Don’t Take that Antibiotic. . . You May Get Fat?

The Science of Healthy Microbiome

Norman Moore, PhD
What do you think are the top 7 threats to the human race?
One of the top 7 issues that threatens the human race

Global Drivers

- Changed C/N cycles and rising atmospheric GHG concentration
- Increasing antibiotic resistance
- Increasing connectivity (economic, social, ecological)
- Rising human numbers and urbanization
- Increasing per capita resource use
- Nuclear proliferation
- International terrorism

Unwanted Outcomes

- CLIMATE
- ECOSYSTEM
- HUMAN HEALTH
- ECONOMIC

Source adapted from: Science, Vol 325, September 2009
Available at: http://www.sciencemag.org/content/325/5948.cover-expansion
Antimicrobial Resistance
Inpatient Settings

One in every three patients will receive two or more antibiotics in the course of their hospital stay.

Of the patients receiving antibiotics, three out of every four will receive unnecessary or redundant therapy, resulting in excessive use of antibiotics.

CDC – Get Smart Campaign
Outpatient Settings

Each year, tens of millions of antibiotics are prescribed unnecessarily for upper viral respiratory infections.

Antibiotic use in primary care is associated with antibiotic resistance at the individual patient level.

The presence of antibiotic-resistant bacteria is greatest during the month following a patient’s antibiotics use and may persist for up to 1 year.

CDC – Get Smart Campaign
Test Target Treat model
What percent of antibiotics made in this country goes into animal feed?
What percent of antibiotics made in this country goes into animal feed?

80%
Why Use Antibiotics With Animals?

Therapeutic
• If they have a disease

Prophylactic
• Before an expected exposure or immediately after an exposure, but prior to illness

Non therapeutic
• No issue of disease prevention
Non Therapeutic Use

Promotion of weight growth
- Can be given in sub-therapeutic doses in food and water

Livestock can become resistant
- Through feces, spread to other animals and water supply

Antibiotics found in meat
- Penicillin
- Tetracycline
- Sulfanamides
- Neomycin
- Gentamycin
- Streptomycin
Deaths attributable to AMR every year compared to other major causes of death

- AMR now: 700,000 (low estimate)
- Tetanus: 60,000
- Road traffic accidents: 1.2 million
- Measles: 130,000
- Diarrhoeal disease: 1.4 million
- Diabetes: 1.5 million
- Cancer: 8.2 million
- AMR in 2050: 10 million

Deaths attributable to AMR every year by 2050

- North America: 317,000
- Europe: 390,000
- Asia: 4,730,000
- Africa: 4,150,000
- Latin America: 392,000
- Oceania: 22,000

Mortality per 10,000 population:
- 5
- 6
- 7
- 8
- 9
- 10
- >
Study on CAP Patients and Therapy

Retrospective study on 175 CAP patients in New York

- Exclusion criteria
  - Hospitalization ≥ 2 days within 90 days
  - Residence in nursing home
  - Prior isolation of MDR organism

Rate of multidrug resistant organism detected within 90 days

- 15% patients on fluoroquinolone
- 4% of patients on cephalosporin/macrolide
What is a Microbiome?
### Basic Definitions

<table>
<thead>
<tr>
<th>Microbe</th>
<th>Microorganisms such as bacteria, fungi, viruses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbiome</td>
<td>The community of microbes</td>
</tr>
<tr>
<td>Biofilm</td>
<td>Community of microbes on a surface</td>
</tr>
</tbody>
</table>
How Do You Develop A Microbiome?

In the womb, a baby is sterile

- Initial exposure is through the mother’s bacteria
  - Vaginal, fecal, and skin
- Breast feeding
  - Establish the appropriate gut colonization
  - Can be disrupted with bottle feeding and/or antibiotic administration
Different Relationships Between Us & Microbiome

**Mutualistic relationship**
- Both benefit
  - *E. coli* can live in colon and produce Vitamin K

**Commensal relationship**
- One benefits and the other isn’t affected
  - *S. epidermidis* in the nasopharyngeal passage

**Parasitic relationship –**
- One benefits at the expense of another
  - Influenza

**Opportunistic pathogens**
- Can be symbiotic or commensal in one part of the body and disease-causing in another
  - *E. coli* in gut go to skin infection
  - *S. pneumoniae* in nasopharyngeal go to lungs
We are Outnumbered!

