


Natural Ventilation in the Healthcare Environment
Russell Olmsted, Dick Moeller, and Linda Dickey
Broadcast live from the 2015 APIC conference... www.apic.org

Natural Ventilation in the Healthcare Environment

APIC 2015 Annual Conference

Russell N. Olmsted, MPH, CIC – Trinity Health
Dick Moeller PE FASHE – Mazzetti
Linda Dickey, RN, MPH, CIC – UC Irvine Health

 *Spreading knowledge. Preventing infection.*
Association for Professionals in Infection Control and Epidemiology


APIC 2015 June 27-29
Nashville, TN

www.webbertraining.com June 29, 2015

Is it Time to Consider NV?

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a bacall

"This really is an innovative approach, but I'm afraid we can't consider it. It's never been done before."

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HARDIN

"if people never tried anything new we wouldn't be living in caves."

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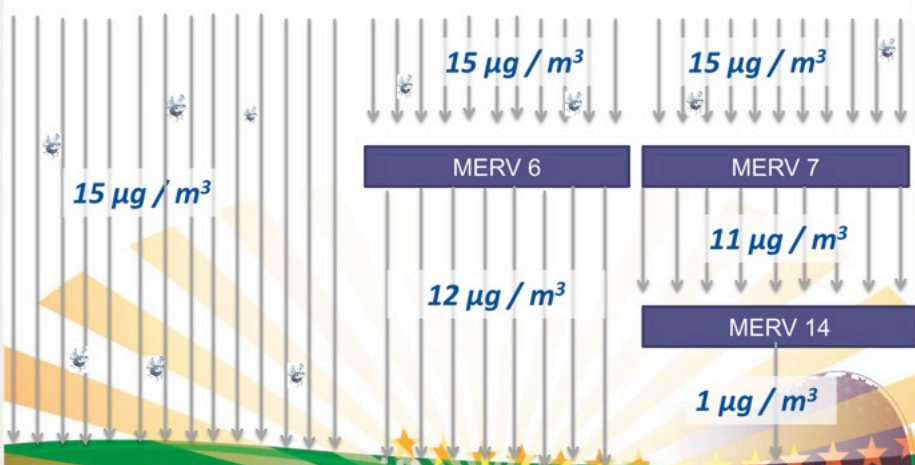
Mechanical **Natural Ventilation**

“Natural ventilation is the flow of outdoor air caused by wind and thermal pressure through intentional openings in the building’s shell.”

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Ventilation and Energy: *Filtration (aseptic air)*

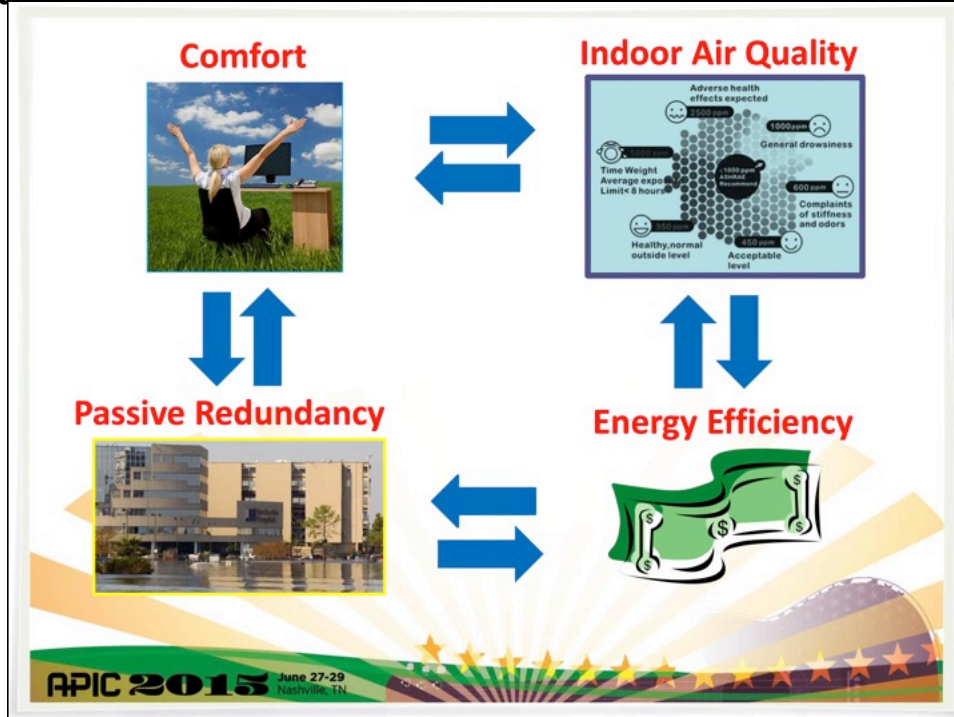
Nature	ASHRAE Standard 62.1	ASHRAE Standard 170
Nature (Screens)	MERV 6	MERV 7 MERV 14



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Codes and Guidelines

- CDC Environmental Guideline
- The FGI Guidelines for Design and Construction of Hospitals and Outpatient Facilities - 2014
- ASHRAE Standard 170 – 2013 'Ventilation of Health Care Facilities'
- AHJ's

