Metrex has been Protecting People across healthcare for over 20 years.

Evidence-based prevention of infectious diseases in schools

-Part I: Fundamentals of infections in schools

-Part II: The importance of surface hygiene

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Outlines

✓ Overview of infectious diseases at school

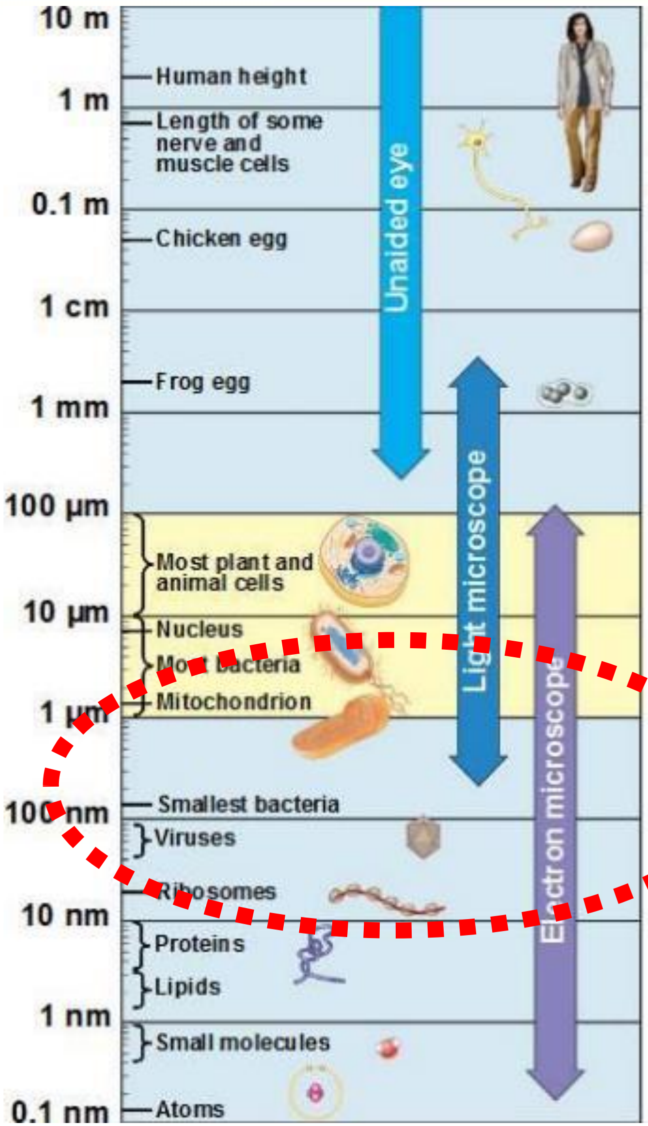
✓ Fundamental principles of infectious diseases

- Basic and clinical microbiology
- Microbial pathogenesis
- Common pathogens and transmission pathways

✓ Evidence-based role of surface disinfection

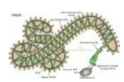
- Hand hygiene
- Surface disinfection

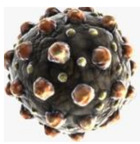
Culprits of Infectious Diseases

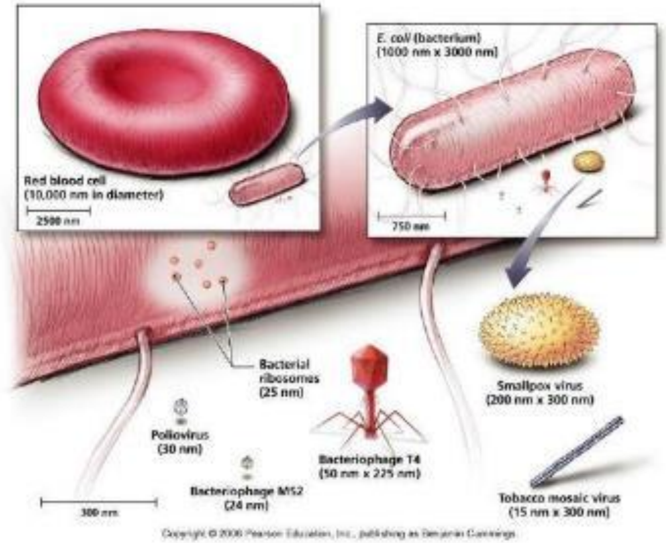


http://www.slideshare.net/5alod/campbell-biology-9th-edition-slides

@Pearson Education/Benjamin Cummings

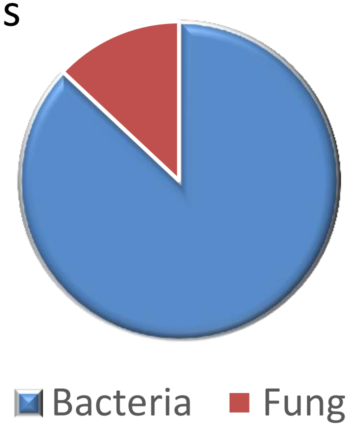

Ebola


Measles virus



Epidemiologically Significant Pathogens

- 28,502 HAIs reported to NHSN b/w Jan 2006-Oct. 2007
- 621 U.S. hospitals



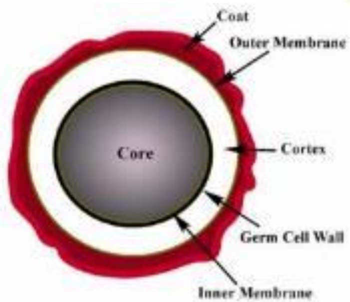
CDC 2010 report

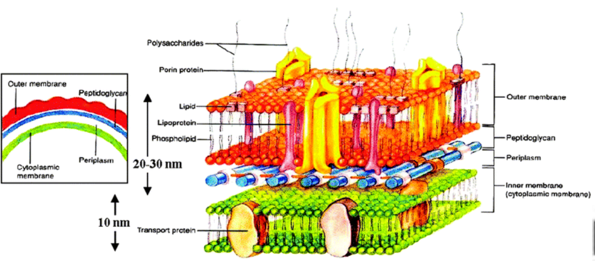
Microbial Resistance Profile to Disinfectants and Sterilants

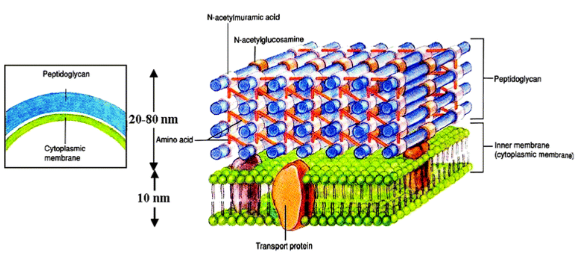
More resistant

- Prions
- Endospores of bacteria
- Mycobacteria
- Cysts of protozoa
- Vegetative protozoa
- Gram-negative bacteria
- Fungi, including most fungal spores
- Viruses without envelopes
- Gram-positive bacteria
- Viruses with lipid envelopes

