Vaporized Hydrogen Peroxide Sterilization & Reuse of Filtering Facepiece Respirators: Project Safety Considerations and Outcomes

Thomas R. Block CIH MPH

Presentation Objectives

1. Identify factors contributing to study origin
2. Define study
   - ‘Benchmarks’
   - Design elements & equipment
   - Challenges
3. Study outcomes
   - Proof of concept
   - Benchmark comparison
4. Bonus (time permitting): PAPR fabrication

Disclaimers

Presentation:	Based upon my observations and role
Opinions:	My own
Publications:	Collaborative effort
General overview:	Fit within allotted time
Study specifics:	Available in publications (citations and links in conference handouts)

Rutgers University EHS Department

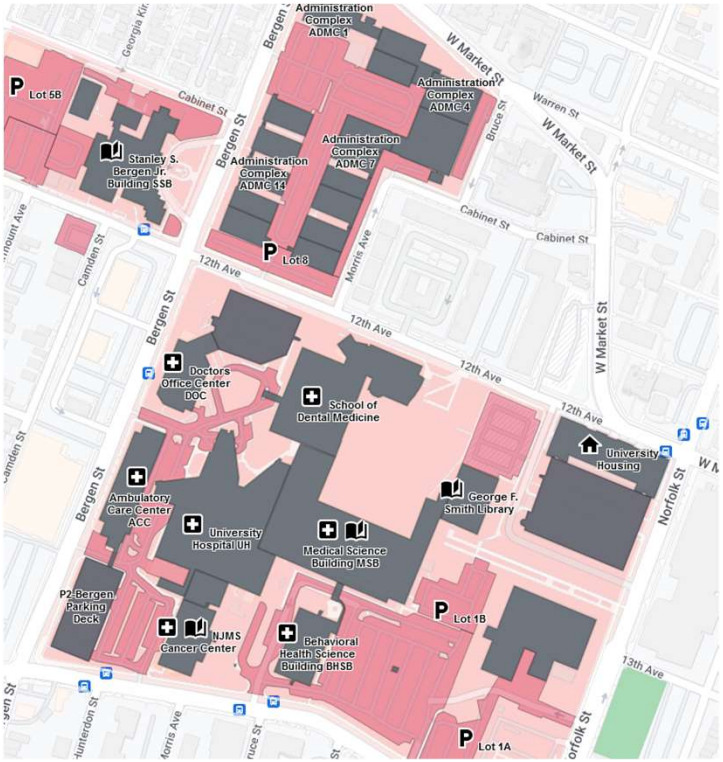
Primary Office: Piscataway NJ

- Biosafety, hazardous materials, occupational health & safety, health physics professionals
- Supports main campus students, faculty, staff activities for academic research & clinical functions, plus satellite campuses (Newark, Camden)
- Supports research extension facilities, clinical support staff, and county cooperative extension offices throughout state

RBHS Newark:

- 3 Biosafety staff
- 3 Health/Safety Specialist Staff (1 Staff – RU Newark)

RBHS – Newark Campus



https://maps.rutgers.edu/lat=40.741221&lng=74.186583

- Urban campus near Newark Penn Station (Amtrak, NJ Transit, PATH)
- 'University Heights' – 4 Campuses
  - RBHS (formerly UMDNJ)
  - NJ Institute of Technology (NJIT)
  - Rutgers – Newark
  - Essex County College
- RBHS Newark
  - NJ Medical School (NJMS)
  - School of Dental Medicine (RSDM)
  - School of Health Professionals (SHP)
  - Cancer Research Center
  - International Center for Public Health (ICPH)

Study Origins & Contributory Factors

Prelude to 3-13-20

January	Concerns about ‘novel virus’ appearing in China
	Student abroad program modified, then cancelled
February	Respiratory protection supplies ‘unavailable’
	Increased illness & fit test compliance observed
March	Increasing infection rates & ‘hysteria’
	University ‘closed 2 weeks’ 3-13-20
	Indefinite closure 3-30-20
	Significant community infection prevalence

‘New Normal’ on 3-16-20

New Brunswick, Newark, Camden

- Support staff: Maintain essential operations (utilities, facilities, Public Safety)
  - Social distancing, barriers
  - Source control masking
  - Work from home 60%, on site 40% (facilities with private offices); all others remote
- Clinical staff: On-site (daily screening, masking) support critical community need
- Research: Initial ‘pause’ (reduced support staff); shut down 3-30-20

RBHS Newark

- Minimal support staff for essential operations, clinical (community) need
- Newark BSO’s and HSS on site
  - HSS: “All hands on deck” to fit test residents, essential clinical staff, research shut down
  - BSO’s: daily review of IBC protocols (COVID research support)

1950 Defense Production Act (Amended 2018)

Presidential disaster declaration 3-26-20 (applicable 1-20-20 to 5-11-23)

Presidential authority to expedite and expand supply of materials and services from US industrial base to:

- Promote national defense
- Support emergency preparedness

Federal Priorities and Allocations System (FPAS)