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Key Perspectives:

- Patient Safety (Location)
- Facility operations
- Financial feasibility



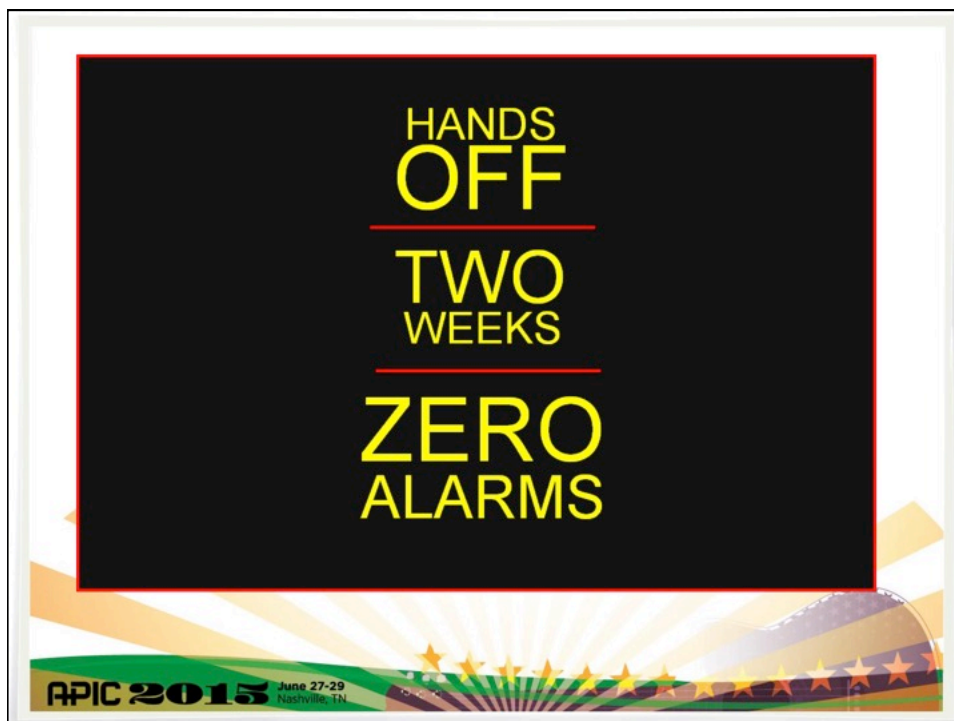
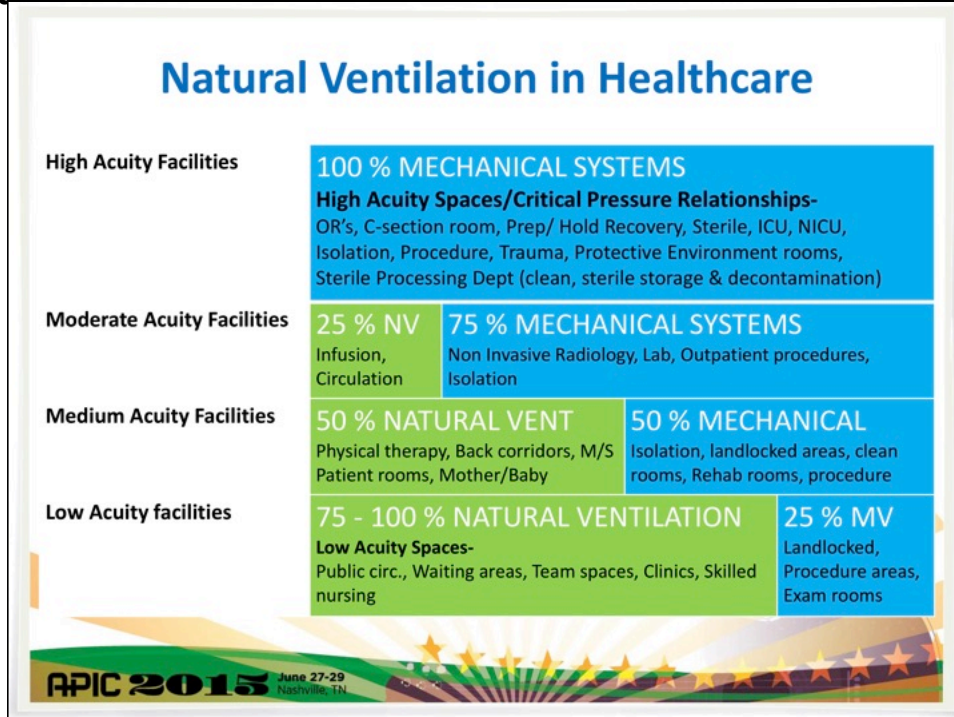
**DO NOT CONSIDER
FOR NATURAL VENTILATION**

- Operating Rooms
- Sterile Core
- Procedure Suite
- Interventional Radiology / Cardiology
- Intensive Care Units
- Airborne Isolation Areas
- Protective Environment