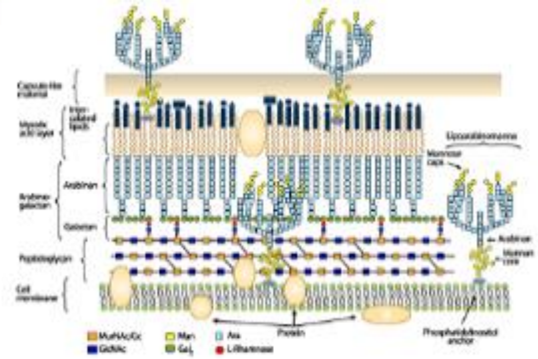
Less resistant

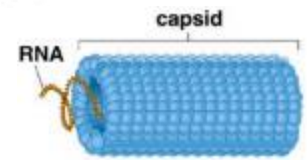


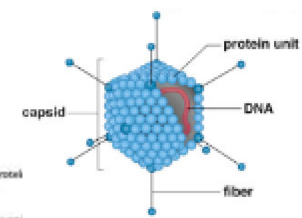


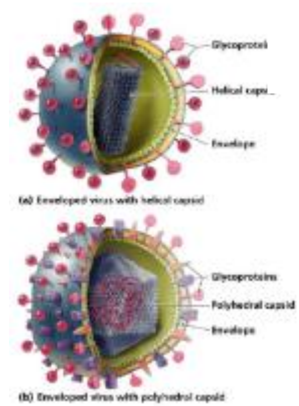


Peptidoglycan





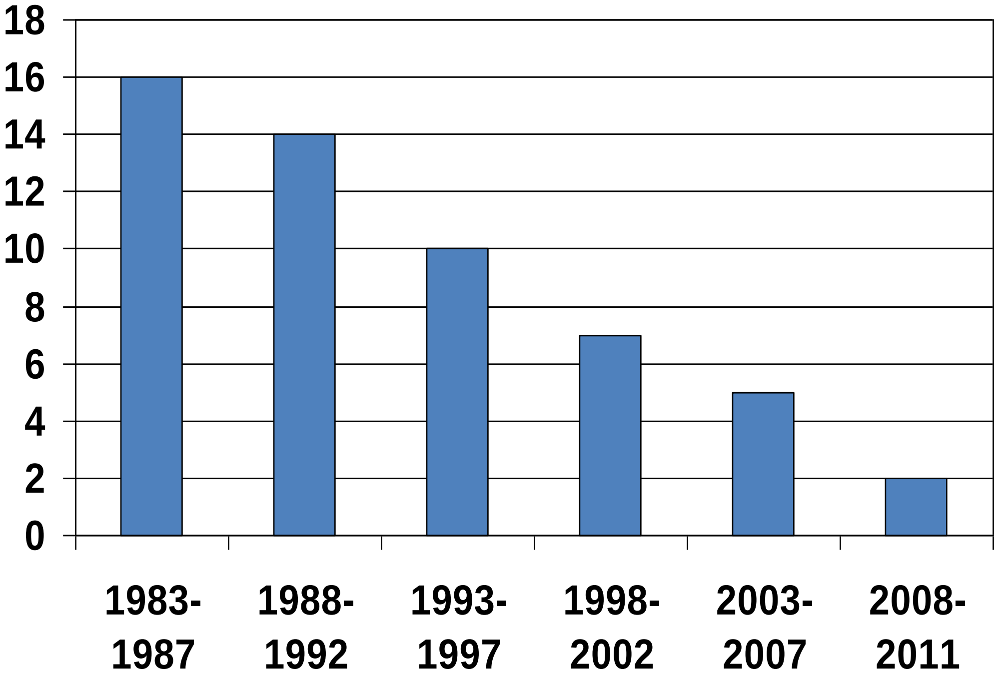




Reference: Gerald E. McDonnell.
"Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance" American Society for Microbiology (ASM)Press, Washington, D.C., 2007

Antimicrobial Therapy

Goal: Seek to suppress or kill pathogenic microorganisms with minimal toxicity and /or side effects to the patient.



Adapted from Spellberg B et al. *Clin Infect Dis*. 2004;38:1279-86.

Metrex How long can pathogens survive on environmental surfaces?

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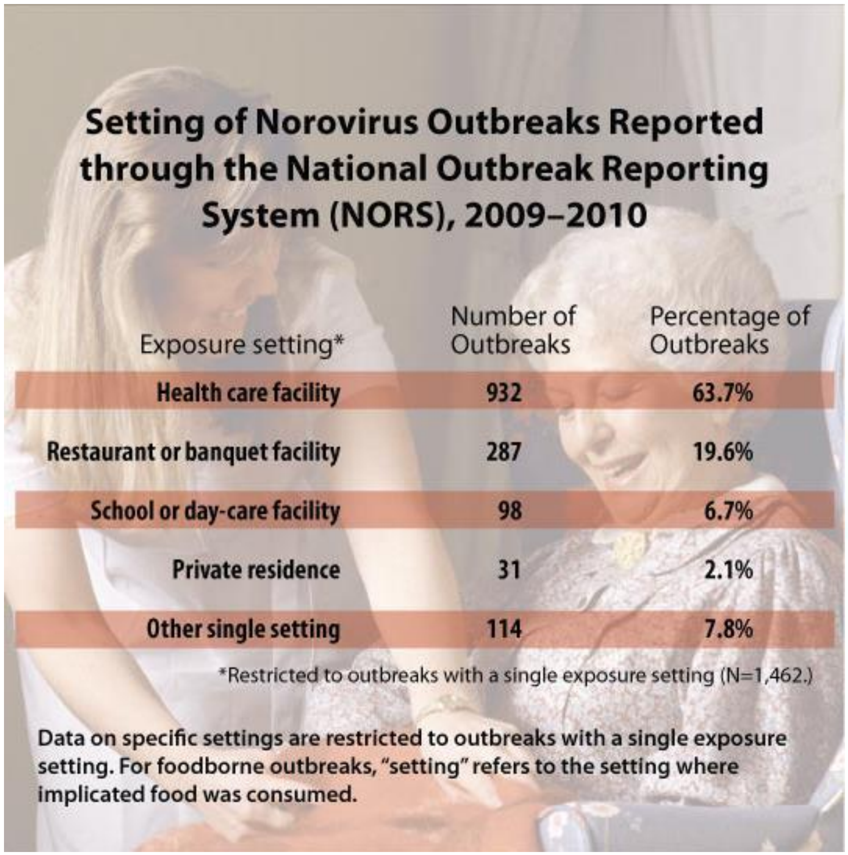
Table 1: Persistence of clinically relevant bacteria on dry inanimate surfaces.

Type of bacterium	Duration of persistence (range)	Reference(s)
Acinetobacter spp.	3 days to 5 months	[18, 25, 28, 29, 87, 88]
Bordetella pertussis	3 – 5 days	[89, 90]
Campylobacter jejuni	up to 6 days	[91]
Clostridium difficile (spores)	5 months	[92–94]
Chlamydia pneumoniae, *C. trachomatis*	≤ 30 hours	[14, 95]
Chlamydia psittaci	15 days	[90]
Corynebacterium diphtheriae	7 days – 6 months	[90, 96]
Corynebacterium pseudotuberculosis	1–8 days	[21]
Escherichia coli	1.5 hours – 16 months	[12, 16, 17, 22, 28, 52, 90, 97–99]
Enterococcus spp. including VRE and VSE	5 days – 4 months	[9, 26, 28, 100, 101]
Haemophilus influenzae	12 days	[90]
Helicobacter pylori	≤ 90 minutes	[23]
Klebsiella spp.	2 hours to > 30 months	[12, 16, 28, 52, 90]
Listeria spp.	1 day – months	[15, 90, 102]
Mycobacterium bovis	> 2 months	[13, 90]
Mycobacterium tuberculosis	1 day – 4 months	[30, 90]
Neisseria gonorrhoeae	1 – 3 days	[24, 27, 90]
Proteus vulgaris	1 – 2 days	[90]
Pseudomonas aeruginosa	6 hours – 16 months; on dry floor: 5 weeks	[12, 16, 28, 52, 99, 103, 104]
Salmonella typhi	6 hours – 4 weeks	[90]
Salmonella typhimurium	10 days – 4.2 years	[15, 90, 105]
Salmonella spp.	1 day	[52]
Serratia marcescens	3 days – 2 months; on dry floor: 5 weeks	[12, 90]
Shigella spp.	2 days – 5 months	[90, 106, 107]
Staphylococcus aureus, including MRSA	7 days – 7 months	[9, 10, 16, 52, 99, 108]
Streptococcus pneumoniae	1 – 20 days	[90]
Streptococcus pyogenes	3 days – 6.5 months	[90]
Vibrio cholerae	[illegible]	[illegible]