- 10 trillion: The number of human cells in a body
- 100 trillion: The number of microorganisms in a body
- 20,000: Estimate of human genes
- 9 million: Estimate of bacterial genes
MICROBES YOU LEAVE ON THE SUBWAY

HUMAN BACTERIAL DNA COMPRIS ONLY 1% OF THE TOTAL GENETIC MAKEUP OF THE SUBWAY MICROBIOME. OF THAT:

- **32.3%** is associated with the gastrointestinal tract.
- **20%** of bacteria are associated with the urogenital tract.
- **1.6%** of bacteria is associated with the eye.
- Almost **10%** of bacteria is associated with breathing (i.e., airways).
- **6.5%** associated with mouth bacteria.
- **29%** associated with skin bacteria.

48% of the genetic data found on the subway did not match to any known organism, showing how vast and unexplored the microbiome is.

Credit: Weil Cornell Medical College // (Data from Weill Cornell's PathoMap study of the NYC-citywide subway microbiome)
Gut Microbiome

Over 1,000 species in gut

$10^{12}$ microbes per gram luminal content (1,000,000,000,000)

60% of fecal weight
Gut Microbiome Interactions

Educating the immune system

- Segmented filamentous bacteria (SFB) essential in development of Th17 cells
- *Bacteroides fragilis* converts pro-inflammatory CD4+ T cells into Tregs

Regulation of the immune system

Microbe-microbe interaction

- Produce microcins, bacteriocins, and colicins to stop invading bacteria and not injure host
- Cooperate on food
- Horizontal gene transfer

Microbiome benefits

Help digest food

Make vitamins – B2, B12, K

Barrier from pathogens
  • *C. difficile* in gut

Attacking pathogens
  • *E. coli* can produce bacteriocines

Modulate innate and adaptive immunity
Diseases
Acne Cycle

Development of ACNE

- Risk Factors
- ↑ Inflammatory Factors
- ↑ Hormonal Activity
- ↑ P. acnes Bacteria
- ↑ Sebum Oil
- Clogged Pores
- Dysregulated Skin Cell Activity
Potential Issues With Microbial Oral Flora

**Streptococcus mitis**
- If gums get inflames, it can enter bloodstream to cause infection

**Candida albicans**
- Thrush

**Dental Caries**
- *Streptococcus mutans* and *Lactobacillus*
- Can be in large numbers in dental plaque
- High sugar intake related to concentration of lactobacilli
- Transmission can be from parents to infant
  - Health of parents’ mouths can matter to infant
For Dental Caries to Develop

- Susceptible tooth
- Diet that has significant fermentable carbohydrates
- Specific bacteria
Clostridium difficile - Background

- Gram positive spore former – the most common cause of healthcare-associated diarrhea
- Spread by health care workers - spores difficult to eradicate
- Causes 25% of antibiotic associated diarrhea and 90-99% of pseudomembranous colitis
- Disease is caused by the toxins the organism produces
Pathogenesis of CDAD

*Clostridium difficile* is spread via the fecal-oral route. The organism is ingested either as the vegetative form or as hardy spores, which can survive for long periods in the environment and can traverse the acidic stomach.

In the small intestine, spores germinate into the vegetative form.

In the large intestine, *C difficile*-associated disease can arise if the normal flora has been disrupted by antibiotic therapy.

*C difficile* reproduces in the intestinal crypts, releasing toxins A and B, causing severe inflammation. Mucous and cellular debris are expelled, leading to the formation of pseudomembranes.

