The hygiene hypothesis misnomer and inflammatory diseases – and its implications for hygiene

Sally F Bloomfield
International Scientific Forum on Home Hygiene, London School of Hygiene and Tropical Medicine
July 2017
Safefood, Dublin
Why should we be concerned?

• Hygiene hypothesis is a misleading misnomer for a concept which is essentially correct
  – “hygiene” not the root cause

• hindering efforts to develop public understanding of hygiene - at a time when hygiene is becoming more important
The original hygiene hypothesis

- 1989 Strachan proposed - a cause of rising allergic diseases was lower incidence of infection in early childhood
- Suggested smaller families provided insufficient “infection” exposure through person-to-person spread

- but also because of “improved household amenities and higher standards of personal cleanliness”
- Named “Hygiene hypothesis”
- From this - notion “we have become too clean for our own good” has arisen.
Are we too clean for our own good?

Clean home could give a tot asthma

Is our cleanliness zeal making us ill?

Too clean for our own good?

Childhood is poisoned by the germ of fear

Clean children run a higher risk of asthma

How dirt can protect you against cancer

Some dirt every day keeps the doctor away

Hygiene is killing us, says Conran
Revised hypothesis

• Most experts now agree that the hygiene hypothesis is a misnomer
• Epidemiological studies confirm that childhood infections do not protect against allergy.

• But the media have not noticed!
The Old Friends Mechanism 2003

Old Friends Mechanism (Rook in 2003)

• microbial exposures not infectious diseases – which evolved only “recently” in human evolution
• But the largely non harmful species, spp need to be tolerated
• Co-evolved role in devt and regulation of immune system

Concept extends to other immune disorders

• Allergies, autoimmune disease (MS, Rheumatoid arthritis), type 1 diabetes, IBD.
• May also contribute to e.g depression/reduced stress resilience.
Rook likens immune system to a computer programme

The immune system

Immune response

Attack and prevent infection

Harmful/pathogens

Old friends microbes, helminths

Build memory of diverse mol structures present in our world.

Immune tolerance

Allergic reaction

Allergens, self antigens etc
What are the likely causes of our loss of exposure to OF microbes?
What has changed in past 2 centuries to deprive us of requisite microbial exposures?

Allergies etc - largely diseases of last 200y - obvious answer is sanitary revolution
- improved water quality, sanitation, environment
- reduced human/animal waste in city streets.

altered diet/foods
- Microbial quality assurance

– Vital protection from ID, but inadvertently reduced exposure to “OFs”
Most rapid rise in allergies etc has occurred in last 50 years

Most likely cause/s are lifestyle changes which have occurred during last 50 yrs which have been linked to rises in inflammatory diseases through epidemiologic studies:

- C-section – reduced exposure during delivery (25% C-S in UK)
- fewer siblings - reduced microbiota sharing,
- Less exposure to natural environment/outdoor activity
  - farm living protects against asthma
- Urbanisation – homes less exposed to the natural environment.
  - Spend up to 80% of our time indoors

Unclear which might be the most important
The human microbiome and health

We also need to understand the role of the human microbiome (microbes in our intestines, skin, respiratory tract etc)

• Diversity of microbiome is key
• mediates interaction between OFs and immune system
• **antibiotic use and altered diet** affect the microbes in our body in a way that can increase inflammatory disease risks

• **Antibiotics** – studies show
  • antibiotics alter and reduce diversity of gut microbiota
  • excessive AB during pregnancy/neonatal – associated w. Increase in inflammatory disease risk

• **Diet** – studies show
  • Breast feeding, dietary fibre help build/maintain “healthy” gut microbiome
Are we too clean for our own good?

• Role of home and personal hygiene small relative to other factors.
  – Clean-looking homes full of bacteria, viruses, fungi, etc.
  – Routine weekly cleaning - no sustained effect on microbe levels

• Microbes constantly replaced via dust, air, body flora, pets, contaminated foods – all impact on domestic microbiome

Key point may be:
• Microbial content of homes now DIFFERENT - but not because of “increased” cleanliness
  – e.g modern urban homes – interact c different environment cf rural homes prior 1800s
  – Homes inhabited by fewer people – who may have altered microbiome
  – Presence of pets increases microbial diversity
What about personal hygiene?