Axel Kramer, et. al. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infectious Diseases. 2006, 6: 130

Norovirus (stomach bug)



Setting of Norovirus Outbreaks Reported through the National Outbreak Reporting System (NORS), 2009–2010

Exposure setting*	Number of Outbreaks	Percentage of Outbreaks
Health care facility	932	63.7%
Restaurant or banquet facility	287	19.6%
School or day-care facility	98	6.7%
Private residence	31	2.1%
Other single setting	114	7.8%

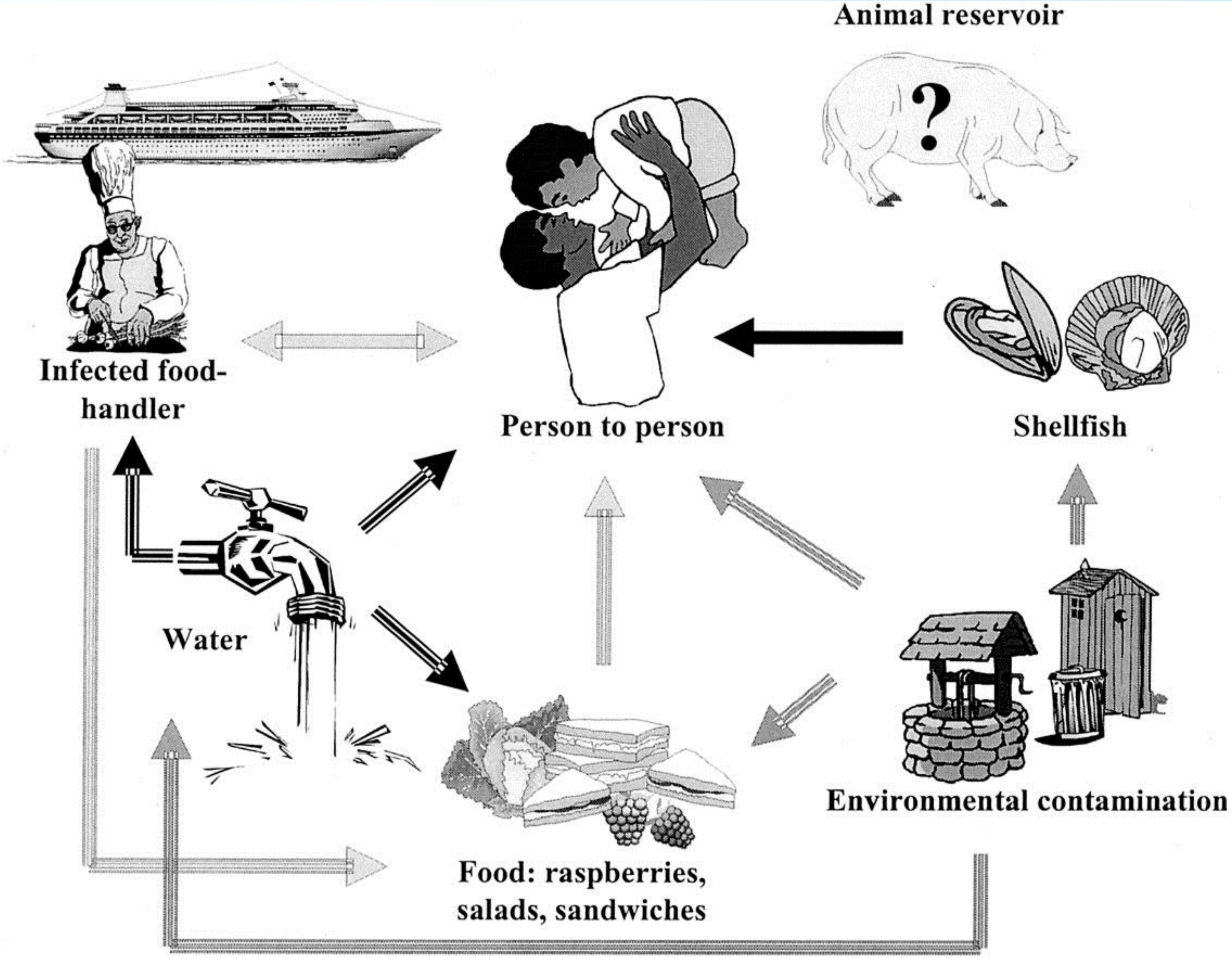
*Restricted to outbreaks with a single exposure setting (N=1,462.)

Data on specific settings are restricted to outbreaks with a single exposure setting. For foodborne outbreaks, "setting" refers to the setting where implicated food was consumed.

http://www.cdc.gov/features/dsnorovirus/figure2.html

http://spacecoastdaily.com/2014/06/the-new-norovirus-from-down-under/

Traditional Norovirus transmission pathways



http://www.cruiselawnews.com/2010/06/articles/norovirus/cruise-ship-norovirus-something-in-the-water/

Transmission pathways can be bridged

A Norovirus Outbreak Related to Contaminated Surfaces

Kimberly K. Repp,[1] Trevor P. Hostetler,[1] and William E. Keene[2]

[1]Washington County Department Health and Human Services, Hillsboro; and
[2]Oregon Public Health Division, Portland, Oregon

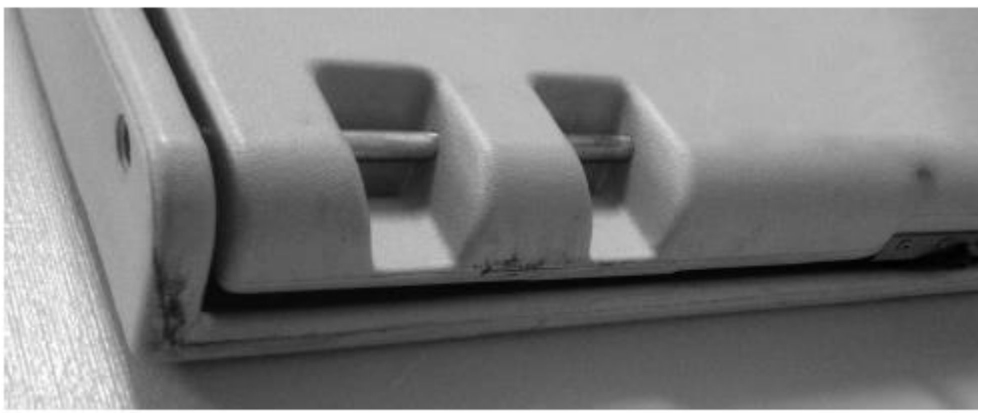
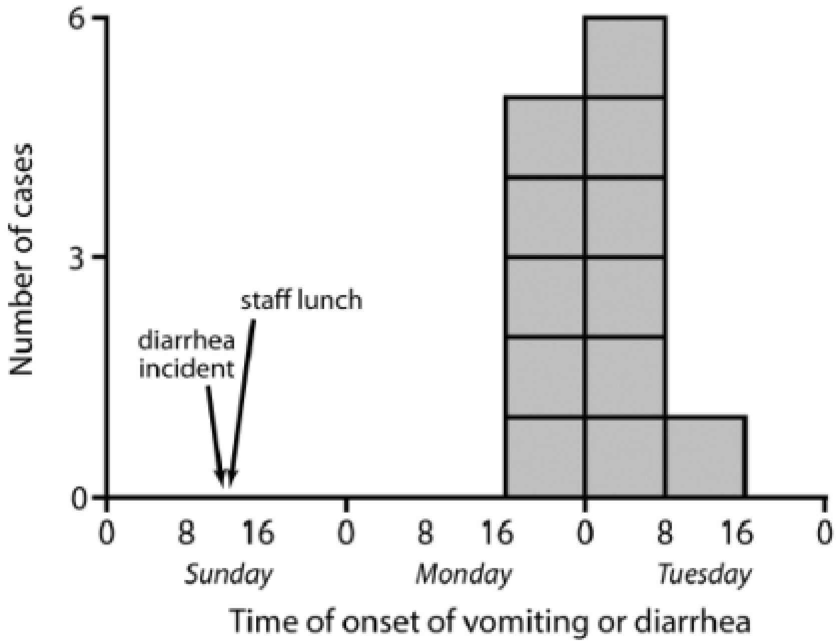


Figure 2. Photograph of underneath the diaper changing station involved in this outbreak, which had allegedly been cleaned twice by janitorial staff. This level of soiling was consistently viewed in public restroom diaper-changing stations.



