Air & Water Sanitation for Infection Control & Prevention

Andrew J. Streifel
Hospital Environment Specialist
Department of Environmental Health & Safety
University of Minnesota, Minneapolis
strei001@umn.edu

Hosted by Paul Webber
paul@webbertraining.com

www.webbertraining.com

2008 Training Program

- Developed for managing emerging infectious diseases-MN Dept of Health
- Topics for hospital infection control
  - – Temporary Negative Pressure Isolation
  - – Instrumentation for objective analysis
  - – Sanitation of body substances
- 60 minute presentation

2

Goals of Program

- Understand the role of the environment for infection control during infectious disease events
- Provide guidance for management of every day infectious disease incidents
- Preparation for emerging infectious disease event

3

Objectives

- Demonstrate containment of aerosols
  - – During infectious disease event
  - – Everyday events for maintenance and construction
- Provide sanitation training for body substance
  - – Emerging infectious disease preparedness
    - Cleanup of body substances from infectious patients
      - – Cleanup of patient discharge
      - – Cleanup after plumbing maintenance
    - Validation of event cleanup
      - – Real-time surrogate microbial measurement

4

CDC Environmental Infection Control Guidelines 2003

	Fungi	Bacteria	Viruses
Numerous reports in health-care facilities	*Aspergillus* spp.+ *Mucorales* (*Rhizopus* spp.)[97, 115]	*Mycobacterium tuberculosis*+	Measles (rubeola) virus[168-170] Varicella-zoster virus[162-166]
Atypical, occasional reports	*Acremonium* spp.[105, 206] *Fusarium* spp.[102] *Pseudoallescheria boydii*[100] *Scedosporium* spp.[116] *Sporothrix cyanescens*¶[118]	*Acinetobacter* spp.[161] *Bacillus* spp.¶[160, 207] *Brucella* spp.**[208-211] *Staphylococcus aureus*[148, 156] Group A *Streptococcus*[151]	Smallpox virus (variola)§[188, 189] Influenza viruses[181, 182] Respiratory syncytial virus[183] Adenoviruses[184] Norwalk-like virus[185]
Airborne in nature; airborne transmission in health care settings not described	*Coccidioides immitis*[125] *Cryptococcus* spp.[121] *Histoplasma capsulatum*[124]	*Coxiella burnetii* (Q fever)[212]	Hantaviruses[193, 195] Lassa virus[205] Marburg virus[205] Ebola virus[205] Crimean-Congo virus[205]
Under investigation	*Pneumocystis carinii*[131]	—	—

Droplet nuclei <5µm particles

- •Tuberculosis
- •Chicken pox
- •Disseminating H. zoster
- •Measles
- •Smallpox

EMERGENT DISEASES
SARS
MONKEY POX
ANTIBIOTIC RESISTANT MICROBES

5

Old fashioned way of isolating patients

Lack of ventilation control

6

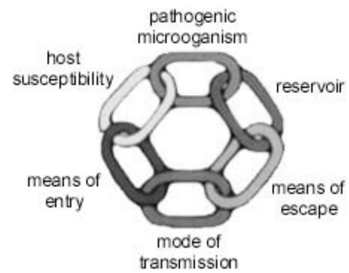
Hospital survey summary of Airborne Infection Isolation Capability

- 678 rooms surveyed using survey and site visit objective analysis
- Most rooms do not meet AIA/CDC criteria
- Inadequate pressures in a large % of rooms checked
- Filtration analysis less than specification in a high % of air handlers checked
- Lack of written plans for negative pressure machines and surge management

Saravia S, A Performance Assessment of Airborne Infection Isolation Rooms, Am J Infection Control, V35 p234 2007

7

Chain of Infection



8

Breaking the Chain of Infection

- Temporary Negative Pressure Isolation
  - Isolate infectious microbe to eliminate the mode of transmission
- Sanitation
  - Direct removal of infectious pathogen from reservoir
  - Change of pathogenic reservoir environment in order to inhibit and prevent it's growth

9

HEALTH CARE FACILITY INFECTIOUS DISEASE MANAGEMENT PRINCIPALS

ADMINSTRATIVE CONTROLS	-design guidelines -policy statements -procedures -training
ENGINEERING CONTROLS	-hand cleansing -surfaces -ventilation specification -self closing doors -sustainable construction -training
PERSONAL PROTECTIVE EQUIPMENT	-appropriate for infectious disease -training

10

What does it take to know it's working?

