INDUSTRIAL HYGIENE INFECTION CONTROL ACTIVITIES IN A LARGE TEACHING HOSPITAL

Thomas P. Fuller,
ScD, CIH, MSPH, MBA
AIHA, Health Care Working Group,
Infectious Disease Team,

Tech Environmental, Waltham, MA

www.techenv.com
Occupational Threats to Naturally Occurring Infectious Agents

Existing

• TB, HIV, Hepatitis, measles, smallpox

Emerging

• New agents or strains (SARS, H5N1 flu),
• MRSA, VRE
• New vectors (moving between species),
• New pathways,
• Possibly more infectious,
• Possibly more lethal,
• ‘Super Spreading Events’,
• Less understood (vaccines, treatment, transmission, viability).

- Infection Control Team
  - Physicians, ICNs, Management

- ICN Activities
  - Surveillance of patient infections,
  - Rapid identification and investigation of outbreaks,
  - Advice on isolation of patients,
  - Development of policies and procedures to control the spread of infections,
  - Training staff,
  - Preparation of annual statistical reports of infection rates.
Goals/Book Did NOT Include:

- Worker safety,
- Environmental or personal monitoring,
- Evaluation of disinfection or sterilization techniques or chemicals (FDA, EPA, OSHA),
- Engineering controls,
- Personal Protective Equipment (PPE), or
- The expertise of an Industrial Hygienist.
Industrial Hygiene & IC

• Misunderstood and underutilized,
• Unaware of IH capabilities and expertise,
• Sophisticated IH activities are performed by other departments with little understanding or knowledge of IH principles,
• Decisions made based on outdated assumptions and poor understanding of IH concepts (e.g. aerosol physics),
• Difficulty for IH principles and suggestions to be understood or accepted.
IC Evaluation-Epidemiology

- Infection rates,
  - Types,
  - Agents,
  - Departments,
- Needle sticks,
- Bed use days.
- Hand hygiene (soap use)
- Increase environmental cleaning,
- Improve equipment cleaning,
- # of training sessions,
- Personnel accountability scorecards.
IH Evaluation

- Environmental viability,
- Exposure route,
- Exposure pathway,
- Infectious dose,
- Incubation,
- Organism size/mass/density,
- Lethality,
- Treatment,
- Communicability,
- Control.

Figure 1. Dispersion of bioaerosols into the air
Air Monitoring

• Historically very little air monitoring of infectious agents is done in U.S.,
• Low germ loads led to the feeling that monitoring didn’t provide any useful information at such low levels,
• As a result few hospitals maintain the equipment or expertise in airborne monitoring for infectious agents,
• Additionally, not a lot is known about how and what to monitor, viability, and what are acceptable concentrations.
What agents to sample?

• Patient Infectious
  – TB, Varicella (chicken pox), Rubeola (measles), SARS, MRSA, VRE

• Environmental Infectious
  – Legionella, fungi, aspergillus, staphlococcus

• Environmental sensitizing
  – Filamentous spore forming agents, toxin producing microbes, insect debris,

• Airborne particulates.
When to sample?

– Commissioning, before occupancy = baseline,
  • Measure all parameters for ventilation assurance and cleanliness,
  • To provide comparison data for future operations,
– Disease outbreak analysis
  • Measure all parameters with emphasis on source detection,
  • Surface and air content for dust and fungi,
  • Water intrusions (legionella),
  • Special events/agents (SARS).
– Ongoing Surveillance
Where to Sample/Monitor?

• Sample environmental opportunistic agents in susceptible patient/process areas;
  – Bone marrow transplants, cancer immunosuppression, solid organ transplants, premature birth babies, AIDS patients, surgical areas, equipment and instrument sterilization (CPD, RT).
Where? - USP 797

- Develop plans and procedures to support **Pharmacies** to meet USP and JC requirements,
- Protect workers and patients;
  - Periodic air monitoring for bioaerosols,
  - Evaluation of air exchanges,
  - Testing air pressure differentials and directions,
  - Air intake and filtration testing,
  - Particle counting in key areas.
Where? - Infection Control Risk Assessments (ICRA)

- Job review and oversight,
- Pressure differential evaluation,
- Contamination control,
- Review of filtration and ventilation,
- Communication and coordination.
How to Sample/Monitor?