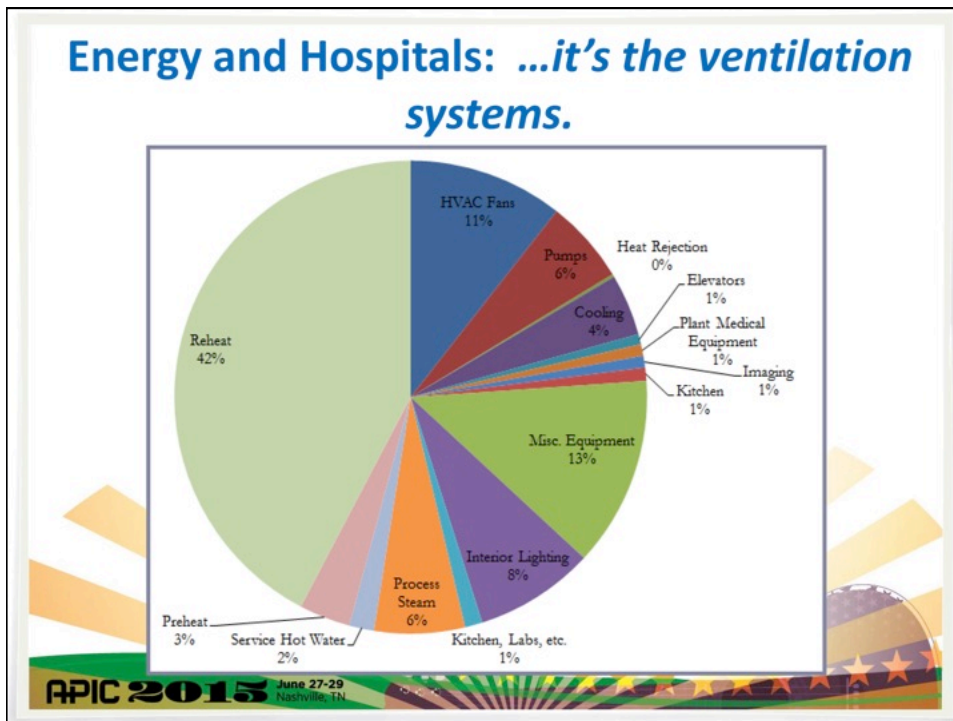
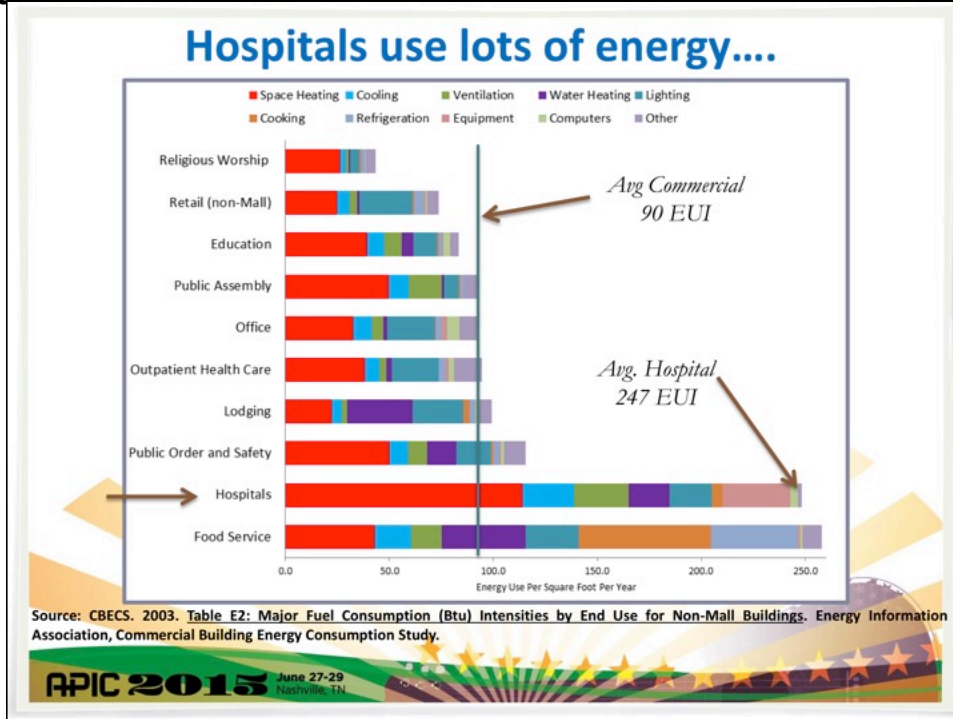
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Pinderfields Hospital Wakefield, West Yorkshire, UK

Natural Ventilation

INTRODUCTION CASE STUDIES PRODUCT GROUPS REGULATIONS

Pinderfields Hospital

Project Details
Project: Pinderfields Hospital
Location: Wakefield, West Yorkshire
Client: Consort and Mid Yorkshire Hospital NHS Trust



SE Controls have been contracted by Balfour Beatty to provide a [natural ventilation](#) system for the new £31m PFI development, Pinderfields Hospital. The system will be used to regulate the internal air temperature and quality of the Stepping Stones Building.

The natural ventilation system being provided will include automation of the [external façade](#) to draw through clean fresh air into the building.

