Agenda

- Costs associated with HAI
- Studies linking Air Quality and HAI
- Industry Regulations
- Ventilation recommendations
- Maintenance of Critical Environments
Healthcare and Fire Statistics

- 1970s – Average 20 deaths per year
- 1980s – Average 13 deaths per year
- 1990s – Average 6 deaths per year
- 2000s – Average <1 per year
Healthcare and Fire Statistics

From 2003 to 2006, less than 1% (0.7%) of all structure fires occurred in healthcare facilities and just 2% of fires in healthcare facilities extend beyond their room of origin. Fires in healthcare facilities have resulted in an average of one civilian death per year, according to the NFPA.

ASHE leaders attribute the current safety record in U.S. hospitals to rigorous building codes and safety regulations, stringent regulatory compliance systems and staff training and drills.
Infection Statistics

Centers for Disease Control and Prevention

- Approx. 2 million patients in the US acquire a HAI in the hospital / year
- About 90,000 of these patients die because of their infection
- 5% of these are attributed to airborne infections from construction and maintenance activities

1- Estimating Health Care-Associated Infections and Deaths in U.S. Hospitals, 2002
http://www.cdc.gov/HAI/pdfs/hai/infections_deaths.pdf
HAC and Medicare Reimbursements

For discharges occurring on or after October 1, 2008, Inpatient Prospective Payment System (IPPS) hospitals do not receive the higher payment for cases when one of the selected conditions is acquired during hospitalization (i.e., was not present on admission) The case is paid as though the secondary diagnosis is not present

Hospital-Acquired Conditions (HAC) in Acute Inpatient Prospective Payment System (IPPS) Hospitals
ICN 901045 October 2012
http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/downloads/hacfactsheet.pdf
Hospital Acquired Conditions

Foreign Object Retained After Surgery
Air Embolism
Blood Incompatibility
Pressure Ulcer Stages III & IV
Falls and Trauma:
  Fracture
  Dislocation
  Intracranial Injury
  Crushing Injury
  Burn
  Other Injuries
Catheter-Associated Urinary Tract Infection (UTI)
Vascular Catheter-Associated Infection
Manifestations of Poor Glycemic Control:
  Diabetic Ketoacidosis
  Nonketotic Hyperosmolar Coma
  Hypoglycemic Coma
  Secondary Diabetes with Ketoacidosis
  Secondary Diabetes with Hyperosmolarity
Surgical Site Infection, Mediastinitis, following
Coronary Artery Bypass Graft (CABG)

Surgical Site Infection Following Certain Orthopedic Procedures
  Spine
  Neck
  Shoulder
  Elbow
Surgical Site Infection Following Bariatric Surgery for Obesity:
  Laparoscopic Gastric Bypass
  Gastroenterostomy
  Laparoscopic Gastric Restrictive Surgery
Surgical Site Infection Following Cardiac Implantable Electronic Device (CIED)
Deep Vein Thrombosis and Pulmonary Embolism Following Certain Orthopedic Procedures:
  Total Knee Replacement
  Hip Replacement
Latrogenic Pneumothorax with Venous Catheterization
CMS to reduce payments to IPPS hospitals with excess readmissions, effective for discharges beginning on October 1, 2012.

**CMS finalized the readmission measures for Acute Myocardial Infarction, (AMI) Heart Failure (HF) and Pneumonia (PN) and the calculation of the excess readmission ratio, which will then be used, in part, to calculate the readmission payment adjustment** under the Hospital Readmissions Reduction Program. CMS defined readmission as an admission to a subsection(d) hospital within 30 days of a discharge from the same or another subsection(d) hospital.

Readmissions Reduction Program
http://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html
Litigation

Data is not known on the number of incidences nor is the cost associated with the litigation and settlements.

But there is anecdotal evidence
Other Costs Associated with HAI

Nosocomial infections frequently

- Prolong hospital stays
- Increase consumption of costly resources
- May have a negative impact on the marketability of the healthcare organization

Requirements for Infrastructure and Essential Activities of Infection Control and Epidemiology in Hospitals: A Consensus Panel Report
SHEA – February, 1998, p116
The Cost of Insurance Premiums

To mitigate risks hospitals carry insurance.

