

Hygiene risk of laundry

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Is laundry a risk?

- Major focus on hand hygiene as key transmission route of hygiene-related infections.
- Increasing evidence – particularly common touch and food preparation surfaces - important part of the equation,
- Supported by recent reviews:
 - Rutala and Webber, AJIC suppl 2013
 - Rudolfe Schulke 2011 - Role of surface disinfection in infection prevention
 - Scott 2013 – AJIC Common touch surfaces as vectors for transmission of infectious agents in home and community settings
- Why is there no reference to clothing and household linens as common touch surfaces?

2 recent IFH reviews of laundry hygiene

- Authors: Bloomfield, Exner, Scott, Signorelli.
- The infection risks associated with clothing and household linens in home and everyday life settings (2011)

Based on data published 1960s → Includes:

- Epidemiological data (what little there is!)
- Microbiological data
- Data comes from hospital and community settings – equally relevant to both



Shedding of pathogens onto clothing etc

- From skin, faeces, body secretions of infected/carriers, raw foods, domestic animals
- Enteric pathogens:
 - Norovirus – Vomiting may produce 30 million particles, faecal shedding persists → 28 days
 - Rotavirus - $>10^{11}$ virions per g faeces.
 - Gerba: if 0.1g of 500g faeces excreted per day remains on undergarment = 10^4 cfu/item
- *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.

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.
 - No data for norovirus
- Survival times for fungal species 1 day - several weeks



Transfer from contaminated fabrics

- Studies show transfer from contaminated fabrics by contact with hands and with other fabrics.
 - Rates from moist fabrics around 1-10%,
 - varied from 0.1% or less, up to 50%.
- Transfer rates varied according to contamination (strain/level), RH, type of fabric
 - significantly less (-→ 10 fold decrease) if donor fabrics or hands are dry.
- Many reports of transfer from contaminated to sterile fabrics included in laundry cycle



What has been found on clothing?

<p>From infected persons (clothing and bed linens)</p>	<p><i>S. aureus</i> (MRSA) (including at home)</p> <p><i>Burkholderia cepacia</i>, <i>P. aeruginosa</i> human papillomavirus</p> <p>but not e.g cold and flu .</p>	<p><i>S. aureus</i>: 1-100 cfu, MRSA: some counts >500 cfu</p>
<p>Sampled at random</p>	<p><i>S. aureus</i> <i>E. coli</i> <i>P. aeruginosa</i></p>	<p><i>E. coli</i>: 1-10, up to 10^4 cfu</p>

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

e.g.

- US1966: community outbreak *S. aureus*: higher prevalence in families who used a community laundry
- US 2005: outbreak CA-MRSA infection in college football team: sharing towels risk factor for nasal carriage.



Other examples

- US jail 2007. Intervention to control outbreak of 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 even before other measures could be implemented
 - Several strains were circulating, suggesting community strains continually introduced during outbreak,
 - i.e. key is not preventing introduction of MRSA – difficult in an endemic situation. Rather, focus should be preventing transmission.



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.
- “How big is the risk?”
- 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 member/hospital patient has diarrhoea/vomiting/skin or wound infection, or where family member/patient has impaired immunity.
- Clothing etc is a risk factor for spread of MRSA and faecal organisms carrying MDR determinants
 - If we can reduce silent spread of nasal, skin, bowel carriage in healthy community, we can reduce frequency of resistant infections in hospitals and community ?

Effectiveness of laundering processes used in domestic (home) settings (IFH report 2013)

- In recent years – move towards laundering at low temps in order to conserve energy
- European “I prefer 30” campaign- launched June 2013
- Is low temperature laundering associated with increased infection risk?
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How does laundering work?

Physical removal.

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

Thermal inactivation.

- Thermal 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

- 29 publications identified and data extracted:
- LR values on fabrics contaminated w. bacteria, fungi and viruses 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) between studies.
 - Modern domestic washing machines do not reach the temperature specified on machine controls:
 - Set at 60°C, max temperature 46-53°C,
 - Set at 40°C, max temperature 35-39°C.
 - Set at 30°C, max temperature 28-29°C.
 - 2013 UK WHICH report : “two thirds of UK domestic machines set to 60°C did not reach prescribed temperature”



LR data: fabrics contaminated with bacterial strains

Temp	Detergent type	N	Summary of LR values obtained from studies				Transfer to sterile samples during laundering	
			Min	Median value shown in bold		Max		
60°C	AOB	6	1.92	>3, 6,	>6	8.0	8.18	<div style="border: 1px solid black; padding: 5px; text-align: center;"> Increased as LR value decreased ↓ </div>
	Non AOB	11	1,75	>3, 4.22, >4.4,	>5	>5, >5, >5, >5,		
38-40°C	AOB	4	2		>3, >6		8.06	
	Non AOB	17	0.54	2.0, 2.3, 2.4, 2.5, 2.6, 2.7, 2.7,	2.85, 3.0	3.0, 3.4, 4.2, 4.3, 5.0, >5	>5	
30-31°C	AOB	13	0.14	1.9, 2.6, 3.0, 3.0, 3.0,	>3.0	3.1, 3.8, 3.9, 4.2, 5.0	7.2	
	Non AOB	18	0.3	0.5, <1, 1.2, 1.66, 2.0, 2.0, 2.1, 2.3,	2.3	2.3, 2.4, 3.6, 4.0, 5.0, 5.0, >5	>5	
27-30°C	No detergent	9	0.38	1.5, 1.6, 1.8, 2.7, 2.7	2.07	2.2, 2.3	3.4	

AOB = Activated oxygen bleach-based detergent

IFH recommendations for domestic laundering (IFH consensus view)

For higher risk items		Launder at 60°C or more with an active oxygen bleach-containing detergent
For lower risk items	For items which come into close and persistent contact with the body	Launder at 30-40°C with an active oxygen bleach-containing detergent
	For items not in close and persistent contact with the body	Laundering at 30°C with all/any formulated detergent should be sufficient

Conclusions

- Clothing/bedlinens/towels etc are risk factors for transmission of infection and spreading MDR carriage in home and healthcare settings.
- Risks must be suitably managed as part of a multibarrier approach to hospital or home hygiene.
- Laundering conditions should be sufficient to
 - Manage daily life infection risks in the community
 - Reduce spread of antibiotic resistant strains in home and healthcare
 - Manage increased risk situations in home and healthcare settings



Further work required

- Domestic WM and detergent manufacturers need to commission studies to understand:
 - extent of hazard to consumers and patients,
 - relative efficacy of laundering under varying conditions of temperature, wash cycle , rinse condition, detergent formulation etc.,

Temperature	Detergent	Max achievable log reductions which may be achievable - as indicated by min-med-max LR profiles		
		Bacteria	Viruses	Fungi
60°C	Non AOB	>5	5.5- 6	5-7
	AOB	6-8		
40°C	Non AOB	4-5	3-7	No data available
	AOB	6-8		
30°C	Non AOB	3-5	3-6	4
	AOB	4-7		

- By exploiting synergistic action - detergency, rinsing and chemical inactivation – and ensuring temp control - should be possible to achieve “sufficient” hygiene effectiveness” at lower temps for “many or most” laundry items

C. difficile

- **Lakdawalla et al. 2011** evaluated whether *Clostridium difficile* could be detected on bed linen following a commercial washing process at 71°C, 3 minutes followed by a steam press.
- Six patients were identified as having diarrhoea and +ve stool toxin test.
- Up to 10^1 – 10^3 cfu/100cm² could be recovered from the bed linen.