- Priority-rated contracts & orders
- Preferential delivery to meet the delivery of items
- Place rated orders to ensure on-time delivery of materials and services
- Used to mitigate risks when delay in performance (MFR, logistics) could undermine program effectiveness

https://www.fema.gov/disaster/defense-production-act/federal-priorities-and-allocations-system

Disaster Declaration & DPA Consequences

Available fit test supplies don't match hospital supplies

- Hospitals given 'priority' to receive PPE
- Universities were not authorized to receive *any* shipments
  - Residents & faculty supporting hospital staff encountered high variability of FFRP supplies
  - Medical and other students sent home
- Manufacturers needed to 'ramp up' production but new transportation and logistic requirements limited supply availability

Available FFPR didn't fit medical professionals

- Size
- Manufacturer

Consumption of FFRP driven by:

- High community infection and prevalence rates
- IC practices based on prepandemic assumption of adequate supplies

Study Design, Benchmarks, & Challenges

Project Inspiration & Design

Annual BSL 3 shut downs ensure worker protection and containment

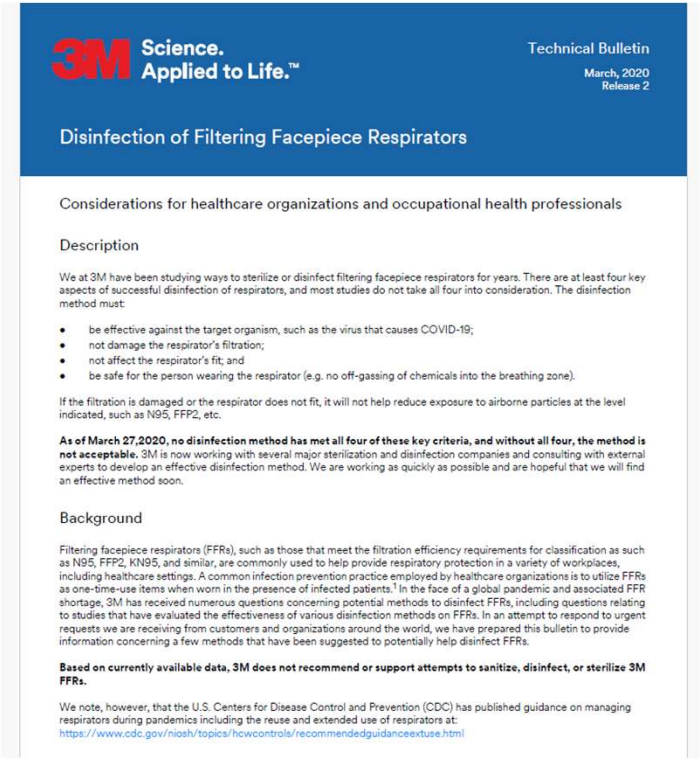
- Experiments completed, organisms secured
- Vendor dispenses sterilant at high concentrations, for prescribed time, within facility and HVAC system
- BSO staff verify facility safety for support staff and vendor entry
- HVAC PM and HEPA filter replacement
- Facility maintenance to prevent fomite accumulation, facility degradation, and to ensure quality research results

Concept: Utilize same approach to sterilize & reuse disposable FFRP

Project Needs

1. Identify benchmarks
2. Access sterilization equipment, supplies, operator training
3. Identify staffing
4. Select appropriate location
   - Isolated HVAC system with HEPA filtration
   - Restricted access
   - Available lab support space (daily bump tests, culture BI's)
5. Identify respirator (source) supplies
6. Determine containment monitoring equipment, acquire equipment
7. Establish processing procedures
8. Define successful outcomes (efficacy)

FFPR Reuse ‘Benchmarks’



3M Science. Applied to Life.™

Technical Bulletin
March, 2020
Release 2

Disinfection of Filtering Facepiece Respirators

Considerations for healthcare organizations and occupational health professionals

Description

We at 3M have been studying ways to sterilize or disinfect filtering facepiece respirators for years. There are at least four key aspects of successful disinfection of respirators, and most studies do not take all four into consideration. The disinfection method must:

- be effective against the target organism, such as the virus that causes COVID-19;
- not damage the respirator's filtration;
- not affect the respirator's fit; and
- be safe for the person wearing the respirator (e.g. no off-gassing of chemicals into the breathing zone).

If the filtration is damaged or the respirator does not fit, it will not help reduce exposure to airborne particles at the level indicated, such as N95, FFP2, etc.

As of March 27,2020, no disinfection method has met all four of these key criteria, and without all four, the method is not acceptable. 3M is now working with several major sterilization and disinfection companies and consulting with external experts to develop an effective disinfection method. We are working as quickly as possible and are hopeful that we will find an effective method soon.