From indirect (fomite surface) to direct (mucus membrane, GI tract, etc.)

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Transmission pathways can be bridged

Journal of Hospital Infection (2004) 58, 42-49

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Available online at www.sciencedirect.com

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www.elsevierhealth.com/journals/jhin

Effects of cleaning and disinfection in reducing the spread of Norovirus contamination via environmental surfaces

J. Barker[a,*], I.B. Vipond[b], S.F. Bloomfield[c]

[a]*Department of Pharmaceutical and Biological Sciences, School of Life and Health Sciences, Aston University, Aston Triangle, Birmingham B4 7ET, UK*
[b]*Health Protection Agency—South West, Regional Virus Laboratory, Myrtle Road, Kingsdown, Bristol BS2 8EL, UK*
[c]*London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, UK*

From indirect (fomite surface) to direct (mucus membrane, GI tract, etc.)

Hand hygiene is significantly compromised if the environmental surfaces are not clean

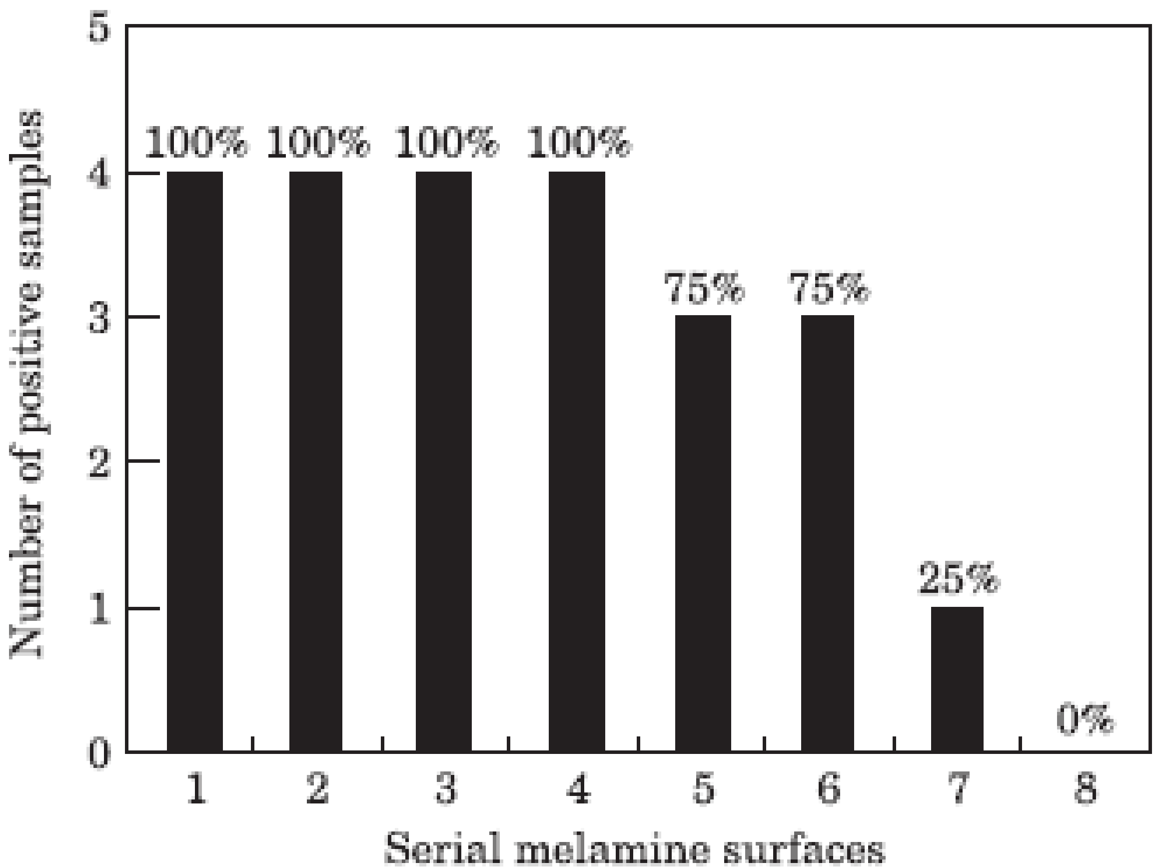

Figure 1 Sequential finger transfer of NV to clean melamine surfaces after initial contamination of fingers with faecally contaminated toilet tissue (four replicate tests).

Transmission pathways can be bridged

Summary A reverse transcriptase polymerase chain reaction assay was used to study the transfer of Norovirus (NV) from contaminated faecal material via fingers and cloths to other hand-contact surfaces. The results showed that, where fingers come into contact with virus-contaminated material, NV is consistently transferred via the fingers to melamine surfaces and from there to other typical hand-contact surfaces, such as taps, door handles and telephone receivers. It was found that contaminated fingers could sequentially transfer virus to up to seven clean surfaces. The effectiveness of detergent- and disinfectant-based cleaning regimes typical of those that might be used to decontaminate faecally contaminated surfaces and reduce spread of NV was also compared. It was found that detergent-based cleaning with a cloth to produce a visibly clean surface consistently failed to eliminate NV contamination. Where there was faecal soiling, although a combined

From indirect (fomite surface) to direct (mucus membrane, GI tract, etc.)

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Transmission pathways can be bridged

