



# Disinfectant Health & Safety Information

Chemicals that kill germs are not likely to be without health concerns.

# Who I am?

Pesticides Toxicologist with Maine  
Board of Pesticides Control

Pamela J. Bryer, PhD

- I am here as a resource for you, your co-workers, friends, and family for questions about pesticides.

**YES, I WORK FROM HOME.**



**HOW DID YOU KNOW?**

# It's a different world

My body has absorbed so much soap and water, hand sanitizer & disinfectant that now when I pee it cleans the toilet.

[@womenafter50.com](https://www.instagram.com/womenafter50.com)

Real frustration with using disinfectants.



Leads us to wonder, why this hub-bub?

Why are we talking about the safety of cleaning chemicals?

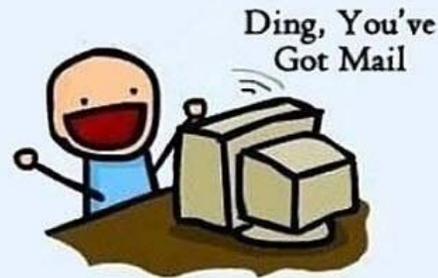


# Familiarity breeds contempt

## 15 Years Ago

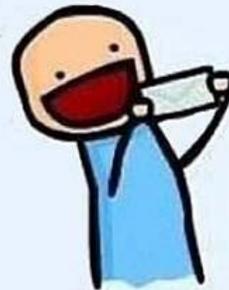


Sigh! Letters



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## Today



OMG! A Letter

When I say “pesticide” what do you think of?



# What is a pesticide?

## What is a Pesticide?

Pesticide law defines a “pesticide” (with certain minor exceptions) as:

- Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.
- Any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.
- Any nitrogen stabilizer.

U.S. Code Title 7, Chapter 6, Subchapter II, Section 136 - Definitions

# What is a pesticide?

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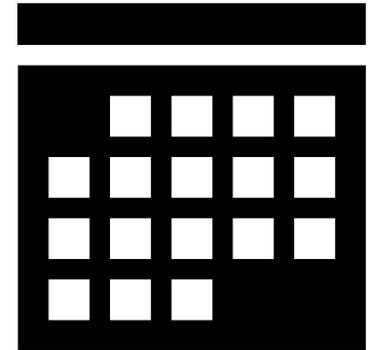
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- Any substance or mixture of substances intended for use as a defoliant or desiccant.
- Any nitrogen stabilizer.



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or mitigating  
any pest.

U.S. Code Title 7, Chapter 6, Subchapter II, Section 136 - Definitions

Important difference  
between agricultural  
and disinfecting uses



# Mainers injured from disinfectants every year

Household cleaning products accounted for 22% of the 926 substances involved in these 847 cases, with bleaches (n = 60), disinfectants (n = 31), and wall, floor and tile cleaners (n = 15) being the most common.

Taken from 2020 Annual Report Northern  
New England Poison Center Maine Report

## Taken from 2020 Annual Report Northern New England Poison Center Maine Report

Maine case statistics were heavily influenced by three factors during this period.

- The NNEPC handled 1,293 cases called in after hours on the Maine CDC's disease reporting line—727 human exposure cases, 14 animal exposures and 552 information requests. This was more than three times the number of such cases the center typically handles, an increase that was directly tied to the COVID-19 pandemic: 63% of the cases (n = 813) were related to COVID-19.
- The pandemic also had a significant effect on the overall makeup of the NNEPC's case load. The center saw a surge in cases generated by calls from residences, largely related to unintentional misuse of household products, while generally receiving fewer calls from health care facilities. These both ran counter to recent trends.
- There were 387 cases stemming from a multipatient incident at a school. This incident was first reported to the NNEPC by a health care facility, although only one patient was treated at the facility. This affected statistics related to calls from health care facilities (see Health Care Facility Exposure Cases and Multicase Exposures below).

exposures in the past two years.

- Adults 60 years and older accounted for 12% of all exposures (n = 1,411). There was a 20% increase in cases involving older adults, largely due to the COVID-19 pandemic.

# Occupational injury trends in Maine

Roughly 20 Mainers die each year on the job



INJURIES AND ILLNESSES DUE TO WORKPLACE CHEMICALS AND RELATED HAZARDS  
ME DOL Publication  
2012-2013 Worker's Comp claims

**TABLE 1**  
NATURE OF WORKERS' COMPENSATION CLAIMS FROM EXPOSURE TO HAZARDOUS CHEMICALS OR ADVERSE ENVIRONMENTAL/MICROBIOLOGICAL CONDITIONS (2012-2013)

| NATURE OF INJURY OR ILLNESS  | INCIDENTS  | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|--|------------|---------|----------------|---------------|
| Respiratory symptoms: coughing, irritation, inflammation, difficulty breathing, asthma | 136        | 33.5%   | 90             | 46            |
| Thermal, chemical and inhalation vapor burns   | 54         | 13.3%   | 47             | 7             |
| Swelling, inflammation, infections   | 43         | 10.6%   | 39             | 4             |
| Dermatitis, allergic skin reactions  | 37         | 9.1%    | 33             | 4             |
| Unspecified injuries and disorders   | 35         | 8.6%    | 26             | 9             |
| Unspecified allergic reactions   | 35         | 8.6%    | 28             | 7             |
| General, physical symptoms   | 23         | 5.7%    | 17             | 6             |
| Dizziness, weakness or nausea  | 20         | 4.9%    | 14             | 6             |
| Headache, migraine, visual loss  | 9          | 2.2%    | 6              | 3             |
| Shock, loss of consciousness, convulsions  | 7          | 1.7%    | 4              | 3             |
| Other traumatic injuries   | 7          | 1.7%    | 7              | 0             |
| <b>TOTALS FOR ALL CLAIMS</b>   | <b>406</b> |         | <b>311</b>     | <b>95</b>     |

**TABLE 4**  
OCCUPATIONS INVOLVED WITH WORKERS' COMPENSATION CLAIMS FROM EXPOSURE TO HAZARDOUS CHEMICALS OR ADVERSE ENVIRONMENTAL/MICROBIOLOGICAL CONDITIONS (2012-2013)

| OCCUPATION (SOC CODE)   | INCIDENTS | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|---|-----------|---------|----------------|---------------|
| Office and administrative support workers (43-0000)           | 50        | 12.3%   | 31             | 19            |
| Production workers (51-9000)                                  | 39        | 9.6%    | 38             | 1             |
| Healthcare practitioners and technicians (29-0000)            | 36        | 8.9%    | 32             | 3             |
| Building/ grounds maintenance and cleaning workers (37-0000)  | 30        | 7.4%    | 18             | 12            |
| Equipment installation, maintenance /repair workers (49-0000) | 29        | 7.1%    | 24             | 5             |
| Healthcare support workers (31-0000)                          | 28        | 6.9%    | 27             | 1             |
| Transportation and material moving workers (53-0000)          | 28        | 6.9%    | 26             | 2             |

**TABLE 2**  
SOURCES OF WORKERS' COMPENSATION CLAIMS FROM EXPOSURE TO HAZARDOUS CHEMICALS OR ADVERSE ENVIRONMENTAL/MICROBIOLOGICAL CONDITIONS (2012-2013)

| SOURCES  | INCIDENTS  | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|--|------------|---------|----------------|---------------|
| Cleaning and polishing agents                                | 61         | 15.0%   | 47             | 14            |
| Ambient conditions, unknown chemicals/microbes in the air    | 66         | 16.3%   | 38             | 28            |
| Unspecified or unclassified chemicals                        | 58         | 14.3%   | 44             | 14            |
| Mold, fungi  | 35         | 8.6%    | 24             | 11            |
| Propane, natural gas, gasoline, diesel fuel, petroleum fuels | 21         | 5.2%    | 19             | 2             |
| Drugs, alcohol, medications, vaccines                        | 19         | 4.7%    | 17             | 2             |
| Paint, lacquer, varnish, thinners                            | 18         | 4.4%    | 14             | 4             |
| Cosmetics, beauty preparation                                | 18         | 4.4%    | 17             | 6             |
| Other specific chemicals with less than three incidents      | 13         | 3.2%    | 10             | 3             |
| Disinfectants  | 9          | 2.2%    | 8              | 1             |
| Scrapo detergents, shampoos                                  | 9          | 2.2%    | 8              | 1             |
| Bleach   | 9          | 2.2%    | 8              | 1             |
| Acids  | 9          | 2.2%    | 8              | 1             |
| Straw (non-fire/lighting)                                    | 9          | 2.2%    | 7              | 2             |
| Evans  | 8          | 2.0%    | 8              | 0             |
| Alkalia, wet cement, lime                                    | 7          | 1.7%    | 7              | 0             |
| Pesticides, herbicides                                       | 7          | 1.7%    | 6              | 1             |
| Gases, adhesives   | 6          | 1.5%    | 5              | 1             |
| Sulfur compounds   | 5          | 1.2%    | 4              | 1             |
| Aldehydes  | 4          | 1.0%    | 4              | 0             |
| Asthma   | 4          | 1.0%    | 4              | 0             |
| Carbon monoxide  | 4          | 1.0%    | 3              | 1             |
| Metallic particles and lead                                  | 4          | 1.0%    | 4              | 0             |
| Solvents, degreasers   | 3          | 0.7%    | 2              | 1             |
| <b>TOTALS</b>  | <b>406</b> |         | <b>311</b>     | <b>95</b>     |

**TABLE 5**  
TOP EMPLOYER INDUSTRIES INVOLVED WITH WORKERS' COMPENSATION CLAIMS FROM EXPOSURE TO HAZARDOUS CHEMICALS OR ADVERSE ENVIRONMENTAL/MICROBIOLOGICAL CONDITIONS (2012-2013)

| INDUSTRY (NAICS CODE)  | NUMBER OF INCIDENTS | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|--|---------------------|---------|----------------|---------------|
| Hospitals (622000)   | 55                  | 13.5%   | 53             | 2             |
| Public Administration (920000)                                   | 51                  | 12.6%   | 1              | 50            |
| Education (610000)   | 42                  | 10.3%   | 11             | 31            |
| Manufacturing (310000 - 330000)                                  | 39                  | 9.6%    | 39             | 0             |
| Ambulatory Services (621000)                                     | 29                  | 7.1%    | 29             | 0             |
| Administrative support waste management and remediation (560000) | 26                  | 6.4%    | 26             | 0             |

Occupational injury  
 2,080 hours in a work year.

88 worker's compensation claims related to  
 disinfectants in Maine for the 2012-2013 year.

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|   |            |      |            |           |
|---|------------|------|------------|-----------|
| Other specific chemicals with less than three incidents | 13         | 3.2% | 10         | 3         |
| Disinfectants   | 9          | 2.2% | 8          | 1         |
| Scrub detergents, shampoos                              | 9          | 2.2% | 8          | 1         |
| Bleach  | 9          | 2.2% | 8          | 1         |
| Airids  | 9          | 2.2% | 8          | 1         |
| Brushes (non-flammable)                                 | 9          | 2.2% | 7          | 2         |
| Evans   | 8          | 2.0% | 8          | 0         |
| Alkalia, wet cement, lime                               | 7          | 1.7% | 7          | 0         |
| Pesticides, herbicides                                  | 7          | 1.7% | 6          | 1         |
| Gases, adhesives  | 6          | 1.5% | 5          | 1         |
| Sulfur compounds  | 5          | 1.2% | 4          | 1         |
| Aldehydes   | 4          | 1.0% | 4          | 0         |
| Asthmatics  | 4          | 1.0% | 4          | 0         |
| Carbon monoxide   | 4          | 1.0% | 3          | 1         |
| Metallic particles and lead                             | 4          | 1.0% | 4          | 0         |
| Solvents, degreasers                                    | 3          | 0.7% | 2          | 1         |
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Occupational injury  
 2,080 hours in a work year.

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Once every 3 days

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| HAZARDOUS CHEMICAL                                      | NUMBER OF INCIDENTS | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|---|---------------------|---------|----------------|---------------|
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| Disinfectants   | 9                   | 2.2%    | 8              | 1             |
| Scrub detergents, shampoos                              | 9                   | 2.2%    | 8              | 1             |
| Bleach  | 9                   | 2.2%    | 8              | 1             |
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| Brushes (non-flammable)                                 | 9                   | 2.2%    | 7              | 2             |
| Evans   | 8                   | 2.0%    | 8              | 0             |
| Alkalies, wet cement, lime                              | 7                   | 1.7%    | 7              | 0             |
| Pesticides, herbicides                                  | 7                   | 1.7%    | 6              | 1             |
| Gases, adhesives  | 6                   | 1.5%    | 5              | 1             |
| Sulfur compounds  | 5                   | 1.2%    | 4              | 1             |
| Aldehydes   | 4                   | 1.0%    | 4              | 0             |
| Asthmatics  | 4                   | 1.0%    | 4              | 0             |
| Carbon monoxide   | 4                   | 1.0%    | 3              | 1             |
| Metallic particles and lead                             | 4                   | 1.0%    | 4              | 0             |
| Solvents, degreasers                                    | 3                   | 0.7%    | 2              | 1             |
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# Occupational injury trends in Maine

Roughly 20 Mainers die each year on the job



| NATURE OF INJURY OR ILLNESS  | INCIDENTS  | PERCENT | PRIVATE SECTOR | PUBLIC SECTOR |
|--|------------|---------|----------------|---------------|
| Respiratory symptoms: coughing, irritation, inflammation, difficulty breathing, asthma | 36         | 33.5%   | 90             | 46            |
| Thermal, chemical and inhalation vapor burns   | 54         | 13.3%   | 47             | 7             |
| Swelling, inflammation, infections   | 43         | 10.6%   | 39             | 4             |
| Dermatitis, allergic skin reactions  | 37         | 9.1%    | 33             | 4             |
| Unspecified injuries and disorders   | 35         | 8.6%    | 26             | 9             |
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| Dizziness, weakness or nausea  | 20         | 4.9%    | 14             | 6             |
| Headache, migraine, visual loss  | 9          | 2.2%    | 6              | 3             |
| Shock, loss of consciousness, convulsions  | 7          | 1.7%    | 4              | 3             |
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| Education (610000)   | 42                  | 10.3%   | 11             | 31            |
| <del>Manufacturing (310000-350000)</del>                         | 39                  | 9.6%    | 39             | 0             |
| Ambulatory Services (621000)                                     | 29                  | 7.1%    | 29             | 0             |
| Administrative support waste management and remediation (560000) | 26                  | 6.4%    | 26             | 0             |

# Occupational injury trends in Maine

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**TABLE 2**  
**SOURCES OF WORKERS' COMPENSATION CLAIMS FROM EXPOSURE TO HAZARDOUS CHEMICALS OR ADVERSE ENVIRONMENTAL/MICROBIOLOGICAL CONDITIONS**  
**(2012-2013)**

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| Paint, lacquer, varnish, thinners                            | 18         | 4.4%    | 14             | 4             |
| Cosmetics, beauty preparation                                | 18         | 4.4%    | 12             | 6             |
| Other specific chemicals with less than three incidents      | 13         | 3.2%    | 10             | 3             |
| Disinfectants  | 9          | 2.2%    | 8              | 1             |
| Soaps detergents, shampoos                                   | 9          | 2.2%    | 8              | 1             |
| Bleach   | 9          | 2.2%    | 8              | 1             |
| Acids  | 9          | 2.2%    | 8              | 1             |
| Smoke (non-firefighting)                                     | 9          | 2.2%    | 7              | 2             |
| Freon  | 8          | 2.0%    | 8              | 0             |
| Alkalis, wet cement, lime                                    | 7          | 1.7%    | 7              | 0             |
| Pesticides, herbicides                                       | 7          | 1.7%    | 6              | 1             |
| Glues, adhesives   | 6          | 1.5%    | 5              | 1             |
| Sulfur compounds   | 5          | 1.2%    | 4              | 1             |
| Aldehydes  | 4          | 1.0%    | 4              | 0             |
| Antifreeze   | 4          | 1.0%    | 4              | 0             |
| Carbon monoxide  | 4          | 1.0%    | 3              | 1             |
| Metallic particles and lead                                  | 4          | 1.0%    | 4              | 0             |
| Solvents, degreasers   | 3          | 0.7%    | 2              | 1             |
| <b>TOTALS</b>  | <b>406</b> |         | <b>311</b>     | <b>95</b>     |

# More grizzly death/injury statistics

## Annual US fatalities

- Public building ~575
- Farm ~400

For comparison the same database counted only 15 deaths from stings and bites.

