

# Why Environmental Services Saves Lives

Dick Zoutman, MD, FRCPC  
Professor & Chair,  
Infectious Diseases & Medical Microbiology,  
Queen's University  
Co-Chair, PIDAC

## Does ES Saves Lives?

Florence Nightingale  
Thinks so!

So do !!



## Hill's Criteria for Causality

- Is there a strong association?
  - "Does cleaning reduce infection?"
- Is there biologic plausibility for the association?
  - "Does cleaning get rid of germs?"
- Is there consistency with other studies?
  - "Are there multiple studies?"
- Is the time sequence compatible?
  - "Clean first then less germs?"
- Is there evidence of a dose-response?
  - Is more cleaning better? Less cleaning worse?

# Burden of HAI's

Infection	Number of Infections	Attributable Mortality	Number of Deaths
Surgical Wound	53,421	2.5%	1,335
Pneumonia	23,060	30%	6,918
Bacteremia	10,377	16.3%	1,691
Urinary Tract	91,853	0.8%	735
Other	41,123	3.3%	1,357
<b>Totals</b>	<b>219,834</b>		<b>12,037</b>

# Prevalence of HAI's in Canada

Table II Distribution of all types of healthcare-associated infection (HAI) by medical unit

Medical unit	All HAIs		UTI		Pneumonia		SSI		BSI		CDAD	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
All units, N = 5750	667	11.6	194	3.4	175	3.1	146	2.5	93	1.6	59	1.0
Critical care, N = 462	153	33.2	20	4.3	72	15.6	22	4.8	34	7.4	5	1.1
Trauma and burn, N = 97	17	17.6	4	4.1	5	5.2	5	5.2	3	3.1	0	0.0
Transplant, N = 82	12	14.7	3	3.7	5	6.1	1	1.2	3	3.7	0	0.0
Surgery, N = 2112	247	11.7	79	3.7	39	1.9	99	4.7	13	0.6	17	0.8
Oncology-haematology, N = 250	28	11.2	6	2.4	7	2.8	0	0.0	9	3.6	6	2.4
Gynaecology-oncology, N = 118	13	11.0	5	4.2	0	0.0	4	3.4	4	3.4	0	0.0
Medicine, N = 2619	197	7.5	77	2.9	47	1.8	15	0.6	27	1.0	31	1.2
Other, N = 10	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

UTI, urinary tract infection; SSI, surgical site infections; BSI, bloodstream infections; CDAD, *Clostridium difficile*-associated diarrhoea.

Canadian Nosocomial Infection Surveillance Program. J Hosp Inf 2007; 6:243-48

# Costs of HAI

Infection Type	Rate per 100 admissions	Expected No. Infections per Year	Extra LOS per Case (Days)	Extra Bed Days/Yr	Cost per Infection	Cost per Year
Surgical Wound	1.39	171	12.0	2,052	12,000	2,052,000
Pneumonia	0.60	74	20.0	1,480	20,000	1,480,000
Bacteremia	0.27	33	24.0	792	24,000	792,000
Urinary	2.39	294	2.4	706	2,400	706,000
CDAD	0.7	86	15	1,290	15,000	1,290,000
Other	1.07	132	4.8	662	4,800	662,000
<b>Totals</b>		<b>790</b>		<b>6,982</b>		<b>\$6,982,000</b>

Based upon 12,300 admissions per year to a general hospital

# Personal Impacts of HAI's

- Pneumonia
  - 30% mortality
  - 20 days extra stay
- A wound infection
  - 3% mortality
  - 8 days extra stay
- A blood stream Infection
  - 16% mortality
  - 24 days extra stay



## HAI Mortality

- There are an estimated 8,500-12,000 deaths attributable to hospital infections annually for a crude mortality of 28-40/100,000
- Compared to:
  - 13.8/100,000 for breast cancer
  - 23.6/100,000 for colorectal cancer
  - 51.1/100,000 for lung cancer mortality rates

## Do Germs Survive on Surfaces?

- MRSA can remain viable for up to 14 days on formica surfaces, and for up to six to nine weeks on cotton-blanket material
- Some epidemic strains of MRSA have been shown to survive longer and at higher concentrations than nonepidemic strains
- *S. aureus* can remain virulent and capable of causing infection for at least 10 days after exposure to dry surfaces