To minimize risk insurance companies encourage practice and procedures that represent best practices.
Other costs related to Critical Environments

Building Performance Over Time

Energy Efficiency

Costs without ongoing measures

Sub-optimum Performance

Lost Opportunity
Agenda

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Hospital Acquired Infections and Air Quality

Many incidents linked to malfunctions and contamination of the ventilation system in hospitals (Abzug et al., 1992; deSilva & Rissing, 1984; Kumari et al., 1998; Lutz, 2003; McDonald et al., 1998; Simmons, Price, Noble, Crow & Ahearn, 1997; Uduman et al., 2002)

Studies have identified the type of air filter, direction of airflow and air pressure, air changes per hour in room, humidity and ventilation-system cleaning and maintenance as factors related to air quality and infection rates

Accumulation of dust and moisture within HVAC systems increases the risk for the spread of environmental fungi and bacteria

Example, study:
- 6 patients / 1 nurse involved with an outbreak of epidemic Staphylococcus aureus (an environmental source was suspected)
- Ventilation grilles were found to be harboring EMRSA-15 (Kumari, et al., 1998)
- The ventilation system, daily shutdown of the system created negative pressure, sucking air in from the ward environment into the ventilation system and contaminating the outlet grilles
- Other case, the source was the exhaust ducting of the adjacent isolation-room ventilation system that allowed the contaminants to enter the unit via a partially open window

Impact of the Environment on Infections in Healthcare Facilities; by Anjali Joseph, Ph.D. Published by The Center for Health Design, 2006
Most of the studies examining the efficacy of ultraclean air involve only orthopedic operations.

Charnley and Eftaknan study

- **Vertical laminar airflow systems and exhaust-ventilated clothing** and found that their use decreased the SSI rate from 9% to 1%

- However, other variables (i.e., surgeon experience and surgical technique) changed at the same time as the type of ventilation, which may have confounded the associations

GUIDELINE FOR PREVENTION OF SURGICAL SITE INFECTION, 1999; Infection Control and Hospital Epidemiology, Vol 20. No. 4, p261
Study (Lidwell et al) examined 8,000 total hip and knee replacements, compared the effects of ultraclean air alone, antimicrobial prophylaxis alone and ultraclean air in combination with antimicrobial prophylaxis on the rate of deep Surgical Site Infections

- **Ultraclean air alone was used decreased from 3.4% to 1.6%**
- Only antimicrobial prophylaxis decreased from 3.4% to 0.8%
- **Both interventions the SSI rate decreased from 3.4% to 0.7%**
- Findings suggest that both ultraclean air and antimicrobial prophylaxis can reduce the incidence of SSI following orthopedic implant operations
- Antimicrobial prophylaxis is more beneficial than ultraclean air
- Intraoperative UV radiation has not been shown to decrease overall SSI risk. 94,312

**GUIDELINE FOR PREVENTION OF SURGICAL SITE INFECTION, 1999 Infection Control and Hospital Epidemiology**, Vol 20. No. 4, p261
Orthopedic Surgery

Study (Babkin et al. in 2007) SSIs in knee replacement surgeries in a single operating room

- Implicated environmental factors, including multiple entrances to the OR with frequent movement
- Non-standardized horizontal-flow A/C above the main door to the room
- Utilization of a washing sink beyond the main door for cleaning of instruments during procedures
- When the sink was removed, the air conditioning unit was disconnected and the door was locked during procedures, the infection rate fell from 5.6% to 2.2%

Airborne Infection Isolation Rooms

**Issue:** June 2007

**Journal:** The American Journal of Infection Control (AJIC)

**Article:** "A Performance Assessment of Airborne Infection Isolation Rooms"

**Data set:** 678 AllRs

**Conclusion:**
"Hospitals are not maintaining AllRs to correspond with current guidelines"

"One deficiency that contributed to problems in these rooms was that the continuous monitoring equipment did not function properly"

Stefan A. Saravia; Peter C. Raynor; and Andrew J. Sterifel; 'A Performance Assessment of Airborne Infection Isolation Rooms', American Journal of Infection Control (AJIC), June 2007;35:5:324-321
Airborne Infection Isolation Rooms

140 AIIRs from 38 facilities were evaluated during 1992 to 1998. The NYSDOH survey identifies the following causes as being associated with outward airflow direction (38% of the rooms) in AIIRs:

- Room ventilation system was not balanced (54% of the rooms failed)
- Shared Anterooms (14%)
- Turbulent Airflow patterns (11%) such as: poorly sealed rooms, disruption of exhaust air
- Automated Control Systems (10%)
In most cases in which **medical workers have contracted respiratory infections from inhalation**, the root cause has been inadequate local ventilation, malfunctioning systems and equipment or administrative-control problems.

