PAPR
(Powered Air Purifying Respirator)
Training Workshop

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PAPR training

• Any respirator must be used within an OSHA-compliant Respiratory Protection Program
• Read manufacturer’s user and maintenance instructions prior to use.
• This teaching program is supplementary only, and could contain errors.
• View 3M PAPR Air-mate™ slides on website or CD
• Incorrect use and maintenance of the PAPR could result in infection and death
• Refer to 3M Air-mate™ at www.mmm/occsafety.com or 3M First responder/First Receiver Training CD Nov 2008 70-071408791-5
• No financial relationship with 3M; PAPR is on loan for teaching; 3M permits use of all teaching materials
PAPR Awareness Level Training

- History of pandemic viral respiratory illness
- What’s a PAPR (powered air purifying respirator)?
- Respiratory disease transmission modes
- OSHA Respiratory Protection Program (RPP)
- **Occupational risk of aerosol generating procedures in** SARS/Avian/Panflu/MDR-TB
- “medical” vs “chemical” PAPR
- PPE (personal protective equipment): N95, PAPR:
  - Orthopedic surgical hood system (SHS)
- PAPR equipment check
- Don/doff sequence
- 3M Resource CD-on UW Anes website
PAPR operations level (practical) training

- Equipment assembly and check
- Don (put on) contact PPE and PAPR
- Practice intubation, bronchoscopy
- Acclimatization to PPE
- Doff (remove) PAPR and contact PPE
- Describe important maintenance issues
History—Pandemic Flu

• 1918: worldwide influenza A pandemic
  • Spanish Flu (H1N1)
  • 675,000 U. S. deaths
  • 50 million deaths worldwide
  • Original source of the virus: waterfowl or pigs

credit: Office of the Public Health Service Historian
History--SARS

2003: Worldwide spread of Severe Acute Respiratory Syndrome (SARS): Novel Coronavirus A

- 29 countries affected
- 8400 cases, 900 fatalities; 1700 healthcare personnel
- Ontario: 2 waves; 438 cases, 25% of cases intubated, 10% died (ref: Caputo 2004)
- 51% of cases were Healthcare professionals, 3 died
- 59 HCWs (22 Anesthes.) performed intubations, of 31 intubators interviewed afterwards, 3 (2 anesthesiologists) contracted SARS (10%), all during 1st wave, 1 died
- 2 wore N95, 1 wore goggles, face shield, none wore additional contact PPE

A practice run for Panflu
SARS Ontario 2003

• Seventeen HCWs contracted SARS following the implementation of SARS-specific infection control practices, which included:
  • Contact precautions (hand washing, gown, gloves, masks, and both goggles and face shields)
  • Droplet and airborne precautions (N95 respirators).
  • All 17 had direct contact with an infected patient.
  • Seven were involved in endotracheal intubation

History—Avian Flu

• 1997: Avian Flu (H5N1)
  – First appeared in Hong Kong
  – 18 infections; 6 deaths

• 2004: Avian Flu moves to Thailand
  – 47 cases; 34 deaths; continued spread

• 2009: 405 cases, 254 deaths 50-80%
  – Anticipating mutation or mingling of viral RNA allowing ready transmission and
  – Much higher mortality than SARS
  – “cytokine storm”, like 1918 panflu
Virulence of Avian, 1918 Flu

- “cytokine storm”
- Viral associated high pro-inflammatory cytokine levels in fatal cases
- Young and healthy, pregnant affected
- No treatment
What’s a PAPR? (Powered Air Purifying Respirator)

Breathing Tube and airflow indicator

Air-Mate Blower

Photos by John Kerchberger MD
What’s a PAPR? (Powered Air Purifying Respirator)

loose-fitting face cover  double shrouded hood

Photos by John Kerchberger MD
PAPR Head Covers in Use

loose-fitting face cover

hood

Photos by John Kerchberger MD
Types of PAPRs

• “Medical” PAPR: 3M “Air-mate”™, Bullard PA20™, several others; particulate filter only; not for vapors or gases. **Do not use for care of victims of hazardous material exposure**

• “Chemical” PAPR: 3M “Breathe-Easy”
  – OSHA requires 8 hrs training (awareness and operations levels) for hospital-based first receivers of victims of hazardous material exposure
  – Vapor absorbent, **for chemical exposure**; dual cartridge available
OSHA RPP

“Any respirator must be used within the context of a complete Respiratory Protection Program”

