

Hospital cleaning

Is visibly clean enough ?

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Outline

- Setting the scene
- Is visibly clean enough?
- Methods of monitoring cleanliness
 - Direct and indirect observation
 - Microbiological and chemical methods
- Conclusions

Expectation & beliefs

- ‘Clean hospitals are good hospitals’
- ‘Unclean hospitals cause disease’
- Patients and staff prefer a clean and well maintained hospital
- Feel safe, comfortable, confident in the organisation

Perception of risk

- Focus on floors, litter, scuffs and scratches
- Benign reservoirs
- Miss the *visibly clean but contaminated* e.g. hand-touch surface and multiple patient use equipment

Is visibly clean enough?

QUESTION	ANSWER
Does the health care environment <i>play a role</i> in the transmission of microorganisms?	YES

Original research article

American Journal of Infection Control 41 (2013) S6-S11

Evidence that contaminated surfaces contribute to the transmission of hospital pathogens and an overview of strategies to address contaminated surfaces in hospital settings

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Dancer SJ. Clin Microbiol Rev. 2014; 27(4): 665-690

Controlling Hospital-Acquired Infection: Focus on the Role of the Environment and New Technologies for Decontamination

Prior room occupancy and risk for HCAs

Scientific evidence suggests that environmental contamination plays an important role in the spread of multidrug-resistant organisms (MDROs). **Outbreaks** have been brought under control with infection control measures that **include enhanced cleaning**.

Organism	Survival time*	Prior room occupancy risk increase [§]
MRSA	7 days to >12 months	1.5
VRE	5 days to >46 months	2.25
<i>Pseudomonas aeruginosa</i>	6 h to 16 months	1.75
<i>Clostridium difficile</i>	>5 months (spores)	2.5
<i>Acinetobacter baumannii</i>	3 days to 11 months	3.5
CRE	19 days	
<i>Norovirus (feline calicivirus)</i>	8 h to 7 days	Limited data
<i>Rotavirus</i>	6–60 days	Limited data

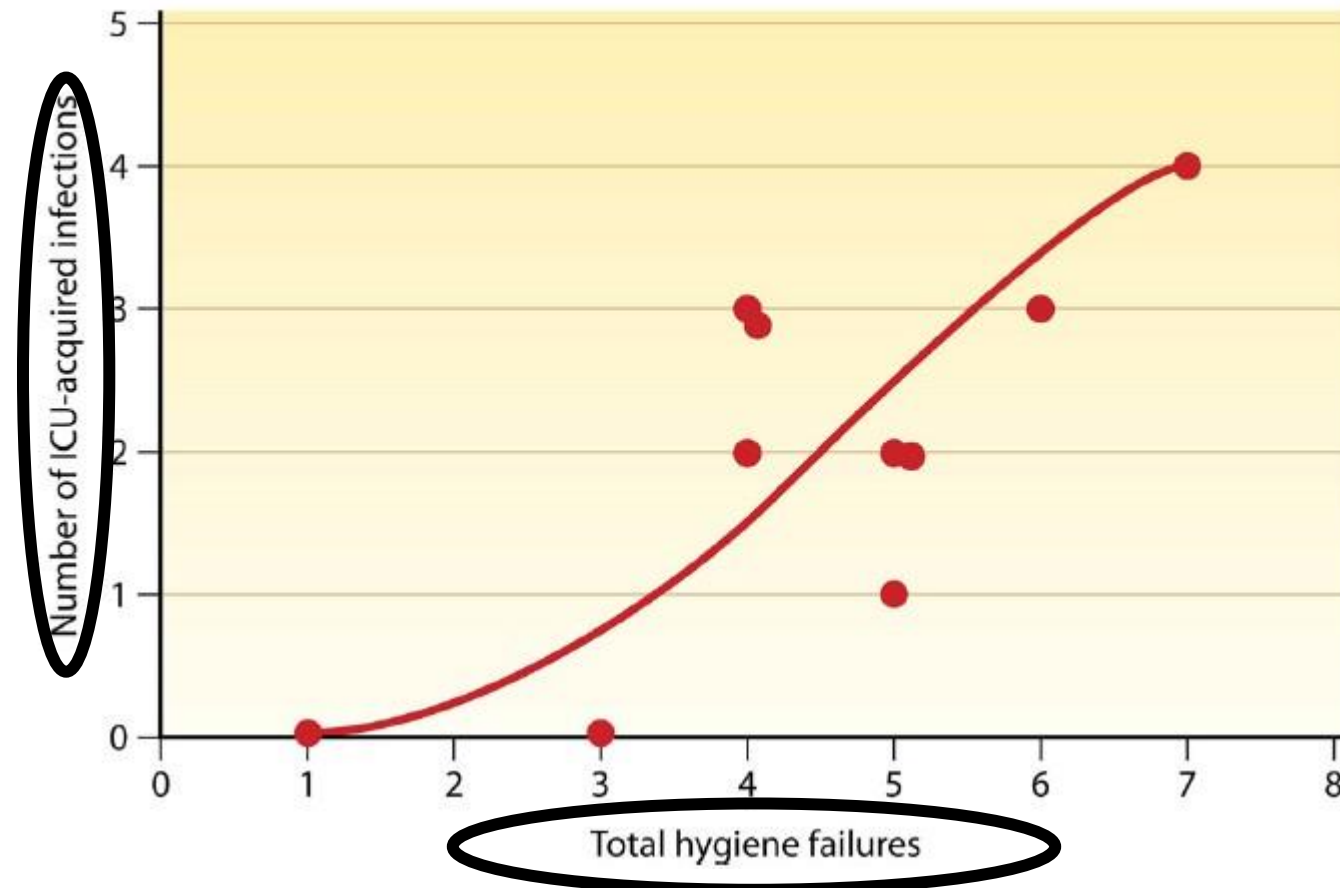
Adapted from Kramer *et al.* [2006], Otter *et al.* [2013], and Havill *et al.* [2014].

*Survival times of multidrug-resistant organisms (MDROs) on dry inanimate objects. Range depends on experimental design and methods of assessing contamination.

[§]Ratio of increased risk associated with the room being previously occupied by patients infected with common MDROs.

Relationship between environmental bioburden and HCAs

Figure shows a relationship between the number of surgical intensive care unit (SICU)-acquired infections and total hygiene fails during a 2-month patient and environmental surveillance study in a Glasgow teaching hospital.