Background

Filtering facepiece respirators (FFRs), such as those that meet the filtration efficiency requirements for classification as such as N95, FFP2, KN95, and similar, are commonly used to help provide respiratory protection in a variety of workplaces, including healthcare settings. A common infection prevention practice employed by healthcare organizations is to utilize FFRs as one-time-use items when worn in the presence of infected patients.[1] In the face of a global pandemic and associated FFR shortage, 3M has received numerous questions concerning potential methods to disinfect FFRs, including questions relating to studies that have evaluated the effectiveness of various disinfection methods on FFRs. In an attempt to respond to urgent requests we are receiving from customers and organizations around the world, we have prepared this bulletin to provide information concerning a few methods that have been suggested to potentially help disinfect FFRs.

Based on currently available data, 3M does not recommend or support attempts to sanitize, disinfect, or sterilize 3M FFRs.

We note, however, that the U.S. Centers for Disease Control and Prevention (CDC) has published guidance on managing respirators during pandemics including the reuse and extended use of respirators at:
https://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html

3M Disinfection Method Considerations

1. Must be effective against target organism
2. Must not damage the respirator’s filtration
3. Must not affect fit
4. Must be safe for person wearing processed FFRP (no off-gassing)

Fulfilling Project Needs

Vendor agreed to rent equipment, train operator

Project support personnel

- Infectious disease researchers (5)
- Essential service staff – BSO's, EHS specialists (safety officer (SO) + deputy), HVAC
- IBC project review

"Retired" BSL 3 containment facility available

- Existing infrastructure operable
- Restricted access, support spaces nearby

SO identified respirator supplies, containment/monitoring equipment

BSO's familiar with decontamination and safety validation procedures

Collaboration between researchers, BSO's, SO defined outcome efficacy

Study Safety & Design Considerations

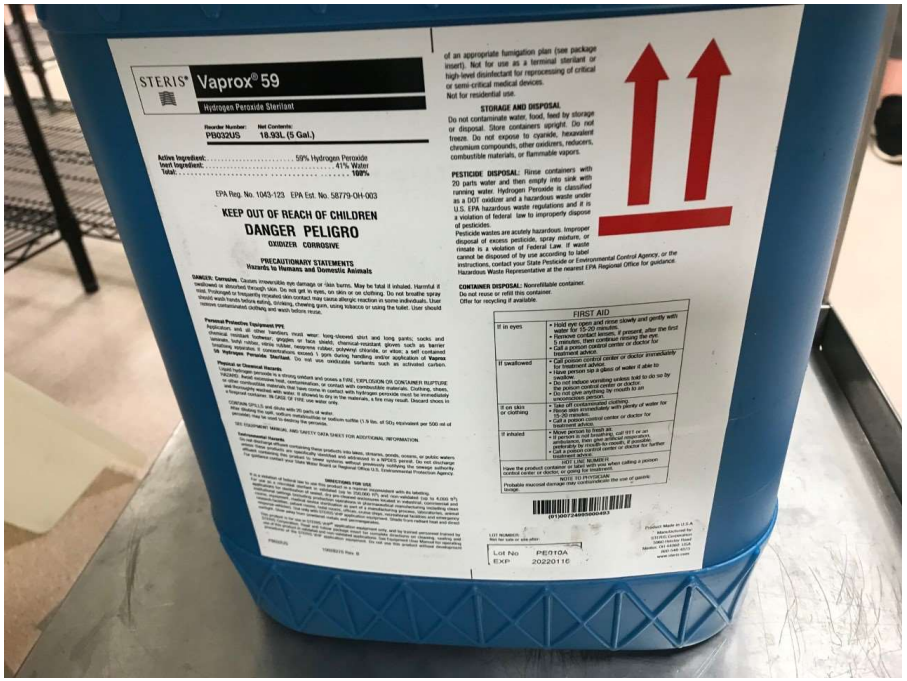
1. Equipment & reagent
2. Confirm FFRP sterilization efficacy
    a. Chemical contact indicators
    b. Biological growth indicators
3. Identify FFRP for evaluation
4. Evaluate respirator fit and reuse
    a. QNFT of sterilized respirators to confirm integrity & fit
    b. Quantify cycles before failure of FFRP
5. Study goals
    a. Research paper publication
    b. Create FFRP supplies for clinical staff