Components of an OSHA RPP

• Qualified RPP Director
• Appropriate Respirator Selection
• Risk Assessment- need for respirator, what kind?
• Written Standard Operating Procedures
• Medical Screening of Respirator Wearer
• Provide Training
• Fit Testing of N95 Respirators
• Maintenance and Reprocessing Program
• Program Evaluation

Medical Clearance Questionnaire UW Hosp

Has a doctor told you that you have any of the following?
Angina
Lung Disease
Heart Attack
Emphysema
Heart Disease
Asthma
High Blood Pressure
Epilepsy or Seizures
Diabetes treated with insulin
Do you get short of breath at work?
Are you short of breath at rest?
Do you get chest pain at work?
Do you get short of breath with walking?
Do you have medical problems that might interfere with TB mask use?
Do you get chest pain with certain activities?
Medical Clearance Decision

Director of OSHA-compliant Respiratory Protection Program (usually the hospital Employee Health Director) reviews the medical clearance questionnaire and decides if employee needs referral to personal physician for clearance to wear PPE, N95 or PAPR.
Transmission modes for SARS and Influenza

Disease acquired through close (face to face) contact: touching, living with, caring for, sharing utensils with contagious person

Droplet: (technically is contact) (small 5-50μ, large 50-100μ) -drop within (3-6 ft old)(6-10 ft new); range of sizes exists (Tellier 2004)

Contact:
  - direct-infected source to hands, eyes, nose, mouth
  - indirect (fomite)-contaminated object,(maybe self-inoculation from contaminated skin, N95, PAPR, other PPE)

Airborne: aerosol particles, < 5μ float on air for indeterminate distance and time. SARS, Influenza by short range (same room) airborne aerosol only, under aerosol-generating conditions
TRANSMISSION MODES

**TB - Airborne:** Aerosol (< 5μ, travel on air indeterminate distance and time) Precautions: particulate respirator, ie **N95 or PAPR**; negative pressure room (most ORs are positive pressure, therefore need to engage plant engr)

**SARS- Droplet** (50-100μ), **Contact**-direct and indirect (fomite), probable **short range Aerosol**

Precautions: N95 or PAPR and contact barrier; negative pressure room,

**Influenza** (H1N1; Avian H5N1, not yet “panflu”)- transmission modes and precautions **same as SARS**;
panflu would be more contagious, more lethal (SARS 5%, Avian 50-80%)

Other: Small pox- airborne, contact
Infectivity of Aerosol

Aerosol is more infective than droplet.

Amount of aerosol (<5 micron particles) required for infection was 100 times less than nasal drops

Aerosol-Generating Procedures:
OSHA “Very High Risk” occupation category

- Intubation/extubation/ventilation
- Fiberoptic bronchoscopy
- Non-invasive ventilation/CPAP, biPAP
- High flow Oxygen
- Open suctioning
- Sputum induction for TB
- Spontaneous coughing-probably
- Nebulized medication delivery
- Autopsy
- HCWs died of SARS: nurse flushed open toilet; anesthesiologist intubating
Assigned Protection Factor (APF)

A unitless value assigned by OSHA and NIOSH (Nat’l Institute for Occupational Safety and Health) based on the ratio of test particles outside to inside the respirator during simulated workplace activities (bending, lifting, other)

PAPR with loose fitting face cover (covers face and chin, air exit holes under chin) reduces exposure by factor of 25; PAPR with full hood (double shrouded head and shoulders cover) reduces exposure by factor of (at least)1000, N95 reduces exposure by factor of 10

Employer must obtain APF test results from each PAPR manufacturer being considered for purchase

PPE: (personal protective equipment)

N-95 Respirator

- Respirator - reduces exposure to pathogen bearing respirable particles (aerosol, inhaled into lungs)
- Half-face filtering facepiece particulate respirator
- Passive air filtration
  - Industrial uses also require identification of resistance of filter to degradation by oil
    - N - not oil resistant
    - R - somewhat oil resistant
    - P - strongly oil resistant
  - Respirators are also classified by the percent of test particles filtered (95, 99, or 99.97%)
  - Thus N-95 respirators are not oil resistant and filter about 95% of test particles.
  - 0.3 micron saline test particles are the most difficult size to filter; smaller and larger particles will be filtered also; (viruses are smaller than 0.3 micron but ride on particles)
PPE (Personal Protective Equipment): N-95 Respirator
Advantages

- Blocks droplet and aerosol sized particle
- Surgical mask only blocks splashes and droplet size, not aerosol; droplet can evaporate to aerosol size (droplet nuclei) and pass through mask
- N95 readily available
- No interference to using a stethoscope
- Not powered, noiseless
- Model with expiratory valve available to reduce work of breathing; can put surgical mask over it to use in surgery
N95 Disadvantages

- Requires fit testing
- Fit testing is time consuming and expensive
- N95 defeated if side leaks occur
- Anecdote: quantitative fit test- merely turning the head increased test material under the N95
- N100 won’t improve side leakage
Major limitation of N95

Face seal leakage

Periodic fit testing does not assure that the HCW will achieve a satisfactory fit at time of use.