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Current Opinion in Virology

Environmental transmission of norovirus gastroenteritis☆

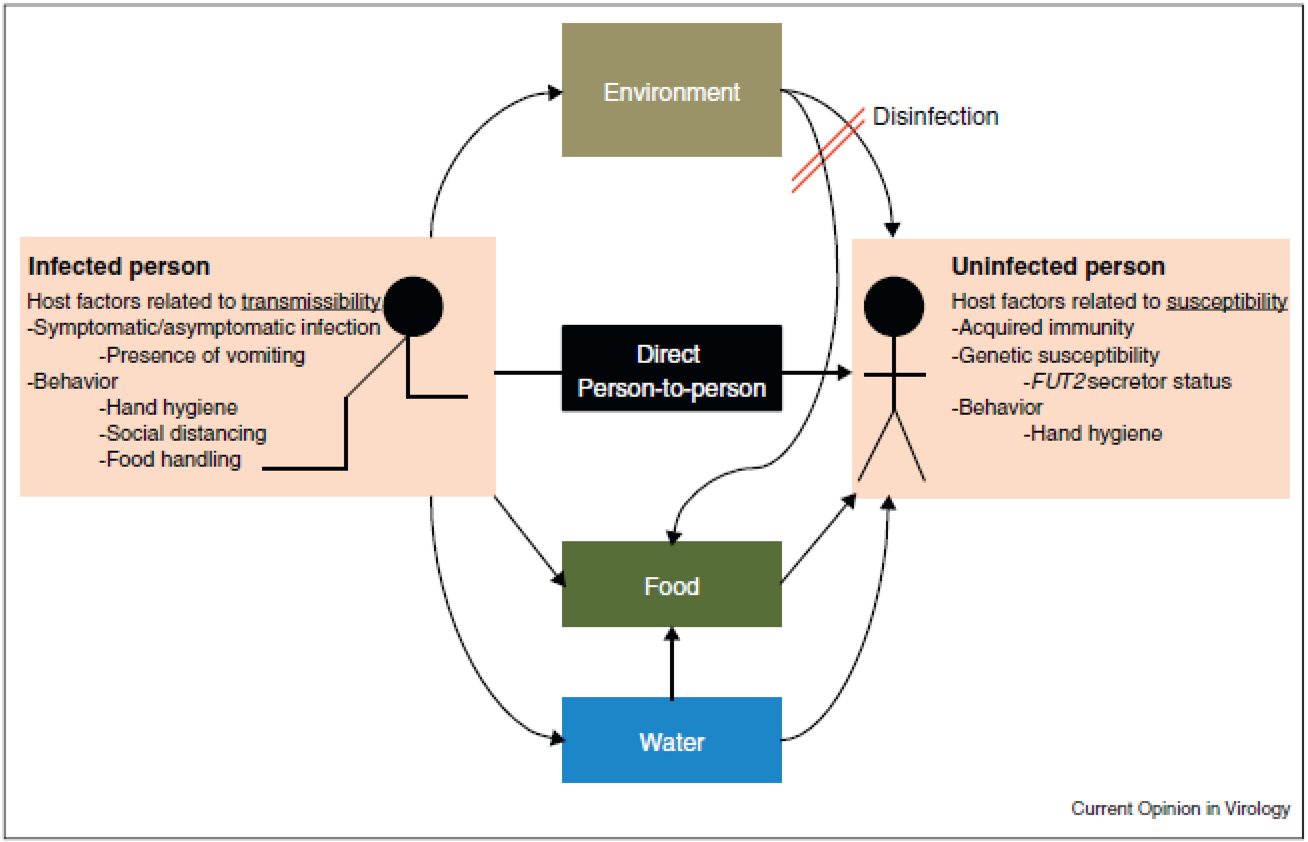
Ben Lopman[1], Paul Gastañaduy[1,2], Geun Woo Park[1], Aron J Hall[1], Umesh D Parashar[1] and Jan Vinjé[1]

The advent of molecular techniques and their increasingly widespread use in public health laboratories and research studies has transformed the understanding of the burden of norovirus. Norovirus is the most common cause of community-acquired diarrheal disease across all ages, the most common cause of outbreaks of gastroenteritis, and the most common cause of foodborne disease in the United States. They are a diverse group of single-stranded RNA viruses that are highly infectious and stable in the environment; both symptomatic and asymptomatic infections are common. Through shedding in feces and vomit, norovirus can be transmitted directly through an array of routes: person-to-person, food or the environment. The relative importance of environmental transmission of virus is yet to be fully quantified but is likely to be substantial and is an important feature that complicates control.

England and The Netherlands have estimated incidence in the general population between 4.1 and 4.6 cases per 100 person-years [2,3•], with regional studies providing generally consistent results [4,5]. Incidence is approximately 5 times higher in children under the age of five years [5]. In the United States, norovirus causes an estimated 21 million cases of acute gastroenteritis [6] and >70 000 hospitalizations annually across all age groups [7]. The burden of disease increases considerably in years where novel genogroup II genotype 4 variants emerge, with hospitalizations surging by approximately 50% [8–10]. Although symptomatic norovirus infections are usually mild and self-limiting in otherwise healthy adults, they may be fatal among the elderly [11] and immunocompromised persons [12]. Excess mortality associated with norovirus has been documented in a

Transmission pathways can be bridged

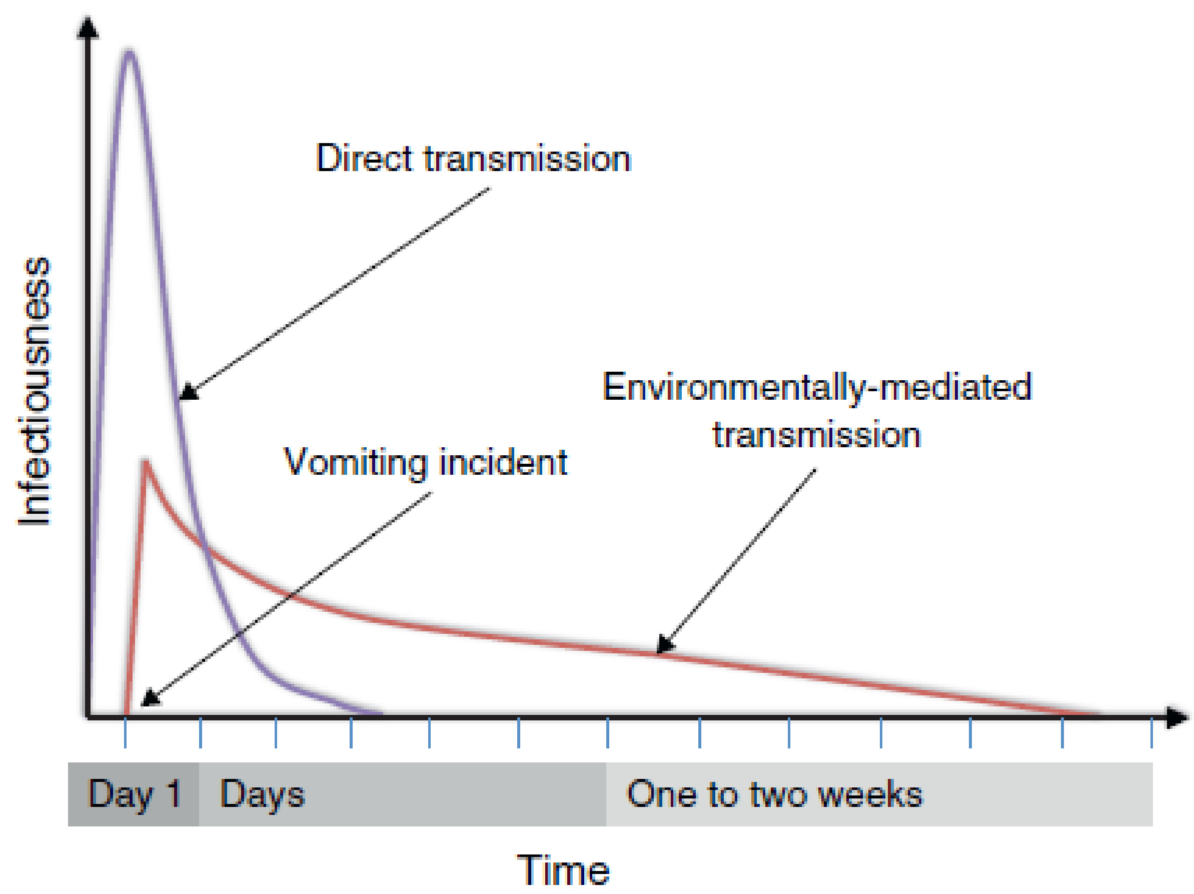
Figure 1 Routes of transmission of norovirus from infected to uninfected people.



Norovirus transmission can occur via a range of transmission routes. Characteristics and behaviors of the infected host and potential susceptibles may mitigate the risk of transmission. This simple schematic is not meant to depict all the intricacies of each pathway, but rather to highlight the interaction of the various routes and to illustrate that all pathways require shedding of virus from infectious hosts. Different control measures may be targeted at each arrow; here, the role of environmental disinfection is highlighted. Certain practices (such as hand hygiene) may reduce transmission through all pathways while targeted interventions (such as exclusion of ill food handlers from work) may reduce transmission through specific pathways.