Toxin A attracts neutrophils and monocytes, and toxin B degrades the colonic epithelial cells, both leading to colitis, pseudomembrane formation, and watery diarrhea.
Antibiotic-Associated Diarrhea: Life’s a Beach with *C. difficile*
Community-Associated

Recent studies suggest 20-45% of CDI cases are CA-CDI

- Approximately 22% not exposed to antimicrobial agents in 90 days prior
- Usually present with less severe symptoms
- Tend to be younger and female compared to healthcare-associated
  - One study had age 50 vs 72 years and 76% female vs. 60%

Risk factors

- Antibiotic exposure – highest first 30 days, but higher risk continues to 60 days & not return to baseline until 150 days
- Outpatient visits
- Contact with *C. difficile* patient
- Proton pump inhibitors?
- Animals? *C. diff* can also colonize calves & pigs and dogs & cats?
Hygiene Hypothesis & Allergies and Autoimmune Disease
Not having the body exposed to infections early in life may lead to increased risk of allergies, asthma, and autoimmune diseases.

Allergies & asthma have exploded in numbers.

Belief is if people are exposed to microbes early in life, the immune system learns a proper response:
- Less issue with asthma & allergies.
Mechanism of Hypothesis

Allergic reactions caused by immune response to innocuous antigens by TH2 cells

Bacteria and viruses elicit TH1 cells that down-regulate TH2

Assumption is insufficient TH1 stimulation leads to over-reaction of TH2

If immune system not properly stimulated, it does not properly develop regulatory cell functions

These people can still have overreaction with TH2
The Immune System

First line of defense
- consists of
- Antimicrobial proteins
- Cilia
- Skin
- Gastric Juice
- Symbiotic Bacteria

Second line of defense
- Phagocytes (neutrophils monocytes)
- Natural Killer Cells
- Complement Proteins

Inflammatory response
- involves
- Basophils release histamine
- causes
- vasodilation
- phagocytosis
- stimulates

Antigens
- major histocompatibility complex (MHC)
- shouldn't affect cells that display
- has targets
- Third line of Defense
- is carried out by lymphocytes
- such as B-cells
- produce antibodies (bind to antigens and inactivate them)
- variable regions
- Y-shaped
- 5 types

Antibody mediated response
- binds to
- Helper T-cell releases interleukins
- when an APC
- then
- B-cell divides into many plasma cells
- which release antibodies

Memory B cells after an infection
- sometimes become
- active immunity
- providing
- can be induced to have
- passive immunity

To activate B cells and cytotoxic T cells
- find a match on B cell or T cell
- Helper T cells
- receive antigens from APC's
- can be cytotoxic T cells
- destroy foreign cells
The Hygiene Hypothesis

Birth

Th2

Older sibs
Many infections
(Th1 stimuli)

No allergies
Th1

Only child
Few infections

Allergies
Still Th2
According to the American Academy of Allergy, Asthma and Immunology:

**Peanut allergies alone have tripled from 1997-2008**

Yearly Cases of Asthma

Number of people who displayed asthma symptoms.

In Millions

<table>
<thead>
<tr>
<th>Year</th>
<th>In Millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>20.3</td>
</tr>
<tr>
<td>2002</td>
<td>20</td>
</tr>
<tr>
<td>2003</td>
<td>19.8</td>
</tr>
<tr>
<td>2004</td>
<td>20.5</td>
</tr>
<tr>
<td>2005</td>
<td>22.2</td>
</tr>
<tr>
<td>2006</td>
<td>22.9</td>
</tr>
<tr>
<td>2007</td>
<td>22.9</td>
</tr>
<tr>
<td>2008</td>
<td>23.3</td>
</tr>
<tr>
<td>2009</td>
<td>24.6</td>
</tr>
</tbody>
</table>
Obesity
Things That Lead to Obesity

- Diet
- Inaction
- Genetics
- Microbiome?
Mouse Experiments

In 2005, shown that obese mice and lean mice had differing microflora in their gut

Gut implantation

- If take gut flora from an obese mouse to a germ-free mouse, can make the germ-free mouse obese, depending on the diet
- The same thing happens when taking gut flora from an obese person
- Control is non-obese mouse

Additional research has shown that a high fat diet can change bacterial diversity in the gut.