- Ventilation management goals and objectives should be spelled out
  - Infection control uncertainty (evidence-based)
  - Historical perspective validation of Airborne Infection Isolation (AII) Rooms
  - Day-to-day construction & maintenance mgmt
- Hospital Sanitation
  - Preparing for biological hazard
  - Cleanup assurance of body substances

11

Introduction to Ventilation

- Definition of Terms
  - **Negative pressure:** air from clean to dirty with airflow into the room being used to isolate a airborne infectious agent.
  - **Air exchange rate:** the rate at which the room air exchanges every hour. For each air exchange particles are reduced theoretically by 66%.
  - **Filtration efficiency:** the rate at which particles are removed according to particle size.
  - **Droplet nuclei:** small particles (1-5μm in diameter) able to remain airborne indefinitely and cause infection when exposed at or beyond 3 feet of the source of these particles.
  - **Inhalation transmission:** infectious particles at greater than 6 feet (2 meters) from the patient.

12

Purpose of Temporary Negative Pressure Isolation (TNPI)

- Meet surge capacity for patient isolation in response to pathogenic event
- Construction project infection control
- Prevent infectious particles from escaping the room envelope
  - Pressure management (>2,5 Pascal)
  - Dilution ventilation (12 air exchanges/hr)
  - Filtration (>90% efficient)

13

What is TNPI used for today?

- Construction
  - Hospitals are being updated and aerosols are released
- ID isolation
  - Airborne infectious disease should be controlled with clean to dirty airflow
- Surge isolation
  - Prepared to handle many infectious patients

14

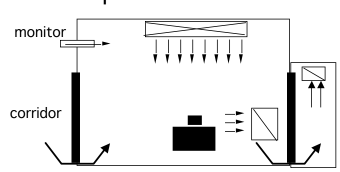
How to validate negative pressure isolation rooms

- Types of NPI
  - Rooms
    - Permanent setting with controls & monitoring
    - Temporary rooms
  - Surge control areas
    - Select areas in hospital for sudden increase in patients
    - Should be relatively modern with ventilation controls
  - Local isolation
    - Temporary set-up for short term

15

What to validate: Ventilation Control

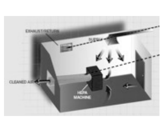
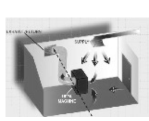
- Airflow direction
  - Clean to dirty airflow
  - When is the patient considered clean?
  - When is the patient contaminated?



16

Creating TNPI with Portable HEPA Filter

Types of Negative Pressure Isolation
- Outside Exhaust
- Supply Return Exhaust
- Local Recirculation

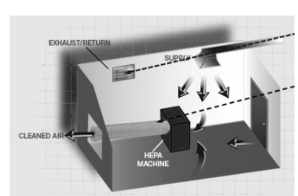




What conditions are needed to create airflow control

www.meret.umn.edu

17

Discharge to: Outside Air



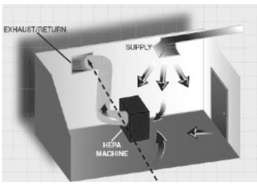
Steps for discharging air *to the outside*

1. Select a room
2. Set up pre-constructed window adapter
3. Set up HEPA machine and flex duct
4. Seal return air grille
5. Turn on HEPA machine and adjust flow

Create airflow into the patient room while extracting filtered air.

18

Discharge to:
Return Air System



Steps for discharging air to *return air system*

1. Select a room
2. Attach flex duct adapter to desired return grille
3. Set up HEPA machine and flex duct
4. Seal remaining air grilles
5. Turn on HEPA machine and adjust flow

Create airflow into the patient room while extracting filtered air.

19

Proof of Containment

- Barriers for containment must show pressure differential (sides pull in as if under a vacuum)
- Differential pressure check with digital pressure gauge

20

How to validate: Mechanical Control

- Pressure differential
  - Airflow intensity
  - Pressure translates to velocity
- Filtration
  - Physical removal of particles
  - Proper installation

Why Validate?

- Existing Conditions of Ventilation Systems
  - Area control
    - Comfort and moisture management
    - Fire management
    - Infection control needs for:
      - Airborne spread infectious diseases
      - Surge of unknown infectious patients
        - » Infectious disease event
      - Construction aerosol control
        - » Potentially infectious
        - » Environmental microbes

22

Managing aerosol presents challenges for construction in hospitals.

Routine cleaning helps maintain cleanliness necessary for safe patient care during construction.

