Safety of Linens and Clothing

IFIC Special Interest Group
Infection Control in Home and Everyday Life Settings

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IFIC/IFH Special Interest Group –
developing and promoting IPC in home healthcare

Activities 2013/4

• Web-based resource on IPC in Home healthcare
• Safety of clothing/linens/effectiveness of laundering
Infection Prevention and Control in Home Healthcare

This is a central resource where hygiene professionals, community workers and others can browse, find information, and exchange knowledge on infection prevention and control issues related to healthcare delivered at home.

General Resources

Guidelines, training & educational resources on principles & practice of home hygiene.

Material produced by the International Scientific Forum on Home Hygiene and other agencies.

IFH resource

Other Resources

Specific Issues

Information and infection prevention and control advice on specific diseases and disease issues, related to home healthcare.

Hand Hygiene
Medical/Patient Care Items
Clinical and Other Waste

Patient Support Materials

Information sources for the public on hygiene and hygiene issues in home healthcare.

General Advice
Hand Hygiene
Medical/Patient Care Items
Clinical and Other Waste
2 recent IFH reviews of laundry hygiene

• Downloadable from www.ifh-homehygiene.org
• Since healthcare inc delivered at home
• Since data used came from community and hospital settings
• Findings equally relevant to all settings
Are clothing and linens an infection risk?

• Major focus remains on **hand hygiene** as key to IPC

• Increasing evidence – **common touch and food preparation surfaces** - important part of the equation,

• Supported by recent reviews:
  – Rutala and Webber, AJIC 2013, 41, suppl – healthcare settings
  – Scott, AJIC 2013,41:1087-92- home and community settings

• Why is there no reference to **clothing and linens** as common touch surfaces?

• Available data Includes:
  – No intervention study data
  – Bus significant amounts Epidemiological data, Microbiological data
What’s new: antibiotic resistance: Are clothing and linens risk factors?

• IPC/hygiene now seen as a central strategy to reducing AR
  – In community – is C&L contributing to incd prevalence of AR strains – skin and bowel stains - MRSA, MDR E.coli, Klebsiella
  – e.g US: could preference for low temp laundering be exacerbating spread of CA MRSA?
  – By reducing silent spread of nasal, skin, bowel carriage in healthy community, we can reduce frequency of resistant infections in hospitals and community?
  – Can we tackle hospital problem without also tackling community?
What’s new: increasing healthcare at home

- Earlier discharge of patients
- Vulnerable groups
  - Cancer chemotherapy
  - Transplant
  - Home dialysis
  - HIV/AIDS
  - Cystic fibrosis
Breaking the chain of Infection

Sources of Infection
People, contaminated food, domestic animals

Way in
Mouth, nose, RT. cuts, grazes

Shedding
Food particles, faces, saliva, cough, sneeze,

Survival and spread
Hands, surfaces, cloths, clothing, linen, baths, basins, toilets, air
Shedding of pathogens and resistant strains onto clothing etc

- **Enteric pathogens:**
  - Norovirus – Vomiting may produce 30 million particles, faecal shedding persists → 28 days
  - Rotavirus - >10^{11} virions per g faeces.

- **S. aureus**
  - between 30 and 60% of general population are carriers
  - Around 10^6 skin squames containing viable organisms are shed daily from normal skin.

- **Antibiotic resistant strains**
  - Gerba: if 0.1g of 500g faeces excreted / day remains on undergarment =10^4 cfu/item
  - Prevalence of CTX-M ESBL carriage in stools of UK community (732 people) - 11.3% Wickramasinghe et al 2012
Survival on fabrics

• Viability declines on dry fabrics, rate depends on species/RH etc

But:

• Gram positive spp. such as *S. aureus*, *C. difficile*
  – survive long periods (days to months)

• Gram-negative species such as *E. coli* and *P. aeruginosa*,
  – survival times -> 4 h or more

• *Salmonella* spp. Survived -> 24 weeks.

• Viruses – survival < bacteria,
  – 30 min-12 h - up to max 48 h
  – but some studies report longer times.
  – Norovirus – 3 months

• Survival times for fungal species 1 day - several weeks
Transfer from contaminated fabrics

- Transfer from contaminated fabrics by contact with hands and other fabrics.
  - Rates from moist fabrics around 1-10%,
  - varied from 0.1% or less, up to 50%.
- Transfer rates varied - strain, level, RH, fabric
  - significantly less (-\(\rightarrow\) 10 fold ) if donor fabrics or hands are dry.
- Many reports of transfer from contaminated to sterile fabrics included in laundry cycle
Epidemiological evidence of link to infection

• No intervention studies identified,
• 19 observational studies (1959-2010): identified transmission via clothing and linens as likely cause, or a significant risk factor.
• 14/19 – community-based; 7/19  *S. aureus/MRSA*
Examples