Only those who used the N95 in their daily work were usually (not always) able to achieve a tight face seal; not related to when fit testing was last done.

Lee M C et.al. 2008 Respirator-Fit Testing: Does It Ensure the Protection of Healthcare Workers Against Respirable Particles Carrying Pathogens? Infection Control and Hospital Epidemiology 29 (12):1149-1156
PPE: N-95 Respirator
Disadvantages

- Disposables depleted rapidly during extreme demand
- Huge numbers, expense, required in 8-12 wk pandemic flu wave; OSHA Stockpiling guidance- 480 for each nurse (4 N95s per nurse per shift)
- UW Hosp - one new N95 every 3 days if scarce; use with face shield
- Re-use not recommended, but may be necessary; risk of self-contamination; store with care; do not allow to become moist
- Leaves some of the face and neck exposed to droplets; self-contamination from touching exposed skin, then eyes, face
- Increases the work of breathing; headaches; uncomfortable (wearer readjusts on face or pinch nose bridge, allows leaks)
- Ineffective when worn over facial hair
- Some can’t achieve satisfactory fit with any model
PAPR Advantages

- High Efficiency Particulate Air (HEPA) filters 99.97% of test particles, greater filtration than N95, same as N100
- Positive inside to outside air flow of 170 l/min (6 cfm) forces contaminated ambient air away (can your max insp flow rate over breathe that?)
- Provides contact protection of head and neck
- No side leakage
- APF 1000 (full hood), 25 (loose fitting face cover), 10 (for N95)
- Comfortable for continuous wear for bedside care or for a reprocessing worker
- No fit testing required
- Hoods are disposable, but may be reused by single user, must be cleaned between use
- Full hood, but not face cover OK with facial hair
Strategies to reduce transmission of severe respiratory disease to the HCW

- Wear optimal PPE for high risk procedures.
- Comply with components of OSHA Resp. Protection Program.
- Become thoroughly familiar with equipment.
- Review procedures for use, cleaning, maintenance with ID dept.
- Perform fit/seal check on N95 and air flow check on PAPR prior to every use.
- Follow correct don/doff sequence.
- Practice don/doff in training sessions in advance of need.
- Practice procedures while in PPE garb.
- Rehearse sequence of events just prior to intubation
- Prevent coughing by using muscle relaxants, but avoid pos. pressure ventilation. Wait for complete paralysis. Or use deep sedation.
- Commit the most experienced person to intubate.
- Excuse non-essential personnel from the room.
- Excuse those with systemic disease, pregnancy, older age (65)
Culture of Safety

• Everyone is equally committed to the success of a personal protective equipment program
• Hosp admin, dept leaders, environmental workers, clinical care providers, plant management
• Healthcare personnel will not and cannot be asked to report to work unless they feel safe
• Nurses in SARS felt concerns were ignored
What?

- Can’t use a PAPR during surgery?
- Then what?
- Can’t we just use the Ortho Surgical Hood? Well….not really (next slide)
- Use full PAPR hood in OR, not loose fitting face cover. Discuss with Infection Control Practitioner for approval. OR use not yet resolved
Orthopedic Surgical Hood Systems (SHS)

- Questionable respiratory protection for SARS/Panflu/TB; not NIOSH approved
- Stryker letter ‘05: If SHS used as resp PPE, must be with N95 and goggles and T4 gown rparker@inst.strykercorp.com
- SHS for SARS?: No. “not marketed for resp protec’n”, tested two SHSSs, less filtration than N95 (Derrick 2004)
- No HEPA; pulls air in thru filtering fabric; intended for wound protection, not protection of the wearer against pathogen bearing respirable particles
PAPR for healthcare

• 3M “Airmate”\textsuperscript{tm}

• ED Bullard Co “PA20”\textsuperscript{tm}
Preparing the “Air-Mate”™ unit: Blower/filter/battery in plastic case

• Remove the back cover
  – Check that the filter is clean, not wet
  – Ensure that the filter arrows point into the unit
  – Seat the gasket correctly *see user instructions

• Replace the back cover
• Do in reprocessing room
• Need to open case only to change battery; filter rarely needs change, but need to confirm placement of gasket

Photos by John Kerchberger MD
Preparing a PAPR

• Attach the breathing tube to the “Air-Mate”™ blower/filter/battery unit by inserting the male end of the hose and turning it clockwise until it stops.