Mouse/Human Experiments 1

**Twins**
- Comparison of both thin or both obese
- Thin twins have more diverse microflora

**Raise genetically identical “humanized” mice in germ-free environment**
- Carry functioning human genes/tissues
- Give one mouse intestinal flora from obese twin and another from thin
- Given same diet
- Mouse with diet from obese person gained more fat

**Same experiment – move mice to shared cage**
- Both remained lean
- Fecal/oral transmission
**Transferring bacteria**

- Moved 54 strains from lean to obese community gave shift to lean
- Moved 39 strains and wasn’t effective

**Transfer bacteria & then give “Western” diet**

- High fat, low in fruits, vegetables, and fiber
- Result is obese mice stayed obese even when living with thin mice
- Diet didn’t allow change in gut flora

**Antibiotics in low doses**

- Mice had 15% more body fat than controls with less microbial diversity
Findings

Microbes that are best at getting nutritional value from high fat foods and then stimulating the storage of that food as fat are selected for.

High diversity gut flora is linked to better health.

Obese mice had higher levels of amino acids and acylcarnitines, usually elevated in type 2 diabetes and obesity.
Infant Exposure – Study on First 2 Years of Life

Exposure to antibiotics in 3 different windows

• Less than 6 months
• 6-14 months
• 15-23 months

Results

• Children exposed less than six months of age were 22% more likely to be overweight
• 6-24 months did not have a significant correlation
• 15-23 months had increased BMI at 7 years

Establishing a Gut Microbiome in Babies

Formula-fed & C-section babies have higher risk of obesity and diabetes than breastfed and vaginal babies:

- Newborns swallow bacteria as they transverse the birth canal
- Breast milk may have substances that better nurture beneficial bacteria & potentially limit colonization of harmful bacteria

One thought – Add the bacteria they may be missing:

- Clinical trial in Puerto Rico on C-section babies
- Swabs babies with gauze from vaginal fluid of babies
- Track health/weight compared to other C-section babies
Prebiotics & Probiotics

Both can change gut flora

Prebiotics

• Food ingredient that can’t be digested by a person, but can by microorganisms
• Shown to increase the genus
• Prebiotics have been shown to increase the genus *Akkermansia* which is thought to help maintain body weight
  • Publicized that there is a human trial giving obese people more *Akkermansia*
  • Possible improvements to glucose tolerance, lower blood triglycerides, and body fat in rat studies

Probiotics

• Bacterial cultures themselves
• Can be limited in scope
• Not well regulated
• Giving healthy people vs. sick?
Insulin Resistance

High fat/sugar, low fibre diet causes an imbalance between "good" and "bad" gut bacteria.

Dysbiosis of colonic microbiota, mucous production and epithelial integrity, resulting in a "leaky gut".

Obesity alters gut microbiota.

Obesity directly increases gut permeability.

Insulin drives Testosterone Production in ovary, while impairing follicle development.

Normal gut function and mucous barrier preventing the trans-epithelial passage LPS.

Macrophages activated by bacterial LPS that passes through gut wall.

Polycystic morphology on ultrasound.

Acne/hirsutism.

Impaired ovulation.
Cancer
## Microbes Specifically Associated with Cancer

<table>
<thead>
<tr>
<th>Microbes</th>
<th>Associated Cancers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Papilloma Virus (HPV)</strong></td>
<td>• Cervical cancer</td>
</tr>
<tr>
<td><strong>H. pylori</strong></td>
<td>• Ulcers</td>
</tr>
<tr>
<td></td>
<td>• Stomach &amp; esophageal cancer</td>
</tr>
<tr>
<td><strong>Fusobacterium</strong></td>
<td>• Colon cancer</td>
</tr>
<tr>
<td><strong>Hepatitis B &amp; C</strong></td>
<td>• Liver cancer</td>
</tr>
<tr>
<td><strong>Epstein-Barr Virus (EBV)</strong></td>
<td>• Lymphomas</td>
</tr>
</tbody>
</table>