# How Long Do Bacteria Live on Surfaces?

Type of bacterium	Duration of persistence (range)
<i>Acinetobacter</i> spp.	3 days to 5 months
<i>Bordetella pertussis</i>	3 – 5 days
<i>Campylobacter jejuni</i>	up to 6 days
<i>Clostridium difficile</i> (spores)	5 months
<i>Chlamydia pneumoniae</i> , <i>C. trachomatis</i>	≤ 30 hours
<i>Chlamydia psittaci</i>	15 days
<i>Corynebacterium diphtheriae</i>	7 days – 6 months
<i>Corynebacterium pseudotuberculosis</i>	1–8 days
<i>Escherichia coli</i>	1.5 hours – 16 months
<i>Enterococcus</i> spp. including VRE and VSE	5 days – 4 months
<i>Haemophilus influenzae</i>	12 days
<i>Helicobacter pylori</i>	≤ 90 minutes
<i>Klebsiella</i> spp.	2 hours to > 30 months
<i>Listeria</i> spp.	1 day – months
<i>Mycobacterium bovis</i>	> 2 months
<i>Mycobacterium tuberculosis</i>	1 day – 4 months
<i>Neisseria gonorrhoeae</i>	1 – 3 days
<i>Proteus vulgaris</i>	1 – 2 days
<i>Pseudomonas aeruginosa</i>	6 hours – 16 months; on dry floor: 5 weeks
<i>Salmonella typhi</i>	6 hours – 4 weeks
<i>Salmonella typhimurium</i>	10 days – 4.2 years
<i>Salmonella</i> spp.	1 day
<i>Serratia marcescens</i>	3 days – 2 months; on dry floor: 5 weeks
<i>Shigella</i> spp.	2 days – 5 months
<i>Staphylococcus aureus</i> , including MRSA	7 days – 7 months
<i>Streptococcus pneumoniae</i>	1 – 20 days
<i>Streptococcus pyogenes</i>	3 days – 6.5 months
<i>Vibrio cholerae</i>	1 – 7 days



Kramer et al. BMC Infectious Diseases 2006, 6:130

# How Are The Germs Spread?

- Transmission of MRSA from environmental surfaces to gloves or hands of HCWs has been documented by several investigators
- **42%** of 12 nurses who had no direct contact with patients contaminated their gloves by touching objects in the rooms of patients with MRSA in a wound or urine



Boyce et al. Infect Control Hosp Epidemiol 1997;18:622-627.

# Deadly Hands!

- **31%** of volunteers who touched bed rails and overbed tables in patient rooms contaminated their hands with *S. aureus* (35% of which were MRSA)
- When volunteers touched bed rails and overbed tables in unoccupied rooms that had been terminally cleaned, **7%** contaminated their hands with *S. aureus*!



# Attack of the Killer Hands!

- 25 HCWs touched VRE-positive sites such as the skin of VRE-colonized patients and contaminated environmental surfaces
- HCWs then touched 151 VRE-negative sites after touching a contaminated site
- VRE was transferred to 16 (10.6%) of negative sites!
- Touching a contaminated environmental surface resulted in transfer of VRE to another site as often as touching a colonized patient

Duckro et al. Arch Intern Med 2005;165:302-307.



## How Many Surfaces Are Contaminated?

- 1% – 27% of surfaces in patient rooms in wards of MRSA + patients
- 3% – 64% of surfaces in burn units of MRSA + patients
- 36% of surfaces cultured in the rooms of patients with MRSA in a wound or urine are contaminated,
  - compared to 6% of surfaces in the rooms of patients with MRSA at other body sites



Boyce et al. Infect Control Hosp Epidemiol 1997;18:622-627.

## MRSA Colonization & Diarrhea

- 10 high-touch surfaces cultured in the rooms of 8 patients with stool colonization with MRSA and diarrhea (cases)
- Controls were 6 patients with MRSA at other body sites, but not in their stool
- 59% of surfaces were contaminated with MRSA in the rooms of diarrhea cases
- Only 23% of surfaces were contaminated in the rooms of control patients
- Contaminated surfaces:
  - bedside rails 100%
  - blood pressure cuffs 88%
  - television remote control devices 75%
  - bedside tables and toilet seats 63% each
  - toilet rails and dressers 50% each
  - door handles 38%
  - intravenous pumps 25%



Otter et al. Presented at the 16th Annual Scientific Meeting of the Society for Healthcare Epidemiology of America, Chicago, IL, 2006; abstract 159.