US cases involving missed days of work injured by chemical products

~1,000 janitors/cleaners

~75 pest control workers

# Interesting data on COVID-19

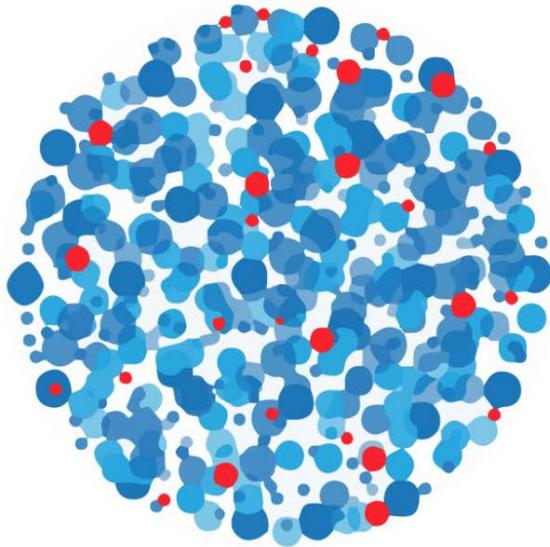
Work in progress

66,491 publications on  
COVID-19



<https://safeairspaces.com/>

## Safe Air Spaces



The SAFEAIRSPACES  
COVID-19 Aerosol  
Relative Risk Estimator

Estimate Your Risk

<https://safeairspaces.com/>

### Exposure Risk Estimation

#### Summary of Inputs

- Air changes per hour (ACH) = 0.6
- Outdoor air supply (cfm/person) = 2.6
- Outdoor air supply (cfm/sq.ft) = 0.10
- Space per person (sq.ft/person) = 27
- Filtration CADR (cfm) = 0.0
- Floor area (sq.ft) = 377
- Volume (cubic.ft) = 3881
- Occupants (#) = 14
- Masks = Off
- High emitter = Off
- Low emitter = Off

#### Summary of Estimation

Average inhaled & deposited dose by all occupants (picoliters) = 0  
Average inhaled & deposited dose per occupant (picoliters) = 0.0  
Average infectious virus inhaled & deposited per occupant = 0

### Current Status

**Low but not-zero risk**

|                       |                         |                           |
|-----------------------|-------------------------|---------------------------|
| Infection probability | # Susceptible occupants | Estimated # of infections |
| 0.00                  | 14                      | 0                         |

$0.00 \times 14 \rightarrow 0$

#### Where do the particles go?

- Exhausted & in-room air
- Surface deposition
- Deposited in occupants
- Filtration

#### Particle Concentration in Room

Current

#### Dose Inhaled & Deposited (total occupants)

Current

#### Risk Scale

|     |      |
|-----|------|
| 5.0 | 0.56 |
| 4.8 |      |
| 4.6 |      |
| 4.4 |      |
| 4.2 |      |
| 4.0 |      |
| 3.8 | 0.49 |
| 3.6 |      |
| 3.4 |      |
| 3.2 |      |
| 3.0 | 0.37 |
| 2.8 |      |
| 2.6 | 0.3  |
| 2.4 |      |
| 2.2 |      |
| 2.0 | 0.23 |
| 1.8 |      |
| 1.6 |      |
| 1.4 | 0.18 |
| 1.2 |      |
| 1.0 | 0.12 |
| 0.8 |      |
| 0.6 | 0.06 |
| 0.4 |      |
| 0.2 |      |
| 0.0 | 0.0  |

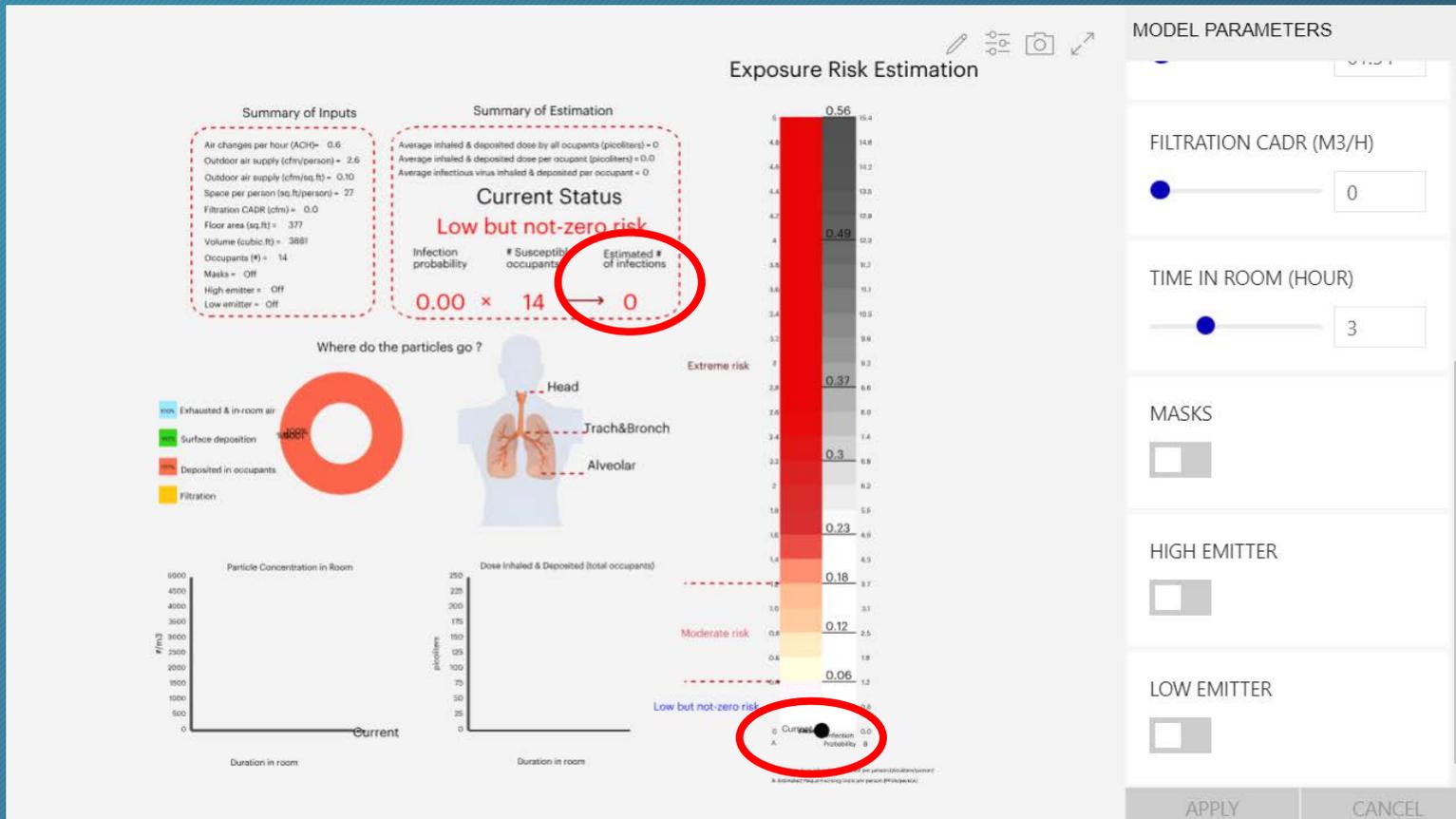
Extreme risk  
Moderate risk  
Low but not-zero risk

#### MODEL PARAMETERS

- OCCUPANTS (#)
- FLOOR AREA (M2)
- CEILING HEIGHT (M)
- OUTDOOR AIR SUPPLY (M3/H)
- FILTRATION CADR (M3/H)
- TIME IN ROOM (HOUR)

APPLY CANCEL

<https://safeairspaces.com/>



<https://safeairspaces.com/>

The screenshot displays the 'Exposure Risk Estimation' interface of the Safe Air Spaces app. It is divided into several sections:

- Summary of Inputs:** Lists parameters such as Air changes per hour (ACH) = 0.6, Outdoor air supply (cfm/person) = 2.6, Space per person (sq.ft/person) = 27, Filtration CADR (cfm) = 0.0, Floor area (sq.ft) = 377, Volume (cubic.ft) = 3881, Occupants (#) = 14, Masks = Off, High emitter = On, and Low emitter = Off.
- Summary of Estimation:** Shows 'Average inhaled & deposited dose by all occupants (picoliters) = 156', 'Average inhaled & deposited dose per occupant (picoliters) = 11.2', and 'Average infectious virus inhaled & deposited per occupant = 34'. The 'Current Status' is 'Extreme risk'.
- Calculation:** A red circle highlights the calculation:  $0.84 \times 14 \rightarrow 12$ . A red arrow points from the 'Estimated # of infections' (12) to the 'Extreme risk' status.
- Warning:** A red text warning says 'Warning! "Current" status exceeds'. Another red circle highlights the 'Exposure Risk Estimation' title.
- Where do the particles go?:** A donut chart shows: Exhausted & in-room air (10%), Surface deposition (30%), Deposited in occupants (45%), and Filtration (15%). A human diagram shows deposition in the Head, Trach&Bronch, and Alveolar regions.
- Particle Concentration in Room:** A line graph showing concentration (particles/m³) vs. duration in room (0 to 30 minutes) for 'Current' conditions.
- Dose Inhaled & Deposited (total occupants):** A line graph showing dose (picoliters) vs. duration in room (0 to 30 minutes).
- Exposure Risk Scale:** A vertical color scale from 0.06 (Low but not-zero risk) to 0.56 (Extreme risk). The current value of 0.37 is marked with a green dot.
- MODEL PARAMETERS:** Includes sliders for FILTRATION CADR (M3/H) set to 0, TIME IN ROOM (HOUR) set to 3, MASKS (unchecked), HIGH EMITTER (checked), and LOW EMITTER (unchecked).
- Buttons:** 'APPLY' and 'CANCEL' buttons at the bottom.

Now with  
-high emitter

<https://safeairspaces.com/>

The screenshot displays the 'Exposure Risk Estimation' interface of the Safe Air Spaces app. It is divided into several sections:

- Summary of Inputs:** Lists parameters such as Air changes per hour (ACH) = 0.6, Outdoor air supply (cfm/person) = 2.6, Space per person (sq ft/person) = 27, and Filtration CADR (cfm) = 248.7.
- Summary of Estimation:** Shows 'Average inhaled & deposited dose by all occupants (picoliters) = 49' and 'Average infectious virus inhaled & deposited per occupant = 11'. The 'Current Status' is 'Extreme risk'.
- Calculation:** A red circle highlights the calculation: Infection probability (0.44) × # Susceptible occupants (14) = Estimated # of infections (6).
- Where do the particles go?:** A donut chart shows the distribution: Exhausted & in-room air (1%), Surface deposition (1%), Deposited in occupants (1%), and Filtration (97%).
- Human Diagram:** Shows particle deposition in the Head, Trach&Bronch, and Alveolar regions.
- Risk Scale:** A vertical bar with a color gradient from red (Extreme risk) to white (Low but not-zero risk). A black dot is positioned at 0.23 on the scale, which is circled in red. Other values on the scale include 0.56, 0.49, 0.37, 0.3, 0.18, 0.12, and 0.06.
- Particle Concentration and Dose Graphs:** Two line graphs showing 'Particle Concentration in Room' and 'Dose Inhaled & Deposited (total occupants)' over 'Duration in room'.
- MODEL PARAMETERS:** A sidebar on the right with sliders for 'FILTRATION CADR (M3/H)' (set to 422.4) and 'TIME IN ROOM (HOUR)' (set to 3). It also includes checkboxes for 'MASKS', 'HIGH EMITTER', and 'LOW EMITTER'.

Now with  
-high emitter

&

-filtration at 420 m<sup>3</sup>/h

<https://safeairspaces.com/>

The screenshot displays the 'Exposure Risk Estimation' interface. It is divided into several sections:

- Summary of Inputs:** Lists parameters such as Air changes per hour (ACH) = 0.6, Outdoor air supply (cfm/person) = 2.6, Space per person (sq.ft/person) = 27, and High emitter = On.
- Summary of Estimation:** Shows 'Current Status' as 'Extreme risk' with a calculation:  $0.60 \times 14 \rightarrow 8$ . A red circle highlights the 'Current' status and the 'Estimated # of infections' (8).
- Where do the particles go?:** A donut chart and a human diagram showing deposition in the Head, Trach&Bronch, and Alveolar regions.
- Particle Concentration in Room:** A line graph showing concentration (#/m³) over time (Duration in room).
- Dose Inhaled & Deposited (total occupants):** A line graph showing dose (picoliters) over time.
- Exposure Risk Scale:** A vertical bar with a color gradient from red (Extreme risk) to white (Low but not-zero risk). A red circle highlights the 'Current' status at the top of the scale.
- MODEL PARAMETERS:** A sidebar on the right with sliders for FILTRATION CADR (M3/H) set to 0, TIME IN ROOM (HOUR) set to 3, and checkboxes for MASKS, HIGH EMITTER, and LOW EMITTER.

Now with  
-high emitter

&

-masks (but no filtration)

# Ventilation reduces all exposures $\rightleftarrows$ Biological Chemical

## Rhinitis and laryngitis

Large particles are deposited in the nose, pharynx, and larynx. More soluble gases (e.g., sulfur dioxide) are absorbed by upper respiratory tract mucous membranes, causing edema and mucus hypersecretion.

## Tracheitis, bronchitis, and bronchiolitis

Large particles (more than  $10\ \mu\text{m}$  in diameter) are deposited and then cleared by cilia. Small particles and fine fibers are deposited in bronchioles and bifurcations of alveolar ducts. Less soluble gases penetrate to deeper, small airways.