The external façade is typically used in natural ventilation strategies to provide either single sided or cross ventilation. The design process takes into account the location of the building in relation to prevailing winds, occupant density of each specific zone adjacent to each external façade.

The design strategy of controlling the [automatic operable vents](#) (AOVs) is by integrating with the BMS and when elevated CO2 and temperature levels will trigger the AOVs to open, exhausting stale hot air and introducing cool fresh air.



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Veterans Home Skilled Nursing Facility



- The project's key strategy is a natural cooling system that capitalizes on the site's mild microclimate and sea breezes.
- 240 operable windows give residents access to fresh air and control over their environment—helping set a precedent for the dignified, empowered treatment of elderly veterans.

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Russ's initial reaction to NV in Health Care:

"I'm full of fears and I do my best to avoid difficulties and any kind of complications."

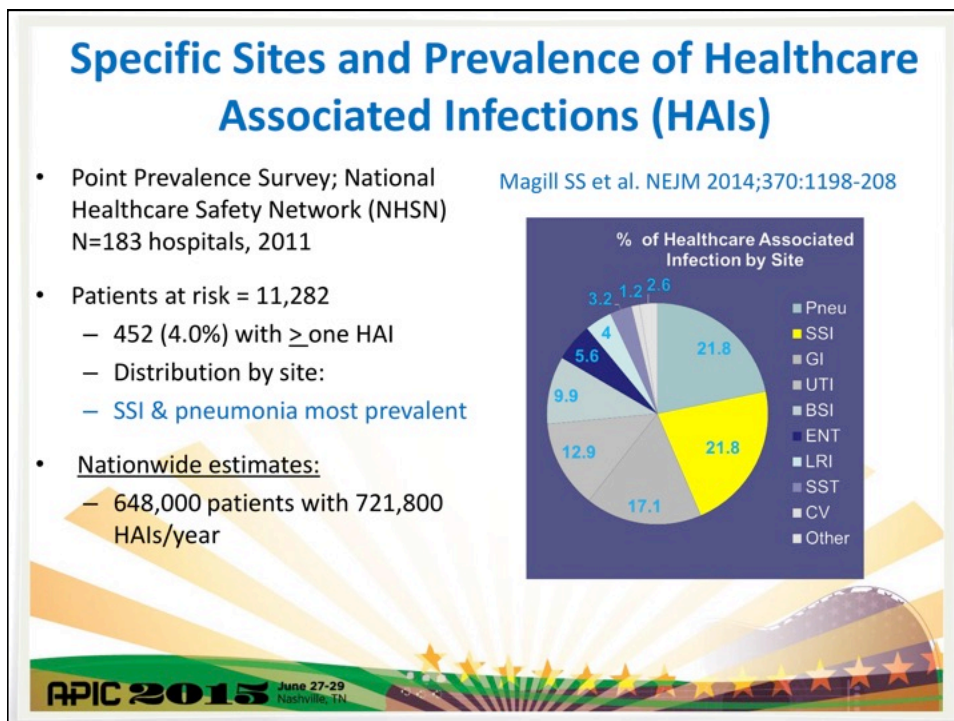
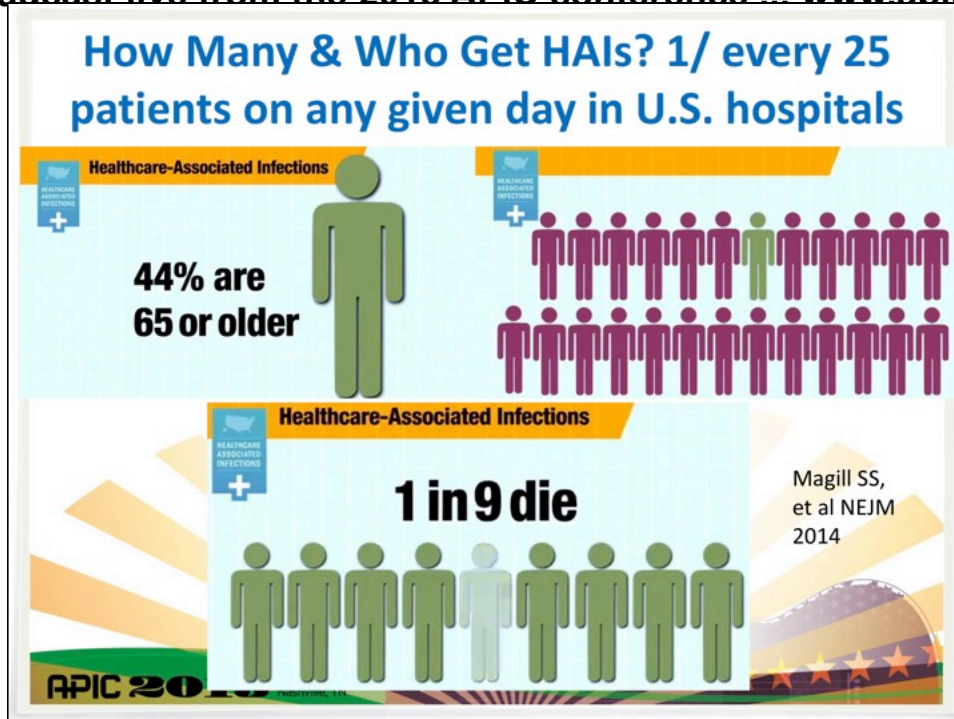
- A. Hitchcock

But let's take a closer look at frequency and cost of healthcare-associated infections (HAIs)...