Environmentally-mediated transmission can last much longer than direct transmission

Figure 2 Illustration of the direct and indirect transmission potential of norovirus over time.



Current Opinion in Virology

Important of environmental disinfection

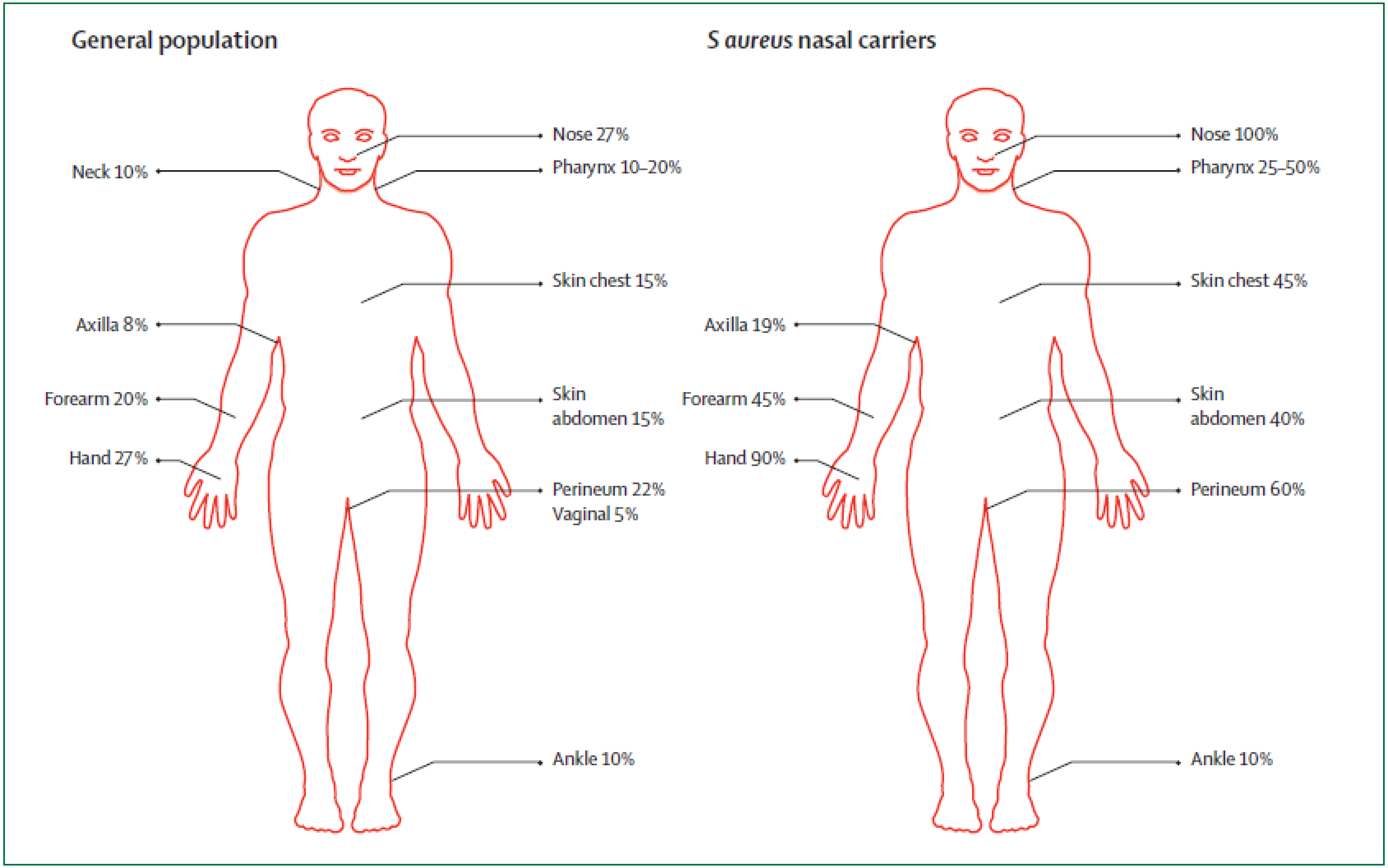


Figure 2: Distribution of *S aureus* on body sites of the general population and of nasal carriers[30]

Dancer SJ. Importance of the environment in meticillin-resistant Staphylococcus aureus acquisition: the case for hospital cleaning. **Lancet Infect Dis**. 2008 Feb;8(2):101-13

Hand hygiene is important, but wait……

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How many times do we touch our faces during one hour?

Please choose one of the following answers.

A. 0-3

B. 4-7

C. 8-11

D. More than 11

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Hand hygiene is important, but wait……

How many times do we touch our faces during one hour?

Alonso and colleagues randomly selected 249 people in public places, on the Washington, D.C. subway and in the Brazilian city of Florianopolis. The researchers observed them, noting how often they touched a common surface and then their mouth or nose. They found that people touched their faces an average of 3.6 times per hour, and common objects an average of 3.3 times per hour.

This rate of self-touching means that people likely get germs on their hands much more frequently than they wash germs off their hands, according to the study[1].

By touching the surfaces, transmission pathways (direct & indirect) are bridged

[1] http://www.livescience.com/25086-stop-touching-yourself-flu-researchers-say.html

Hand hygiene is important, but wait……

How many times do we check our cell phones in one day?

Please choose one of the following answers.

A. 0-40

B. 41-80

C. 81-120

D. More than 120

Hand hygiene is important, but wait……

How many times do we check our cell phones in one day?

A study by Kleiner Perkins Caufield and Byers found the average user checks their phone nearer to **150 times** per day. In its annual Internet Trends report, carried out in May this year, found that people check their phones, on average, **23 times** a day for messaging, **22 times** for voice calls and **18 times** to get the time.

By doing so, we complete the pathogen exchange between hands and environmental surfaces.

http://abcnews.go.com/blogs/technology/2013/05/cellphone-users-check-phones-150xday-and-other-internet-fun-facts/

Role of environmental surfaces in infectious disease transmission

American Journal of Infection Control 41 (2013) 254-8

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Review article

Lifting the lid on toilet plume aerosol: A literature review with suggestions for future research

David L. Johnson PhD [a,*], Kenneth R. Mead PhD [b], Robert A. Lynch PhD [a], Deborah V.L. Hirst PhD [b]

[a] Department of Occupational and Environmental Health, University of Oklahoma College of Public Health, Oklahoma City, OK

[b] Division of Applied Research and Technology, National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Cincinnati, OH