## Asthma and chronic obstructive pulmonary disease

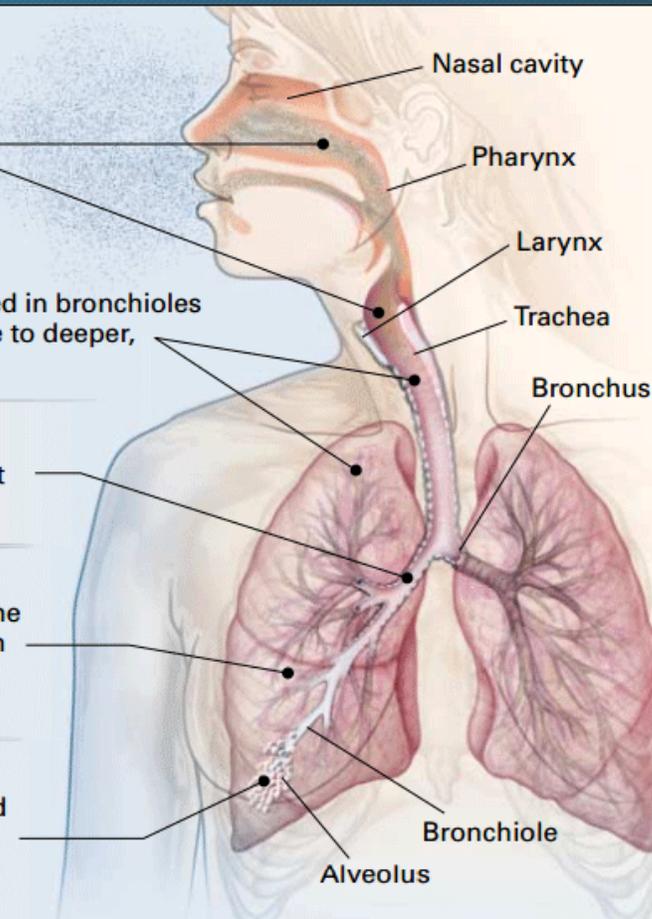
Allergens and irritants are deposited in large airways by turbulent flow, causing chronic inflammatory changes.

## Cancer

Carcinogens (asbestos and polycyclic aromatic hydrocarbons) come into contact with bronchial epithelial cells, causing mutations in proto-oncogenes and tumor-suppressor genes. More than one such contact results in malignant transformation.

## Interstitial disease

Small particles (less than  $10\ \mu\text{m}$  in diameter) and fibers are deposited in terminal bronchioles, alveolar ducts, and alveoli. Penetration to the interstitium results in fibrosis and the formation of granulomas.



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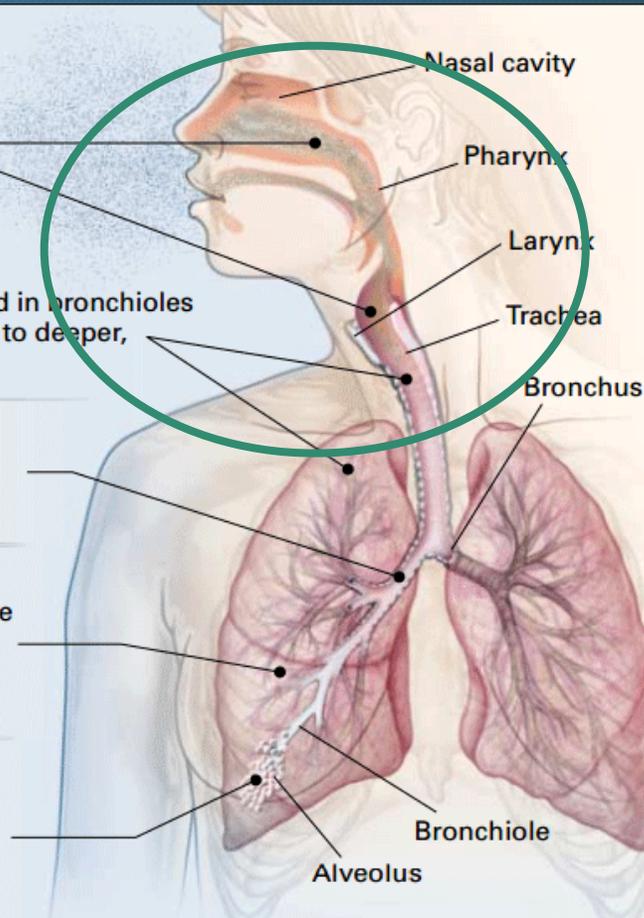
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# Ventilation reduces all exposures $\rightleftarrows$ Biological Chemical

**Rhinitis and laryngitis**  
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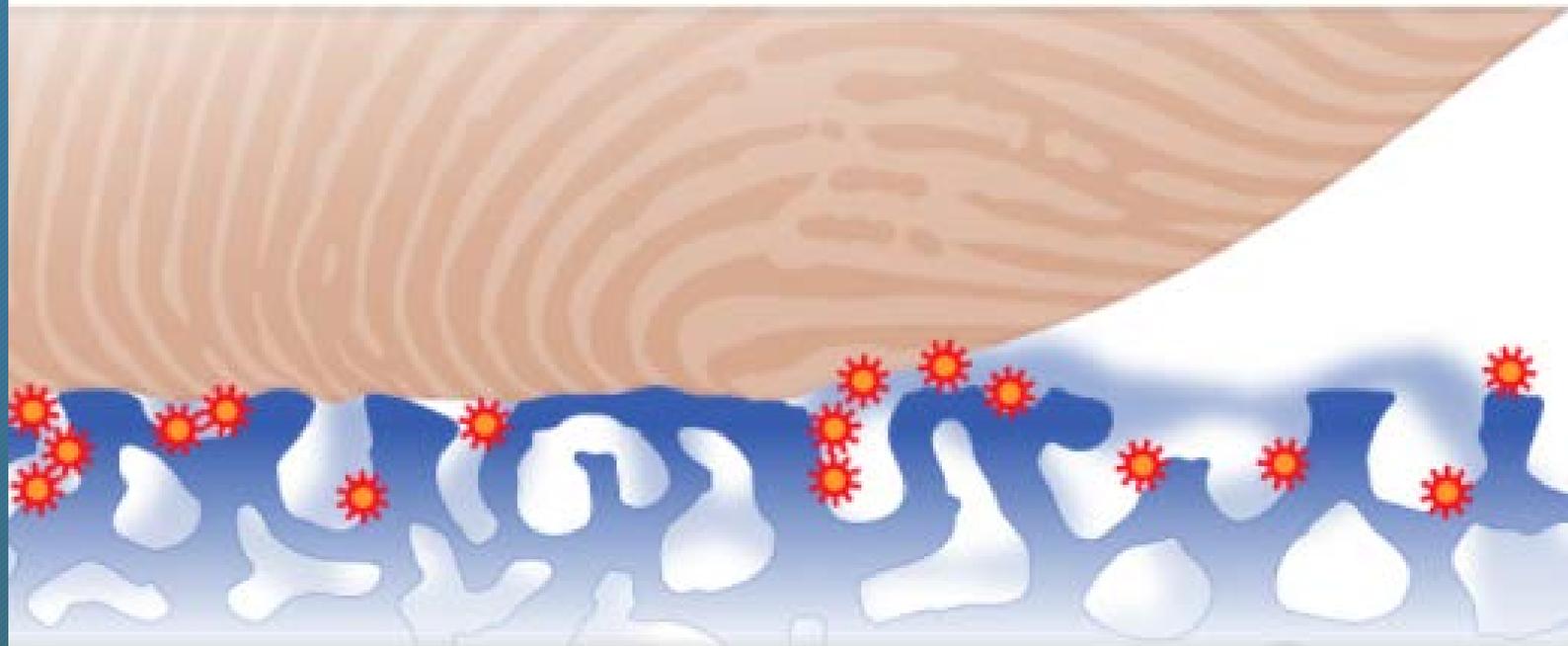
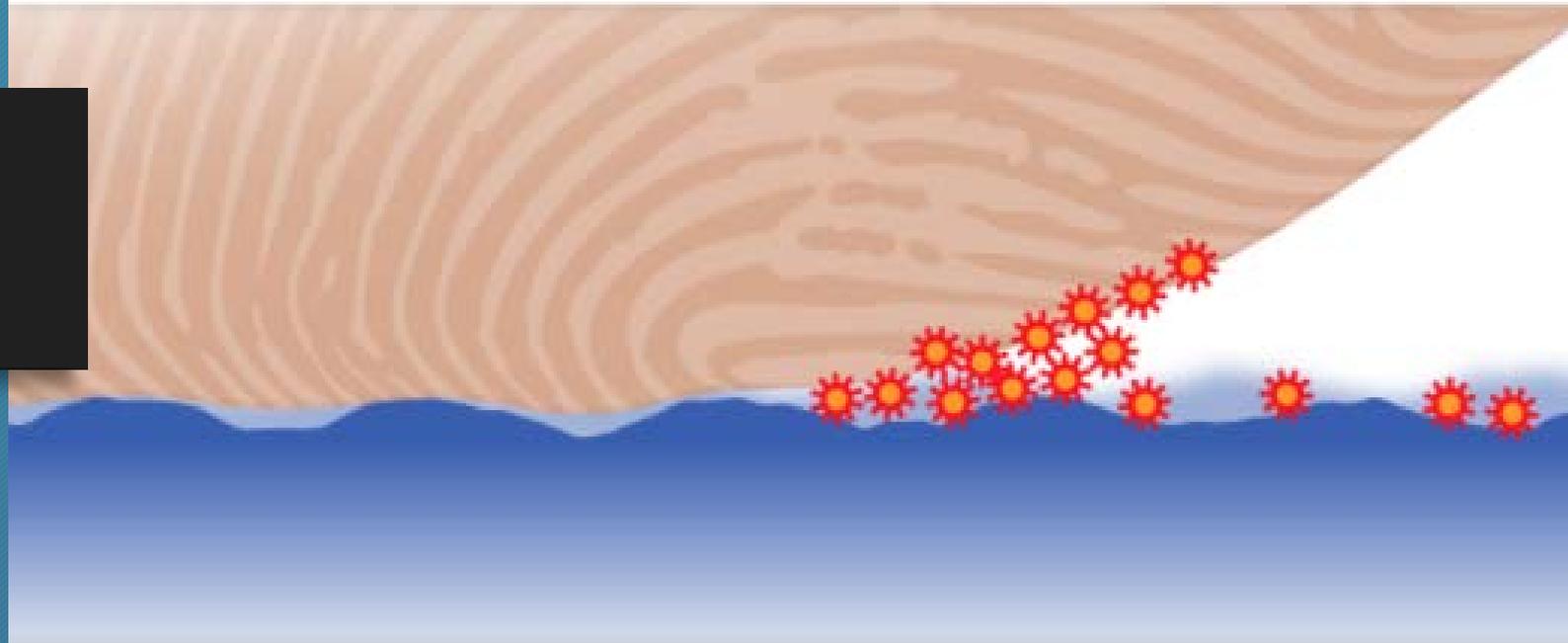
**Tracheitis, bronchitis, and bronchiolitis**  
Large particles (more than  $10\ \mu\text{m}$  in diameter) are deposited and then cleared by cilia. Small particles and fine fibers are deposited in bronchioles and bifurcations of alveolar ducts. Less soluble gases penetrate to deeper, small airways.

**Asthma and chronic obstructive pulmonary disease**  
Allergens and irritants are deposited in large airways by turbulent flow, causing chronic inflammatory changes.

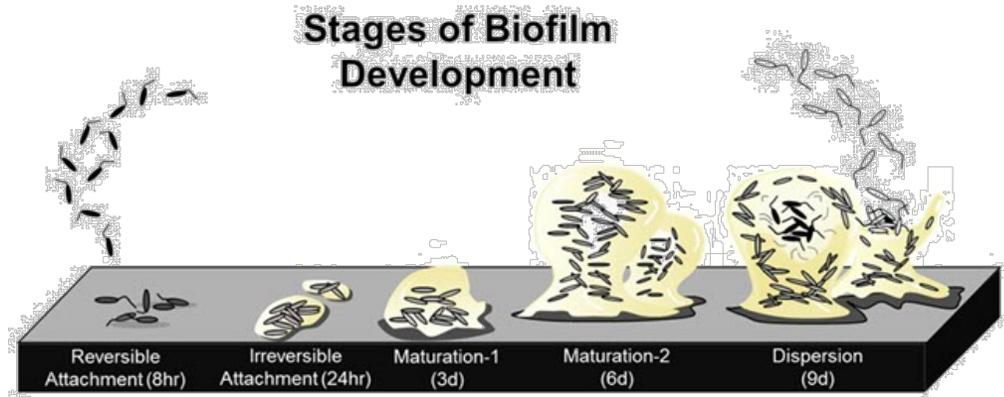
**Cancer**  
Carcinogens (asbestos and polycyclic aromatic hydrocarbons) come into contact with bronchial epithelial cells, causing mutations in proto-oncogenes and tumor-suppressor genes. More than one such contact results in malignant transformation.

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Small particles (less than  $10\ \mu\text{m}$  in diameter) and fibers are deposited in terminal bronchioles, alveolar ducts, and alveoli. Penetration to the interstitium results in fibrosis and the formation of granulomas.

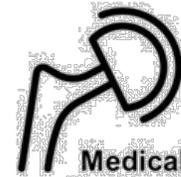
# Surface transfer



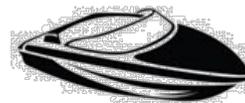
Residue from  
cleaning/disinfecting  
leading to biofilm  
growth