• US jail 2007. Outbreak: MRSA skin infection. Intervention included correcting the laundry process (thermostat defective, machines overloaded, soap malfunction)

• Importance of laundering suggested by:
  – Laundry first area where change implemented → immediate decline of skin infections before other measures could be implemented
  – Several strains were circulating, suggesting community MRSA strains continually introduced during outbreak,
  – i.e. key is not preventing introduction of MRSA – but consistent QA of laundry processing
Studies by Larson et al. 2000-2003

• Impact of cleaning/hygiene practices on ID incidence in 238 New York households, 3 months.
• Infections recorded: fever, cough, cold, diarrhoea, vomiting, sore throat, skin infection
• Hygiene practices recorded: mostly non-targeted practices - daily personal bathing/showering, laundry practices, bathrooms and toilet cleaning, dishcloth care, use of antimicrobial products.
• Only practices significant association with infection risks were:
  – using hot water and use of bleach for laundering was protective
  – using a communal laundry and not using bleach in communal laundering predictive of increased risk of infection
**IFH concludes:**

- Clothing, bed linen, towels etc are risk factors for infection both in healthcare and home settings.
- Probably less than for hands and contact surfaces because:
  - Pathogen survival on porous fabric surfaces is lower
  - Transfer rates from fabrics lower
  - Opportunities for transfer probably less frequent.
- Risks increase where family/hospital patient has diarrhoea/vomiting/skin or wound infection, or impaired immunity.
- Clothing etc is a risk factor for spread of MRSA and faecal organisms carrying AR determinants.
used in domestic (home) settings (IFH report 2013)

• Move towards low temp laundering in order to conserve energy
  • energy to heat washing machine water contributes the largest part of environmental impact of laundry
• Is low temperature laundering associated with increased infection risk?
How does laundering work?

• Main cycle, dirt and microbes detached and suspended into the wash water. Then “washed away” by rinse & spin cycles.

**Thermal inactivation.**

• Inactivation: increases as temperature increases.

**Chemical inactivation.**

• Some chemical inactivation: increases with temperature
  – Heavy duty powder detergents contain activated oxygen bleach. Primarily to digest stains, but also produce some inactivation of bacteria, fungi, viruses.
  – Surfactants exert some microbicidal action - but extent of action not known.

• Other factors can contribute: drying and ironing:

• Adding hypochlorite bleach increases microbicidal action
IFH review 2013

- LR values on fabrics contaminated with bacteria (13), fungi (5) and viruses (7) during machine wash cycles.
- Major difficulty - variability in LR values from different studies
- Arise from 2 main sources:
  - Lack of standardisation /control of test conditions (wash cycle time, number of rinses etc)
  - Modern domestic washing machines do not reach specified temperature:
    - Set at 60°C, max temperature 46-53°C,
    - Set at 40°C, max temperature 35-39°C.
  - 2013 UK report: “two thirds of domestic machines set to 60°C did not reach prescribed temperature”
contaminated with bacteria (Test strains: *S. aureus*, *E faecalis*, *E faecium*, Acinetobacter)

<table>
<thead>
<tr>
<th>Temp</th>
<th>Detergent type</th>
<th>N</th>
<th>Min</th>
<th>Median value shown in bold</th>
<th>Max</th>
<th>Transfer to sterile samples during laundering</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°C</td>
<td>AOB</td>
<td>6</td>
<td>1.92</td>
<td>&gt;3, 6,</td>
<td>8.0</td>
<td>8.18</td>
</tr>
<tr>
<td></td>
<td>Non AOB</td>
<td>11</td>
<td>1.75</td>
<td>&gt;3, 4.22, &gt;4.4</td>
<td>&gt;5</td>
<td>&gt;5</td>
</tr>
<tr>
<td>38-40°C</td>
<td>AOB</td>
<td>4</td>
<td>2</td>
<td>&gt;3, &gt;6</td>
<td>8.06</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non AOB</td>
<td>17</td>
<td>0.54</td>
<td>2.0, 2.3, 2.4, 2.5, 2.6, 2.7, 2.7</td>
<td>2.85, 3.0</td>
<td>3.0, 3.4, 4.2, 4.3, 5.0, &gt;5</td>
</tr>
<tr>
<td>30-31°C</td>
<td>AOB</td>
<td>13</td>
<td>0.14</td>
<td>1.9, 2.6, 3.0, 3.0, 3.0, 3.0</td>
<td>&gt;3.0</td>
<td>3.1, 3.8, 3.9, 4.2, 5.0</td>
</tr>
<tr>
<td></td>
<td>Non AOB</td>
<td>18</td>
<td>0.3</td>
<td>0.5, &lt;1, 1.2, 1.6, 2.0, 2.0, 2.1, 2.3</td>
<td>2.3</td>
<td>2.3, 2.4, 3.6, 4.0, 5.0, 5.0, &gt;5</td>
</tr>
<tr>
<td>27-30°C</td>
<td>No detergent</td>
<td>9</td>
<td>0.38</td>
<td>1.5, 1.6, 1.8, 2.7, 2.7</td>
<td>2.07</td>
<td>2.2, 2.3</td>
</tr>
</tbody>
</table>