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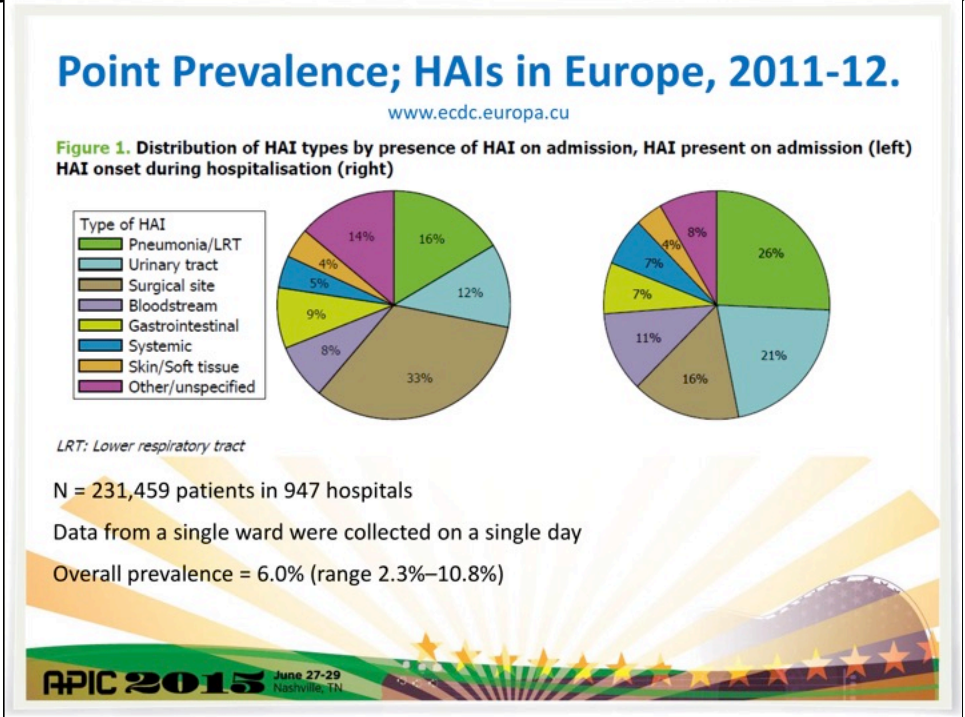
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Perspective on Modes of Transmission of Pathogens; comparing the risks

Contact: *most common mode for pathogens - HAIs*
Direct & Indirect

Droplet: microbe in respiratory droplets produced by cough or sneeze; droplets travel 1-2 meters; examples: influenza, MERS-CoV

Airborne: microbe in respirable droplet becomes airborne and can travel long distance and be inhaled deep into lung; examples: *Mycobacterium tuberculosis*, *Aspergillus spp.*

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Historical Experience with Natural Ventilation (NV); What Did Florence DO?

“At her behest, new windows capable of opening were installed to air out the wards..”

Nightingale in Scutari:
Her Legacy Reexamined. Gill CJ. Clin Infect Dis 2005.

OUTCOME SCORECARD:
F. Nightingale arrives, Scutari, 1854

Mortality Rate among soldiers:

Jan-Mar. 1855 =	33%
Apr-June	6%
July-Sept.	2%



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Review

Roles of sunlight and natural ventilation for controlling infection: historical and current perspectives

R.A. Hobday^a, S.J. Dancer^{b,*}

^a8 Springvale, Cwmbran, Torfaen, UK

^bDepartment of Microbiology, Hairmyres Hospital, East Kilbride, Lanarkshire G75 8RG, UK

- 1) “Current knowledge of indoor transmission of pathogens is inadequate, partly due to lack of agreed definitions for particle types and mechanisms of spread. There is recent evidence to support historical data on the effects of natural ventilation but virtually none for sunlight...”
- 2) ...designing buildings to allow increased exposure to sunlight and outdoor air may discourage survival and spread of infectious agents
- 3) consequential health benefits for occupants potential benefits from sunlight penetration and natural ventilation merit further investigation...”

Journal of Hospital Infection 84 (2013) 271-282

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Important Need for Preventing Healthcare Associated Aspergillosis – Limitation of NV

- 53 clusters or outbreaks:
 - 458 patients
 - Overall case fatality rate = 57.6%
- In one half of these the probable / possible source =
 - Construction &/or demolition work in healthcare facilities
- Infections observed even with concentration of *Aspergillus* spp in air was ≤ 1 colony-forming unit /m³

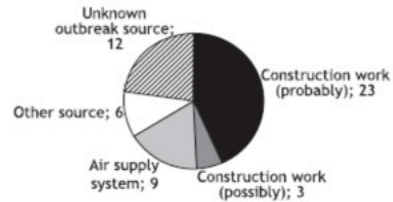


Figure 1 Distribution of sources of nosocomial aspergillus outbreaks.