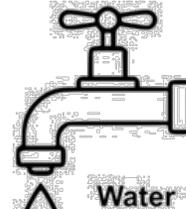
Teeth



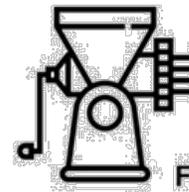
Medical Implants



Ship Hulls

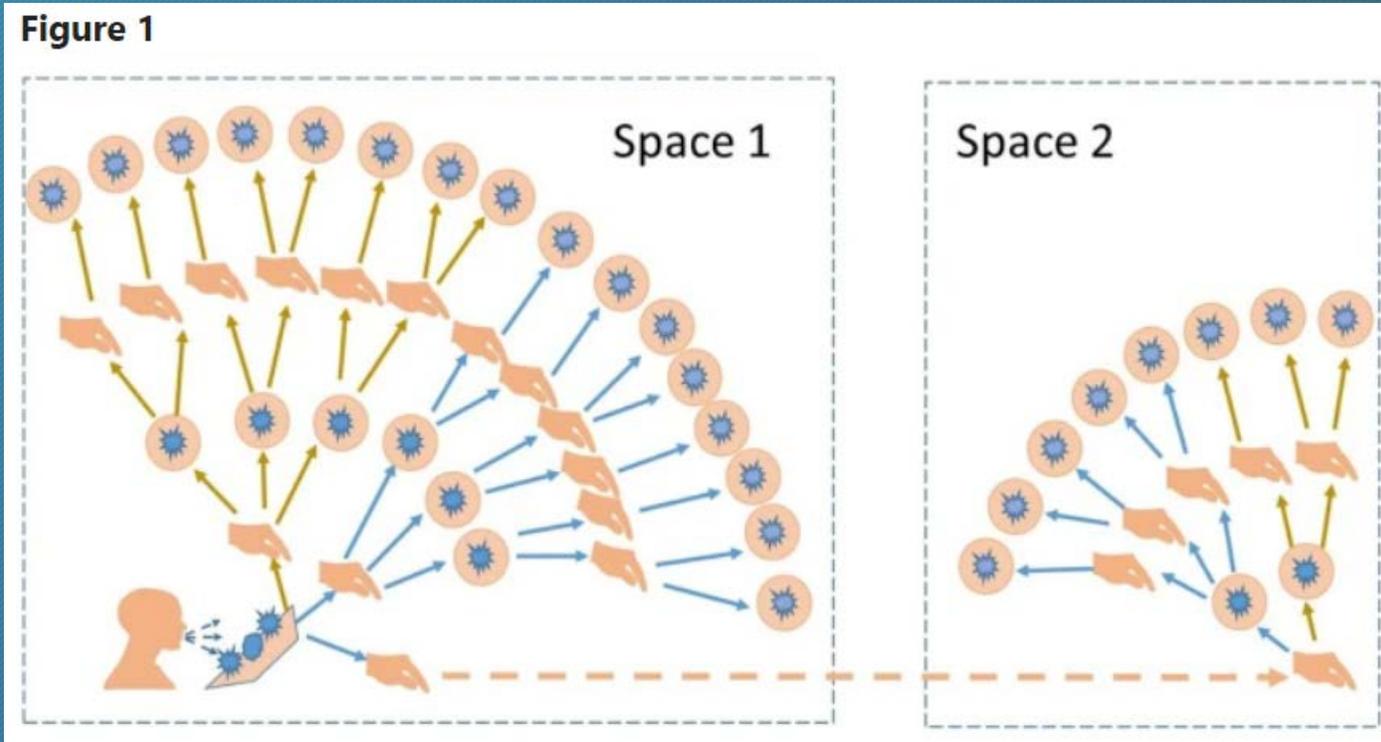


Water Systems



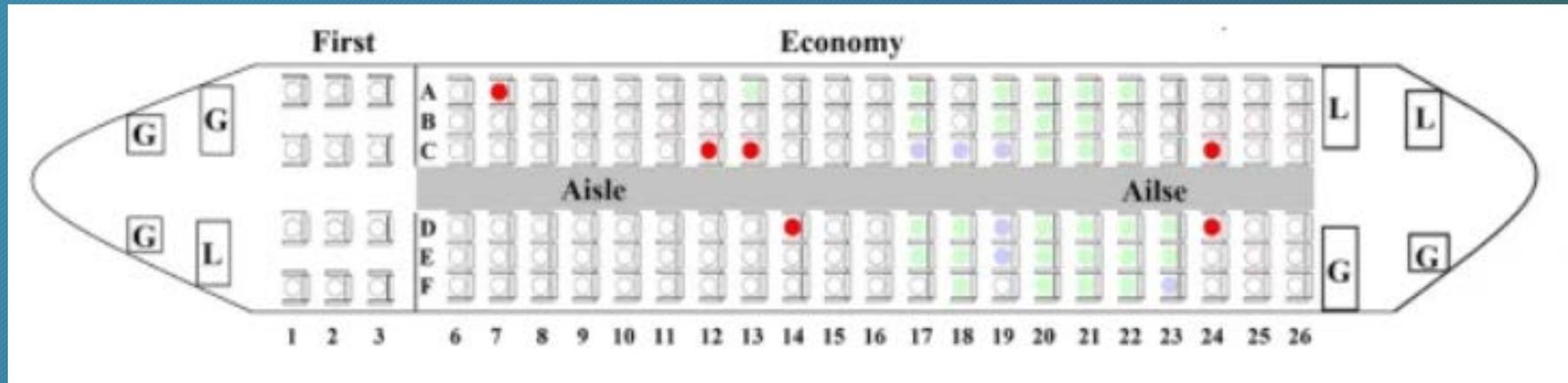
Food Processing

# Norovirus outbreak from plane



A hand contaminated ... can contaminate up to seven other surfaces

# Norovirus outbreak from plane



A hand contaminated ... can contaminate up to seven other surfaces

# One hour after routine cleaning

**Table 1.** SARS-CoV-2 RNA test results from environmental surfaces in a COVID-19 designated hospital

|                  | Sampling locations   | Number of samples <sup>a</sup> | Number of positive samples <sup>b</sup> |
|------------------|--|--------------------------------|---|
| High-risk area   | Bed rails and nightstands in the ICU ward for COVID-19 patients                                      | 9                              | -                                       |
|                  | Patients' personal belongings (mobile phone, clothes, pillowcase, towel)                             | 12                             | -                                       |
|                  | Surfaces of medical supplies (infusion pump, operating table in nurse station, temperature gun etc.) | 12                             | -                                       |
|                  | Hands of doctor/nurse in the ICU   | 6                              | -                                       |
|                  | Toilet and sink in isolation ward  | 6                              | -                                       |
|                  | Door handle in isolation ward  | 6                              | -                                       |
|                  | Inside of the patient's mask   | 3                              | 2 (first and second)                    |
|                  | Goggles after use  | 6                              | -                                       |
| Medium-risk area | Door handle in buffer zone   | 6                              | -                                       |
|                  | Inner wall of waste container  | 6                              | -                                       |
| Low-risk area    | Hands of doctor/nurse in clean zone  | 6                              | -                                       |
|                  | Computer keyboard in nurse station   | 6                              | -                                       |
|                  | Computer mouse in nurse station  | 6                              | -                                       |
| Total            |  | 90                             | 2                                       |

<sup>a</sup>All samples were collected 1 h after routine cleaning.

<sup>b</sup>All samples were tested by qualitative RT-PCR. Sampling and testing were repeated three times at each location.

INSIDE  
PATIENT'S MASK

**Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results**

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| <b>Patient's room</b>                  |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| <b>Toilet area</b>                     |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

TABLE

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

BED RAIL

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

CHAIR

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.54                              |
| 10. Sink, internal bowl                | 1/1  | 37.54                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

LIGHT SWITCH

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

SINK

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

FLOOR

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  |                                    |
| 10. Sink, internal bowl                | 1/1  |                                    |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

WINDOW

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

**Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results**

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| <b>Patient's room</b>                  |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.95                              |
| 10. Sink, internal bowl                | 1/1  | 37.95                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| <b>Toilet area</b>                     |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

- 2 no COVID anywhere in room
- 1 COVID everywhere

DOOR

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

Table 2. Environmental and PPE Sites Sampled and Corresponding RT-PCR Results

| Sites <sup>a</sup>                     | Positive samples (patient C; before routine cleaning) <sup>b</sup> | Cycle threshold value <sup>c</sup> |
|--|--|------------------------------------|
| <b>Environmental sites<sup>d</sup></b> |  |                                    |
| Patient's room                         |  |                                    |
| 1. Cardiac table, including handle     | 1/1  | 35.44                              |
| 2. Entire length of bed rail           | 1/1  | 37.95                              |
| 3. Control panel on bed                | 0/1  |                                    |
| 4. Call bell attached to bed           | 0/1  |                                    |
| 5. Locker with hand slot               | 1/1  | 36.21                              |
| 6. Chair                               | 1/1  | 37.07                              |
| 7. Light switches behind bed           | 1/1  | 37.54                              |
| 8. Stethoscope                         | 1/1  | 38.24                              |
| 9. Sink, external rim                  | 1/1  | 37.94                              |
| 10. Sink, internal bowl                | 1/1  | 37.94                              |
| 11. Floor                              | 1/1  | 30.64                              |
| 12. Glass window in room               | 1/1  | 35.79                              |
| 13. Glass door interior                | 1/1  | 35.71                              |
| 14. PPE storage area over sink         | 1/1  | 34.89                              |
| 15. Air outlet fan                     | 2/3  | 32.96, 37.94                       |
| Toilet area                            |  |                                    |
| 16. Door handle                        | 1/1  | 35.83                              |
| 17. Toilet bowl, surface               | 1/1  | 37.75                              |
| 18. Hand rail                          | 0/1  |                                    |
| 19. Sink, external rim                 | 0/1  |                                    |
| 20. Sink, internal bowl                | 1/1  | 37.11                              |

3 patients in hospital

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AIR VENT

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- 2 no COVID anywhere in room
- 1 COVID everywhere

TOILET

Postcleaning samples were negative, suggesting that current decontamination measures are sufficient.

# Balance of risks

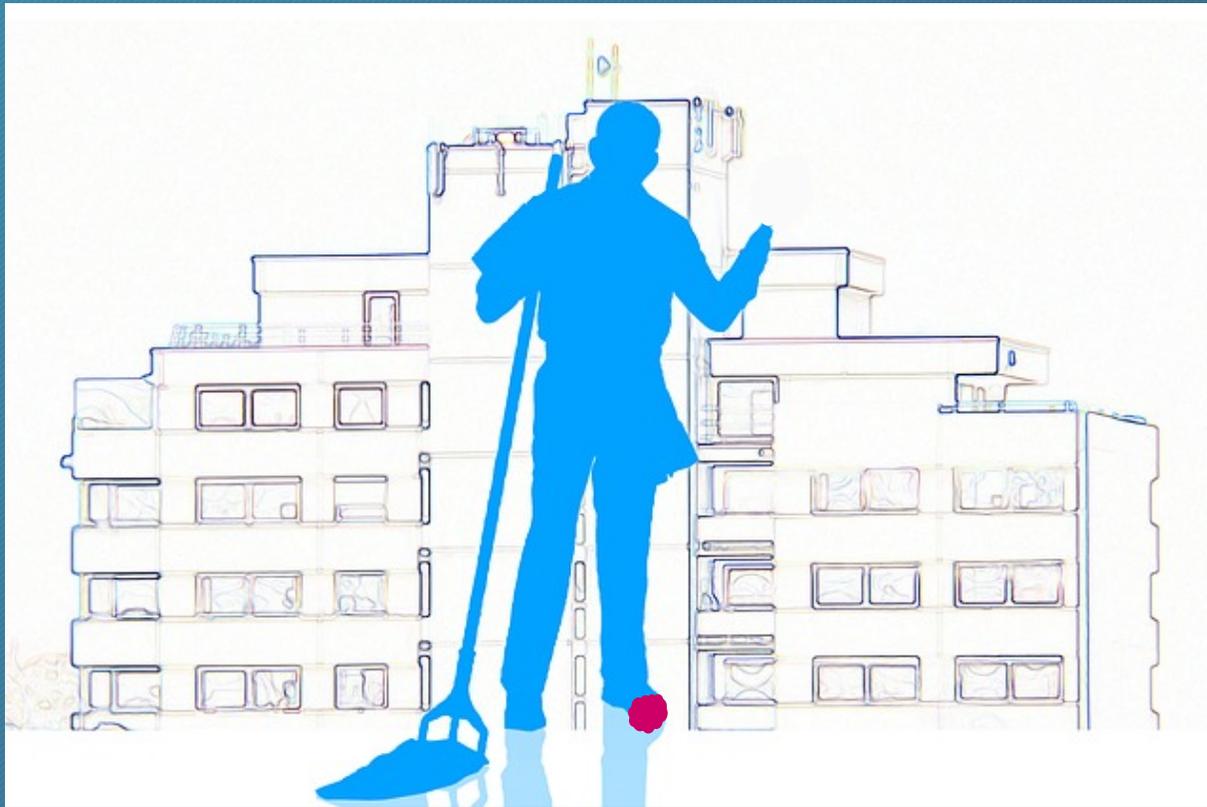
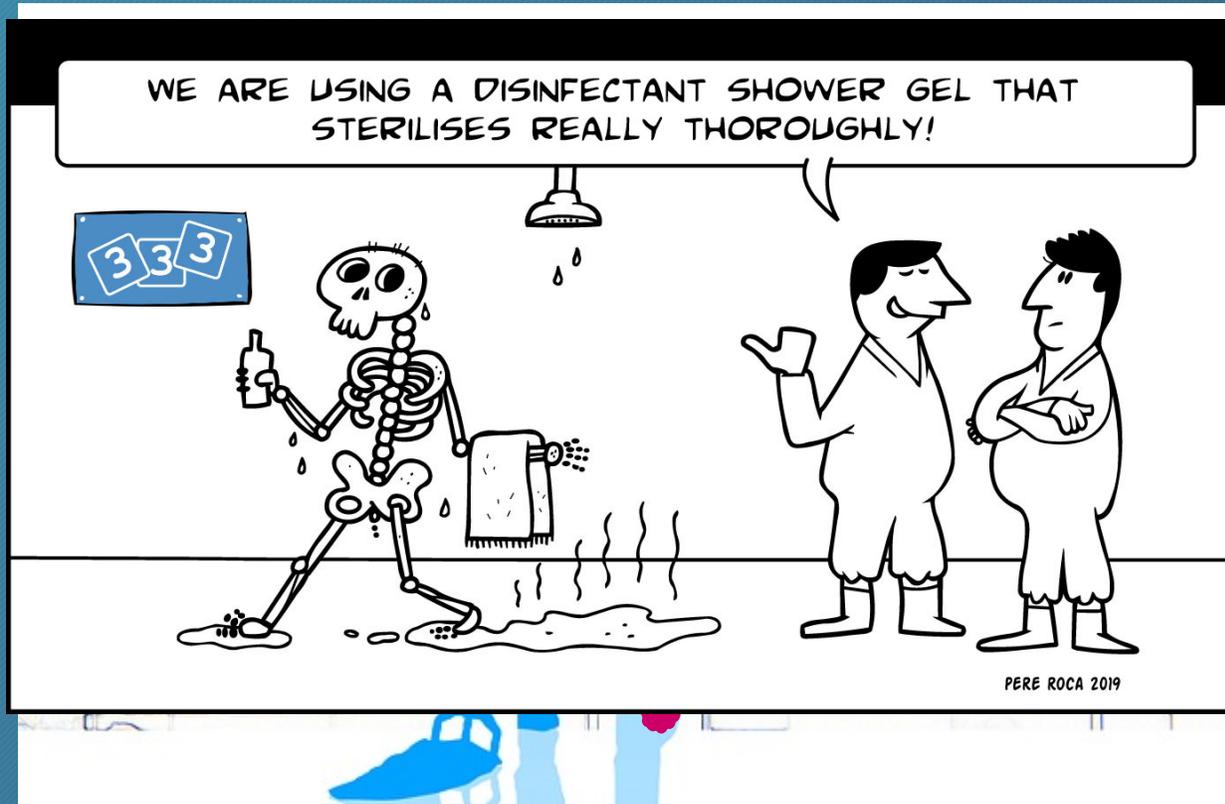


Image by [Gerd Altmann](#) from [Pixabay](#)