# C. difficile in the Environment

Culture Negative Patient	Culture Positive No Symptoms	Culture Positive Active Diarrhea
7/88 (8%)	11/38 (29%)	44/90 (49%)

McFarland LV, Mulligan ME, Kwok RY, Stamm WE. Nosocomial acquisition of Clostridium difficile infection. N Engl J Med. 1989;320:204-210.

## VRE VRE Everywhere VRE!

- Overall, 7-29% of environmental sites were positive in areas housing VRE patients
- 46% of environmental cultures obtained in the rooms of VRE patients who had diarrhea are contaminated
  - compared to 15% of surfaces cultured in the rooms of VRE patients who did not have diarrhea
- 12% of 1294 environmental cultures were positive for VRE in an intensive care unit (ICU)
  - environmental contamination as high as 60-70% in rooms of patients colonized with VRE at > three body sites
- Prospective studies in ICU's demonstrate that about 23% of patients who are VRE-negative become positive after their room became contaminated
- Two of 10 VRE-negative patients whose bedside rails became contaminated acquired the same strain of VRE that was present on the bedside rail
- Hospital sites most commonly contaminated with VRE include bedside rails, bedside tables, blood pressure cuffs, and floors

Bonten et al. Lancet 1996;348:1615-1619.



## When Was My Room Cleaned?

- In a retrospective case control study with multivariate analysis by Martinez et al.
- Patients who acquired VRE were much more likely than controls to have occupied a room with persisting VRE environmental contamination
- Implying that inadequately cleaned rooms served as a source of transmission to new patients

Martinez et al. Arch Intern Med 2003;163:1905-1912.



# Does Cleaning Help Get Rid of Germs?

- Schultsz et al revealed that contaminated ultrasonic nebulizers were implicated in transmission of MRSA
  - Cleaning them solved the problem!
- Rampling showed that increased cleaning of an outbreak ward was associated with control of the MRSA outbreak



Schultsz et al. J Hosp Infect 2003; 55:269-275.  
Rampling et al. J Hosp Infect 2001;49:109-116.

# Does Cleaning Prevent Transmission?

- Enhanced environmental cleaning is associated with a 34% reduction in VRE transmission on affected wards
- Enhanced environmental cleaning, when used in combination with other control measures, was considered a major factor in terminating an outbreak of VRE in a burn unit

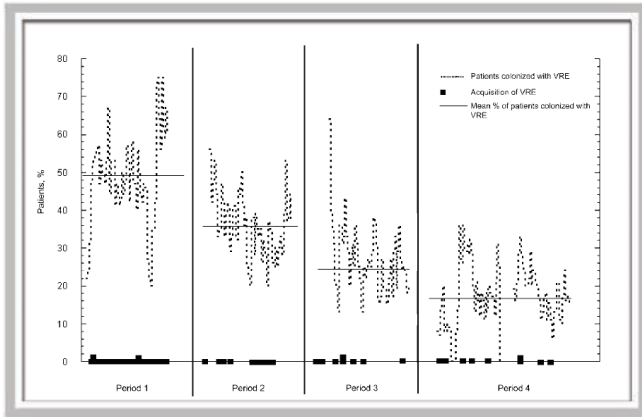
Brooks et al. Infect Control Hosp Epidemiol 1998;19: 333-336  
Falk et al. Infect Control Hosp Epidemiol 2000;21: 575-582.

# VRE & Cleaning

- Hayden et al conducted a 9-month prospective study in a medical ICU
- Examined impact of enhanced environmental cleaning on VRE spread transmission
- Admission and daily VRE screening of patients
- 4 time periods:
  - Baseline period with observation only
  - Education with effort to improve environmental cleaning
  - "Wash-out" period with no specific intervention
  - Lastly a multimodal hand hygiene intervention
- Enhanced cleaning with a disinfectant was found to independently contribute to reduced VRE environmental contamination and hand contamination
- Hand Hygiene did NOT improve at all
- Significantly reduced VRE rates due to improved cleaning!

Hayden et al. Clin Infect Dis 2006;42:1552-1560.

# VRE & Cleaning (2)



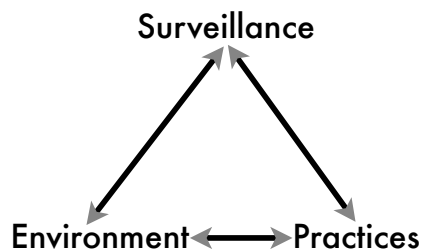
Hayden et al. Clin Infect Dis 2006;42:1552-1560.