Vonberg R-P, Gastmeier. Nosocomial aspergillosis in outbreak settings. *J Hosp Infect* 2006;63:246-54.

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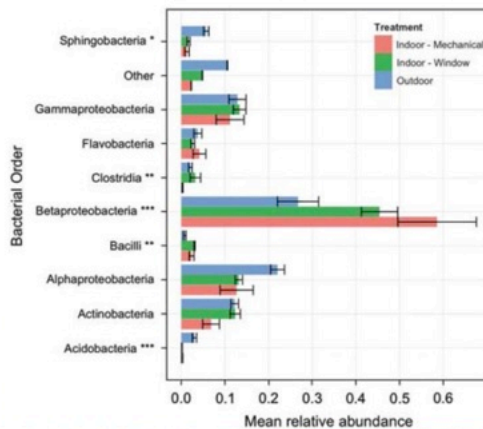
The Building Microbiome Project; study site = acute care hospital in Oregon

“...we found that the abundance of potentially pathogenic bacteria was not higher in NV compared to MV rooms.”

Kembel SW, et al. *ISME Journal* (2012) 6, 1469–1479

Russ’s observations:

- The predominant bacteria in MV made up of microbes on our skin.
- Does this study instead suggest MV system did a good job removing microbes in outdoor air?



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What's Frequency of CLABSI in Facilities in Country with Fewer Resources/Infrastructure?

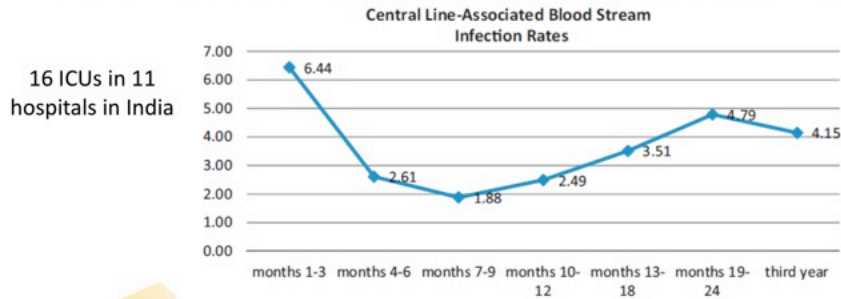


Figure 1. Central line-associated blood stream infection rates by period.

Yes, study found 53% drop in CLABSI rates after improvement program + feedback of data to providers

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WHO Surgical Safety Checklist, 8 cities



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Outcome Indicators; Surgical Morbidity Around the Globe

	Baseline	Checklist	P value
Cases	3733	3955	-
Death	1.5%	0.8%	0.003
Any Complication	11.0%	7.0%	<0.001
SSI	6.2%	3.4%	<0.001
Unplanned Reoperation	2.4%	1.8%	0.047

Haynes et al. A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population. *New England Journal of Medicine* 360:491-9. (2009)

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WHO Guidance on NV; Min. hourly ave. ventilation rates:
160 l/s/patient (AIIR)
60 l/s/patient (gen. wards, outpatient care)
2.5 l/s/m³ (corridors)

Natural Ventilation for Infection Control
 In Healthcare Settings. WHO, 2009

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Table 2.1 Summary of advantages and disadvantages of different types of ventilation systems for hospitals

	Mechanical ventilation	Natural ventilation	Hybrid (mixed-mode) ventilation
Advantages	Suitable for all climates and weather with air-conditioning as climate dictates More controlled and comfortable environment Smaller range of control of environment by occupants	Suitable for warm and temperate climates — moderately useful with natural ventilation possible 50% of the time Lower capital, operational and maintenance costs for simple natural ventilation Capable of achieving high ventilation rate Large range of control of environment by occupants	Suitable for most climates and weather Energy-saving More flexible
Disadvantages	Expensive to install and maintain Reported failure rate in delivering the required outdoor ventilation rate Potential for noise from equipment	Easily affected by outdoor climate and/or occupant's behaviour More difficult to predict, analyse and design Reduces comfort level of occupants when hot, humid or cold Inability to establish negative pressure in isolation areas, but may be provided by proper design; depends on situation Potential for noise intrusion High-tech natural ventilation shares some of the limitations and disadvantages of mechanical ventilation	May be expensive May be more difficult to design

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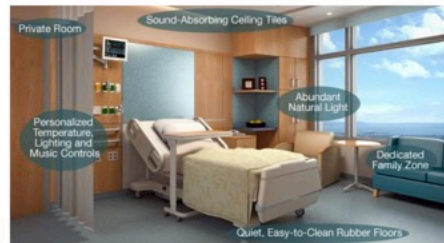
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Juxtaposition of Two Principles:
Indoor air quality / Preventing
cross transmission of
pathogens

In U.S., design guidance
(FGI) and trend is towards
single patient rooms.
Rationale;
spatial separation =
less transmission