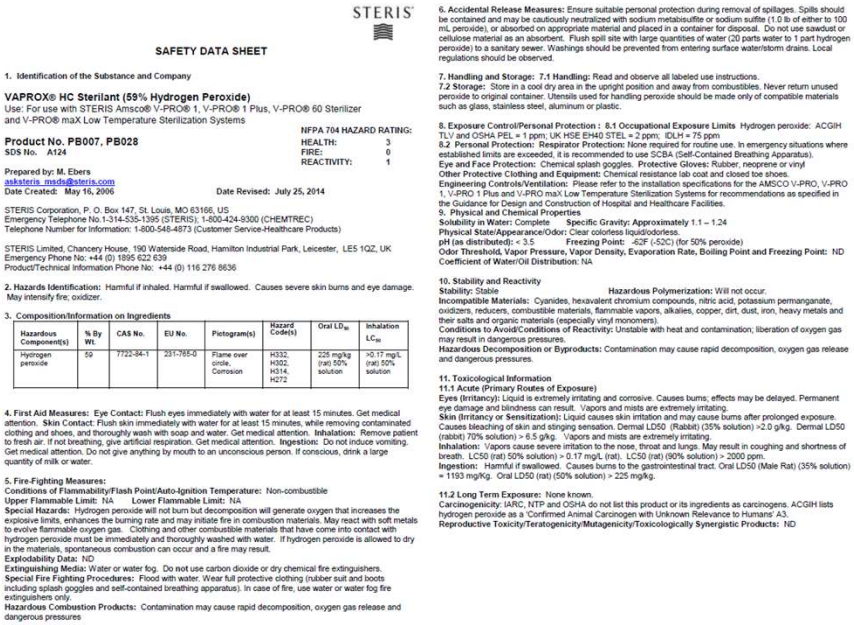
Safety Considerations - Equipment

Vendor provided ID researcher:

- Equipment & operational training
- Laptop for remote operation and monitoring processing room
- Equipment (stationary fans) & layout recommendations
- Identified direct reading monitoring equipment (leak detection)

Hydrogen Peroxide





STERIS

SAFETY DATA SHEET

1. Identification of the Substance and Company

VAPROX® HC Sterilant (59% Hydrogen Peroxide)
Use: For use with STERIS Amsco® V-PRO® 1, V-PRO® 1 Plus, V-PRO® 60 Sterilizer and V-PRO® maX Low Temperature Sterilization Systems

Product No. PB007, PB028
SDS No. A124

NFPA 704 HAZARD RATING:
HEALTH: 3
FIRE: 0
REACTIVITY: 1

Prepared by: M. Ebers
asksteris_msds@steris.com
Date Created: May 16, 2006 Date Revised: July 25, 2014

STERIS Corporation, P. O. Box 147, St. Louis, MO 63166, US
Emergency Telephone No.1-314-535-1395 (STERIS); 1-800-424-9300 (CHEMTREC)
Telephone Number for Information: 1-800-548-4873 (Customer Service-Healthcare Products)

STERIS Limited, Chancery House, 190 Waterside Road, Hamilton Industrial Park, Leicester, LE5 1QZ, UK
Emergency Phone No: +44 (0) 1895 622 639
Product/Technical Information Phone No: +44 (0) 116 276 8636

2. Hazards Identification: Harmful if inhaled. Harmful if swallowed. Causes severe skin burns and eye damage. May intensify fire; oxidizer.

3. Composition/Information on Ingredients

Hazardous Component(s)	% By Wt.	CAS No.	EU No.	Pictogram(s)	Hazard Code(s)	Oral LD_{50}	Inhalation LC_{50}
Hydrogen peroxide	59	7722-84-1	231-765-0	Flame over circle, Corrosion	H332, H302, H314, H272	225 mg/kg (rat) 50% solution	>0.17 mg/L (rat) 50% solution

4. First Aid Measures: **Eye Contact:** Flush eyes immediately with water for at least 15 minutes. Get medical attention. **Skin Contact:** Flush skin immediately with water for at least 15 minutes, while removing contaminated clothing and shoes, and thoroughly wash with soap and water. Get medical attention. **Inhalation:** Remove patient to fresh air. If not breathing, give artificial respiration. Get medical attention. **Ingestion:** Do not induce vomiting. Get medical attention. Do not give anything by mouth to an unconscious person. If conscious, drink a large quantity of milk or water.

5. Fire-Fighting Measures:
Conditions of Flammability/Flash Point/Auto-Ignition Temperature: Non-combustible
Upper Flammable Limit: NA **Lower Flammable Limit:** NA
Special Hazards: Hydrogen peroxide will not burn but decomposition will generate oxygen that increases the explosive limits, enhances the burning rate and may initiate fire in combustion materials. May react with soft metals to evolve flammable oxygen gas. Clothing and other combustible materials that have come into contact with hydrogen peroxide must be immediately and thoroughly washed with water. If hydrogen peroxide is allowed to dry in the materials, spontaneous combustion can occur and a fire may result.
Explodability Data: ND
Extinguishing Media: Water or water fog. Do not use carbon dioxide or dry chemical fire extinguishers.
Special Fire Fighting Procedures: Flood with water. Wear full protective clothing (rubber suit and boots including splash goggles and self-contained breathing apparatus). In case of fire, use water or water fog fire extinguishers only.
Hazardous Combustion Products: Contamination may cause rapid decomposition, oxygen gas release and dangerous pressures

6. Accidental Release Measures: Ensure suitable personal protection during removal of spillages. Spills should be contained and may be cautiously neutralized with sodium metabisulfite or sodium sulfite (1.0 lb of either to 100 mL peroxide), or absorbed on appropriate material and placed in a container for disposal. Do not use sawdust or cellulose material as an absorbent. Flush spill site with large quantities of water (20 parts water to 1 part hydrogen peroxide) to a sanitary sewer. Washings should be prevented from entering surface water/storm drains. Local regulations should be observed.

7. Handling and Storage: 7.1 Handling: Read and observe all labeled use instructions.
7.2 Storage: Store in a cool dry area in the upright position and away from combustibles. Never return unused peroxide to original container. Utensils used for handling peroxide should be made only of compatible materials such as glass, stainless steel, aluminum or plastic.