## The Built Environment

- A retrospective cohort of adult patients admitted to a Kingston General Hospital between June 30, 2001 and December 31, 2005 was studied
- Exposures were characterized as total daily roommate exposures
- Outcomes examined were time to first MRSA, VRE and C. difficile
- The number of roommate exposures per day was significantly associated with:
- MRSA: HR=1.10 (95% CI: 1.05-1.15)
- VRE: HR=1.11 (95% CI: 1.02-1.21)
- C. difficile: HR=1.11 (95% CI: 1.03-1.19)
- A private room is a safer room!
- Hamel, Zoutman and O'Callaghan, Am J Inf Control 2010



## The Three Pillars of IC

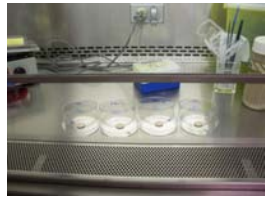


# Steam For Hospital Cleaning



- Potential Advantages
- Uses tap water
  - No chemicals
  - Portable
  - Fast
  - Excellent cleaning
  - Achieves 6 log<sub>10</sub> reduction on surfaces
    - That's sterilization!

## Bacteria Tested



- MRSA
- VRE
- Pending
  - *C. difficile*
  - *P. aeruginosa*

## Steam Trials

- 5 second exposure
- Stainless steel
- Laminate
- Toilet seat plastic



# Steam on Steel

Organism	Control (log <sub>10</sub> )	Steam (log <sub>10</sub> )
MRSA	5.35	0
VRE	6.17	0

# Steam on Laminate

Organism	Control (log <sub>10</sub> )	Steam (log <sub>10</sub> )
MRSA	6.52	0
VRE	6.34	0

# Steam on Toilet Seat

Organism	Control (log <sub>10</sub> )	Steam (log <sub>10</sub> )
MRSA	6.46	0
VRE	5.93	0

## Let's Review



**Germs are everywhere in a hospital & especially in patient care areas**

**Germs survive there for long times, mostly undetected and unsuspected**



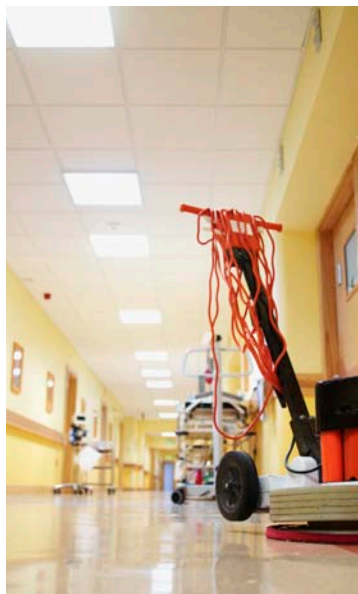
**These germs are easily transmitted to hands and clothes of care providers & directly to patients**



**From the hands of care providers germs transmitted to patients**



**Cleaning the environment reduces amount of germs**



**Less germs on environment reduces risk of transmission to patients**



**Less transmission to patients reduces infections**

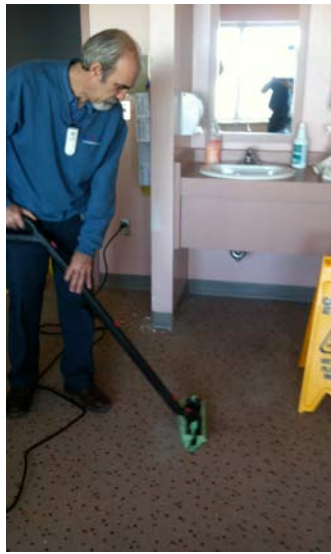


**Healthcare Associated Infections are common, costly and can be deadly**



# Many good cleaning options

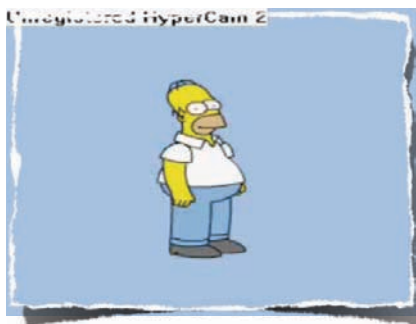
Excellent chemical products  
Steam has great potential  
New methods:  
Vapours/gases



# Therefore: Environmental Services Saves Lives!



# According to Homer



# Thank You!



Tracy Arm, Alaska