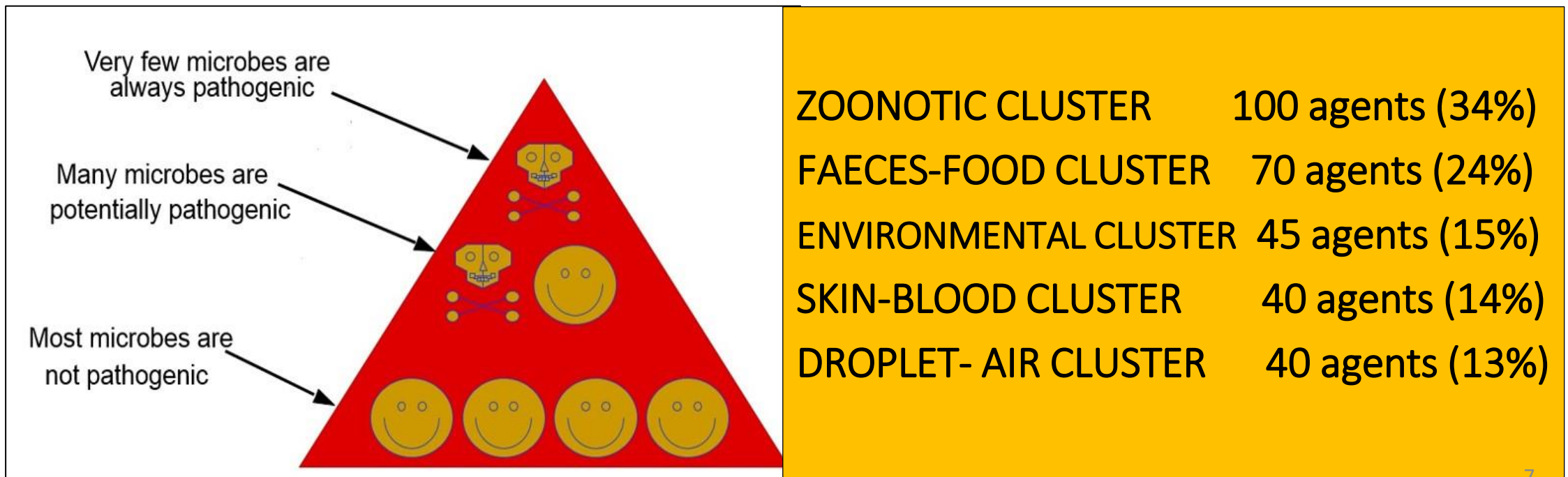
(Defined as aerobic colony counts (ACCs) of 2.5 CFU/cm² and/or the presence of *Staphylococcus aureus* on hand touch sites).

White L, Dancer SJ *et al.* *Am J Infect Control* 2008;36: 381–384.

Is visibly clean enough?

QUESTION	ANSWER
Do <u>all</u> microorganisms cause human diseases?	NO

Vast majority of microbes are harmless and according to J Ingraham
'the percentage of disease-causing microorganisms (pathogens) are far, far less than the percentage of humans that commit first-degree murder'.



QUESTION

ANSWER

Amongst pathogens, do all microorganisms have *equal* pathogenicity/virulence and/or infective dose?

NO

TABLE 1 Survival times and infectious doses retrieved or extrapolated from published studies^a

Organism	Survival time	Infectious dose
Methicillin-resistant <i>Staphylococcus aureus</i>	7 days→7 mo	4 CFU
<i>Acinetobacter</i>	3 days→5 mo	250 CFU
<i>Clostridium difficile</i>	>5 mo	5 spores
Vancomycin-resistant <i>Enterococcus</i>	5 days→4 mo	<10 ³ CFU
<i>Escherichia coli</i>	2 h–16 mo	10 ² -10 ⁵ CFU
<i>Klebsiella</i>	2 h→30 mo	10 ² CFU
Norovirus	8 h–7 days	<20 virions

^a Survival times and infectious doses of a range of pathogens according to, or extrapolated from, original studies, some of which involved animal-based research (2, 7–14).

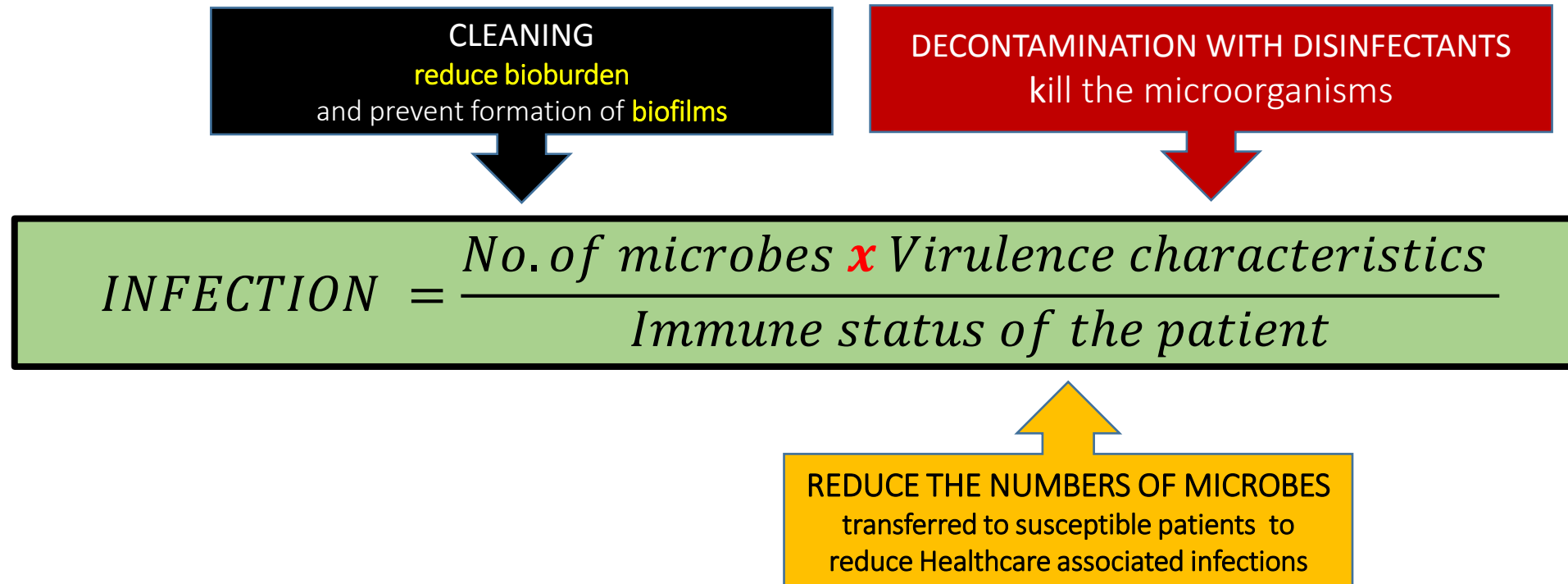
NEED SUFFICIENT No.
Various microorganisms have different infective dose to cause infection

VIRULENT MICROBES
Virulence is the capacity for a strain to produce disease and it varies as some microorganisms are more pathogenic than others

$$INFECTION = \frac{\text{No. of microbes} \times \text{Virulence characteristics}}{\text{Immune status of the patient}}$$