How to validate:
Particle Counters

- Filter Management
  - Objective reduction of particles
    - Filtration validation
    - Quality Check
    - Standards modified ISO
      - Before occupancy
      - After occupancy
  - Interpretation
    - Rank order
    - I/O ratio
    - Particle size
    - Construction (ID) Zone vs. clean area

24

Air & Water Sanitation for Infection Control and Prevention

Andrew Streifel, University of Minnesota

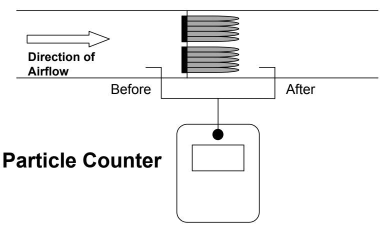
A Webber Training Teleclass

How to Validate: Tools

- Pressure Gauges
  - Airflow management
    - Test location
    - Intensity of airflow
    - Direction consistency
    - Interpretation
    - Velocity and pressure

25

Removal Efficiency In-Situ by Particle Size and Resistance to Flow



Depiction of particle counts before and after filtration in air handling system

26

Sample log for measuring particle counts APPENDIX I

This log can be used for testing portable HEPA filters as well as whole building air filters.

"PC INITIAL" and **"PC FINAL"** refer to the initial and final particle counts, respectively.
For **testing a HEPA filter,** PC INITIAL refers to the particle count at the air intake, and PC FINAL refers to the particle count at the air output of the HEPA filter.
When testing a **whole building air filtration system,** PC INITIAL can refer to either the particle count outside or before the filter, and PC FINAL can refer to the particle count inside or after the filter.

DATE	FAN	PC INITIAL HEPA: *Outside room* Building Air Filter: *Outside/Before filter*	PC FINAL HEPA: *Output of filter* Building Air Filter: *Inside/After filter*	EXPECTED PERCENT REDUCTION	ACTUAL PERCENT REDUCTION $\frac{PC_I - PC_F}{\div PC_I}$	COMMENTS

Before filter
12176 p/ft^3

After filter
40 p/ft^3

>99% reduction

27

VENTILATION CHECK LIST FILTERS

AIIR Maintenance Schedule APPENDIX B

Sample Preventive Maintenance Schedule for AIIRs

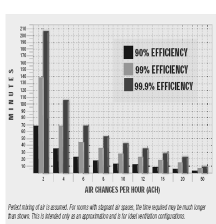
For each item, place a "**X**" in the appropriate box.
"**Y**" indicates "Yes. Room is in compliance." "**N**" indicates "No. Room does not comply." "**NA**" indicates "Not Applicable to this room."

DATE	ROOM	WINDOWS CLOSED/SEALED	DOORS SELF-CLOSING OPERATIONAL	ALARMS ELECTRONICS FUNCTIONING	MECHANICAL DEVICE ZEROS WHEN DOOR OPENS	PRESSURE READING* HAND-HELD	PRESSURE READING* ELECTRONIC	COMMENTS
		Y N	Y N NA	Y N NA	Y N NA			
		Y N	Y N NA	Y N NA	Y N NA			

28

How to Assure Isolation Ventilation Parameters

- Fixed rooms
  - Local control
    - Dilution ventilation
      - High volume purified air
    - Particle capture
      - Filtered room air
    - Airflow direction
      - Directional for control
  - Portable HEPA Filter Utilization



29

Determining Air Exchanges

ACH (Air changes per hour):

$$\frac{60\text{minutes} \times \text{Airflow (cubic feet/minute)}}{\text{Room Volume}}$$

Airflow = Mechanically exhausted airflow rate in cubic feet per minute (cfm)

Volume = Room air volume = (length x width x height) in cubic feet (ft^3)

30

Hosted by Paul Webber paul@webbertraining.com

www.webbertraining.com

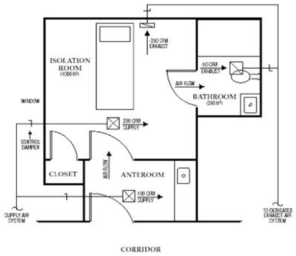
Air & Water Sanitation for Infection Control and Prevention

Andrew Streifel, University of Minnesota

A Webber Training Teleclass

AIR BALANCE VALIDATION

Special Ventilation Rooms: AIIR, PE, OR & Procedure Rooms



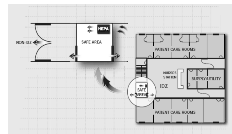
-Supply and exhaust/return location
-validate volumes
-seal room for efficiency
-validate pressure differential
-assure filter installation
-determine air exchanges/hour
-if necessary; age of air for room particle removal

Ante Rooms are not required as a minimum except in certain states.