- Strachan suggested “higher standards of personal cleanliness” could be an underlying cause
- Temporal correlation - increased bathing/showering, shampooing/bathing baby since 1950s
- Bathing and showering remove microbes from skin but rapidly replaced
- Evidence that skin microbiota are OF microbes – studies with mice

Lack of data:
- Does “obsessive” personal hygiene affect skin microbiome?
- If so – is this linked to immune dysregulation/allergies?
Does cleanliness matter?

• From a 2015 study 399 German families, Von Mutius et al concluded

• Development of allergies and asthma not related to increased cleaning activities (personal cleanliness (e.g. HWWS) and home cleanliness)
Microbial exposure is not the only factor?

• Lifestyle changes apply to all of us – why do we not all suffer from immune diseases?

• Increased risk of allergies/CIDs also depends on other factors:
  – diet (vitamin D deficiency), pollution, less physical activity, obesity,
  – socio-economic factors and stress,

• Genetic predisposition - key risk factor.
Where have we got to?

• Can we reverse trends in allergies and other CIDs through restoring microbial exposure and immune tolerance?
  – Lifestyle changes, probiotics, therapeutic interventions
  – Rook: “The work is progressing very fast, but it has a long way to go”

• Controlling infectious diseases through hygiene
  • Good news! - allergies/CIDs not the price we have to pay for protection against infectious diseases
Addressing the issues

• Fundamental question is “How can we reintroduce beneficial microbes whilst at the same time promoting good hygiene practice to protect from infectious disease”

• Answer lies in targeted hygiene
The urgent need to change perceptions about the so-called hygiene hypothesis - and restore public confidence in hygiene
Current situation

• Researchers generally agree re “OF mechanism” and underlying “lifestyle” changes as a fundamental cause

Problem is:
• “too clean/hygienic” idea still rooted public mind
• (and media, health professionals, opinion formers, policy makers etc.)

Why?

Number of factors contribute:
• Researchers – scientific and clinical – don’t care
• Consumer media – won’t let go of a good story
• Microbiomists and nutritionists – new kids on the block!
Clinical and scientific researchers view

<table>
<thead>
<tr>
<th>Agree:</th>
<th>- Likely causes are</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced exposure to Ofs and reduced diversity of human microbiome</td>
<td>- Clean Water,</td>
</tr>
<tr>
<td>Linked to: Allergic, autoimmune etc diseases</td>
<td>- Sanitation,</td>
</tr>
<tr>
<td></td>
<td>- food quality,</td>
</tr>
<tr>
<td></td>
<td>- C-section,</td>
</tr>
<tr>
<td></td>
<td>- breastfeeding,</td>
</tr>
<tr>
<td></td>
<td>- social contact,</td>
</tr>
<tr>
<td></td>
<td>- urban living,</td>
</tr>
<tr>
<td></td>
<td>- antibiotic use</td>
</tr>
<tr>
<td></td>
<td>- Diet</td>
</tr>
</tbody>
</table>

They cannot decide on a new name so still call it the Hygiene Hypothesis
What do experts tell us via the media?

Extract from PNAS article by Scudellari:

• “The call to experts to abandon the original “hygiene” hypothesis term has fallen on deaf ears. Several researchers interviewed for this article said the issue was semantics - they didn’t care what name is used”

• i.e. their impact on public - who see “hygiene” as personal and home cleanliness is not their concern

http://www.pnas.org/content/114/7/1433.full.pdf
What do the Consumer media tell us?