8. Exposure Control/Personal Protection : 8.1 Occupational Exposure Limits Hydrogen peroxide: ACGIH TLV and OSHA PEL = 1 ppm; UK HSE EH40 STEL = 2 ppm; IDLH = 75 ppm
8.2 Personal Protection: Respirator Protection: None required for routine use. In emergency situations where established limits are exceeded, it is recommended to use SCBA (Self-Contained Breathing Apparatus).
Eye and Face Protection: Chemical splash goggles. **Protective Gloves:** Rubber, neoprene or vinyl
Other Protective Clothing and Equipment: Chemical resistance lab coat and closed toe shoes.
Engineering Controls/Ventilation: Please refer to the installation specifications for the AMSCO V-PRO, V-PRO 1, V-PRO 1 Plus and V-PRO maX Low Temperature Sterilization Systems for recommendations as specified in the Guidance for Design and Construction of Hospital and Healthcare Facilities.

9. Physical and Chemical Properties
Solubility in Water: Complete **Specific Gravity: Approximately** 1.1 – 1.24
Physical State/Appearance/Odor: Clear colorless liquid/odorless.
pH (as distributed): < 3.5 **Freezing Point:** -62F (-52C) (for 50% peroxide)
Odor Threshold, Vapor Pressure, Vapor Density, Evaporation Rate, Boiling Point and Freezing Point: ND
Coefficient of Water/Oil Distribution: NA

10. Stability and Reactivity
Stability: Stable **Hazardous Polymerization:** Will not occur.
Incompatible Materials: Cyanides, hexavalent chromium compounds, nitric acid, potassium permanganate, oxidizers, reducers, combustible materials, flammable vapors, alkalies, copper, dirt, dust, iron, heavy metals and their salts and organic materials (especially vinyl monomers).
Conditions to Avoid/Conditions of Reactivity: Unstable with heat and contamination; liberation of oxygen gas may result in dangerous pressures.
Hazardous Decomposition or Byproducts: Contamination may cause rapid decomposition, oxygen gas release and dangerous pressures.

11. Toxicological Information
11.1 Acute (Primary Routes of Exposure)
Eyes (Irritancy): Liquid is extremely irritating and corrosive. Causes burns; effects may be delayed. Permanent eye damage and blindness can result. Vapors and mists are extremely irritating.
Skin (Irritancy or Sensitization): Liquid causes skin irritation and may cause burns after prolonged exposure. Causes bleaching of skin and stinging sensation. Dermal LD50 (Rabbit) (35% solution) >2.0 g/kg. Dermal LD50 (rabbit) 70% solution) > 6.5 g/kg. Vapors and mists are extremely irritating.
Inhalation: Vapors cause severe irritation to the nose, throat and lungs. May result in coughing and shortness of breath. LC50 (rat) 50% solution) > 0.17 mg/L (rat). LC50 (rat) (90% solution) > 2000 ppm.
Ingestion: Harmful if swallowed. Causes burns to the gastrointestinal tract. Oral LD50 (Male Rat) (35% solution) = 1193 mg/Kg. Oral LD50 (rat) (50% solution) > 225 mg/kg.

11.2 Long Term Exposure: None known.
Carcinogenicity: IARC, NTP and OSHA do not list this product or its ingredients as carcinogens. ACGIH lists hydrogen peroxide as a "Confirmed Animal Carcinogen with Unknown Relevance to Humans' A3.
Reproductive Toxicity/Teratogenicity/Mutagenicity/Toxicologically Synergistic Products: ND

35% aqueous hydrogen peroxide solution dispensed to achieve between 400 – 800 ppm concentration for 3 hours

Verify Operation & Containment

Operator responsibility:

- Monitor VHP concentration within containment facility
- Assess processing room containment integrity
- If containment failure, then:
  - Terminate process
  - Quantify ambient concentrations (emergency response, safe entry)

External (containment) parameters:

1. Relative room pressure
2. Hydrogen peroxide concentrations

Post Sterilization Verification

Two challenge methods used within processing room at specific locations:

1. Chemical indicators – colorimetric test (Sterrafin VHP Process indicators; violet → yellow) provides instant, visual confirmation of chemical concentrations at placement areas
2. Biological indicators – challenge test organisms (Spordex VHP biological indicator discs) placement in room and within enclosed control respirators
   - Cultured and incubated @ 37° C
   - Evaluated after 24 hr and 7 days
   - Growth/no growth

Respirator Stock

Initial plan: Use FFRP discards from failed hospital fit tests (unlimited supply). However, concerns regarding:

- Variability in manufacturers, models, sizes, construction (supply chain)
- Potential COVID contamination by clinical staff from facial contact (unknown COVID infection status); additional processing procedures & PPE?
- Visual damage noted to some FFRP before treatment
- 'Aesthetic' issues (cosmetics, creams)