31

Surge Capacity

- Isolation surge capacity is the ability to manage high volumes of specialized patients.
- Permanent and temporary
  - Smoke zones, engineered system and temp surge



32

Knowing a good barrier from a bad depends on pressure management?

Which barriers will help control the airflow direction?

Monitoring Devices

Flutter strip

Digital pressure gauge

Cheap flutter strip

Ping pong ball

34

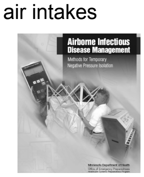
Portable filters

- Isolation with plastic and HEPA are used
  - Patient isolation
    - Short term
  - Construction isolation
    - Short and long term

35

EID Surge Capacity Criteria

- Airflow in surge area should remain negative, optimally 0.01inch w.g. (2.5 pa)
- Area should be physically separated from other areas by doors
- Air from this area should not re-circulate to other areas
- Exhaust air outside building > 25 feet from air intakes and public areas
- No flow-through traffic
- Maintain required means of egress
- Capable of function within 12 hours
- Mechanical upgrade and/or improvised

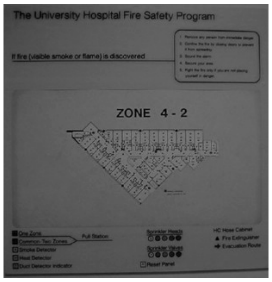


TRAINING MODULES <WWW.MERET.UMN.EDU> 36

Hosted by Paul Webber paul@webbertraining.com
www.webbertraining.com

Smoke Zone

Pressure management for smoke control



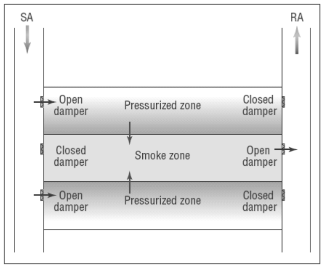
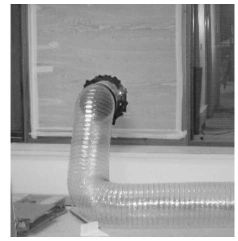


FIGURE 4. Floor-isolation and smoke dampers at shaft penetrations in sandwich-pressurization systems can be used for both smoke control and CBR isolation.

Complex building system control

37

Contaminated air must be removed from the building



Specified areas within the healthcare facility can create a isolation zone if the contaminated air is relieved to the outside. This requires sophistication in the controls that will allow for other priorities to be maintained: fire mgmt,fresh air makeup,etc. But this process can be improvised to expedite the need for ventilation control

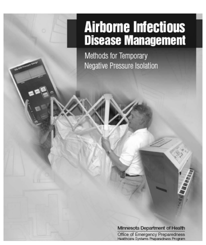
38

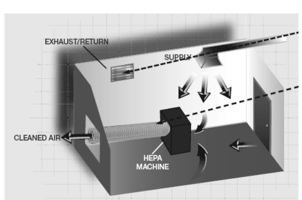
Essential Ventilation Parameters

- **Room air exchanges per hour**
  - each air exchange reduces particles about 66%
  - AII and PE rooms at >12 ac/hr
- **Pressure control for AII & PE rooms**
  - air velocity to create 0.01 inch w.g. (2.5 Pascals)
  - air velocity 0.001"wg=120 lfpm, 0.01"wg=400 lfpm, 0.1"wg= 1300 lfpm
  - design for >125 cfm offset for supply versus exhaust
  - minimal leakage < 0.5ft^2
- **Filtration supply to PE rooms & exhaust from AII rooms**
  - particle reduction to include both viable and nonviable particles
  - rank order reduction of particles from dirty to cleanest areas
  - non viable particles can be analyzed real time

39

Contaminated air must be controlled





Training for temporary negative pressure isolation can be found at: www.health.state.mn.us/oep/training/bhpp/airbornenegative.pdf

Training modules with certification for TNPI found at: www.meret.umn.edu

41

Introduction to Sanitation

- Chain/ring of infection control
- Sanitation practice during patient care
- Validation of sanitation
  - Methods
    - Culture
    - Real time visual
    - Surrogate
  - Comparison correlations
    - Contact time with bioload relationship
    - Chemical inactivation indicator

42

Provide Sanitation Training for response to infectious events

- Clean up of the environment is needed to control emerging infectious diseases

- Knowledge of good sanitation practice is essential for controlling certain environmental contaminants