# Balance of risks



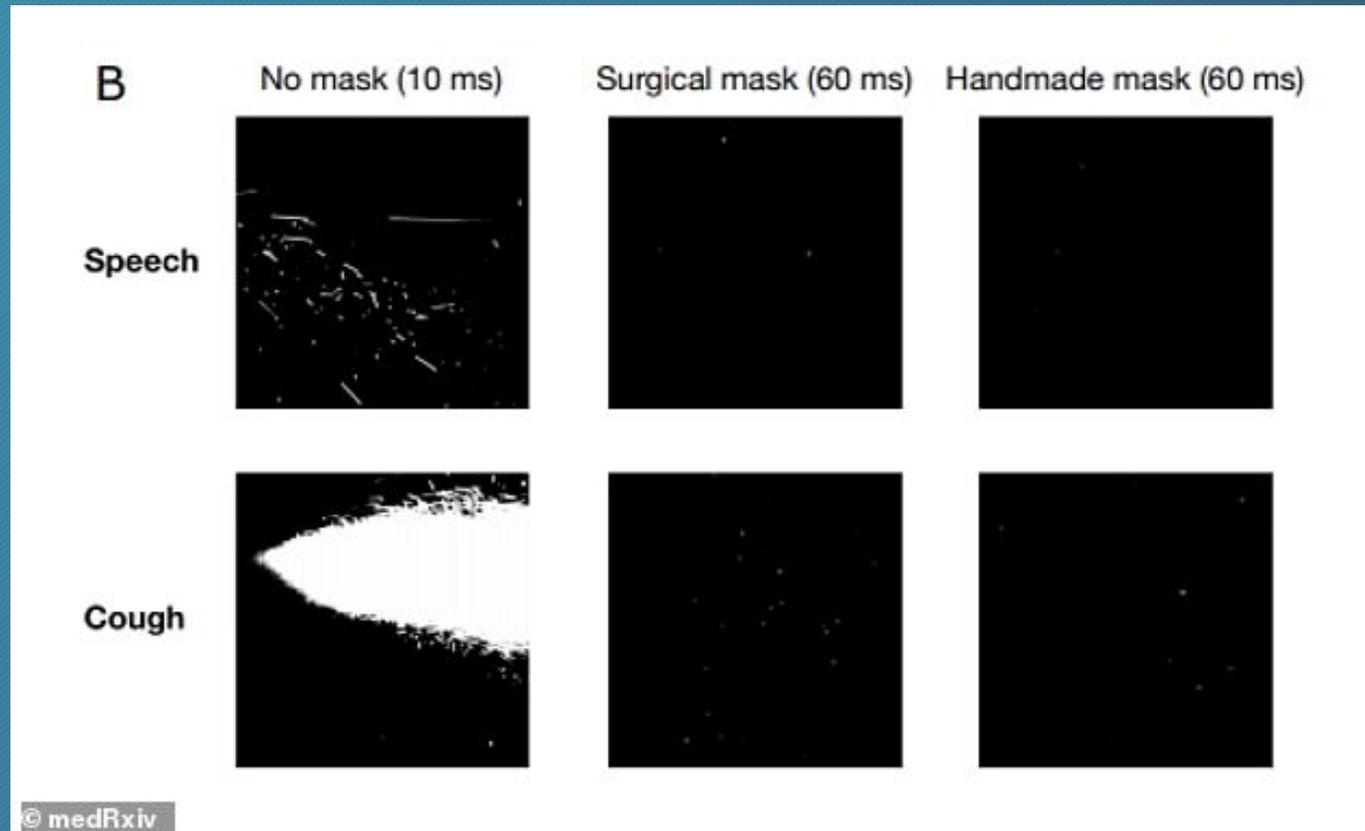
# COVID-19 persistence will vary

Humidity  
Temperature  
Sunlight

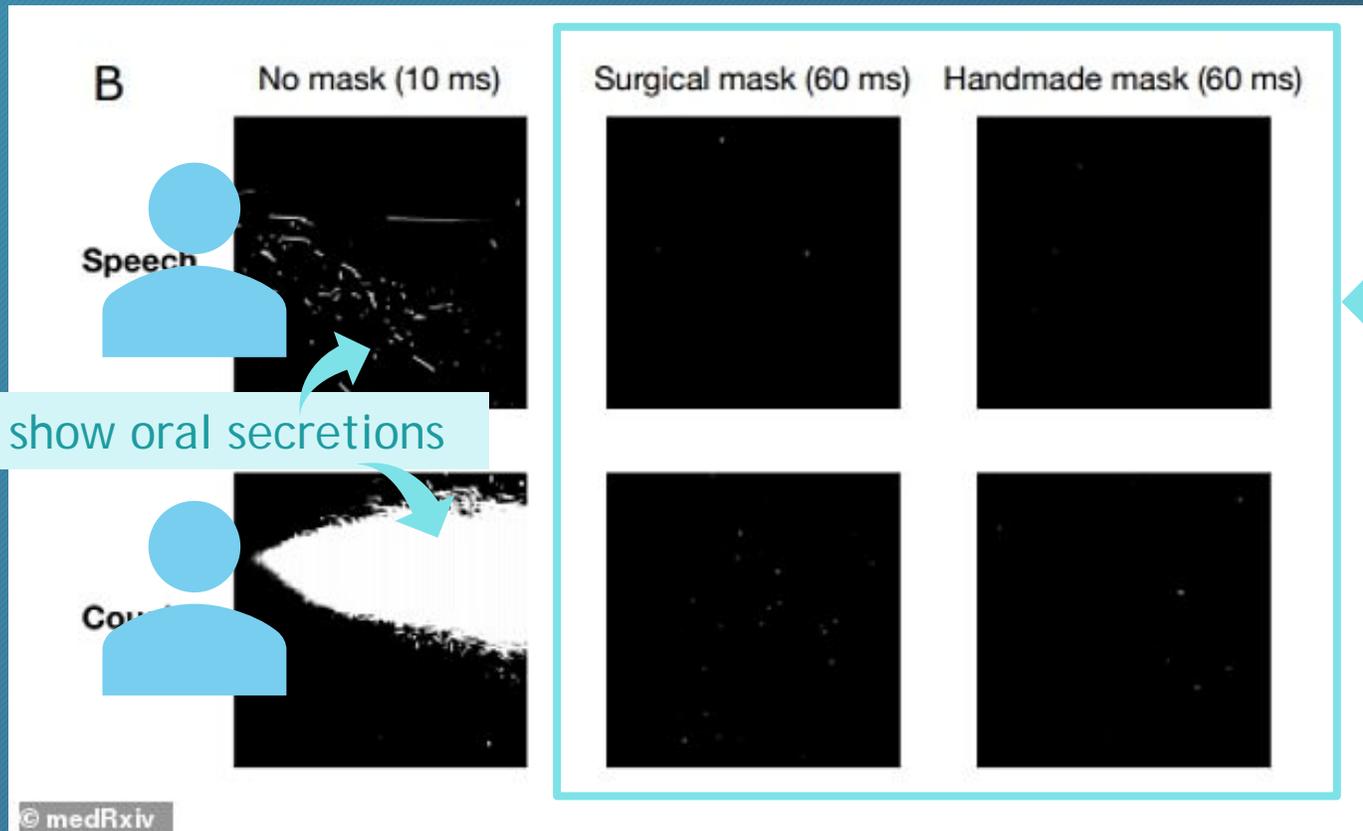
...

- Glass: five days
- Wood: four days
- Plastic and stainless steel: three days
- Cardboard: 24 hours
- Copper: four hours.

# People are constantly spreading germs



# People are constantly spreading germs

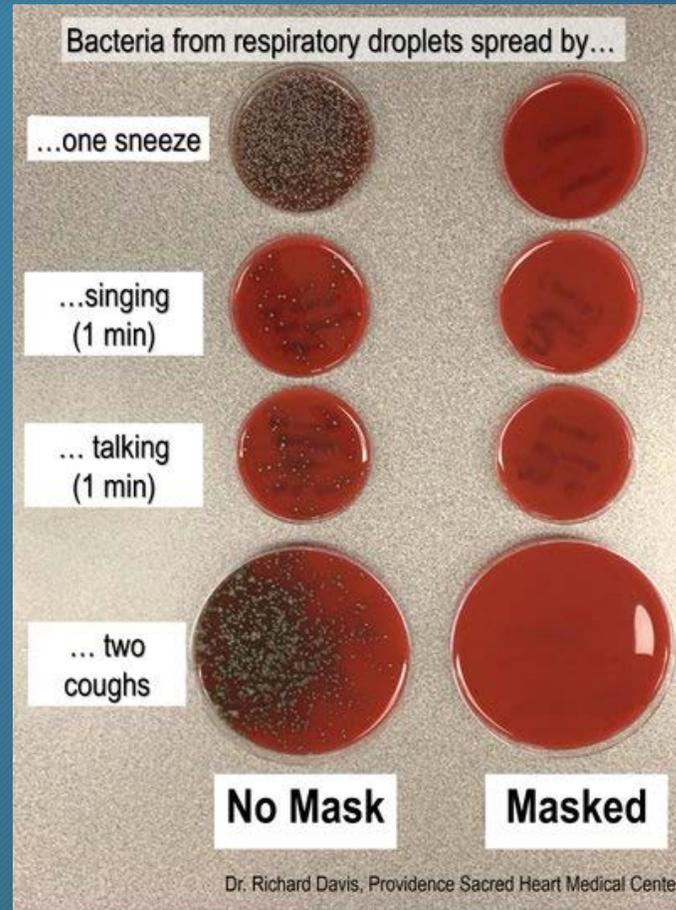


White marks show oral secretions

Masks shown to reduce bulk

# Choosing priority surfaces

- particles from the air (greatest on upward-facing surfaces),
- direct emission through coughing,
- aerosolization due to vomiting and diarrhea incidents,
- toilet flushing,
- and hand touching (greatest on high-touch surfaces).



Note: In this demonstration presence of bacteria (not viruses) on plates is only meant to be a proxy for microbes present in respiratory droplets.

Likely, smaller aerosolized droplets (that could carry viruses like SARS-CoV-2) are also produced by coughing, sneezing etc. and that these would travel further and stay in the air longer than larger respiratory droplets.

# IPM -a common sense approach to pest management

Germs only travel so far. 

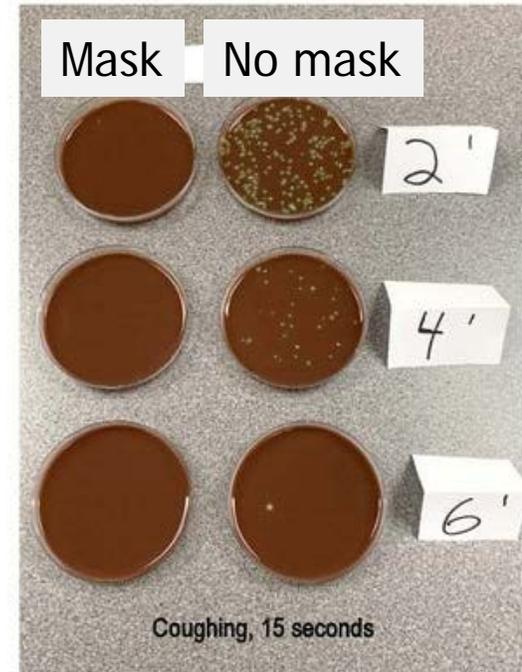
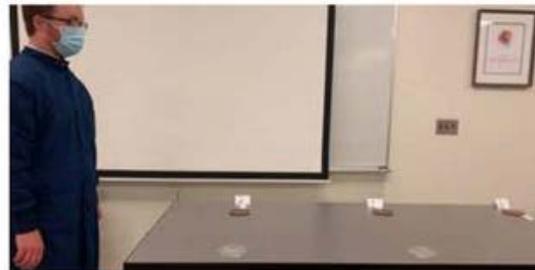
-The entire facility doesn't need constant intense disinfection.

-Areas with unmasked people will need greater disinfection.



**Masks limit the spread of most microbe-containing droplets produced by coughing. Even without a mask, these droplets mostly traveled less than 6 feet.**

Demonstration: To show the value of appropriate masking and distancing, bacteria culture plates were placed 2 feet, 4 feet and 6 feet away from a person who coughed aggressively for ~15 seconds. Droplets from the upper respiratory tract and mouth landed on the plates and after culturing for 24 hours, colonies of bacteria (not viruses\*) can be seen.



**\*Note:** It is likely that smaller aerosolized droplets (that could carry viruses like SARS-CoV-2) are also produced by coughing, sneezing etc. and that these would travel further and stay in the air longer than larger respiratory droplets.

Experiment performed by: Richard E. Davis, PhD,  
PHC Regional Director of Microbiology Providence  
Sacred Heart Medical Center and Children's Hospital

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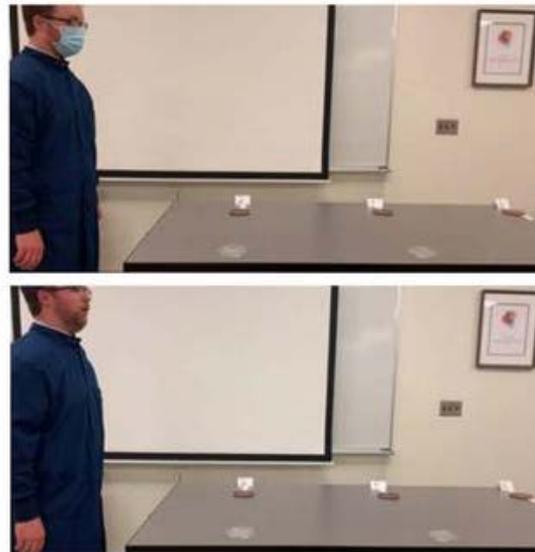
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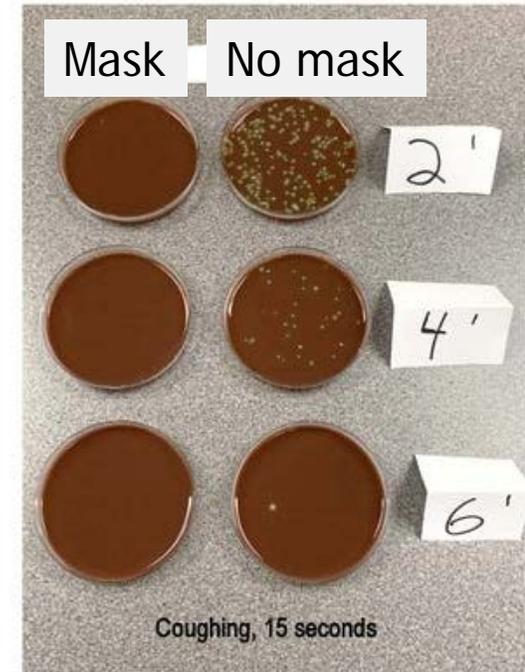
\*yes, viruses are smaller and will travel farther but gravity still applies

**Masks limit the spread of most microbe-containing droplets produced by coughing. Even without a mask, these droplets mostly traveled less than 6 feet.**