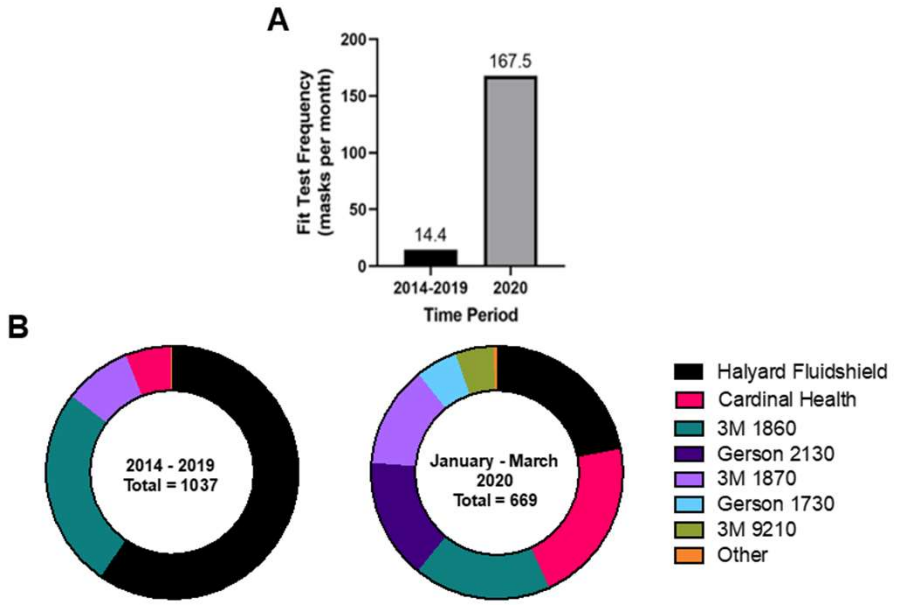
Final Plan: Used 'preferred' respirator models for clinical applications

- FDA fluid resistant models, small and regular sizes
- Existing performance history by residents, faculty, clinical support staff

Respirator Selection Criteria

Review 2013 – 2019 resident & medical student fit test records, identify:

- Models available & in use at UH and RWJUH
- Fluid resistant, comfortable FFRP
- Models becoming ‘somewhat more available’ over time
- Models sought by university procurement team



Graphic source: Alland research group

Filtering Facepiece Respirators Selected

3M

- ‘Round’ shape, Models 1860, 1860S
- ‘Oval’ shape, fold flat, Models 1870, 1870+, 9210

Cardinal Health

- ‘Round’ shape, Small and Medium/Large sizes

Gerson

- ‘Rectangular’ pleated shape, models 2130 and 1730

Halyard

- ‘Duck bill’ 46827 (small) and 46727 (regular)

Assessing Functional Filter Integrity

At the end of each contamination run, select respirators for:

- Visual inspection for damage to filter, nosepieces, and headbands
- Functional filtration integrity quantitatively assessed using the Porta Count Model 3038 on fit test subjects

Test subjects trained to properly don and doff FFRP, then assess

- QNFT performed on unused FFRP devices [8 cycles]
- QNFT performed on 'lightly used' respirators
  - Lightly used – QLFT failure on test subject, VHP processed, then QNFT FFRP
  - Lightly used – QNFT to second user that fit on unused devices (mimic anticipated conditions of reuse to extend supplies)

Benchmark Criteria:

Sterilization efficacy confirmed
No filter damage
No adverse effect on fit
No off-gassing

Improving Workflow, Cosmetic Influences

Hanging FFRP on hooks prior to VHP processing → time consuming

- Stack FFRP in piles of various depths to assess process efficacy; compare outcome to hanging individual FFPR on racks
  - Pile depth (stacks) 4, 6, 8, 10, 12 units
  - CI's and BI's inserted into the middle of each pile to assess efficacy
- Individual, used FFRP (1 or 2) stored inside paper bags; FFRP taped shut, bags closed (worse case) to assess efficacy

Does cosmetic & cream presence on discarded FFRP's influence sterilization outcomes?

- Applied cosmetic and moisturizer layer to interior of FFRP
- Inserted CI's and BI's, folded and taped FFRP shut to assess process efficacy

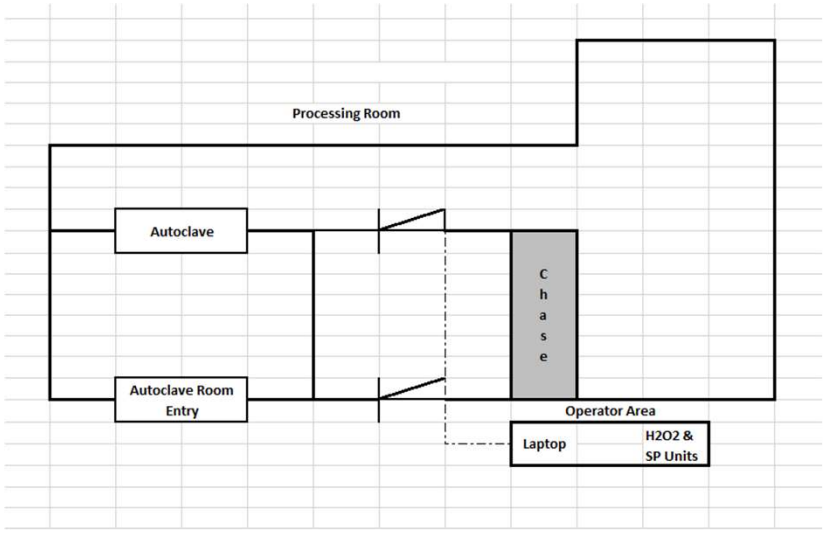
Environmental Monitoring Challenges

Tubing from processing room door (through anteroom) to VHP operator table ~ 20 – 25 feet