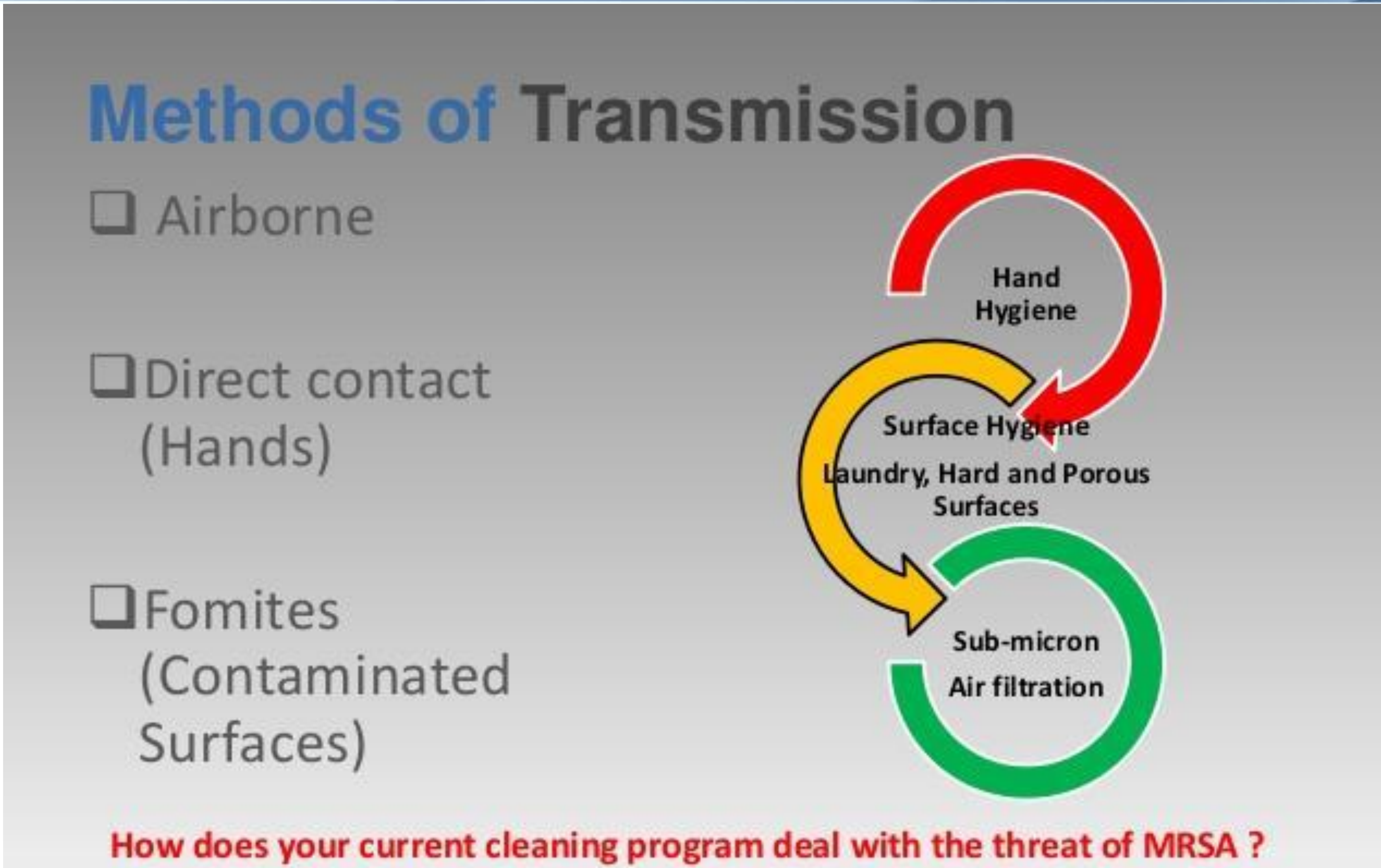
Role of environmental surfaces in infectious disease transmission

Ann Ist Super Sanità 2013 | Vol. 49, No. 2:124-132
DOI: 10.4415/ANN_13_02_03

Viral infections acquired indoors through airborne, droplet or contact transmission

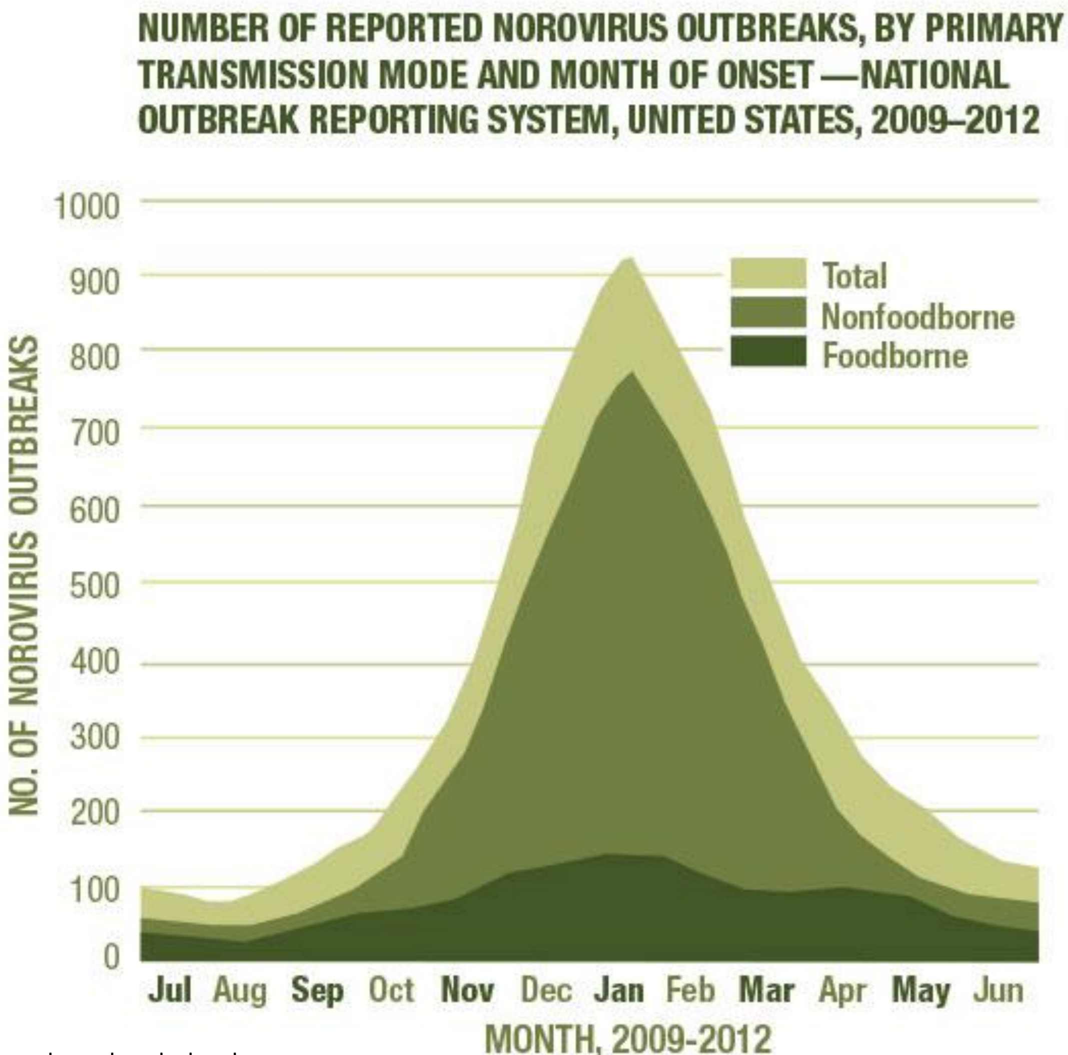
Giuseppina La Rosa, Marta Fratini, Simonetta Della Libera, Marcello Iaconelli and Michele Muscillo
Dipartimento di Ambiente e connessa Prevenzione Primaria, Istituto Superiore di Sanità, Rome, Italy

Importance of surface hygiene in infectious disease transmission



Dancer SJ. Importance of the environment in meticillin-resistant Staphylococcus aureus acquisition: the case for hospital cleaning. Lancet Infect Dis. 2008 Feb;8(2):101-13

Evidence-based norovirus infections



http://www.cdc.gov/norovirus/trends-outbreaks.html

Key message: Environmental surfaces can bridge transmission pathways and play a key role in spreading of infectious diseases

Can surface disinfection and hand hygiene prevent all infectious diseases?

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Many of them, but **not all of them**. For example, TB.

Tuberculosis (TB) is caused by a bacterium called *Mycobacterium tuberculosis*.

TB is spread through the air from one person to another.