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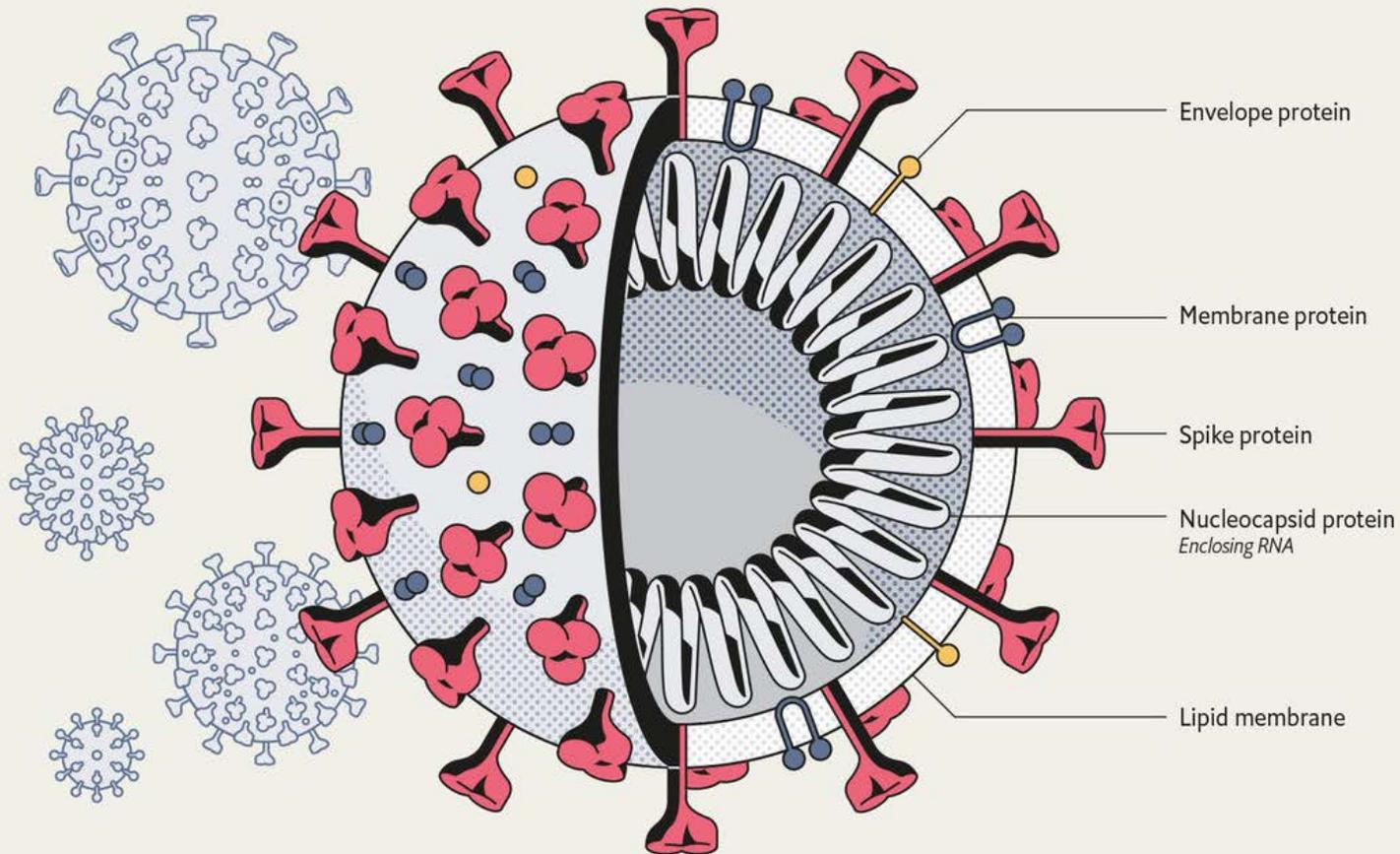
Experiment performed by: Richard E. Davis, PhD,  
PHC Regional Director of Microbiology Providence  
Sacred Heart Medical Center and Children's Hospital



*“Yuck! Am I crazy or do they all taste like disinfectant?!”*

# Mechanics of soap & disinfectants

COVID-19 virus



# Mechanics of soap & disinfectants

Soap:

water-y head & oil

Oil & Water don't

Oily part of soap s

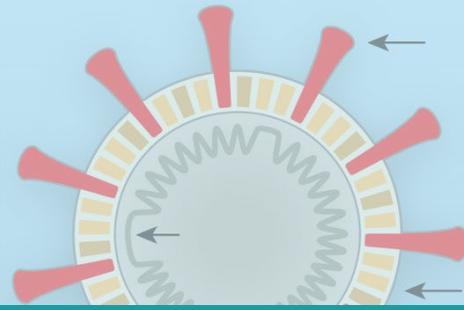
Watery part seeks out watery areas

Bacteria, viruses, cells in general  
effected by soaps

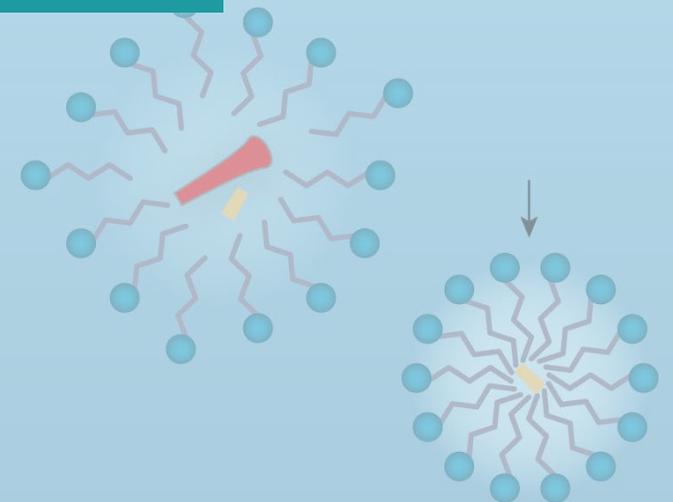
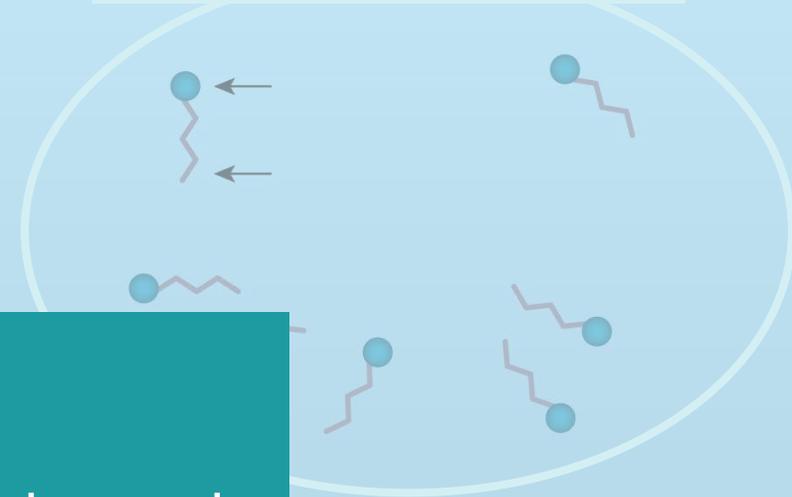
Quick word on "soap" vs "detergent":

I'm using "soap" to mean both soap and detergent.

Yes, there are small differences.



Individual soap molecules



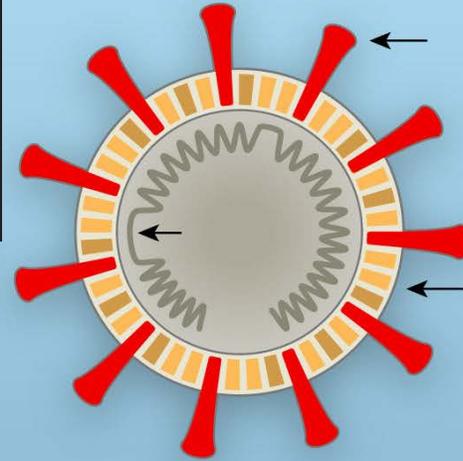
# Mechanics of soap & disinfectants

Soap:  
water-y head & oil-y tail

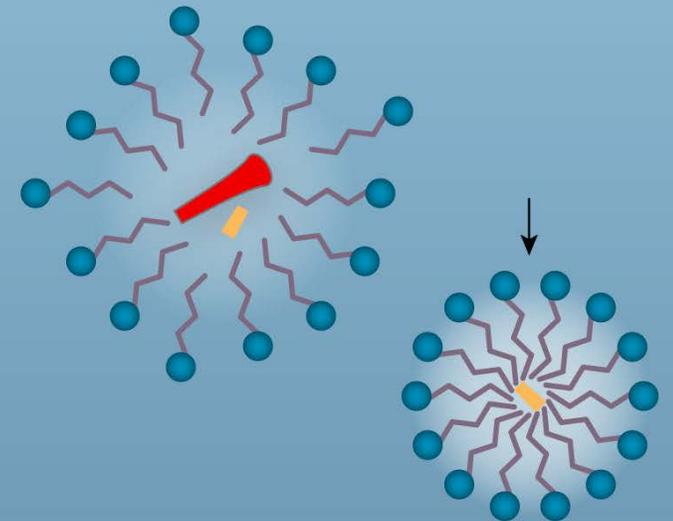
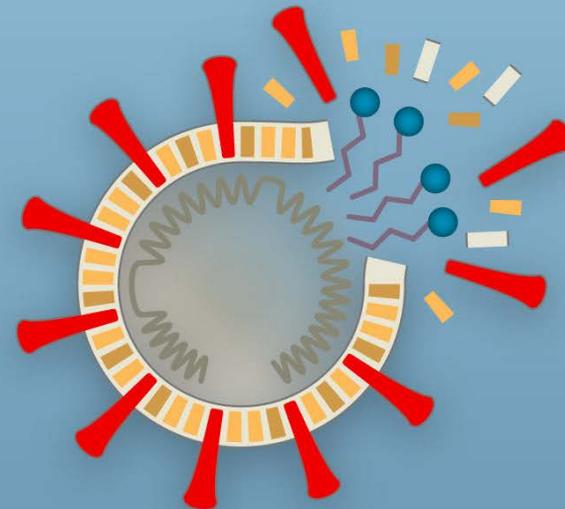
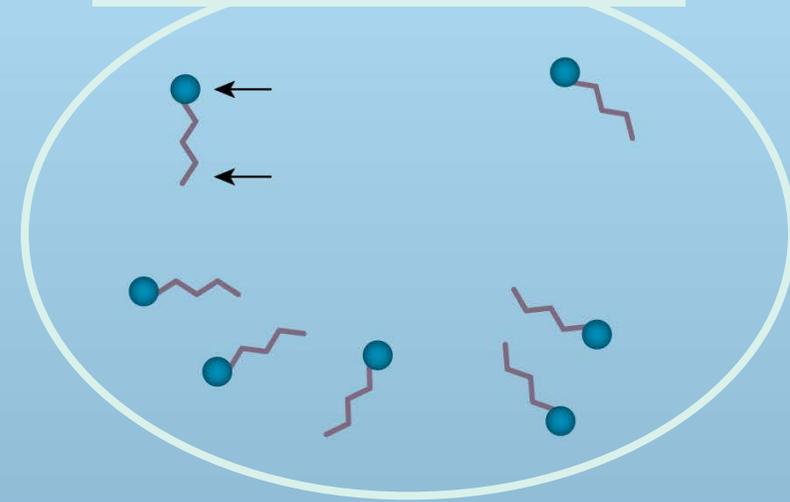
Oil & Water don't mix

Oily part of soap seeks out oily areas  
Watery part seeks out watery areas

Bacteria, viruses, cells in general  
effected by soaps



Individual soap molecules



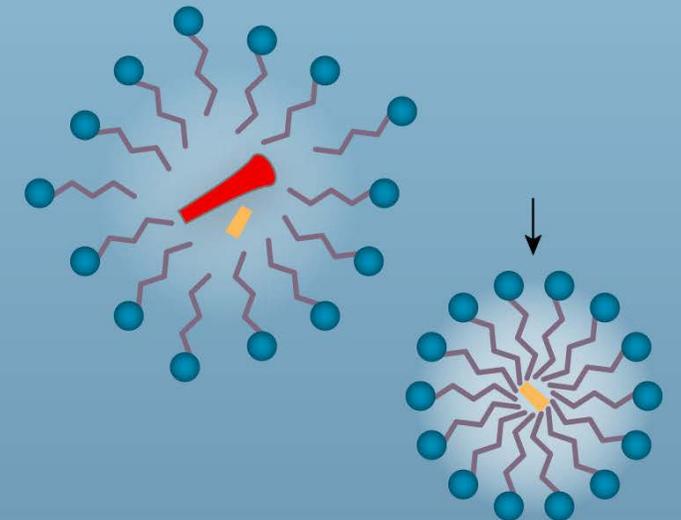
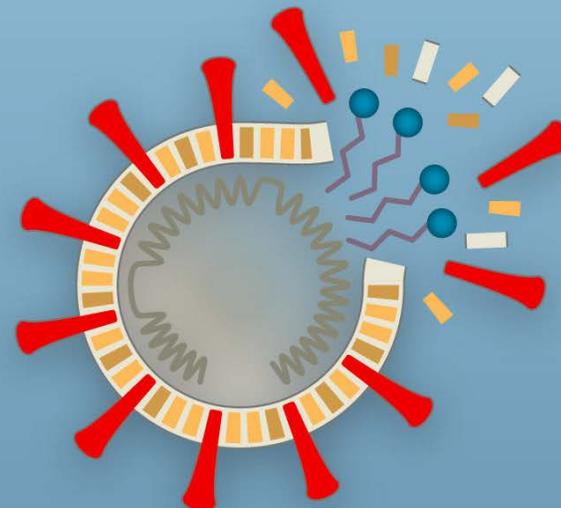
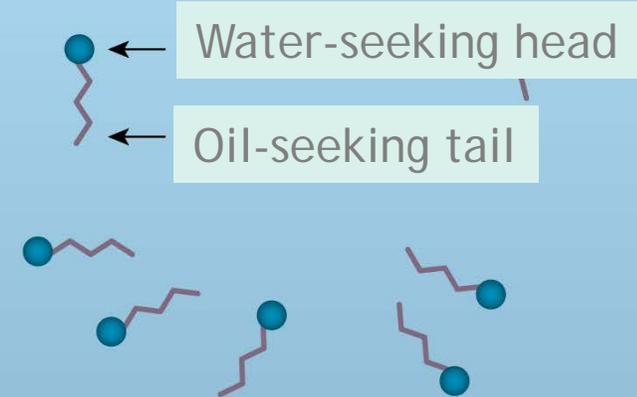
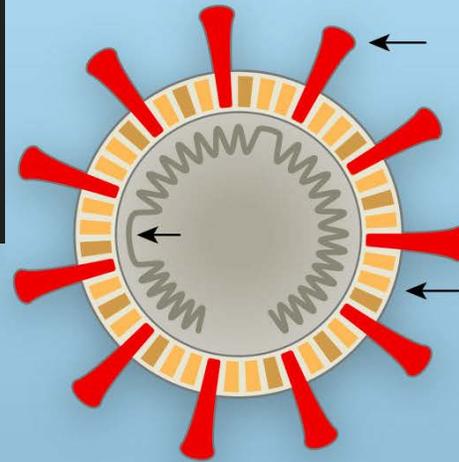
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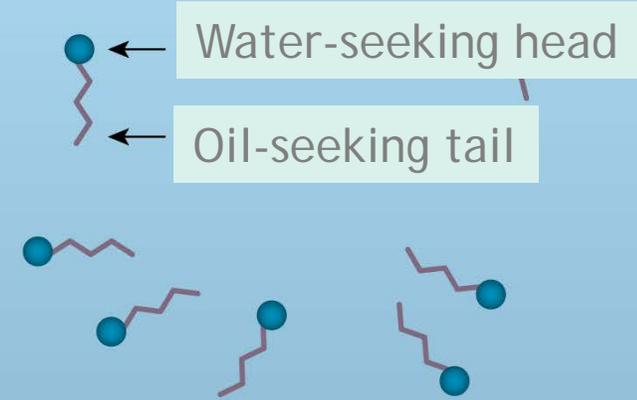
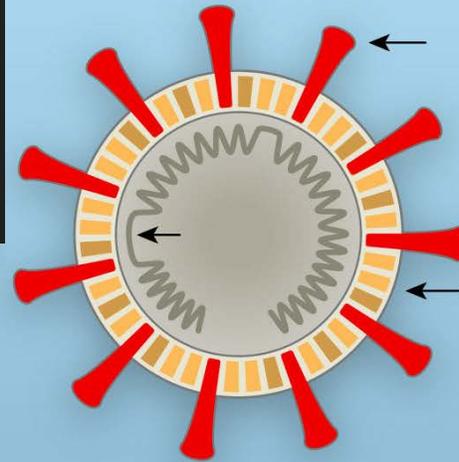
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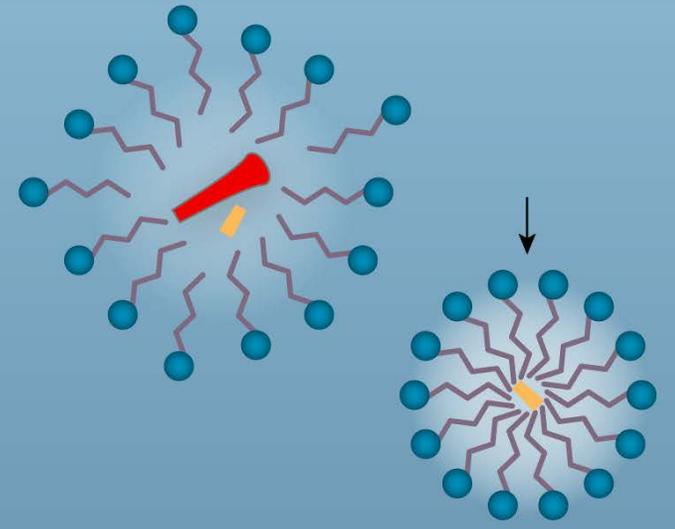
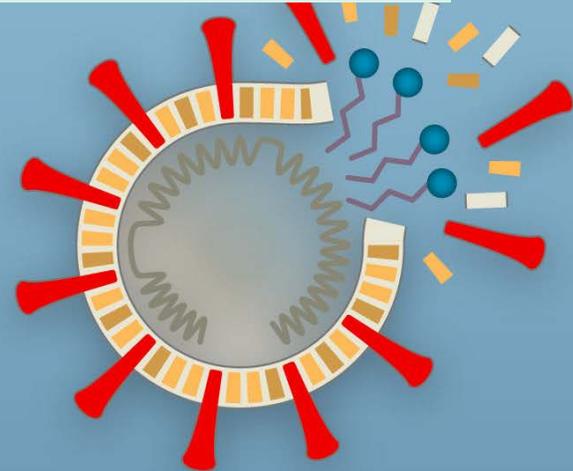
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Bacteria, viruses, cells in general  
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Oil-seeking tails slip  
right into the  
protective layer