Position static pressure & direct reading instrument next to laptop

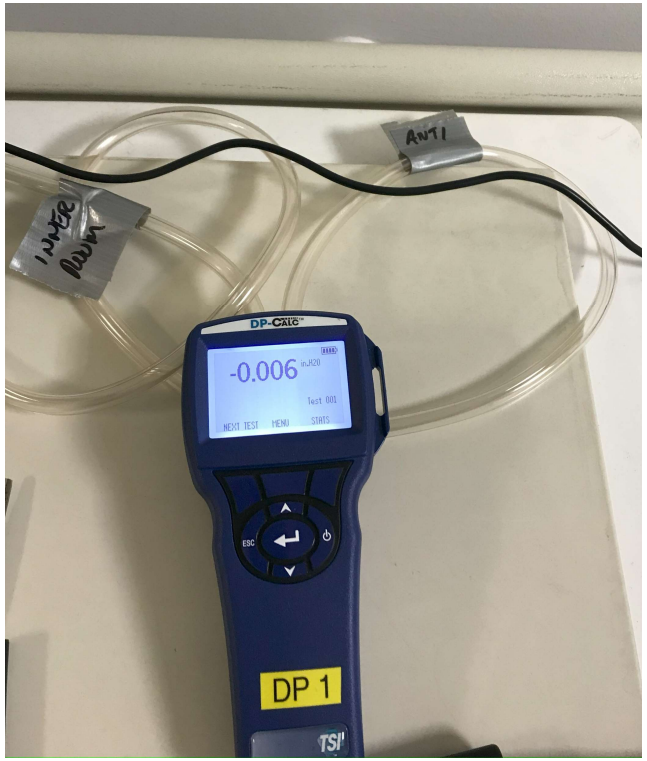
Operator cognizant of pressure and VHP concentration changes (containment confirmation)

Processing Room & Operator Layout



Pressure Reading Instrument

- Position Tygon tubing at base of processing room door (at PC serial communication cord penetration), secure to floor
- Zero instrument after processing room & tubing secured
- Observe pressure changes



Drager VHP Instrument

Intended for area monitoring

- Inlet diameter 1”
- Sampling rate 500 cc/min

Preferred sampling location: next to processing room penetration for serial communication cable and pressure tubing

Challenges:

- Inlet adapter vs tubing diameters
- Sustain sampling rate in tubing to alleviate instrument ‘fault’

Study Results

Positive Project Results

1. Equipment & methods used to sterilize rooms effective on FFRP
    a. 90 minutes to achieve target concentration in processing room
    b. All CI's turned yellow indicating optimal VHP exposure
    c. All BI's had no growth 7 days post media inoculation
2. Surfaces of FFRP decontaminated when folded
    a. CI's inside control respirators turned yellow
    b. BI's inside control respirators had no growth after 7 days
3. Improved workflow observed for stacks of 4, 6, 8
    a. Confirmed with chemical & biological indicators
    b. Increased processing: 250 units/rack (hung) vs 720 units/rack per pile (6)
    c. Increased capacity [4250 hung vs 12,240 piled], decreased time [2 hrs vs 8.5 hrs]
    d. Effective sterilization for FFPR folded inside bags (CI's and BI's)

Positive Results (Continued)

4. Confirmed cosmetic application on Halyard FFRP surface did *not* interfere with decontamination procedure
5. FFRP filters did not exhibit visual signs of degradation
6. Most FFRP continue to fit and function properly for at least 6 decontamination cycles

Negative Project Results & Limitations

1. Facility degradation after 8 runs
   a. Visible deterioration to walls, floors, door sealants
   b. Quantifiable leakage detected at processing room door
   c. Off-gassing observed from porous surfaces/damaged areas
2. Quantifiable VHP off-gassing noted from FFRP immediately after reentry
3. Resilience to VHP process varies by FFRP manufacturer & model
   a. Halyard exhibited observable downward trend
   b. Functional integrity of 3M 1870 reduced after worn, processed, fit tested on second user
4. Fit test subject facial features, sizing not representative of general population
5. Clinical staff wanted 'their' FFRP sterilized & returned to them
6. Processing resources and concerns
   a. Requires dedicated space, equipment, operator training, monitoring (area & process efficacy with CI's and BI's)
   b. Labor intensive
   c. Handling 'contaminated' PPE during rack loading activities
   d. Achieved only 3 out of 4 3M benchmarks

