≥12 ACH.

(An average room has approximately 1,600 ft$^3$ of airspace.)
3. Cleaning and disinfection measures for protected areas

The crucial point is designated and trained staff for cleaning!

The use of cleaning tools that may create dust or aerosols is absolutely contraindicated.

Almost all substances used for surface disinfection are able to eliminate fungi and fungal spores.
4. Can patients at risk be moved around the hospital?

A prospective, randomised study on the use of well-fitting masks for prevention of invasive aspergillosis in high-risk patients

G. Maschmeyer¹*, S. Neuburger², L. Fritz¹, A. Böhme³, O. Penack⁴, R. Schwerdtfeger⁵, D. Buchheidt⁶ & W.-D. Ludwig⁷ on behalf of the Infectious Diseases Working Party (AGIHO) of the German Society of Haematology and Oncology

¹Department of Haematology and Oncology, Ernst-von-Bergmann Clinic, Potsdam; ²Department of Haematology and Oncology, Charité University Medical School, Campus Virchow-Klinikum, Berlin; ³Department of Internal Medicine II, Johann-Wolfgang-Goethe-University Medical Centre, Frankfurt am Main; ⁴Department of Haematology and Oncology, Charité University Medical School, Campus Benjamin Franklin, Berlin; ⁵Centre for Bone Marrow and Stem Cell Transplantation, German Diagnostic Clinic DKD, Wiesbaden; ⁶Department of Internal Medicine III, University Medical School Mannheim, Ruprecht-Karls-University of Heidelberg, Mannheim and ⁷Department of Haematology, Oncology and Tumour Immunology, Robert Roessle-Clinic, Helios Clinic Berlin-Buch, Charité University Medical School, Berlin, Germany

Received 22 July 2008; revised 22 October 2008; accepted 26 January 2009

• Adults undergoing chemotherapy for acute leukaemia or allogeneic haematopoietic stem-cell transplantation (aHSCT).

41 patients (masks) 39 patients control group

This first randomised study on the use of well-fitting masks failed to show a reduction of invasive fungal infections.
5. Routine environmental cultures

Only useful in HEPA-filtered rooms to test the system

- once a year,
- occurrence of Aspergillosis cases
- construction work

Conidia count: < 0.1 CFU/m3
5. Routine environmental cultures

Not useful in unfiltered areas;

Significant variation according to
- geographical area
- degree of activity in the area sampled
- temperature
- humidity

Condida count: usually between 10-25 CFU/m3
5. Routine environmental cultures

- No fixed rules for sampling
  - Various methods and equipment
  - Quantitative results
6. Infection control measures during construction projects
Successful control of an outbreak of invasive aspergillosis in a regional haematology unit during hospital construction works

C.C. Chang, A.C. Cheng, B. Devitt, A.J. Hughes, P. Campbell, K. Styles, J. Low, E. Athan

Department of Infectious Diseases, Geelong Hospital, Geelong, Victoria, Australia
Clinical Haematology Unit, Geelong Hospital, Geelong, Victoria, Australia
Infection Prevention Unit, Geelong Hospital, Geelong, Victoria, Australia

Received 19 November 2007; accepted 7 February 2008
Available online 3 April 2008

Outbreak of six cases of nosocomial invasive aspergillosis (IA) in a haematology unit coinciding with major hospital construction works.

Among 18 following high-risk patients only one developed IA.
Nosocomial aspergillosis in outbreak settings

R-P. Vonberg*, P. Gastmeier

Institute for Medical Microbiology and Hospital Hygiene, Charité-University Medicine Berlin, Germany

53 outbreaks involving 458 patients

Figure 1  Distribution of sources of nosocomial aspergillus outbreaks.
6. Infection control measures during construction projects

• set up a multidisciplinary team that includes infection control staff to coordinate proactive prevention measures to reduce exposure to fungal spores and **monitor adherence**

• provide education to HCW and the construction crew in immunocompromised patient care areas regarding aspergillosis

• dust control measures (dust barriers, safe air handling, negative pressure in construction work zones)

• water damage response plan to prevent fungal growth

• maintain surveillance for aspergillosis cases
Volumetric air sampling performed during the course of epidemiologic investigations in 24 of the outbreaks noted spore counts ranging from 0 to 100 spores per cubic meter.

Data from outbreak analyses have shown that it is impossible to provide a threshold below no problems are expected.
Poor correlation of Aspergillus ssp. recovered from the environment and species isolated from patients with aspergillosis

**Explanations:**
- Lack of a clearly defined incubation period for aspergillosis and the relationship to exposure within the hospital environment and subsequent infection
- Methods of air sampling used
- Broad diversity of Aspergillus spp. in the environment and the various methods used for typing of Aspergillus
7. Education

Health care workers must receive specific training on epidemiology and prevention measures to control and prevent infections.
8. Guidelines for food

- Avoiding fresh fruits and vegetables that cannot be effectively washed.

- Unpasteurized dairy products, cheese made from mold cultures, uncooked eggs, meat, fish tofu

Marr et al. Bone Marrow Transplantation 2009; 44:483-87
9. Guidelines for outpatient setting

- Avoiding activities such as gardening, mowing and vacuuming

- Avoid cleaning methods that disperse dust (family members)

- Leftover foods placed in the refrigerator should be discarded after 72 h

- Avoid fresh flowers and potted plants

Partridge-Hinckley K et al. Mycopathologia 2009; 168: 329-37
Anforderungen an die Hygiene bei der medizinischen Versorgung von immunsupprimierten Patienten

Empfehlung der Kommission für Krankenhaushygiene und Infektionsprävention beim Robert Koch-Institut (RKI)
Guidelines for the prevention of invasive mould diseases caused by filamentous fungi by the Spanish Society of Infectious Diseases and Clinical Microbiology (SEIMC)

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