Photo by John Kerchberger MD
Preparing the “Air-Mate”™ Blower

• Turn on the power
• Check the airflow with the airflow indicator
  – The indicator should float on the air coming out of the “breathing” tube
  – Two lines on the indicator float should be visible
  – If this test fails do not use the unit
  – Do not use PAPR if test float is missing

Photo by John Kerchberger MD; click on image for movie
Most important

• Battery charging schedule: after use, weekly, run stored units every 6 mo
• Air flow check: don’t lose test float
• Presence and correct location of filter gasket
• Integrity of hoods
• Avoid contamination
• Each user has own hood
• Stockpile anticipated equipment in advance
Donning/Doffing a PAPR

Prior to entering the patient’s room

– Put on shoe covers
– Put on hair cover
– Prepare the “Air-Mate”™ blower:

• http://www.health.state.mn.us/divs/idepc/dtopics/infectioncontrol/ppe/ppezapapr.html
Donning a PAPR

• Attach the breathing tube to the headgear

• Remove the tissue covering the faceplate

• Place the “Air-Mate”™ on mid-back; attach and secure belt around waist

Photo by John Kerchberger MD
Donning a PAPR

• Pull the hood over your head
  – Adjust the headband for comfort
  – Verify adequate airflow
• Remove PAPR if:
  – Breathing becomes difficult
  – You feel dizzy or anxious
  – You smell or taste contaminants
  – Your eyes, nose, or mouth become irritated
• Remove a PAPR only outside a contaminated room

Photo by John Kerchberger MD
Donning a PAPR

• Put on gown and gloves
  – If using a full hood, the inner shroud tucks inside the gown; the outer shroud hangs outside the protective clothing.

• You may now enter the patient’s room
Doffing a PAPR

- Before leaving the room:
  - Remove shoe covers
  - Remove gown by grasping the shoulders pull forward, rolling the outside of the gown inward and keeping the contaminated surface away from your body
  - Remove gloves
- Discard gown and gloves in the red biohazard bag
Doffing a PAPR

• Wash your hands or use gel after removing gown!

• Put on new gloves

• Exit the room, close the door

Photo by John Kerchberger MD
Doffing a PAPR

- Assistant (wearing gloves) supports the PAPR unit while the wearer takes off the belt

- Take off the hood from the inside, disconnect the breathing tube (from the inside of the hood)
  - Place hood in reprocessing bag or waste

Photo by John Kerchberger MD
Doffing a PAPR

- The assistant places the breathing tube and Air Mate in a biohazard bag for reprocessing
- Both remove their gloves
- **Wash your hands!!**
Donning a PAPR

1. Put on shoe covers and hair cover

2. Wearing gloves, open case and check for filter gasket around rim under filter; replace filter with arrows pointing into case

3. Turn on the PAPR unit. Check air flow out of the blower hose using the float

4. Snap the blower hose into the PAPR hood; attach the Airmate belt securely on your waist

5. Put on PAPR loose-fitting face cover or hood; turn on unit, verify adequate air flow (no trouble getting air)

6. Put on gown and gloves; gown goes over the inner shroud of PAPR hood; tie neck loosely to allow air exit, but cover back fully

Doffing a PAPR

1. Inside the room take off shoe covers, gown and gloves. Wash hands and put on new gloves; leave room

2. Outside the room, your assistant holds the PAPR unit while you unsnap the belt & remove hood

3. Disconnect the hose from the inside of the PAPR hood (push off with thumbs)

4. Place PAPR headpiece, hose and unit in Red Bag for cleaning

5. Peel off gloves, don’t snap; WASH HANDS!
PAPR References

- [http://www.health.state.mn.us/divs/idepc/dtopics/infectioncontrol/ppe/ppepapr.html](http://www.health.state.mn.us/divs/idepc/dtopics/infectioncontrol/ppe/ppepapr.html)
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PAPR References

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- UWMF Employee Health/Infection Control Policy and Procedures
- UW Hosp and Clinics Employee Health Medical Clearance form

-3M Technical Data Bulletins-#150,160,171,174,175,176
-3M Resource CD from Jim Brachmann jfbrachmann1@mmm.com
-3M Technical Service
  USA: 1-800-243-4630
  Canada: 1-800-267-4414
  Web Site: www.3M.com/occsafety

-PA20™ Powered Air Purifying Respirator