Contaminated environment,
item/equipment & hands

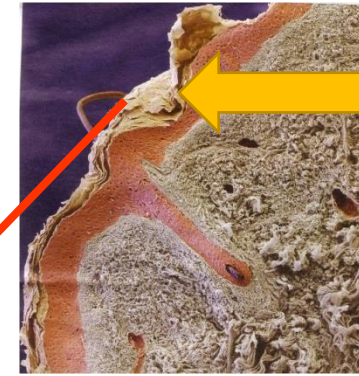
Impact of cleaning and decontamination of environment



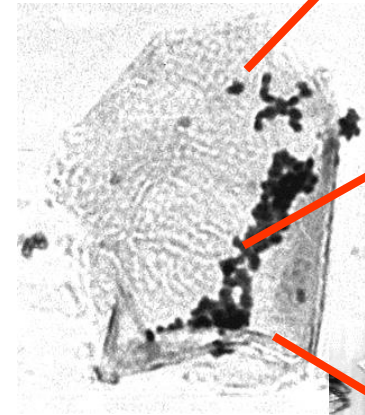
Source of environmental contamination of microorganisms

Shedding of skin scales from skin

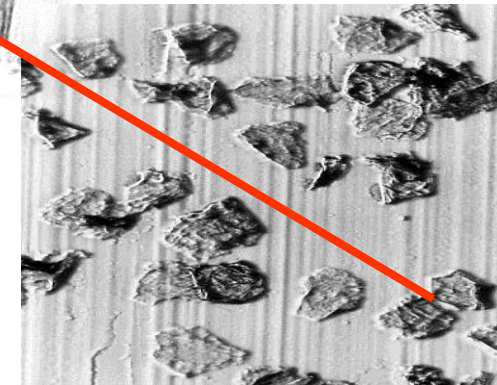
- 1,000 skin particles/min are dispersed when walking
- Nearly 1 million skin squames are shed daily from normal skin
- 4 tons in the average life time
- 3-6 ounces of skin is shed per day