### Study done on 18 to 90 year old women
- Some have lactated and others haven’t
- Different areas of the world
- If sample submitted for cancer, sample taken 5 cm away from tumor

### Canadian samples
- Bacillus (11.4%)
- *Acinetobacter* (10%)
- *Enterobacteriaceae* (8.3%)
- *Pseudomonas* (6.5%)
- *Staphylococcus* (6.5%)
- *Propionibacterium* (5.8%)
- *Comamonadaceae* (5.7%)
- *Gammaproteobacteria* (5%)
- *Prevotella* (5%)

### Irish
- *Enterobacteriaceae* (30.8%)
- *Staphylococcus* (12.7%)
- *Listeria welshimeri* (12.1%)
- *Propionibacaterium* (10.1%)
- *Pseudomonas* (5.3%)

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How Is the Breast Microbiota Established?

How do bacteria get there?

- From skin through nipple-areolar orifices
- Hands
- Translocation from gut
- Oral – breast feeding or sexual

Breast tissue has distinct environment

- pH
- Oxygen levels
- Diet?
Breast Cancer

Statistics

• Leading cause of cancer death among women
• 70% of breast cancers are from women of average risk
• About 292,130 women and 2,350 men diagnosed with breast cancer each year
• Every 2 minutes, a new case is diagnosed and 13 minutes, a woman dies from breast cancer
The Microbiome of Breast Cancer

Breast tissue obtained from sterile surgery has its own unique microbiome

- Not the same as from overlying breast skin

Breast microbiome different between benign and malignant disease

- Malignant disease had enrichment of *Fusobacterium*, *Atopobium*, *Gluconacterobacter*, *Hydrogenophaga*, and *Lactobacillus*

- Hypothesized *Fusobacterium* secretes virulence factors and leads to a pro-inflammatory environment that can potentially promote carcinogenesis

Hieken et al. The Microbiome of aseptically collected human breast tissue in benign and malignant disease. Scientific Reports. DOI: 10.1038/srep30751.
The Big Question

Can a change in the microbiome reduce the risk of cancer?

- Restore the “appropriate” microbiome and eradicate causative organism?
- Looking at *Fusobacterium* and colorectal carcinoma
Autism
Autism Basics

Been described as a medical condition since 1943

Early rates were roughly 1 in 5000 and now are 1 in 68.2

Boys are four to five times greater chance to have it

Potential causes

- Genetic factors?
- Maternal immune factors?
- Prenatal or environmental toxicity?
- Metabolic derangement?
- Gastrointestinal and dietary factors?

Data suggests autistic children have same GI issues as usual pediatric community, but at a larger frequency

- Diarrhea
- Constipation
- Acid reflux

Is this due to altered eating patterns?
Is There Evidence Supporting the Connection Between Autism and an Altered Microbiome?

### Data

- **Mouse model** – treat with commensal bacteria *Bacteroides fragilis*
  - Anxiety-related behaviors improved
  - Assumption in paper is that *B. fragilis* produces a polysaccharide that promotes better T-cell development and corrects imbalances
- Question of whether certain bacteria influence early immune system development
- Evaluating stool samples
- Parracho reported greater Clostridia species in autistic group compared to unaffected siblings


And So Is There A Connection?

Most current thought leaders think there isn’t

The microbiome differences are probably due to dietary choices

Changes to the microbiome can be done and do not affect autism
Behavior?
Life Cycle of Toxoplasma gondii

- Unsporulated oocysts shed in cat feces
- Oocysts sporulate in the environment and become infective
- Sporulated oocysts infect animals or birds through contaminated feed, water and soil
- Cats infected through cysts in tissues of intermediate host
- Intermediate hosts infect each other through tissue cysts
- Intermediate hosts include pigs and many other mammals such as sheep, goats, rats and birds
- Humans infected through cysts in tissues of intermediate host (raw and undercooked meat)
- Fetus infected through trophozoites transmitted through placenta
Can Microbes Affect Behavior