TB is **NOT spread** by:

- shaking someone's hand
- sharing food or drink
- touching bed linens or toilet seats
- sharing toothbrushes
- kissing

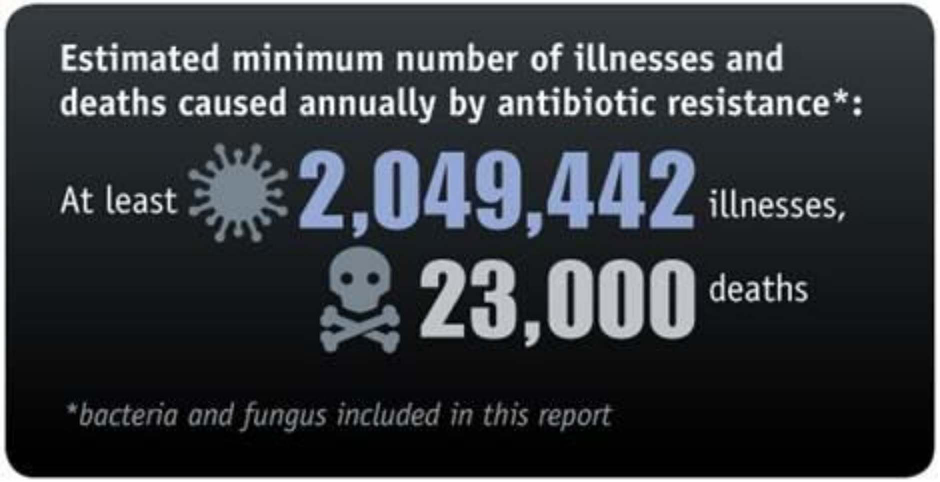
CDC suggests a three-level hierarchy of control measures:

1. Administrative measures: reduce the risk of uninfected people who are exposed to people who have TB disease
2. Environmental controls: reduce the amount of TB in the air
3. Use of respiratory protective equipment: use of respiratory protective equipment in situations that pose a high risk of exposure to TB

TB is preventable, treatable and curable, but not through environmental surfaces.

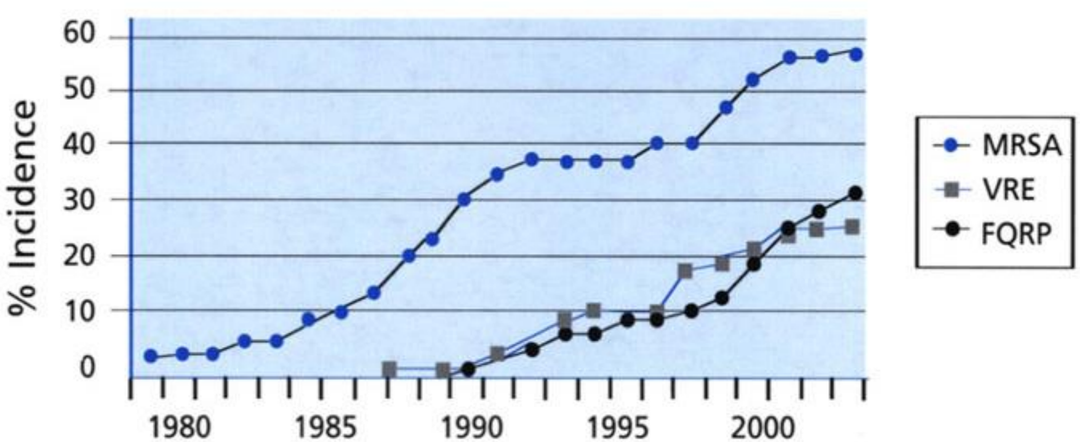
http://www.cdc.gov/tb/topic/basics/

Increasing public health threat due to antibiotic resistance

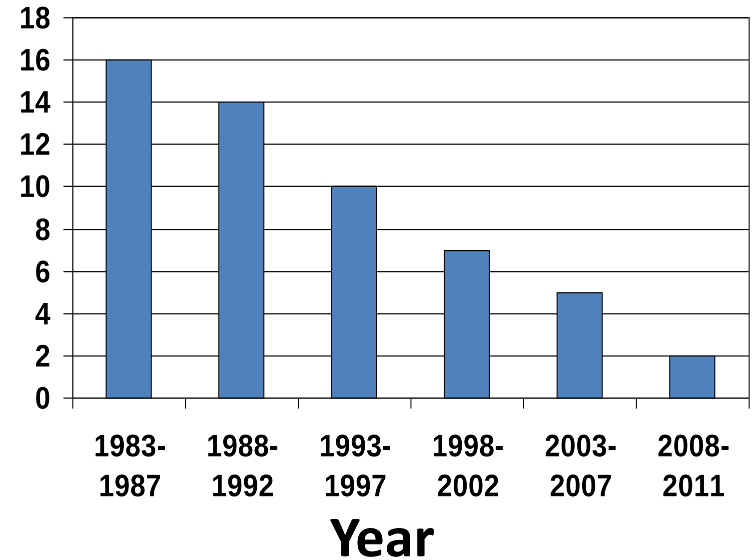


CDC data

Rise of Antibiotic Resistance in Various Common Infections



MRSA = methicillin-resistant *Staphylococcus aureus*; VRE = Vancomycin-resistant *enteroccoci*
FQRP = Fluoroquinolone-resistant *Pseudomonas aeruginosa*



healthblog.ncpa.org

Adapted from Spellberg B et al. *Clin Infect Dis*. 2004;38:1279-86.

CDC: Cleaning and disinfecting are part of a broad approach to preventing infectious diseases in schools

- **Know the difference between cleaning, disinfecting, and sanitizing**
  - ✓ Cleaning removes germs
  - ✓ Disinfecting kills germs
  - ✓ Sanitizing lowers the number of germs
- **Know the difference between cleaning, disinfecting, and sanitizing**
  - ✓ Daily sanitizing surfaces and objects that are touched often, such as desks, countertops, doorknobs, computer keyboards, hands-on learning items, faucet handles, phones, and toys. Some schools may also require daily disinfecting these items. **Standard procedures often call for disinfecting specific areas of the school**, like bathrooms, door handles
  - ✓ Immediately clean surfaces and objects that are visibly soiled with PPE.
- **Simply do routine cleaning and disinfecting (**school staff should not be allowed to bring in their own disinfectant products for safety, proper use reasons**.)**
- **Clean and disinfect correctly**
  - ✓ Use an EPA-registered disinfectant to kill germs
- **Know your products and use products safely**

http://www.cdc.gov/flu/school/cleaning.htm

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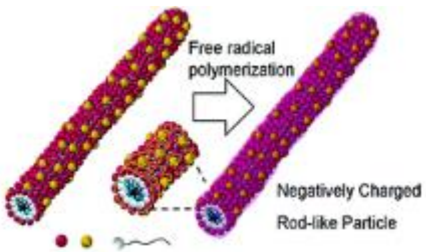
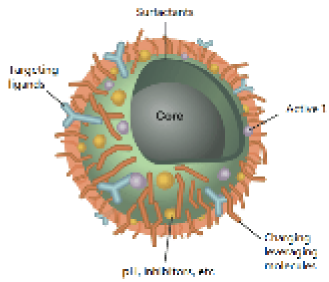
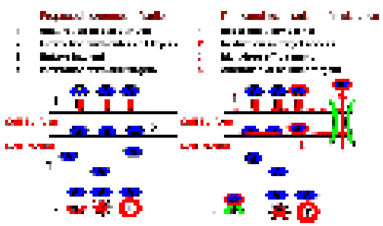
Jointed efforts towards prevention of infectious diseases

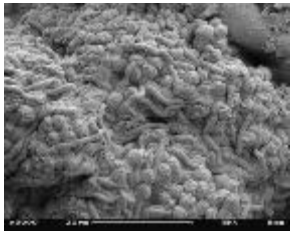
Complex, multiple actives

Mechanistic understanding









- ✓ Size, shape, charge, binding affinity, kinetics, residual effects
- ✓ Stability, aesthetics (odor, appearance, etc.)
- ✓ Safety and compatibility

Evidence-based knowledge + Product + Practice

Questions?

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Thank you!