Skin scales



10% can carry between 100 to 5,000 viable bacteria

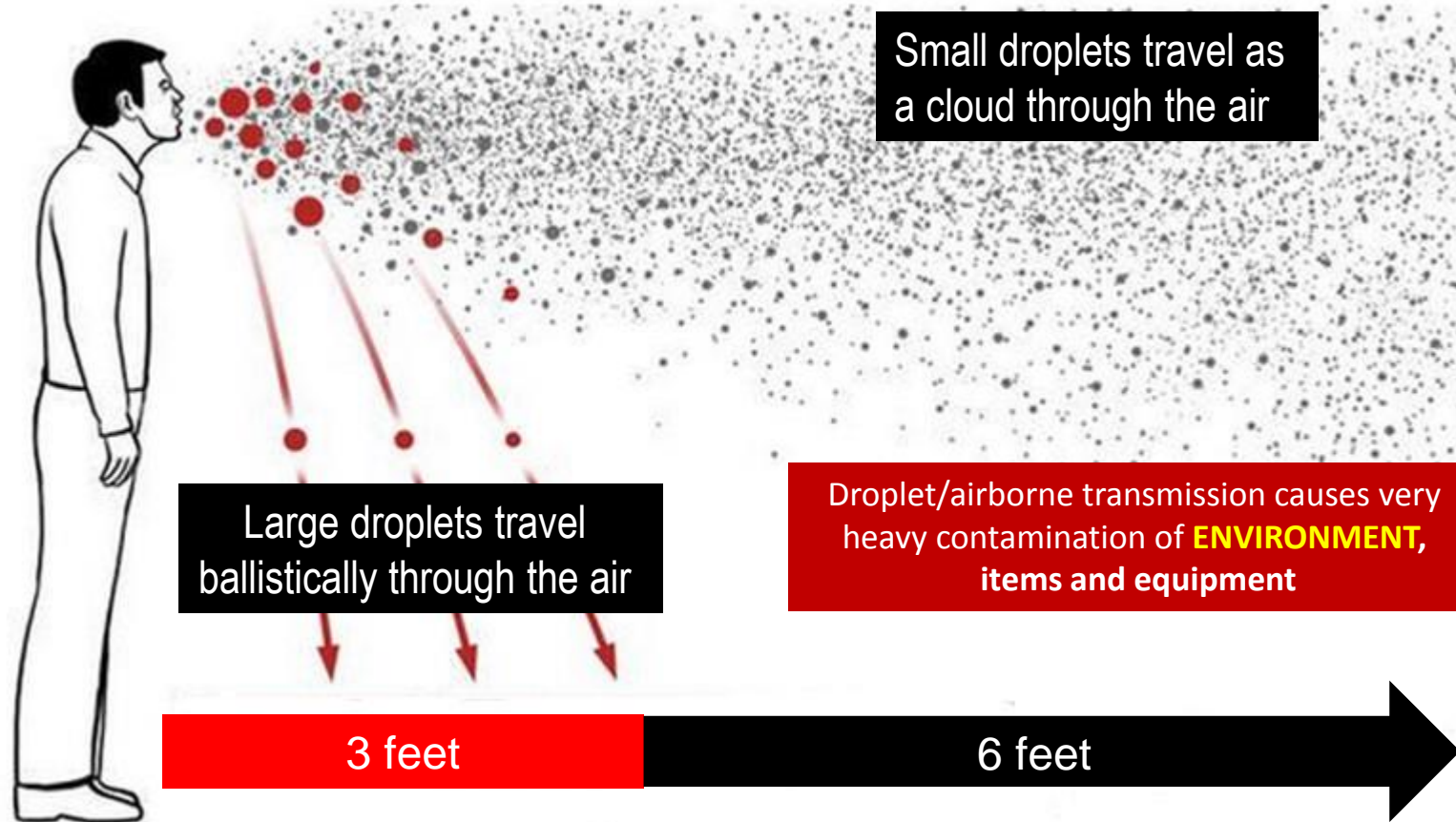


Droplet transmission

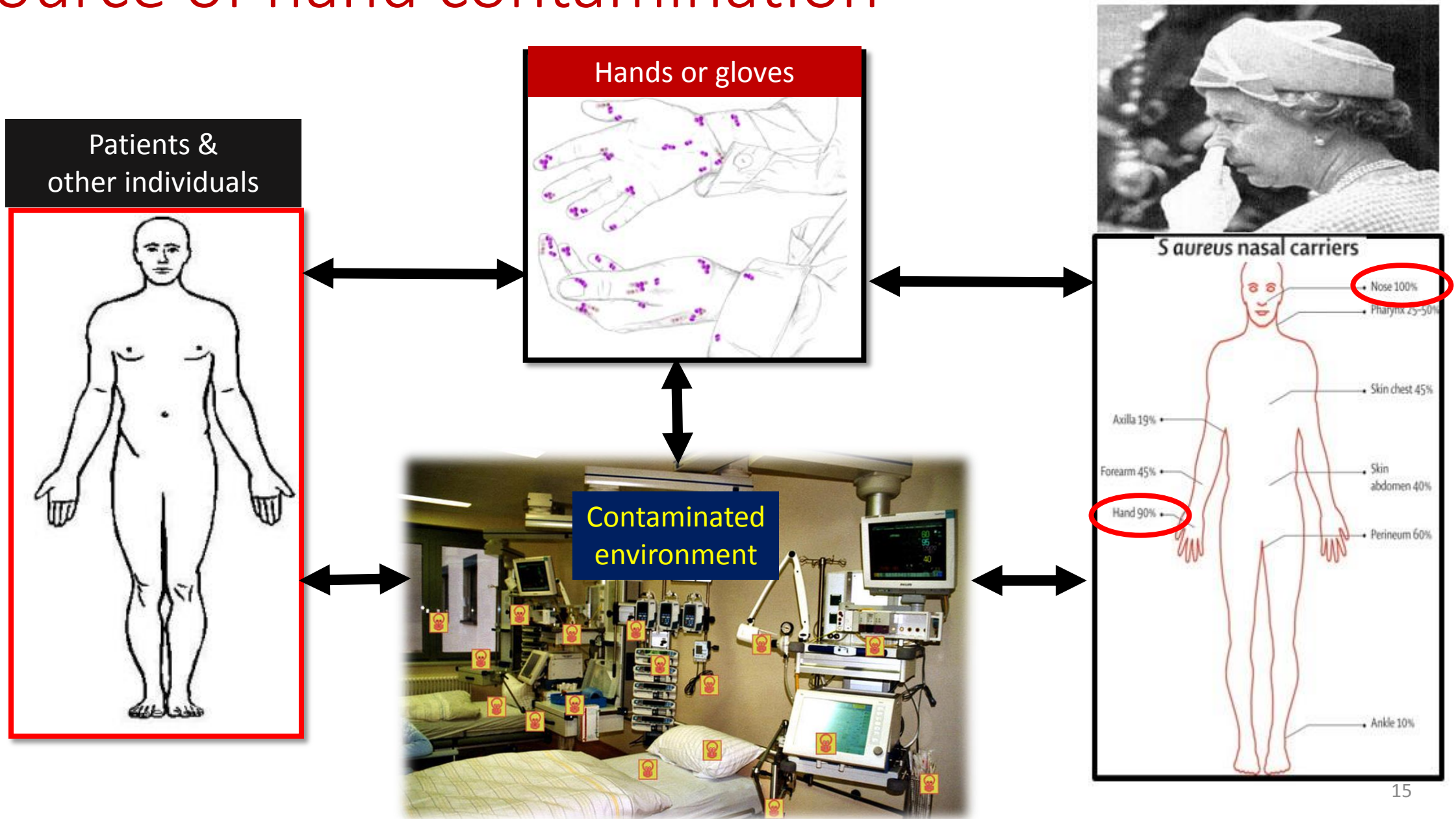
Respiratory manoeuvres	Number of droplets carrying bacteria (100 μ or less)
Sneezing	4,500 -1,000,000
Coughing	3,500
Speaking	210

Dugid J. *Journal of Hygiene* 1946;44(6):471–479.

Droplet/airborne transmission



Source of hand contamination



In most healthcare settings it is
impossible to keep the environment
clean all the time
due to frequency of cleaning

If environmental surfaces are vectors of infection,
would **increased attention to staff HAND HYGIENE**
be more productive than increased cleaning frequencies?
Problem with **HAND HYGIENE compliance !**

Risks of infection from environment

HIGH-TOUCH SURFACES	<ul style="list-style-type: none">• Surfaces that have <u><i>frequent contact</i></u> with hands• <u>High risk sites</u> are near-patient hand-touch sites• Examples: doorknobs, elevator buttons, telephones, call bells, bedrails, light switches, computer keyboards, etc.	<ul style="list-style-type: none">• Require <u><i>more frequent cleaning and decontamination</i></u> with appropriate disinfectants• Cleaning and disinfection is usually done at least daily and more frequently if the risk of environmental contamination is higher e.g. in intensive care units, during outbreaks.
LOW-TOUCH SURFACES	<ul style="list-style-type: none">• Surfaces that have <u><i>minimal contact</i></u> with hands; floors, walls, ceilings, window sills etc.• Items not in close contact with the patient or their immediate surroundings	<ul style="list-style-type: none">• <u><i>Require cleaning on a regular</i></u> basis (but not necessarily daily)• When soiling or spills occur, and• When the patient/resident is discharged from the health care setting.

Frequency of cleaning & use of disinfectants

High or Low touch items



Level of contamination



Susceptibility of patients



Determining how often to clean

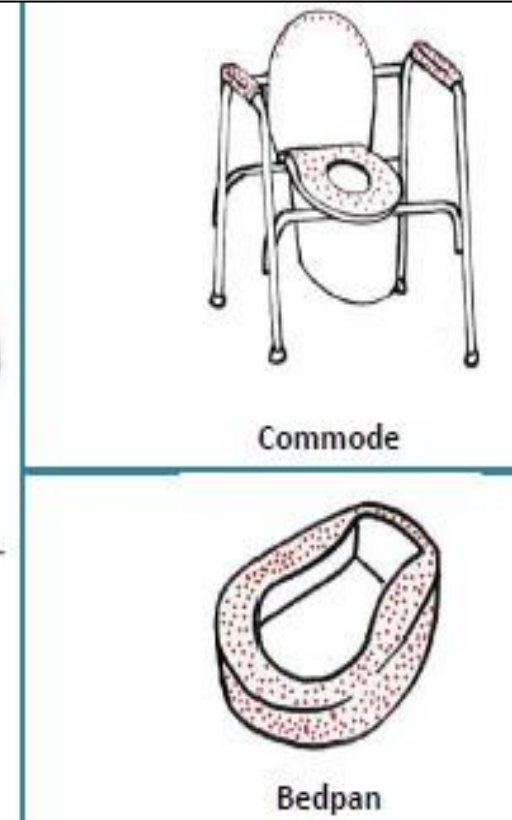
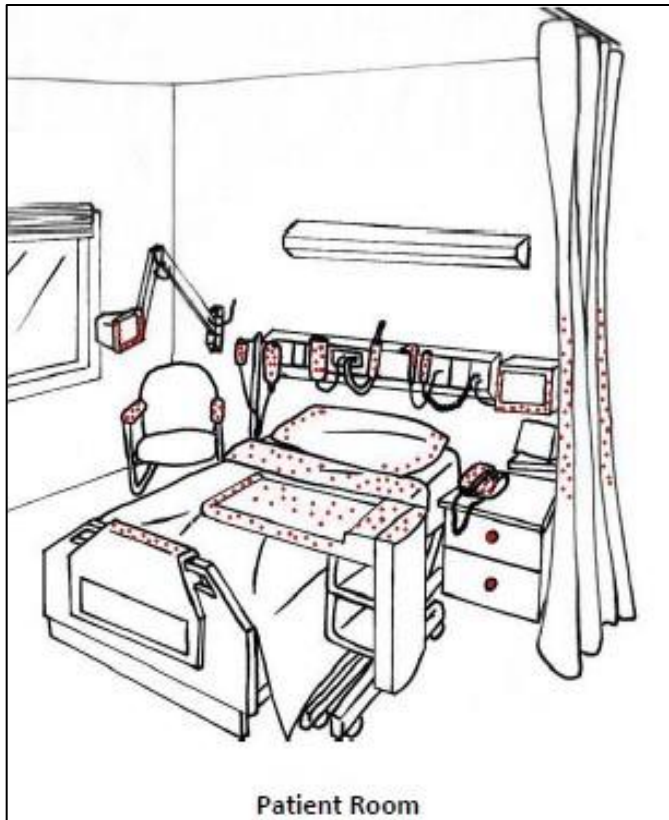
Probability of contamination with pathogens	POTENTIAL FOR EXPOSURE			
	High touch surface = 3		Low touch surface = 1	
	At risk persons = 1	Less at risk persons = 0	At risk persons = 1	Less at risk persons = 0
Heavy contamination = 3	7	6	5	4
Moderate contamination = 2	6	5	4	3
Light contamination = 1	5	4	3	2