<table>
<thead>
<tr>
<th>Report new studies showing likely causes of allergies etc as:</th>
<th>c-section, antibiotics, diet, less outdoor activity etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>But still report solution as:</td>
<td>Being less clean! Why?</td>
</tr>
</tbody>
</table>

Feel bound to explain the HH - “less infections – due to too much hygiene - increased risk of allergies”

Example of misleading messages - Daily Telegraph, 2016

*Don't wash your hands! A bit of dirt is good for you: Experts say cleaning less often would protect against allergies by allowing helpful bacteria into the body*
What do microbiome experts now tell us (via the media?)

• The Times: health supplement  Nov 3\textsuperscript{rd} 2015
• Microbiome vital for health
• Why is the human gut microbiome depleted? – 3 main culprits
  – Antibiotics
  – Sterility of modern life and diet
  – C-sections

\begin{quote}
Nutrition Expert: “The idea that children should wash their hands before eating. I don’t think we should be washing our hands before a meal now.

If you think about the number of food poisoning infections in the home-they are incredibly rare

we are over-cleaning enough, our sterility is causing us problems”
\end{quote}
What does the public think - what do they say?

Old friends microbes, helminths

Immune response

Attack and prevent infection

Harmful/pathogens

Immune system

Allergens, self antigens etc

Immune tolerance

• I encourage my children not to worry about being dirty, e.g. if we are on a picnic I don’t bother to get them to wash their hands because they need **plenty of exposure to germs to keep their immune system strong**
What does the public think - what do they say?

• My daughter is the only one in her class who washes her hands before school lunch - and often the only one not to catch stomach bugs and colds. But many in her class have allergies - so poor hygiene evidently doesn’t guard against allergies.
What do we actually understand about “hygiene”?
What are germs?

- Yuck!, Uurgh!
- Nasty dirty germs
- Poo – smelly!
- Don’t touch!
- Make you sick
- Disgusting

- We are brainwashed as children with Germophobia
So “Tell me where are the germiest places in my home?”

- Where do germs lurk?
- Where are the dirtiest places in my home?
- The 5 second rule – is food dropped on the floor (perceived as the dirtiest place in the home) still safe to eat?

- Hmn – actually it’s the people, animals and food in your home which are the germiest places!
But now they have a paradox

OED – germs = microbes, particularly those that cause disease, ----

Now we are all totally confused!
So you think your bathroom is clean?
Daily Mail – 10th April 2017

“Bathroom is a haven for bacteria, breeding in places you believe are sparkling clean”

“Here’s a map to help identify where germs love to lurk and help you to banish the bugs”
“How do I get rid of germs from these dirty places so that my family is safe?

• By getting rid of dirt?

Assuming:
• If a surface is dirt free it is also germ free
• If surfaces / my hands look clean they are free of germs
• If my home is clean – its hygienic – germ safe
Pilot study

- 117 people were asked - What do YOU understand by terms clean & hygienic – and what’s the difference?

<table>
<thead>
<tr>
<th>Clean</th>
<th>Hygienic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of visible dirt</td>
<td>Numbers of germs is reduced 53%</td>
</tr>
<tr>
<td>Both clean and hygienic mean dirt and germ reduction 38.5%</td>
<td></td>
</tr>
<tr>
<td>Clean means using soap and water</td>
<td>Hygiene means using a disinfectant 8.5%</td>
</tr>
</tbody>
</table>

In this group, 41% saw a discriminator: hygiene is more rigorous cleaning - “more clean, clean enough, safe for purpose”,

BUT

that left 59% who did not make this distinction – “if it’s clean – it’s also hygienic”,

water | disinfectant |
Explains so called hygiene hypothesis and implications for hygiene in simple language.
Conclusions

- Hygiene hypothesis is dangerous misnomer - but is only the tip of iceberg
  - Microbe/good germ:bad germ misunderstanding is endemic
  - As is dirty/clean/hygienic

- Not just consumers! – endemic misunderstanding extends to health professionals, opinion formers, public health policy makers etc
Conclusions

• In future we are going to have to view our microbial world very differently?

• Restoring public confidence in hygiene/changing behaviour is vital

• We will have limited success in changing hygiene behaviour through hygiene promotion

• Unless and until we resolve public misunderstandings about our microbial world and its relationship to health and disease