Toxoplasma gondii in mice

- Within 3 weeks of a mouse being infected, it loses its fear of cat odor
- Researchers had a strain that could mount an immune response so should be able to be cleared from the body
- After four months, not detectable in the brain
- Mice still did not fear cat odor
- Suggests microbe had permanent change in brain

Toxoplasma gondii in humans

- Linked to increased high risk-behavior and less self-control


Flegr et all.  Correlation of dudration of latent Toxoplasma gondii infection with personality changes in women.  Biol Psychol.  2000.  53:” 57-79.

PANDAS, PANS and Acute-onset OCD: Moving Beyond the Controversy to Improved Patient Care

Susan E. Swedo, M.D.

Pediatrics & Developmental Neuroscience Branch
National Institute of Mental Health
NIH Intramural Research Program
Criteria for PANDAS

I. Presence of OCD and/or Tic Disorder
II. Prepubertal onset
III. Acute onset and episodic course (relapsing-remitting, not waxing & waning)
IV. Association with neurological abnormalities (choreiform movements)
V. Temporal relationship between symptom exacerbations and Group A beta-hemolytic Strep (GABHS) infections

Am J Psychiatry, 1998
PANDAS Comorbid Symptomatology

Sleep disorders 80%
Insomnia, night terrors, refusal to sleep alone

Behavioral regression
Separation anxiety (98%), baby talk, tantrums

Inability to concentrate 90%

Hyperactivity, inattentiveness 70%
Aggressiveness 60%
Learning difficulties 60%
Eating disorder 20%
Hallucinations 10%

Terror stricken look (mydriasis) or Hyper-alert appearance 80%

Urinary frequency, urgency, enuresis (night & daytime) 90%
Handwriting deterioration 90%
Tics 70%
Short-term memory loss 60%
Sensory hypersensitivity or insensitivity 40%
PANDAS Model of Etiopathogenesis

Group A Streptococci → Genetically Susceptible Host → Abnormal Immune Response → Post-GAS Sequelae
GAS Infections Correlate with Abnormal Movements and Hyperactivity

Tanya Murphy and colleagues at Univ FL

In-person observations among 693 elementary school children revealed:
- Direct correlation between + GAS throat cultures and
- Presence of tics, adventitious movements and problem behaviors
- Recurrence of GAS infections increased the risk.

TK Murphy et al, Biol Psychiatry 2007
12 patients identified over 3 years period
7 boys & 5 girls presented with neuropsychiatric symptoms related to GABHS infections
- 100% with OCD (3/4’s were germ-related) and emotional lability
- 58% (7/12) with urinary frequency or enuresis
- 42% (5/12) with acute separation anxiety
- 33% (4/12) with tics or handwriting changes

Antibiotic treatment of GABHS infections reduced symptom severity in 5 – 21 days

### Comorbid Symptomatology

<table>
<thead>
<tr>
<th>Symptom</th>
<th>NIMH (N=48)</th>
<th>Hinsdale (N=42)</th>
<th>Bethesda (N=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Anxiety</td>
<td>#</td>
<td>%</td>
<td>#</td>
</tr>
<tr>
<td>2. Emotional lability and/or depression</td>
<td>44</td>
<td>92%</td>
<td>40</td>
</tr>
<tr>
<td>3. Irritability, aggression, and/or severely oppositional behaviors</td>
<td>18</td>
<td>38%</td>
<td>11</td>
</tr>
<tr>
<td>4. Behavioral (developmental) regression</td>
<td>30</td>
<td>63%</td>
<td>29</td>
</tr>
<tr>
<td>5. Deterioration in school performance</td>
<td>36</td>
<td>75%</td>
<td>37</td>
</tr>
<tr>
<td>6. Sensory or motor abnormalities</td>
<td>37</td>
<td>77%</td>
<td>40</td>
</tr>
<tr>
<td>7. Somatic signs and symptoms, including sleep disturbances, enuresis, or urinary frequency</td>
<td>43</td>
<td>90%</td>
<td>41</td>
</tr>
<tr>
<td><strong>Average # of categories present per patient</strong></td>
<td><strong>5.65</strong></td>
<td><strong>4.86</strong></td>
<td><strong>4.97</strong></td>
</tr>
</tbody>
</table>
The Microbiome Mutiny Hypothesis
Mutiny from the Microbes

Hypothesis

- Microbes may make coordinated change to virulence factors to leave an older host or seriously ill

Reason

- Increase ability to jump to other hosts

Is there data?