Cleaning frequency based on risk stratification matrix

Total Risk Score	Risk Type	Minimum Cleaning Frequency
7	High Risk	Clean after each case/event/procedure and at least twice per day Clean additionally as required
4-6	Moderate Risk	Clean at least once daily Clean additionally as required (e.g. gross soiling)
2-3	Low Risk	Clean according to a fixed schedule Clean additionally as required (e.g. gross soiling)

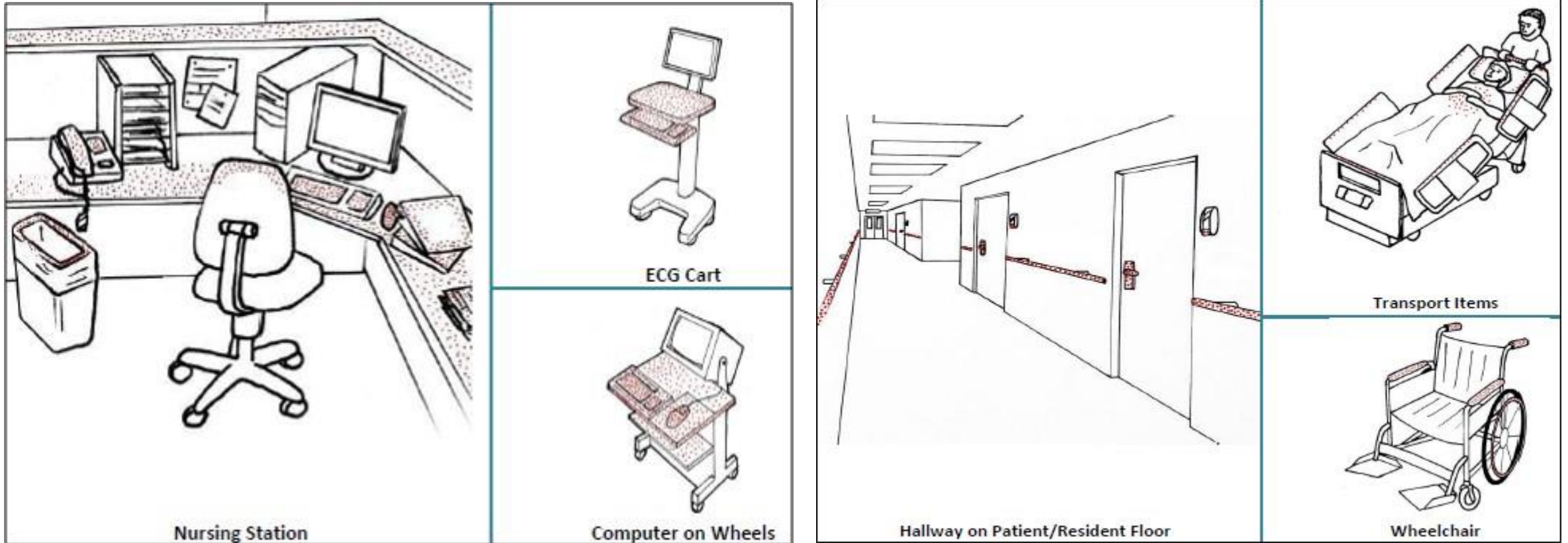
Examples of High-touch Items and Surfaces in the Healthcare Environment