Plate 1. Six stage Andersen sampler
Plate 2. SAS Single stage sampler
Plate 3. Burkard Cyclone sampler
Interpretation

• Quantitative analysis
  – (cfu/m³)(viable)
  – (#/m³) non-viable
  – Comparison necessary with outdoor control

• Qualitative analysis
  – Pathogens/agents

• Guidelines and standards
Surface Monitoring

- Not historically done to any great extent in health care,
- Few guidelines for methods or levels,
- Very useful demonstration of hospital transmission during the SARS outbreak,
- Potentially important pathway for MRSA or other nosocomially transmitted agents,
- (cfu/cm²).
Infection Control Controls

• Environmental cleaning,
• Re-train the workers,
• Increase antibiotics,
• Isolate patients,
• Wash hands.
Industrial Hygiene Controls

- Ventilation
- Filtration
- Irradiation (UV, IR, RF, microwave, heat)

- Chemicals, gases
- Environmental Isolation
Ventilation Controls

- % outdoor air,
- ACH
- Volume, direction, plena,
- Evaluation
  - Frequency, acceptance
  - criteria, IAQ, humidity,
  - particulates,
- Filtration,
  - Type, efficiency, testing,
  - maintenance,
Baseline Ventilation Information
FIGURE 1. Schematic floor plan of the third floor bone marrow transplant unit. The second floor, which houses the leukemia unit, is identical in layout. The number of cases in each room is indicated by variable shading, and the cases in the two floors have been combined for the figure. Fourteen of the 21 cases were in the southeast corner of the floor, near the door to the central stairwell. The inpatient-outpatient clinic is labeled as IPOP. The entrance through the double doors is located on the northern end of the floor.
Positive Pressure Room Control

- Positive pressure greater supply than exhaust air volume
- Pressure differential @ >2.5 Pascal's or 0.01"w.g. ideal at 0.03"wg or 8 Pascal’s-range from 2.5 to 8.0 Pa
  - Clean to dirty airflow,
  - Monitoring
    - Sealed room, about 0.5 sq feet leakage
  - Recirculate air back through filters
  - >12 air exchanges per hour
- Greater than 125 cfm airflow differential supply vs exhaust

Intended usage's:
- Immune compromised patient rooms
- Operating rooms
Negative Pressure Room for Airborne Infection Isolation

- Negative pressure greater exhaust than supply air volume
- Pressure differential @ 2.5 Pascal's or 0.01"w.g
- Sealed room, with about 0.5 sq. feet leakage
- Airflow differential >125 cfm
- Clean to dirty, airflow
- Monitoring
- >12 air exchanges per hour new or 6 ac/hr renovation
- Exhaust to outside or HEPA filtered if recirculated

Intended usage's:
+ Procedure/treatment rooms
+ Bronchoscopy rooms
+ Autopsy
+ Emergency rooms
Containment System Monitoring

• Monitors and alarms:
  – HEPA Filters
  – Airflow Velocity
  – Building Exhaust Fans
  – Primary Containment

• Periodic testing
  – Patient isolation rooms
  – Negative pressure labs
  – Hospital ventilation and filtration systems
Plate 5. Wall mounted open field UV device (Lumalier, Memphis, USA)

(a) No UV Devices
(b) Two wall mounted UV devices
Administrative Controls

- Policies/Plans/Programs/Procedures
- Oversight and Review
- Enforcement
- Access Control/Contact/Transport
- Training (simulated Labs, medical drills)
- Vaccination, patient screening and isolation, **medical surveillance**, prophylaxis and treatment,
- Cleaning, Disinfection, Sterilization.
Barrier management

• Solid versus plastic barriers,
• Short and long term,
• Framed or taped barriers,
• Ceilings and doors as Barriers,
• Smoke and aerosol control,
• Pressure differential Management.
Contamination Control

- Not as well understood in health care as we might like to think (health physics, nuclear power),
- Little actual experience of workers with real-time monitoring,
- Little actual awareness of how agents are spread on surfaces or might physically move about,
- Few measurement methods currently available, basically none in real-time!
Contamination Control

• Consists of making a “best guess” of where the agents are likely to be (get),

• Often there is very little understanding on the part of the medical community of the environmental viability of known organisms, much less unknown ones! (SARS, MRSA).
Contamination Control

• Sterilization, Disinfection, Cleaning,
• People, surfaces, equipment,
• Ensure the methods (procedures)
• and agents are appropriate for the needs and don’t expose patients or workers to undue risks,
• Chemicals (EtO, glutaraldehyde, formaldehyde, hydrogen peroxide, detergents),
• Physical agents (microwave, UV, IR).
PPE

- Selection of gowns, face shields, eyewear, gloves, coats, booties,
- Selection of respiratory protective devices,
- Program development and implementation,
- Training.
Conclusions

• IH plays a key role in effective infection control at any hospital,
• Needs and activities span across a wide spectrum of IH rubrics,
• The need for improved infection control increases with the increasing threat of new and challenging agents.
Acknowledgements

• Andy Striefel – University of Minnesota

• Andy Sleigh - Aerobiology Research Group, School of Civil Engineering, University of Leeds
Thank You!