**Air-Treatment Systems for Controlling Hospital-Acquired Infections.** The epidemiology and aerobiological pathways of airborne nosocomial infections and methods of air and surface disinfection

Apr. 2, 2008 W. Kowalski, PE, PhD, Vice President, Immune Building Systems Inc.
Study
Hospital Acquired Infections and Air Quality

- The degree to which the transmission of nosocomial infections is airborne is unknown
- One source estimates that 10% of nosocomial infections are airborne
- Another states that 16% of ICU infections result from airborne-pathogen transmission

Air-Treatment Systems for Controlling Hospital-Acquired Infections. The epidemiology and aerobiological pathways of airborne nosocomial infections and methods of air and surface disinfection
Apr. 2, 2008 W. Kowalski, PE, PhD, Vice President, Immune Building Systems Inc.
Agenda

- Costs Associated with HAI
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- Maintenance of Critical Environments
Temperature, humidity and airflow in the operating rooms must be maintained within acceptable standards to inhibit bacterial growth and prevent infection and promote patient comfort.

Excessive humidity in the operating room is conducive to bacterial growth and compromises the integrity of wrapped sterile instruments and supplies.

Each operating room should have separate temperature control.
20%–60% RH can be considered as an operational best practice for both new and existing ORs and other short stay patient care areas.

CMS, however, will continue to write up healthcare organizations during validation surveys if the 35% rH of NFPA 99 is not met until they have issued interim language that will permit the lower limit. Waivers may be applied for if an OR occasionally falls below the 35% RH during this cold winter season.

CMS intends to accept this
- Must rewrite conditions of participation
- Will only grant retrospective waivers

CMS Considers Reducing Low-End Humidity Requirement, Outlines Interim Waiver Process

January 18, 2012

- CMS is considering changing the low-end humidity requirement in operating rooms from 35% to 20%, according to the ASHE.
- Draft memo on the subject is currently undergoing an internal review at CMS.
- While high-end humidity requirements are important to reduce infections and prevent mold and mildew, the current CMS low-end requirement for at least 35% relative humidity was first put in place to reduce static discharge and possible ignition of flammable anesthetics. Because such anesthetics are no longer used, this low-end requirement has outlived its usefulness.
- 20% in operating rooms has no adverse affect on patients but can save hospitals thousands of dollars – by reducing the initial ventilation system installation cost, eliminating the need to modernize existing systems to maintain 35% relative humidity and providing energy conservation savings.

Joint Commission Elements of Performance

EC 02.05.01

The hospital:

- Maintains a written inventory of all operating components of utility systems – based on risks for infection, occupant needs and systems critical to patient care (including all life-support systems)
- Identifies, in writing, inspection and maintenance activities
- Identifies, in writing, the intervals for inspecting, testing and maintaining all operating components
- The ventilation system provides appropriate pressure relationships, air-exchange rates and filtration efficiencies
Standard EC.02.05.05

The hospital inspects, tests and maintains utility systems

**Note:** At items, maintenance is performed by an external service. In these cases, hospitals are not required to possess maintenance documentation but must have access to such documentation during survey and as needed.

**Elements of Performance for EC.02.05.05**

The hospital inspects, tests and maintains the following:

1D The hospital tests utility system components on the inventory before initial use. The completion date of the tests is documented. (see also EC.0205.01. EP2)

The hospital inspects, tests and maintains the following:

A 3 D Life Support utility system components on the inventory. These activities are documented (See also EC.02.05.01, EPs 2-4) 3 R

A 4 D Infection control utility system components on the inventory. These activities are documented. (See also EC.02.05.01, EPs 2-4) 3 R

C 5 D Non-life support utility system components on the inventory. These activities are documented. See also EC.02.05.01, EPs 2-4) **M**
Standard EC.02.06.01

The hospital establishes and maintains a safe functional environment

Elements of Performance for EC.02.06.01

A 13 The hospital **maintains ventilation, temperature and humidity levels suitable for the care, treatment** and services provided
Health Facilities Management January 2012

"Temperature and humidity levels in the ORs, delivery rooms, central sterile, endoscopy, cath lab and sub-sterile storage areas are being evaluated closely by the Joint Commission surveyors, along with appropriate pressure differentials. This closer look may directly relate to the increased frequency of citations"
Temperature, Humidity, Pressure

- Need written hospital policy
- Temperature and humidity recorded daily
- Pressure differentials checked at least annually

Source: Health Facilities Management January 2012
Agenda

- Costs Associated with HAI
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Filtration

The control of air pollutants (micro-organisms, chemicals, dust and smoke) at the source is the most effective way to maintain clean air.

The second filter bank usually consists of high-efficiency filters. This filtration system (90% efficiency filters) is quite adequate for most patient-care areas in ambulatory-care facilities and hospitals, including the operating-room environment and areas providing central services (Sehulster & Chinn, 2003). Once the frames for the filters are in place, it is possible to increase the efficiency of the filters by adding HEPA filters for special-care areas of the hospital such as surgical areas, burn ICU units and protective environments for immunocompromised patients (Petska & Yeong, 2006). HEPA filters are at least 99.97% efficient for removing particles 0.3 μm (as a reference, Aspergillus spores are 2.5–3.0 μm in diameter) (Sehulster & Chinn, 2003).