NOTE: Dots indicate areas of highest contamination and touch



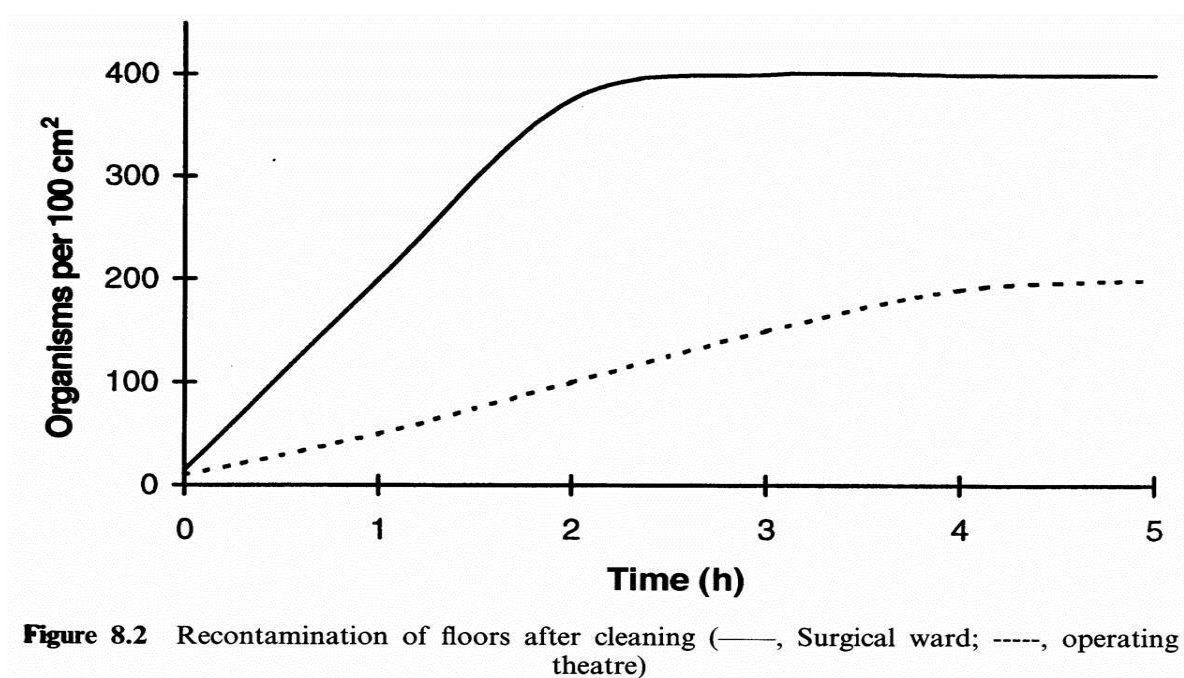
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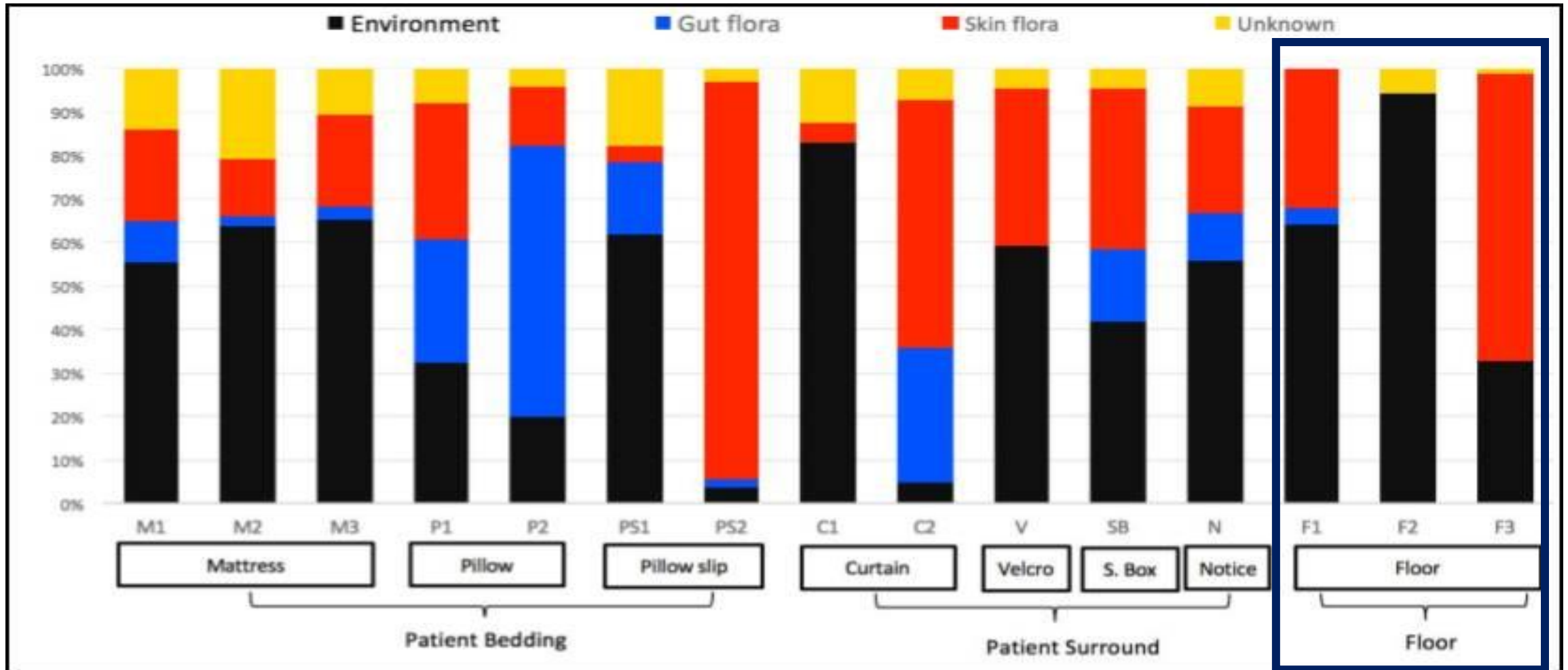
Environmental cleaning: non-touch surfaces

- Cleaning can remove 80% of contamination on a floor
- Disinfection can remove 95% of contamination on a floor
- An hour later, both surfaces are back to their former contamination levels

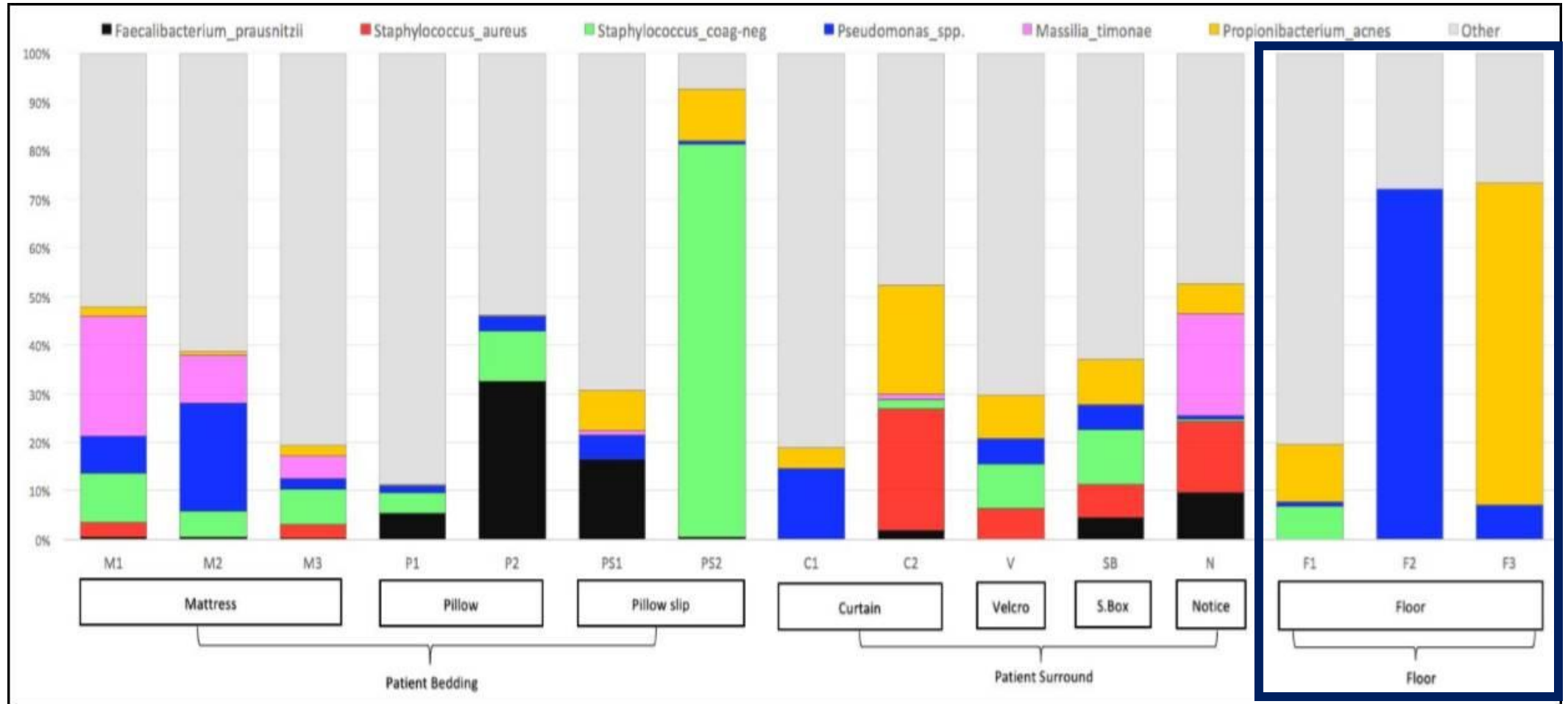


from Ayliffe GAJ et al, 1999

Groups of the species by their usual niche i.e. skin flora, gut flora, or environmental species



Most common species demonstrated on the various **biofilm** containing surfaces



Hotel Clean & Hospital Clean

Hotel Clean

Measure of cleanliness based on visual appearance that includes dust and dirt removal, waste disposal and cleaning of windows and surfaces.