*AOB = Activated oxygen bleach-based detergent*
## IFH recommendations for domestic cleanliness

<table>
<thead>
<tr>
<th>Higher risk items</th>
<th>Infected family members, or those at greater risk</th>
<th>All items</th>
<th>Launder at 60°C or more with an active oxygen bleach-containing detergent</th>
</tr>
</thead>
<tbody>
<tr>
<td>For lower risk items</td>
<td>“Normal” daily wear</td>
<td>come into close and persistent contact with the body</td>
<td>active oxygen bleach-containing detergent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>close and persistent contact with the body</td>
<td>Laundering at 30°C with all/any formulated detergent should be sufficient</td>
</tr>
</tbody>
</table>

www/ifh-homehygiene.org
Recommendations for hospital Laundering

• Laundering recommendations vary
  • Laundering recommendations vary
    – UK DOH: 65°C 10 mins; 71°C not less than 3 min
    – CDC 71°C 25 mins
  • Little published data on efficacy of laundering above 60°C

Concern about C. difficile

• 6 patients c. diarrhoea/+ve stool toxin test. After laundering bedlinen at 71°C, 3 mins and a steam press - up to $10^3$ C. diff / 100cm$^2$ recovered. (Lakdawalla et al. 2011)
  • Toxigenic C. difficile present in 2 -5% of asymptomatic persons in community
  • 50% of healthy neonates (<1 year old) are carriers
Conclusions

• Laundry Infection risks – although less than hands etc - must be suitably managed as part of a multibarrier approach to hospital or

• If we are serious about tackling AR – and maintaining IPC standards
  – must ensure hygiene efficacy of laundering is sustained both in domestic and healthcare settings
Conclusions – further work

• If we are to reduce laundering temps
  – must compensate for efficacy loss by increasing mechanical/rinsing or chemical inactivation components

  – Typical & worst case bioburden of pathogens and potential AR strains on clothing during risk and normal daily
  – Dose response relationship for individual components of laundering process
Further work required

• Hygiene of laundry is not the same as cleanliness
• What bioburdens of pathogens can be found on clothing
• How can we
  – Optimise synergistic action - detergency, rinsing and chemical inactivation
  – Ensure temp control
    • to consistently deliver “hygiene effectiveness” appropriate for healthcare and everyday life laundry items
What has been found on clothing?

<table>
<thead>
<tr>
<th>(clothing and bed linens)</th>
<th>Burkholderia cepacia, P. aeruginosa, human papillomavirus but not e.g. cold and flu.</th>
<th>MRSA: some counts &gt;500 cfu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampled at random</td>
<td>E. coli, P. aeruginosa</td>
<td>E. coli: 1-10, up to $10^4$ cfu</td>
</tr>
</tbody>
</table>
rotavirus, HAV, M52 bacteriophage

<table>
<thead>
<tr>
<th>Temp</th>
<th>N</th>
<th>LR values obtained from studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>54-60°C</td>
<td>3</td>
<td>3.6</td>
</tr>
<tr>
<td>35-46°C</td>
<td>6</td>
<td>2.4, 2.7, 3.1, 3.96, 6.3</td>
</tr>
<tr>
<td>30-31°C</td>
<td></td>
<td>No data available</td>
</tr>
<tr>
<td>21-27°C</td>
<td>8</td>
<td>1.2, 2.0, 2.2, 2.3, 2.6, &gt;3.6,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max: 5.8</td>
</tr>
</tbody>
</table>

Log Reduction: fungi (C. albicans, T mentagrophytes)

<table>
<thead>
<tr>
<th>Temp</th>
<th>N</th>
<th>LR values obtained from studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>60°C</td>
<td>4</td>
<td>&gt;5.36</td>
</tr>
<tr>
<td>30°C</td>
<td>9</td>
<td>2, 2.1, 2.2, 2.4, 2.5, 2.6, 3.0</td>
</tr>
<tr>
<td>30°C + AOB</td>
<td>2</td>
<td>3.9, 4.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Max: &gt;7</td>
</tr>
</tbody>
</table>
2013 study Exner et al

- Increased carriage of *K. Oxytoca*, pediatric unit, German hospital – potentially fatal infection
- Phase 1: *K Oxytoca* found in ward sinks, hygiene interventions did not terminate “outbreak”
- Phase 2: *K Oxytoca* found in door seals of laundry machine
- Retrospective study showed that only infants whose clothes were laundered in the machine became colonised
- Low risk is not no risk – laundry must always be considered during outbreak investigation