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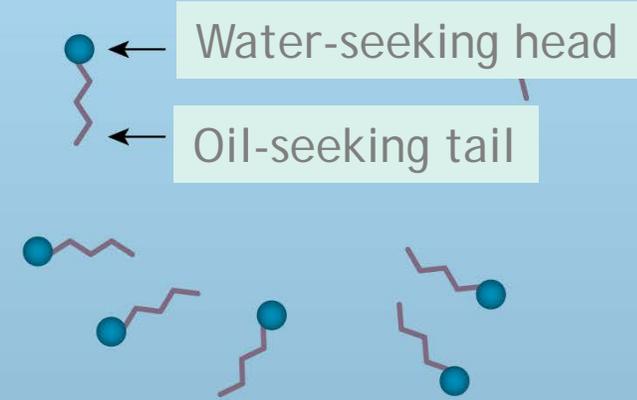
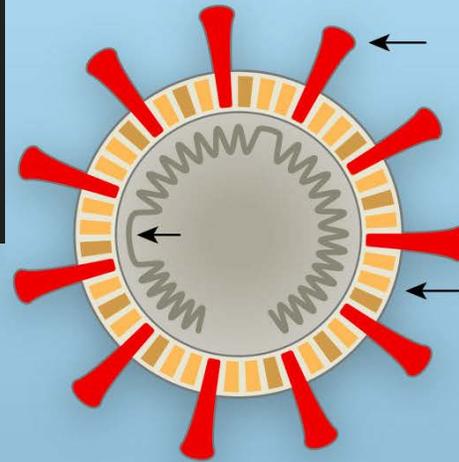
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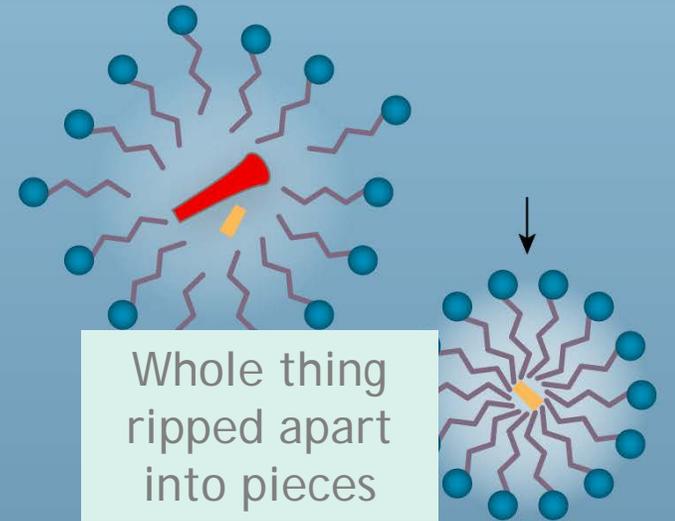
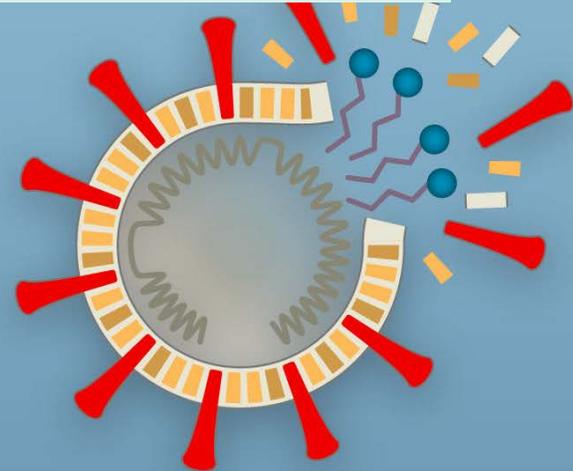
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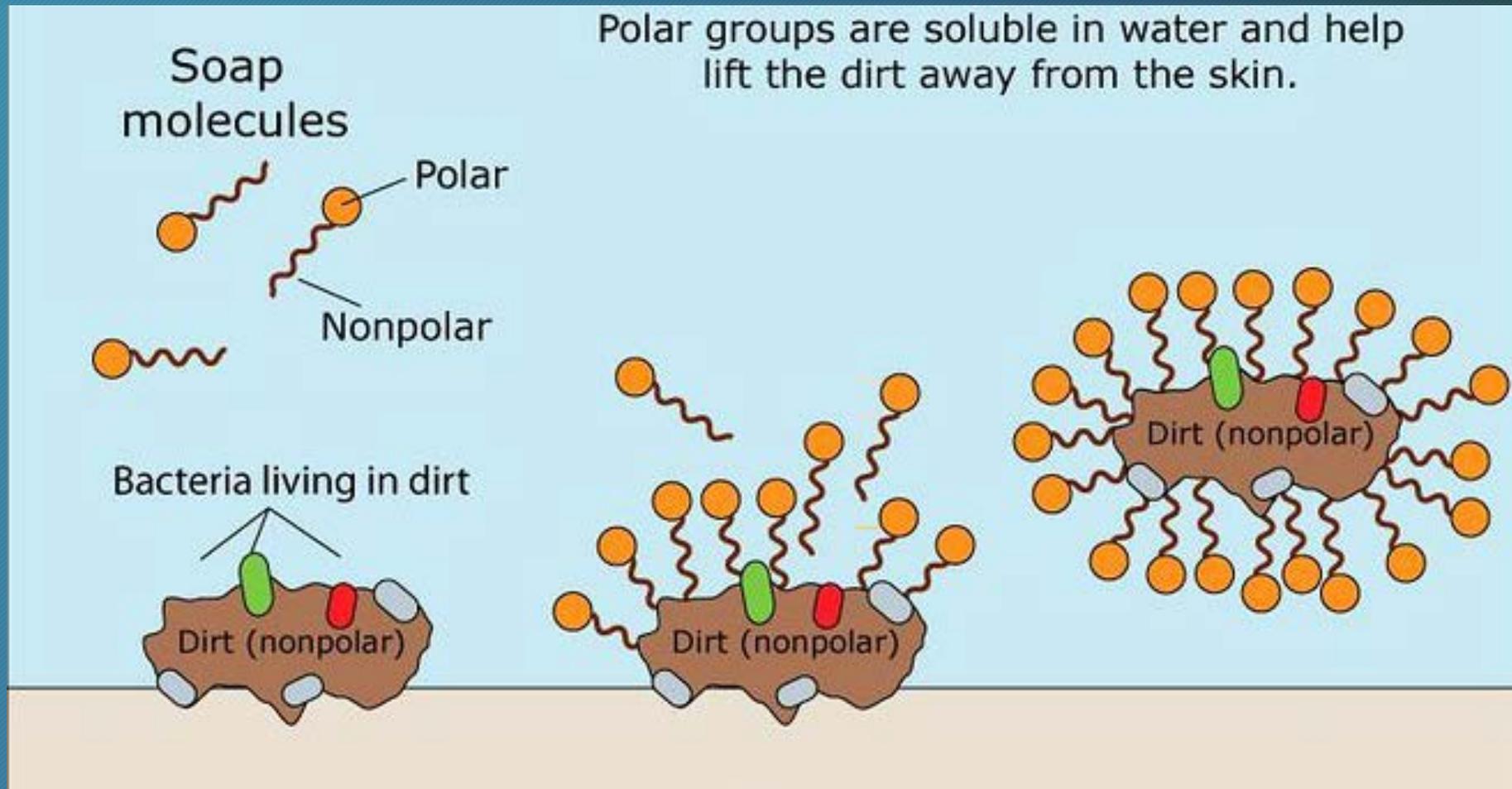


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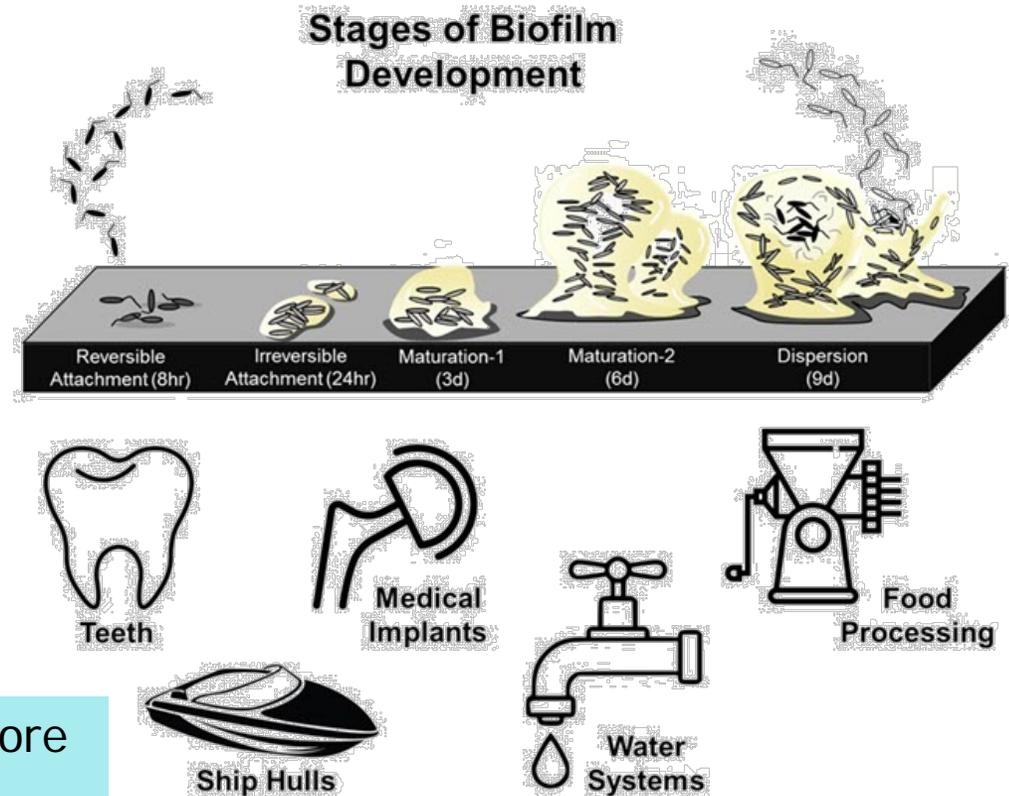
Whole thing  
ripped apart  
into pieces

# Works for dirt too

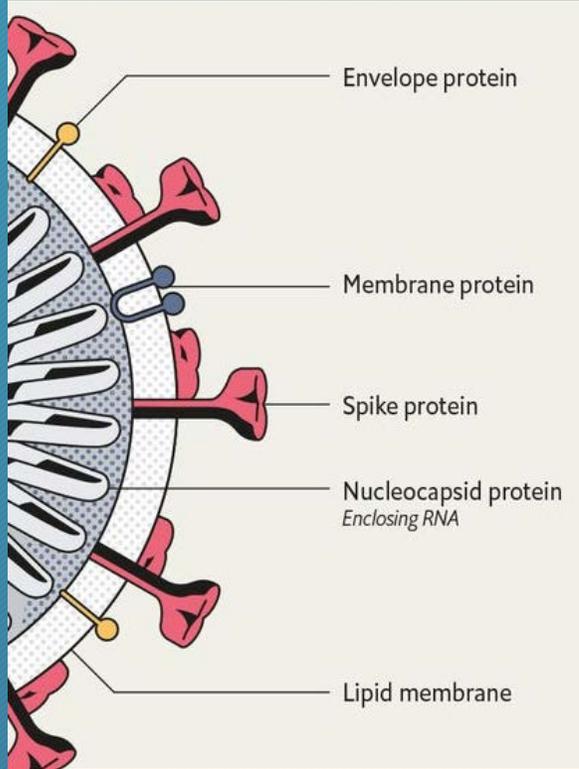


Residue from  
cleaning/disinfecting  
leading to biofilm  
growth

“Natural” soap products are more  
likely to leave residue than  
detergent products.