Hospital Clean is a hotel clean PLUS

High touch surfaces in patient care areas are cleaned and disinfected with appropriate disinfectant.

Visual Inspection

Method	Ease of Use	Cost	Identifies Pathogens	Useful for individual teaching
VISUAL INSPECTION	SIMPLE	NONE	NO	YES

COMMENTS

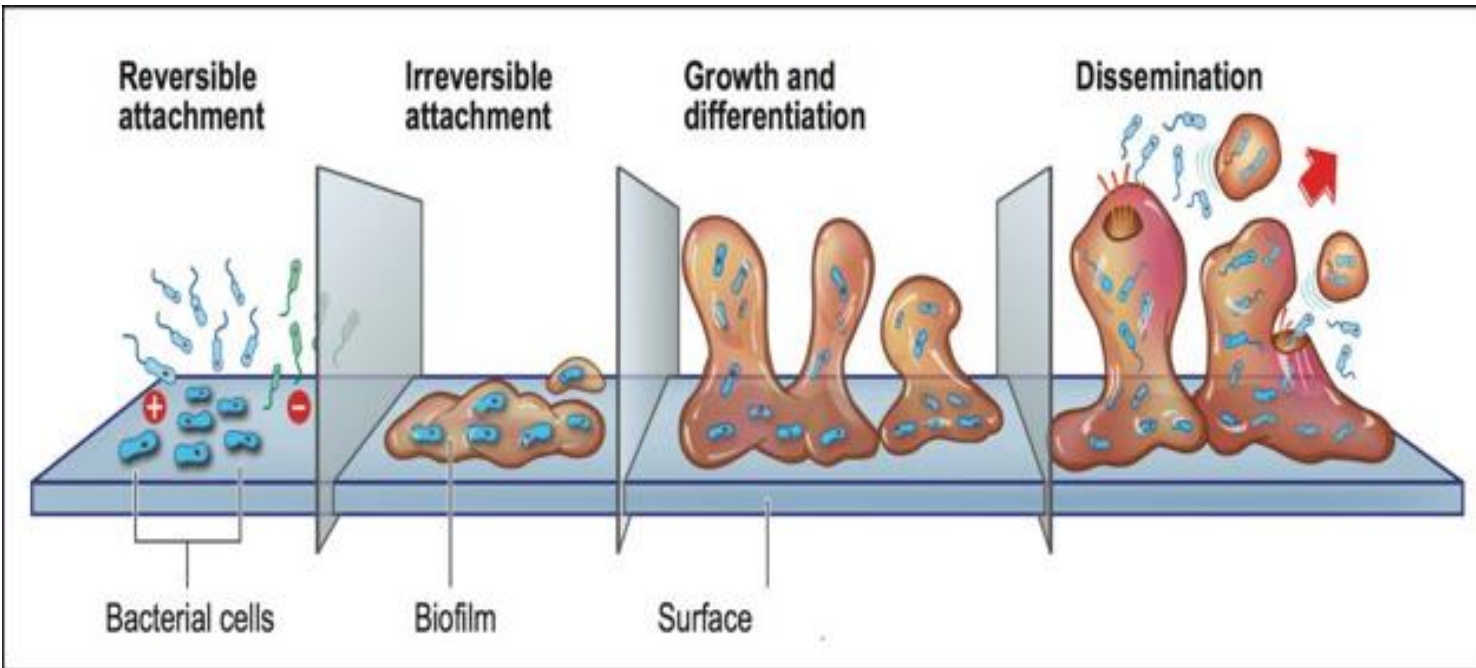
- Visual inspection ***cannot*** accurately ***provide a reliable assessment*** of cleanliness nor ***determine the infection risk to patients***
- Emphasis on ***visible dirt***
- Assessment of cleanliness is subjective as *what is clean is 'what an individual thinks it is'!*

Dancer SJ. 2004. *J. Hosp. Infect.* 56:10–15.

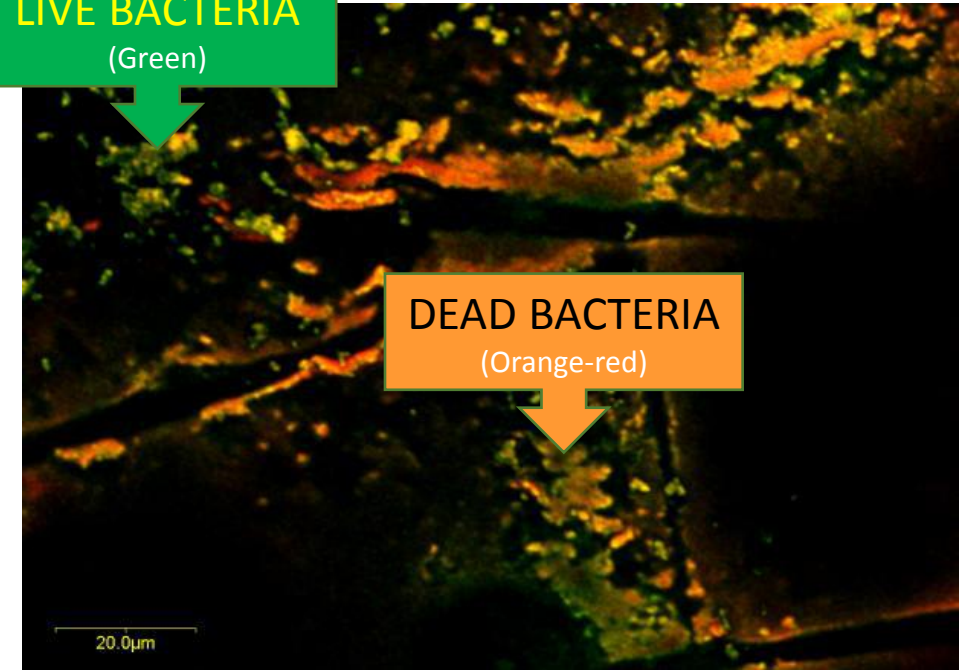
Malik RE et al. 2003. *Am. J. Infect. Control* 31: 181–187.

Dancer SJ et al. 2008. *Int. J. Environ. Hygiene.* 18:357–36.

Do biofilms on hospital surfaces impede the effects of cleaning?