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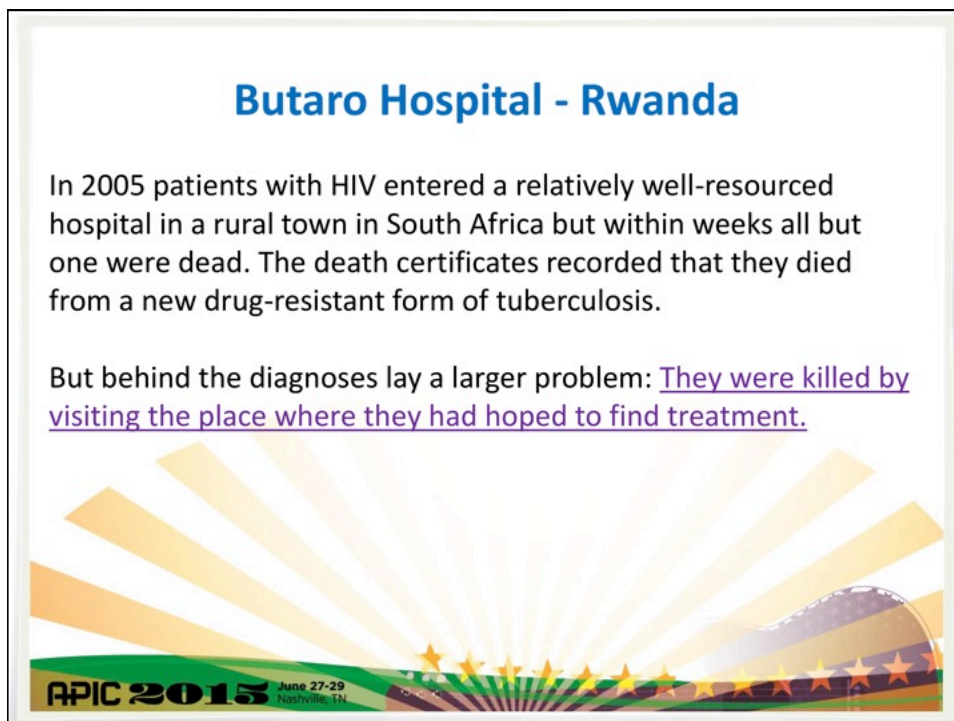
Summary Points on NV & Infection Prevention

- The predominant mode of transmission of pathogens that cause HAIs is via direct or indirect contact.
- For facilities in the U.S.; design and operation of HVAC that uses NV must not disrupt or inhibit recommended pressure relationships of key areas, e.g. OR, AIIR, PE.
- Surveillance of HAIs differ between countries but does not seem that HVAC design accounts for major difference in frequency of endemic HAIs
- There remain continued questions on NV and more experience/evidence is needed comparing incidence of HAIs in buildings with NV vs MV.

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Butaro Hospital - Rwanda

'Many hospitals in poorer countries are based on designs from other countries, regardless of whether or not they are site appropriate', according to a co-author of the WHO's new guidelines on design for infection control.

The problem is compounded by a desire to utilize complex technology but, without the resources for its upkeep.



Women's & Children's Center

- Operable Windows in Patient Family Rooms – low acuity spaces
- Extraordinary setting for natural ventilation

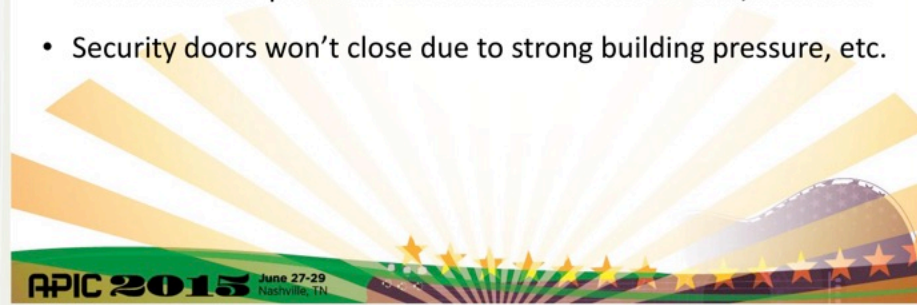


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Post Occupancy reviews with staff:

- It's the dustiest facility ever experienced in her career - dust bunnies are a usual occurrence
- Thin, fine layer of dust reportedly found on computer screens and desk tops daily
- Can't maintain pressure differential between rooms/corridors
- Security doors won't close due to strong building pressure, etc.



Post project reviews with staff:

"Fresh flowers brought to the office die in less than 2 days - flowers from the same bouquet survive up to 7 days in the home environment. Do we need a canary?"

"Obviously the HVAC system doesn't work."



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Facility Response:

Facility self-inspection + review by a certified industrial hygienists for HVAC and building analysis - conclusion: 'The HVAC system was properly designed, installed & maintained.'

(Third party tape lifts showed: tire dust, charred wood, insect/plant/bird parts, humus, soil, dog/cat dander, fern spores, rust, soil, metal wear, aerosolized dog feces . . .)



New Rural Medical Center

- Operable windows in all patient rooms
- Water and energy conservation
- HVAC components optimized for energy and IAQ



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Patient perception versus reality:



Even though the windows were open, building pressurization was adjusted so that all airflow was outward - however, the patient perceived a better environment and was much happier.