Impact of the Environment on Infections in Healthcare Facilities
by Anjali Joseph, Ph.D.
Published by The Center for Health Design, 2006

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Building Technologies Division
Proper Ventilation

…the second most effective way of controlling the level of pathogens in the air is through ventilation
Air changes/hour (ACH) and time required for airborne contaminant removal efficiencies of 99% and 99.9%

<table>
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Guideline for Environmental Infection Control Healthcare Facilities, Center for Disease Control
June 6, 2003, Table 1
http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5210a1.htm
Standard 170: Ventilation of Health Care Facilities:

The ceiling in the OR should be monolithic

- Air entering the OR should be sequentially filtered through two filters: the first of which should be rated at 30% efficient; the second at 90% efficient.
- The OR should be maintained in positive pressure
- **A minimum of 20 air exchanges/hr, with 4 from outside air are recommended.**
- The airflow should be unidirectional, downwards- w/ an avg velocity of the 25 to 35 cfm/ft² (127 L/s/m² to 178 L/s/m²) delivered by non-aspirating diffusers. The diffusers should provide an airflow pattern over the patient and surgical team
- Details on temperature, humidity, etc., are provided in the 2010 FGI Guidelines
- There should be at least two returns low on sidewalls or at opposite corners with the bottom of these installed approximately 8 in. (203 mm) above the floor

**An APIC Guide; 2010; Guide to the Elimination of Orthopedic Surgical Site Infections, p.44**
Agenda

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Recommendations

Ongoing Maintenance of Environmental Controls – Periodic checks of AIIRs room pressurization is recommended to ensure differential pressure and optimal operation of AIIR. A general statement is made "that ongoing maintenance is a critical part of infection control that should be addressed in the written TB infection-control plan. This plan should outline the responsibility and authority of maintenance and address staff needs"

Issue: June 2007
Journal: The American Journal of Infection Control (AJIC)
Article: "A Performance Assessment of Airborne Infection Isolation Rooms"
To put it simply, how can a specific differential airflow rate be maintained if it is not periodically measured?

**Issue:** June 2007  
**Journal:** The American Journal of Infection Control (AJIC)  
**Article:** "A Performance Assessment of Airborne Infection Isolation Rooms"
Comparing the results of the NIST and NYSODH studies, three reasons can be identified as why AIIRs typically do not maintain differential pressurization:

- Poorly sealed room envelopes (room leakage)
- Use of shared anterooms (ganged anterooms)
- Room ventilation system was not tested and balanced
Laminar-airflow systems with 16 to 17 ACH supplied through HEPA filters are capable of holding OR airborne concentrations below 10 cfu per cubic meter.

Ventilation-system performance may change over time and reversals of airflow direction may occur between zones, resulting in contaminant intrusion in ICUs and ORs.
Energy Costs, Maintenance Testing and Re-Commissioning

ASHE 2011 Conference
- Developing an Effective Energy Conservation Program
- Tom Stewart
  - Administrative Director of Facilities
  - Southern Illinois Healthcare
- Clark Reed
  - Director of Healthcare Facilities Division
- US EPA
Building Performance Optimization

- **Start Energy Services Agreement**
- **Implement Quick Measures**
- **Continuous improvement in operation**
- **Your Value Added**

Without ongoing improvement measures

**Optimization**

- The trend of Operational Costs is increasing
- With ongoing optimization, opportunities can be found for continued improvement
- An annual maintenance plan is often lower than the value added

**Small investments – Big results!**
Energy and Focus on Continuous Improvement

Project vs. Program

Program’s focus on continuous improvement

Source: 2011 ASHE Conference
Perform Commissioning

- Commissioning new systems
- Retro – commissioning
- Constant commissioning
Benefits of a reduction in HAI

Prevention and control of nosocomial infections has allowed

- Decrease in length of stay
- Decrease morbidity
- Decrease costs
- Maximize appropriate use of materials
- Increase patient satisfaction
- Prevention of adverse infections outcomes in healthcare workers
  - Decreased days off work
  - Decreased personnel costs
  - Increased employee satisfaction

Requirements for Infrastructure and Essential Activities of Infection Control and Epidemiology in Hospitals: A Consensus Panel Report
SHEA – February, 1998
Quality Care
Infection Prevention

- CDC estimates that 70% of hospital-acquired infections cases are preventable

- The Center for Health Design analyzed more than 120 independent studies before concluding that clinical outcomes improve when patients receive quality-centered care in a healthcare facility where the temperature, humidity and indoor air quality are effectively managed

- Modern HVAC systems help hospitals control the spread of the airborne pathogens that cause more than 30% of HAIs, according to the CHD
Thank you!