43

Water related incidences

At University of Minnesota Medical Center, Fairview from 11/21/06 to 11/20/07

1364 total water events

- 612 toilet plugged
- 47 showers plugged
- 41 shower leaking
- 32 sink leaking
- 22 water leaks

71 water events in Bone Marrow Transplant (BMT)

- 20 toilet plugged
- 20 sink plugged

44

Emerging Infectious Diseases

Environmental Associated Infectious Diseases

- MRSA
  - Skin contaminant
- VRE
  - Gastrointestinal organism
- C. DIFFICILE
  - Resistant spores
- NORO VIRUS
  - Low infectious dose

45

Patient events

- Vomit
  - Captured in basins
  - Environmental contamination
- Fecal material
  - In toilet or UT appliances
  - Environmental contamination
- Blood
  - Blood borne precautions

46

Introduction to Sanitation

- **Definition of terms**
  - **Sanitize:** a reduction of microbial contamination to safe levels as judged by public health standards or requirements.
  - **Disinfect:** a less lethal process of microbial inactivation (compared to sterilization) that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms (e.g., spores)
  - **Sterilize:** the use of a physical or chemical procedure to destroy all microbial life including microbial forms.
  - **D-value:** time required to reduce microbial population by one-tenth its number or one-logarithm reduction.

47

Today’s Sanitation issues:

- Consistent daily cleaning
  - Surfaces commonly contaminated
  - Surfaces “off” limits?
- Environmental event driven cleaning
  - Patient substance contamination
  - Plumbing related incidents

48

Sanitation Practice comes with Disease Management.

- Review
- Day by day application of learning
- Airborne infection isolation and construction management principles
  - Demonstrate concepts
- Sanitation of surfaces
  - Body fluid and building spills daily decontamination requirements
  - Validation of cleaning

49

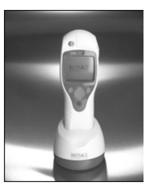
Body Waste Management

- Access to sick patient body substance
  - Health care workers
  - Family members
  - Housekeeping staff
  - Maintenance personnel
  - Nutrition service
- Disposal process
  - Waste into hopper or toilet
  - Disposal of patient cleaning material
- Sanitation
  - Basins for collection
  - Environmental splatter
  - Hands & clothing

50

How to Validate Sanitation

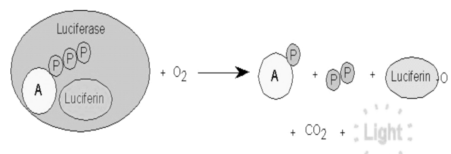
- Visual
- Culture
- Real Time Analysis

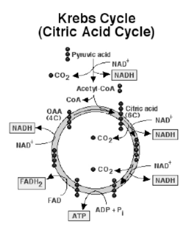


ATP technology a measure of cleanliness?

51

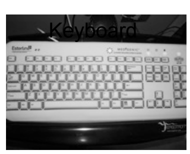
Did you ever think the Kreb's cycle was important??



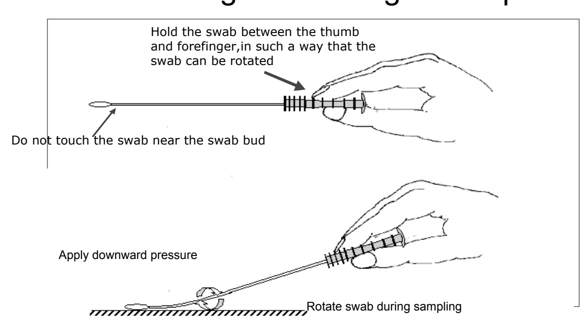


University of Minnesota Medical Center

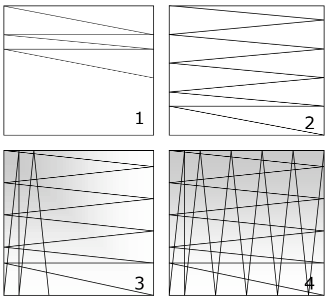
ATP surface sampling study



How to perform ATP Bioluminescent surface testing- Swabbing technique



How to perform ATP Bioluminescent surface testing- Swabbing pattern



- After following manufacture's instructions: results take less than a minute
- ATP is the "energy currency molecule" all cells utilize
- Results are in Relative Light Units (RLU)