- Increased diarrhea in elderly
- Higher pneumonia and urinary tract rates
- Increased reactivation of things like herpesviruses

Microbes would need data about their host’s health

Rozsa, Ljos, Peter Apari, and Victor Muller. The microbiome mutiny hypothesis: can our microbiome turn against us when we are old or seriously ill? Biology Direct. DOI 10.1186/s13062-014-0034-5
Health Benefits
HIV and Fecal Transplants

HIV patients

- Even with ART, patients have increased morbidity/mortality
- Significant GI dysfunction in HIV disease
- Usual loss in gut microbial diversity
  - Less Bacteroidetes, Firmicutes, and Proteobacteria

Can it be changed?

- Experiment on SIV-infected Macaques
- Fecal transplant was well-received
- Increased Th17 and Th22 and decrease in activation of CD4+ T cells

Side Benefits
Fermented milk can be seen back in Egyptian hieroglyphics

1800’s – scientists started looking at benefits of fermented milk products

1930’s – yogurts became fashionable probiotic

Studies going on now

- Antibiotic-associated diarrhea
- Irritable bowel syndrome
- Pediatric diarrhea
- Treating *C. difficile*
- Constipation
- Treating *H. pylori*
- Allergies
Hygiene

Listerine

- Started as floor cleaner
- Invented the word halitosis

Bathing

- Used to do it once a week
- Bathing/showering every day was massive ad campaign by soap companies to sell more soap
- Over showering dry out skin – remove protective lipids, just under arms or groin is fine
Replacing Showering?

AOBiome sells mist that contains Nitrosomonas eutropha

- Ammonia-oxidizing bacteria
- Hypothesis is that it used to live freely on us and continual washing, deodorant, etc. has taken it away

Is it effective?

- Inventor is an MIT chemical engineer who hasn’t showered for 12 years
- Chairman uses soap once or twice a month and shampoos 3x per year

L’Oréal, Estée Lauder, Clinique looking at & patenting probiotics for skin
Diagnostics Can Help With Therapeutic Decisions
Advantages of Rapid Testing for Infectious Diseases

Faster directed therapy to reduce:
- antibiotic resistance
- hospital length-of-stay

Less adverse consequences

Teachable moment

Reduced length-of-stay in Emergency Department

Timely application of appropriate infection control procedures
There aren’t enough good rapid tests to confirm the professional judgment of the doctor... this is not acceptable: we need to encourage more innovation and ensure that useful products are used. I call on the governments of the richest countries to mandate now that by 2020, all antibiotic prescriptions will need to be informed by a rapid diagnostic test wherever one exists.\(^\text{12}\)

- Jim O’Neill 2016

What’s driving the need for rapid accurate diagnostic tests?

Transition to “patient-centered” value based health service delivery³

- Get the diagnosis right the first time
- Diagnose in an actionable timeframe
- Early optimal treatment selection
- Avoid the waste of unnecessary investigations
- Avoid the waste of over treating
- Avoid the consequences of incorrect patient management
- Better health outcomes and reduced healthcare costs

The results of diagnostic tests are immensely influential, affecting around 60–70% of all clinical decisions, although they still amount for only 4–5% of healthcare costs.³

Question:

What is the future of the microbiology laboratory?
Conclusions

Antibiotic resistance is an immediate global threat

Treating empirically can lead to increased resistance

Directed therapy after diagnosis can reduce antibiotic resistance while improving care and reducing costs
Discussion