LIVE BACTERIA
(Green)



DEAD BACTERIA
(Orange-red)

CLEANING OF ENVIRONMENT SURFACES
is essential as biofilms on dry surfaces may prolong
the survival of microorganisms

Staining conducted *after twelve months* of storage at room temperature. Panel is from a *storage box used to hold sterile supplies* of single-use patient equipment; this surface cultured *S. aureus*.

Monitoring methods

- **Direct observation**
 - Visual assessment
 - Observation of performance
- **Indirect observation**
 - Patient/resident satisfaction surveys
- **Measurements of cleanliness**
(Environmental markers measure the residual bioburden)
 - Environmental cultures
 - ATP bioluminescence
 - Environmental marking

CDC Environmental Checklist for Monitoring Terminal Cleaning¹

Date:			
Unit:			
Room Number:			
Initials of ES staff (optional):²			

Evaluate the following priority sites for each patient room:

High-touch Room Surfaces ³	Cleaned	Not Cleaned	Not Present in Room
Bed rails / controls			
Tray table			
IV pole (grab area)			
Call box / button			
Telephone			
Bedside table handle			
Chair			
Room sink			
Room light switch			
Room inner door knob			
Bathroom inner door knob / plate			
Bathroom light switch			
Bathroom handrails by toilet			
Bathroom sink			
Toilet seat			
Toilet flush handle			
Toilet bedpan cleaner			

Evaluate the following additional sites if these equipment are present in the room:

High-touch Room Surfaces ³	Cleaned	Not Cleaned	Not Present in Room
IV pump control			
Multi-module monitor controls			
Multi-module monitor touch screen			
Multi-module monitor cables			
Ventilator control panel			

Mark the monitoring method used:

<input type="checkbox"/> Direct observation	<input type="checkbox"/> Fluorescent gel	<input type="checkbox"/> Agar slide cultures
<input type="checkbox"/> Swab cultures	<input type="checkbox"/> ATP system	

¹Selection of detergents and disinfectants should be according to institutional policies and procedures
²Hospitals may choose to include identifiers of individual environmental services staff for feedback purposes.
³Sites most frequently contaminated and touched by patients and/or healthcare workers

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion

Culture Methods

Method	Ease of Use	Cost	Identifies Pathogens	Useful for individual teaching
CULTURE METHODS (SWAB OR AGAR PLATE)	Relatively simple	Expensive	YES	YES

COMMENTS

- Results not available for 48 hrs.
- There is no clear evidence on what are the accepted international standards for 'microbial clean' (Aerobic colony counts of 2.5 to 5 CFU per cm² on hand touch sites and 1 CFU/cm² hospital pathogen (e.g., MRSA, VRE, *C. difficile*, etc.) have been proposed and tested as microbiological benchmarks)
- Useful to establish epidemiology link during an outbreak
- **Routine environmental swabbing is not recommended**

ATP SYSTEM: Adenosine triphosphate

- Provides *quantitative measure* of cleanliness and reflects the amount of bioburden present
- Quick results
- ATP is a chemical substance that is *present in all living cells*, including bacteria and viruses (Result can also be confounded by the presence of bleach, microfibre products and manufactured plastics used in cleaning)
- *RLU* measurements *do not correlate precisely with microbial counts* as readings occur with residual organic soil, and dead bacteria (The benchmark levels range from 25 to 500 relative light units (RLU) for 10 to 100 cm² healthcare surfaces)
- *ATP monitoring* is more useful for detecting the *need for cleaning attention*
- Some systems are not sufficiently sensitive to detect very low microbial counts (10 CFU/cm²)

Griffith CL *et al. J Hosp Infect* 2000;45:19:
Boyce JM *et al. Infect Control Hosp Epidemiol* 2009;30:678
Boyce JM *et al. Infect Control Hosp Epidemiol* 2010;31:99:
Dancer SJ *et al. J Hosp Infect*; 2010. p. S34
Mulvey D *et al. J Hosp Infect.* 2011;77(1):25-30.
Dancer SJ. *Clin Microbiol Rev.* 2014; (27) :665-690

Fluorescent Marker System



Method	Ease of Use	Cost	Identifies Pathogens	Useful for individual teaching
FLUORESCENT MARKER SYSTEM	Relatively simple	Relatively less expensive than other methods	NO	YES

COMMENTS

- Apply clear marker/gel to high-touch surfaces in patient/resident rooms prior to cleaning, then evaluate to see if the solution was removed by cleaning
- Provides *immediate and objective* feedback to cleaning staff

ATP : Bioluminescence Assay Systems

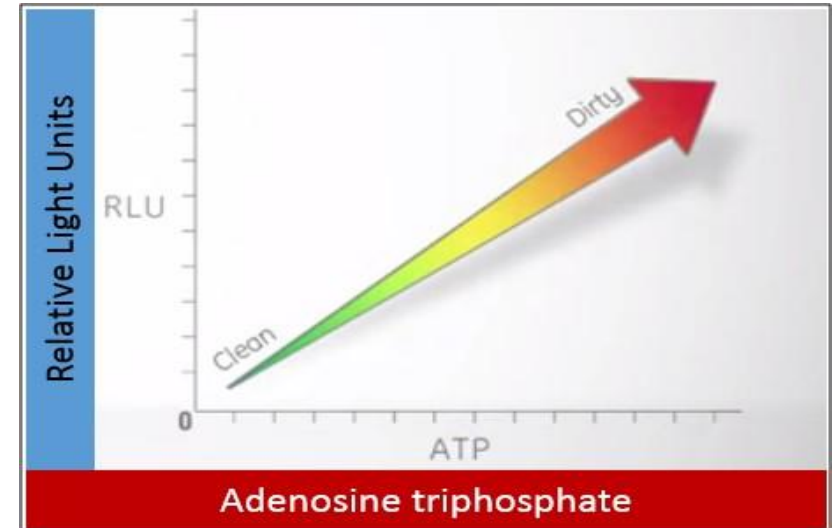
Method	Ease of Use	Cost	Identifies Pathogens	Useful for individual teaching
ATP SYSTEM	Relatively simple	Expensive (Requires special equipment)	NO	YES



Step 1
Use special swab and place swab in reaction tube to sample surface

Step 2
Place tube in luminometer

Step 3
Results
Relative Light Units (RLU)



Conclusions

- Direct observation by **visual assessment** after cleaning is **not a reliable method**
- **Objective measurement** using **environmental markers** of cleanliness is necessary to measure the residual bioburden
- **Routine swabbing** of environmental is **not** necessary. Useful to establish epidemiology link during an outbreak
- Cleaning practices are **periodically monitored and audited** using check list
- 'If you cannot measure it, you cannot improve it'.
- Provide *feedback* of actual work and *identify opportunities for improvement*
- **ONGOING EDUCATION AND TRAINING**
 - Methods of cleaning
 - Preparation and use of detergents and disinfectants
 - Risk : Infections and chemical disinfectants

Thank you