55

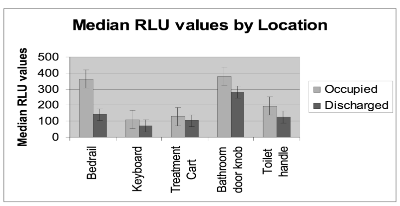
Audit UMMC-Fairview ATP Patient Care Baseline Levels

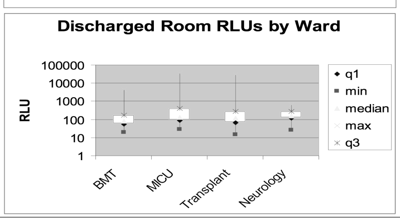
	Mean RLU values		Median RLU values		Range (RLU)	
Surfaces	Occupied	Discharged	Occupied	Discharged	Occupied	Discharged
Bedrail	1287	458	363	142	37 – 26,825	57 - 6891
Keyboard	223	238	111	71	15 – 6911	15 - 5642
Treatment Cart	399	309	129	104	20 – 4571	20 – 4280
Door knob	608	445	379	282	56 – 6640	25 - 2949
Toilet flush handle	422	856	194	126	14 - 3458	21 – 27,896

Unpublished data 2008

56

University of Minnesota Medical Center ATP surface sampling





500 RLU STD

Griffith, et.al. JHI, 2007

57

Audit of bedrail cleaning with ATP surface sampling

Why is body Substance Cleaning Inconsistent?

- •Standard Precautions?
- •Multiple Care givers
  - -visitors & healthcare worker
- •Multiple persons for cleanup
  - -visitor, HCW, housekeeping, maintenance worker

59

Develop Alert Plan

- Vomit alert
  - Determine 2 step clean up
  - Use appropriate disinfectant
- Brown alert
  - Determine 2 step clean up
  - Use appropriate disinfectant
- Sewer overflow alert
  - Determine 2 step clean up
  - Use appropriate disinfectant

60

Body substance issues

- Two step cleanup
  - Remove solid organic
  - Disinfect
- Disinfectant
  - Hospital approved
  - Chlorine and chlorine compounds
  - Steam
  - Gas fumigation
- Where to disinfect
  - Who reports discharge?
  - Who cleans it up?
  - Who disinfects?

61

Training for Respective Care Givers

- What do hospital employees do for body discharge
  - Not all body discharge is infectious?
- Family and visitor response
  - What do they need to know?
- Housekeeping and maintenance response
  - How do they disinfect after backup?
  - Disinfection after clean out and toilet plug?

62

Emphasis on Contamination Management

- What did you touch after you touched?
  - Your response is appropriate
  - But your reaction to cleaning will prevent spread….
- Should we do something different for suspect infectious body substance cleanup or make it consistent?

63

Cleanliness Verification

•Hands
–Demonstrate compliance of hand washing
•Air quality
–Demonstrate comparison data
•Surfaces
–Demonstrate cleaning
•Training
–Demonstrate understanding and competency

64

Incident management infectious disease element

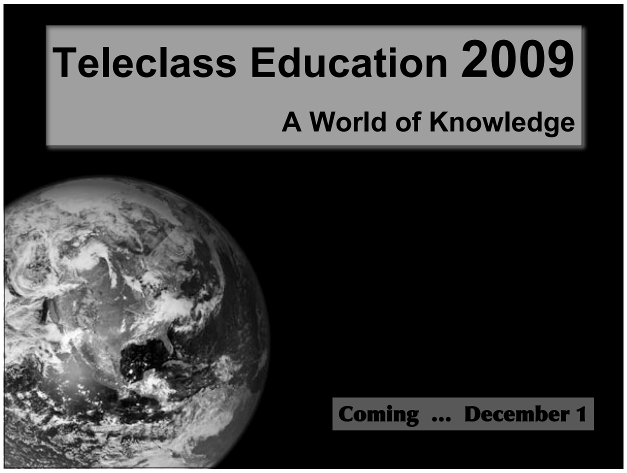
•Consistent response to body fluid clean-up
–Patient care giver & visitor
–Maintenance & Plumbers
–Housekeeping
•Proper disposal of wipes and other non water soluble material

65

Water and Air Sanitation

•Water problems can come at you fast
–Response plans for cleaning and drying
–Sanitization of surfaces
–Mitigation of mold before it grows
•Air quality can deteriorate without knowing
–Preventative maintenance is essential
–Planning provides for sustainability for comfort & infection control

66


Teleclass Education 2009
A World of Knowledge
Coming ... December 1