Final Thoughts

1. You think you're prepared – realize you're not – then it's too late
2. Stockpiling PPE is good, but you need excellent storage & management practices. Even then, an emergency rapidly depletes resources, with questionable replenishment capabilities

   2020 NIOSH Beyond Shelf Life/Stockpiled Assessment Results N-95 respirators
   https://www.cdc.gov/niosh/npptl/respirators/testing/ExpiredN95results.html
3. Disposable PPE manufacturing is scalable upon demand; however, you're at risk to interruptions and shortages until demand initiates more production
4. Government and manufacturers are working to incorporate more reusable textiles in PPE to address sustainability & supply chain issues

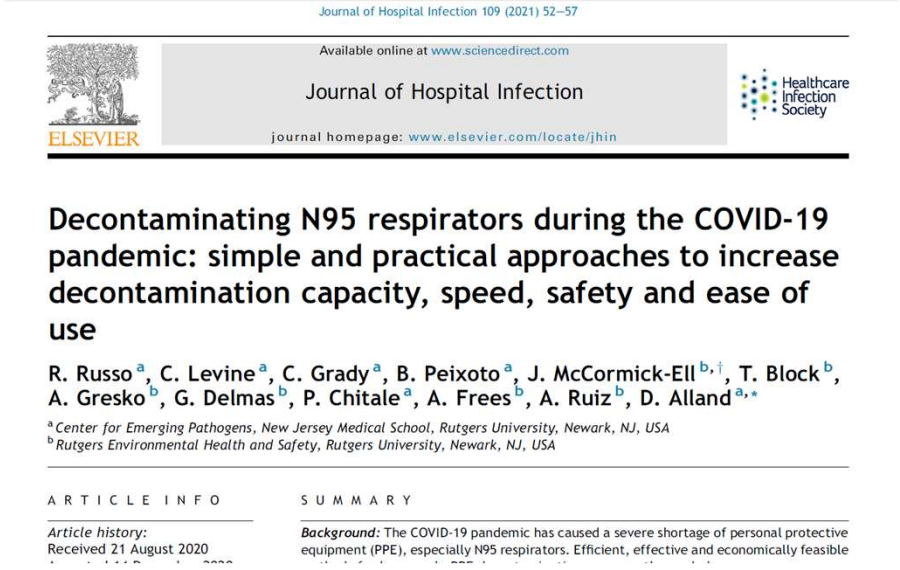
   → Europeans utilize 60 – 70% reusable (laundered) textiles in healthcare PPE

   NAS Webinar March 4-5, 2024 "Reuseable Health Care Textiles for PPE Workshop"
   https://www.nationalacademies.org/event/41729_03-2024_reusable-health-care-textiles-for-personal-protective-equipment-a-workshop

Publications

Russo, R, Levine C, Grady C, Peixoto B, McCormick-Ell J, Block T, et al. Decontaminating N95 Respirators during the COVID-19 Pandemic: Simple and Practical Approaches to Increase Decontamination Capacity, Speed, Safety, and Ease of Use. J Hosp Infect 2021; 109:52 – 57.

https://www.sciencedirect.com/science/article/pii/S019567012030570



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Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Decontaminating N95 respirators during the COVID-19 pandemic: simple and practical approaches to increase decontamination capacity, speed, safety and ease of use

R. Russo [a], C. Levine [a], C. Grady [a], B. Peixoto [a], J. McCormick-Ell [b,†], T. Block [b], A. Gresko [b], G. Delmas [b], P. Chitale [a], A. Frees [b], A. Ruiz [b], D. Alland [a,*]

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SUMMARY

Background: The COVID-19 pandemic has caused a severe shortage of personal protective equipment (PPE), especially N95 respirators. Efficient, effective and economically feasible

Levine, C, Grady C, Block T, Hurley H, Russo R, Peixoto B, et al. Use, Reuse, or Discard: Quantitatively Defined Variance in N95 Respirator Integrity following Vaporized Hydrogen Peroxide Decontamination during the COVID-19 Pandemic. J Hosp Infect 2021; 107:50 – 56.

https://www.sciencedirect.com/science/article/pii/S0195670120304679

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Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Use, re-use or discard? Quantitatively defined variance in the functional integrity of N95 respirators following vaporized hydrogen peroxide decontamination during the COVID-19 pandemic

C. Levine [a,b], C. Grady [a,b], T. Block [a,c], H. Hurley [a], R. Russo [a], B. Peixoto [a], A. Frees [a,c], A. Ruiz [a,c], D. Alland [a,*]

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[c] Rutgers Environmental Health and Safety, Newark, NJ, USA

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SUMMARY

Background: Coronavirus disease 2019 has stretched the ability of many institutions to supply needed personal protective equipment, especially N95 respirators. N95 decon-

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Dr. Alland's Research Group

- R Russo, C Levine, C Grady, B Peixoto, P Chitale, H Hurley

A Frees – deputy safety officer (my backup)

Rutgers IBC members

All mentioned in journal articles

Thank You!

PAPR Fabrication