# Disinfectants also can ruin proteins



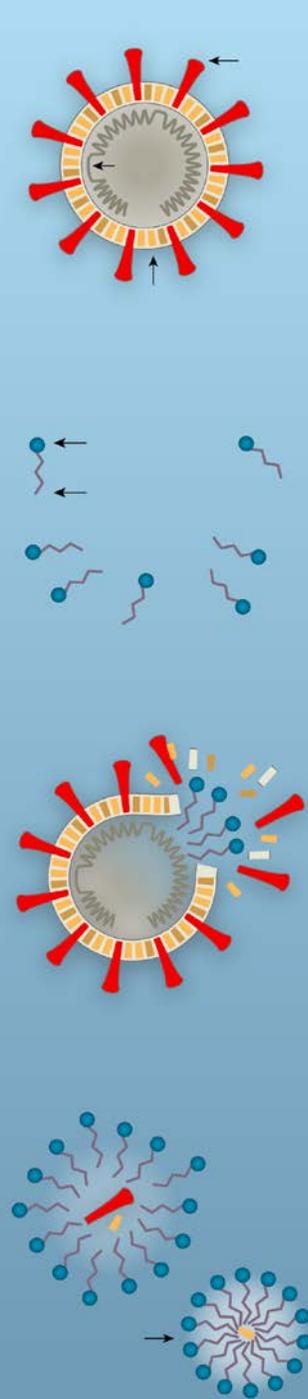
# Mechanics of soap & disinfectants

This is why more doesn't always help

This is why timing is important

This is why agitation is frequently needed

This is why disinfectants can affect us too



# Risk = Hazard + Exposure

- Risk: how safe/dangerous something is for you
- Hazard: inherent danger of something
- Exposure: amount or time around the thing

# Risk = Hazard + Exposure

- Risk: how safe/dangerous something is for you
  - Swimming vs swimming when you can't swimAccidents happen in all scenarios but some are higher risk than others
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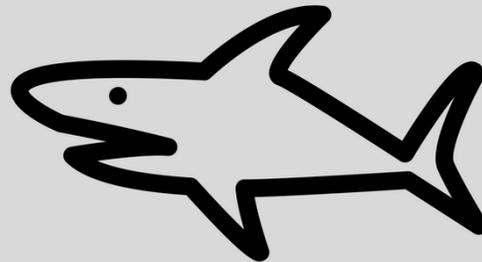
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  - Sand vs glass (both silica)There is nothing without hazard.
- Exposure: amount or time around the thing
  - Oxygen in air vs. 100% oxygen from tank
  - 10 minutes in bright sun vs. 10 hours in bright sun

# Risk equation

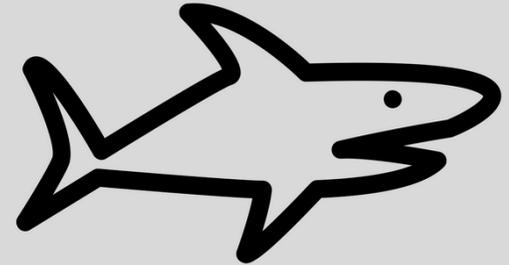
$$\text{Risk} = \text{Hazard} + \text{Exposure}$$

## Hazard

Something that can potentially cause harm



## Risk



= hazard + exposure

# Acute vs Chronic Exposures

## Alcohol as example

- (Toxicologist's perspective alcohol is a poison)

Acute alcohol poisoning,  
cognitive deficits,  
vomiting, & worse.

Acute exposures happen over short period of time



Think

24 hrs

# Acute vs Chronic Exposures

## Alcohol as example

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Acute exposures happen over short period of time



# Acute vs Chronic Exposures

## Alcohol as example

- (Toxicologist's perspective alcohol is a poison)

Chronic alcohol poisoning,  
heart disease, liver  
disease, cancer.

Chronic exposures happen over a long period of time



# Acute vs Chronic Exposures



Alcohol as example

- (Toxicologist's perspective)

Chronic exposures have



# Work-Related Asthma

Two types:

## Occupational asthma

Asthma caused by something in the workplace



**Enzymes**  
(in detergents or laboratories) and moulds



**Proteins from animals, plants, foods, insects, fish and shellfish**



**Wheat or other flour and enzyme exposures**



**Western red cedar dust**



**Isocyanates in spray paints, some glues, foundry moulds, polyurethane foam**

**15%**

Internationally, up to 15% of adult onset asthma may be related to the workplace.

## Work-exacerbated asthma

Something in the workplace aggravates existing asthma



**Perfumes**



**Dusts**  
(construction, grains)



**Ozone**  
(some swimming pools, bottling plants, photocopiers)



**Ammonia**  
(farming environments such as barns)



**Fumes, vapours, smoke and gases**  
(metalworking fluids, paint fumes, cleaning chemicals)



**Environment**  
(cold, heat and humidity)

What employers can do...



Read and be aware of safety data sheet information about respiratory health effects.



Replace substances with less harmful ones.



Minimize exposure (ventilation, enclosures).



Develop administrative controls (such as changing the job or tasks).

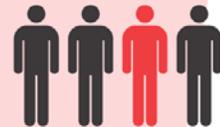


Educate workers on proper handling, avoiding spills and good housekeeping practices.



Provide personal protective equipment. This should be the last option.

If there is one worker with asthma symptoms, it may warrant a closer look at the air quality of the workplace and its ventilation controls.



Asthma is a respiratory disease

It creates a narrowing of the air passages that makes it difficult to breathe.



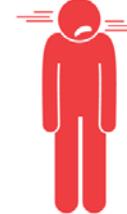
## Symptoms



**Tightness of the chest**



**Difficulty breathing**



**Wheezing**



**Coughing**

Symptoms are usually worse on work days and improve when away from the workplace.

## Industries affected

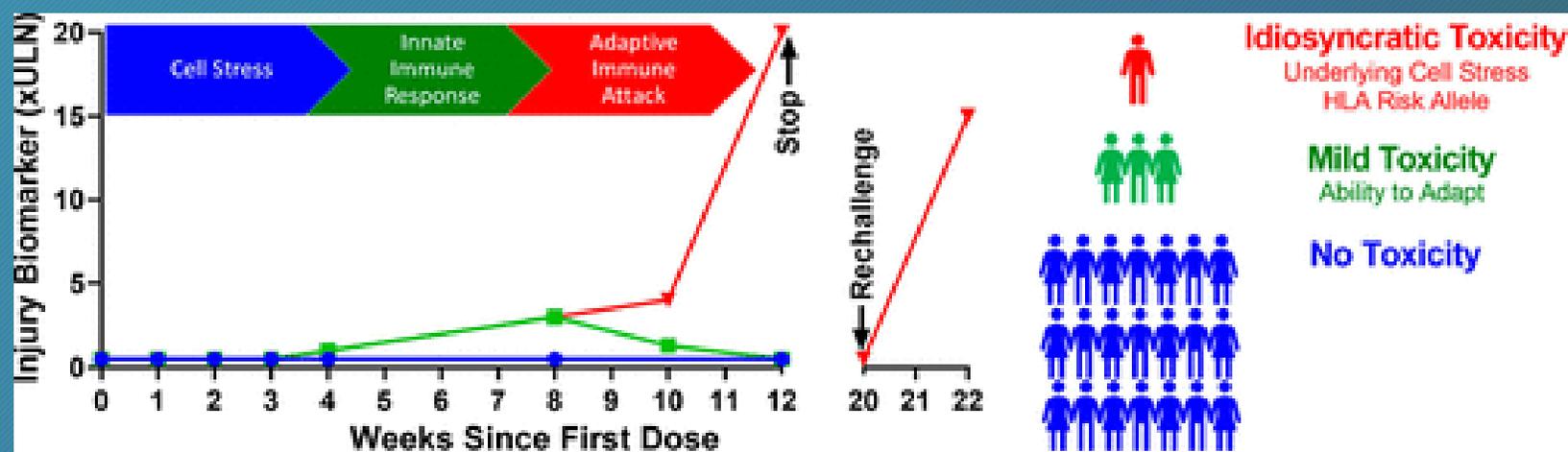
- Cleaning and janitorial services
- Bakeries
- Healthcare
- Manufacturing
- Construction
- Agriculture
- Automobile spray painting
- Insulation and polyurethane work
- Fisheries and fish processing
- Forestry

Created in partnership with

THE  LUNG ASSOCIATION™

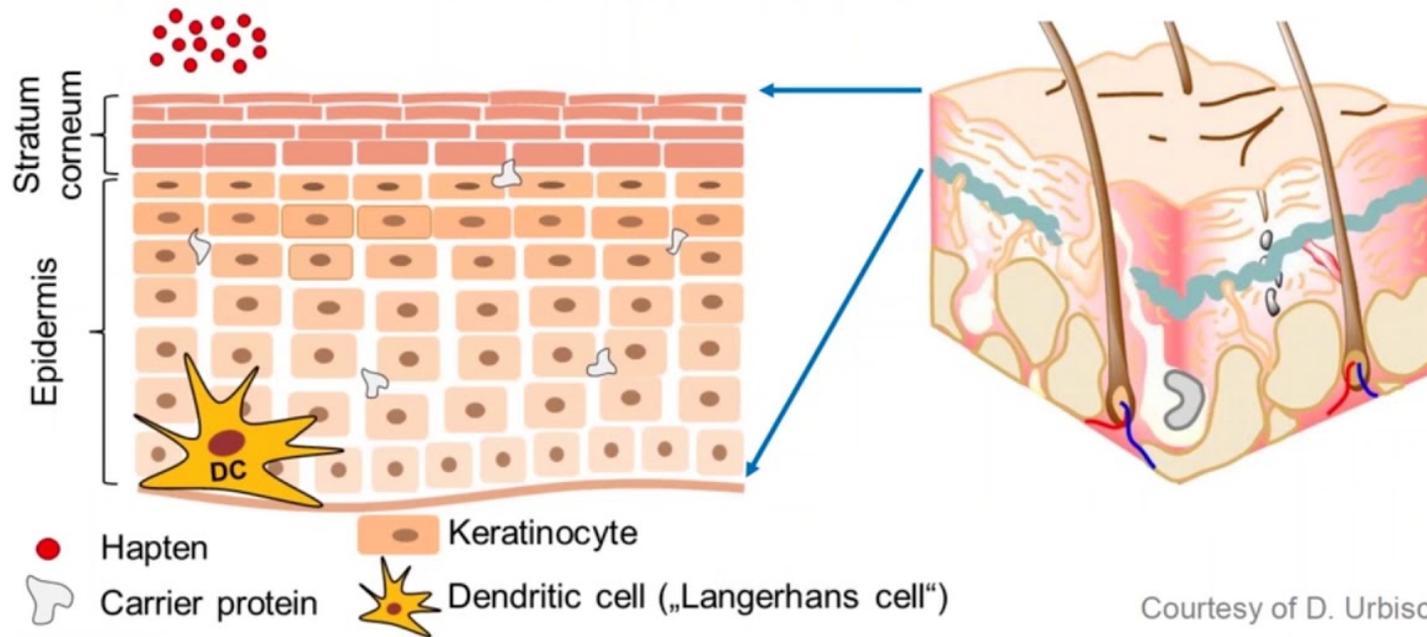
 **CCOHS.ca**  
Canadian Centre for Occupational Health and Safety

# Response to chemicals is different between and within people



# Response to chemicals is different between and within people

## The Skin Sensitisation Mechanism



Courtesy of D. Urbisch

# Tools for evaluating chemicals

Hazard Comparison Dashboard    Hazard    Predict    Search    Standardizer

Hazard Comparison    None    Export   

3 / 3      

Legend: **VH** - Very High, **H** - High, **M** - Medium, **L** - Low, **I** - Inconclusive    **Authoritative**, Screening, QSAR Model

| CAS Name                         | Human Health Effects     |            |        |                 |                           |                      |              |               |                 |                 |                   |                 | Ecotoxicity        |                 | Fate           |                        |                          |             |                 |
|----------------------------------|--------------------------|------------|--------|-----------------|---------------------------|----------------------|--------------|---------------|-----------------|-----------------|-------------------|-----------------|--------------------|-----------------|----------------|------------------------|--------------------------|-------------|-----------------|
|                                  | Acute Mammalian Toxicity |            |        | Carcinogenicity | Genotoxicity Mutagenicity | Endocrine Disruption | Reproductive | Developmental | Neurotoxicity   |                 | Systemic Toxicity |                 | Skin Sensitization | Skin Irritation | Eye Irritation | Acute Aquatic Toxicity | Chronic Aquatic Toxicity | Persistence | Bioaccumulation |
|                                  | Oral                     | Inhalation | Dermal |                 |                           |                      |              |               | Repeat Exposure | Single Exposure | Repeat Exposure   | Single Exposure |                    |                 |                |                        |                          |             |                 |
| 89-83-8<br>Thymol                | M                        | I          | L      | I               | L                         | H                    | I            | I             | I               | I               | I                 | I               | I                  | VH              | VH             | H                      | H                        | L           | L               |
| 64-19-7<br>Acetic acid           | M                        | H          | M      | I               | L                         | L                    | I            | L             | I               |                 | M                 | H               | I                  | VH              | VH             | M                      | L                        | L           | L               |
| 7681-52-9<br>Sodium hypochlor... | L                        | L          | L      | I               | I                         |                      | I            | I             |                 |                 | M                 | M               | L                  | VH              | VH             | VH                     | VH                       | L           | L               |

Skipped (0)  
 Filters (0)  
 Sorting (0)  
 Products (0)  
 Structure

<https://hazard.sciencedataexperts.com/#/hazard>

# Growing safety literature

- Better Ways to Clean
  - Walk-off mats placed inside and outside of entry-ways (to prevent dirt from being tracked into the building);
  - Microfiber mops, cloths and dusters;
  - High-filtration HEPA vacuums;
  - Walk-behind hard floor auto-scrubbers;
  - Hands-free mops; and
  - Chemical-free cleaning systems.

Source: <https://www.osha.gov/Publications/OSHA3512.pdf>

# Reducing exposure beyond PPE



- Saferchoice
- <https://www.cdc.gov/niosh/topics/disinfectant/default.html>

|  |                  |  |   |  |  |
|--|------------------|--|---|--|--|
| <p><b>Sodium hypochlorite</b><br/>(solution, active chlorine<br/>&gt;10%)<sup>1, 55</sup><br/>Bleach</p> | <p>7681-52-9</p> |  <p>Corrosive</p>           | <ul style="list-style-type: none"> <li>• Causes severe skin burns and eye damage.</li> <li>• May cause respiratory irritation.</li> </ul> | <p><b>&gt;8 hours:</b><br/>Butyl rubber<br/>Natural rubber<br/>Neoprene rubber<br/>Nitrile rubber<br/>Polyvinyl chloride</p>       | <p>Follow manufacturer's recommendations in the product safety data sheet.</p> |
| <p><b>Thymol<sup>®</sup></b><br/>2-Isopropyl-5-methylphenol</p>  | <p>89-83-8</p>   |  <p>Corrosive    Hazard</p> | <ul style="list-style-type: none"> <li>• Harmful if swallowed.</li> <li>• Causes severe skin burns and eye damage.</li> </ul>             | <p>No barrier guidance is provided in Forsberg (2020). Follow manufacturer's recommendations on the product safety data sheet.</p> | <p>Follow manufacturer's recommendations in the product safety data sheet.</p> |

Northern New England  
**Poison Center**

1 800 222 1222 | LIVE CHAT | TEXT

POISON INFORMATION | EDUCATION | STATISTICS | FOR PROVIDERS

Call Us 24 hours / day  
**1 800 222 1222**

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**> POISON SAFETY DURING A PANDEMIC: GUIDANCE FOR SCHOOL NURSES, TEACHERS AND DAYCARE PROVIDERS**

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