The FM commented *“Who am I to explain they’re wrong when it was an obvious benefit to the patient”*.

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Natural Ventilation Considerations:

- Non-filtered air into the facility
- Loss of environmental control within the NV area
- ‘Downstream’ effects of NV space
- Misuse of the NV system through intent, misunderstanding or ‘system’ failure
- Increased staff/housekeeping impact
- Litigation

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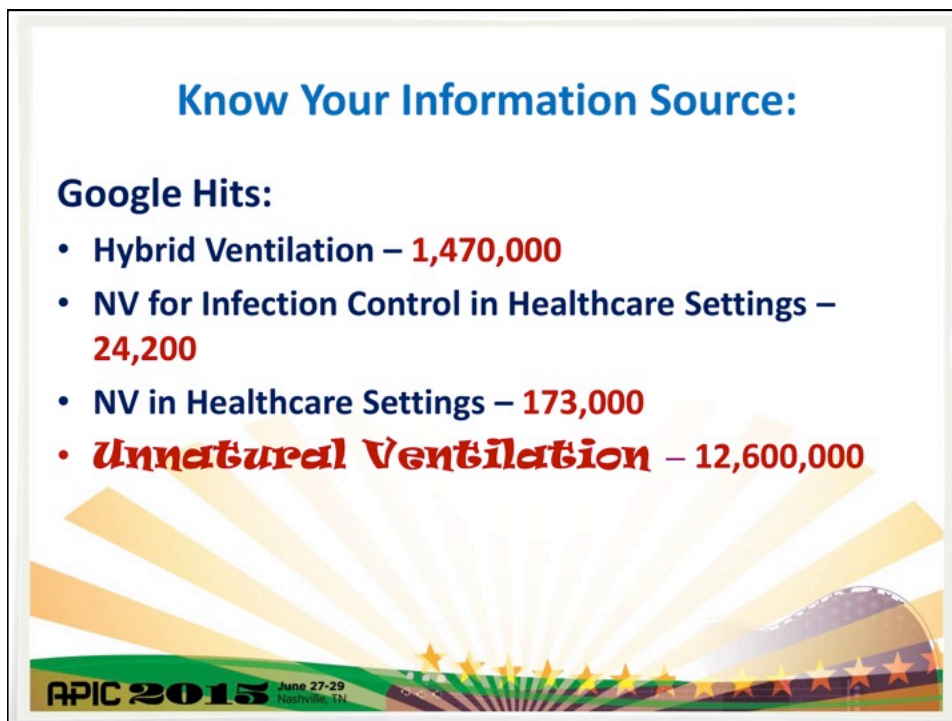
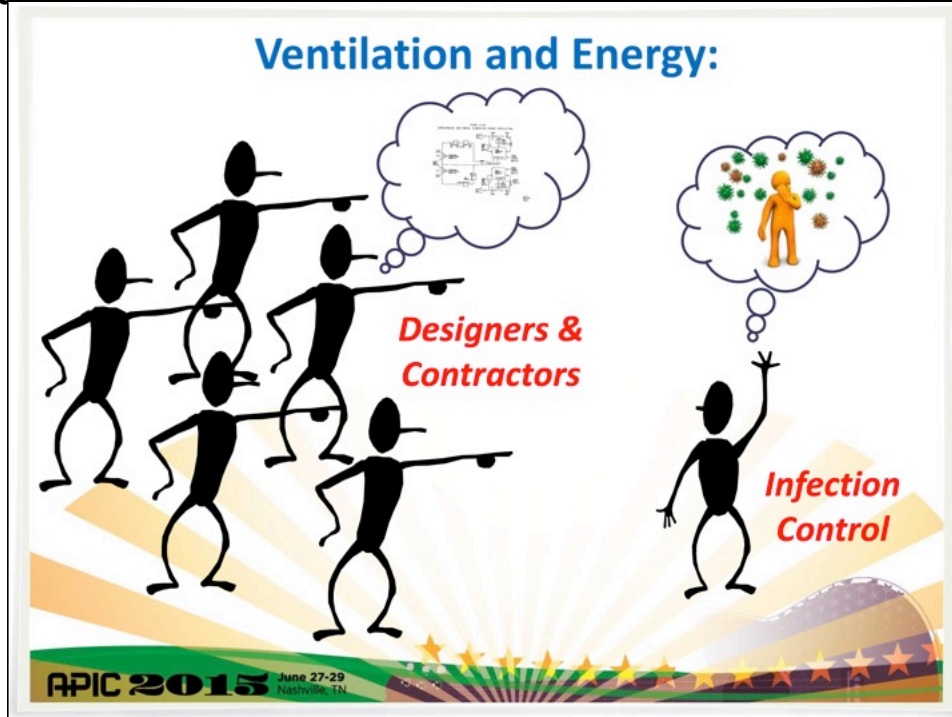
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When Considering NV Information:

- Is the "study" published in a true peer-reviewed, scientific publication?
- Consider the methodology described in the study by the authors
- Designers typically review trade journals different from what IPs review-Design/Function vs Pt. Outcomes
- Context of the information

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Natural Ventilation in Healthcare

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