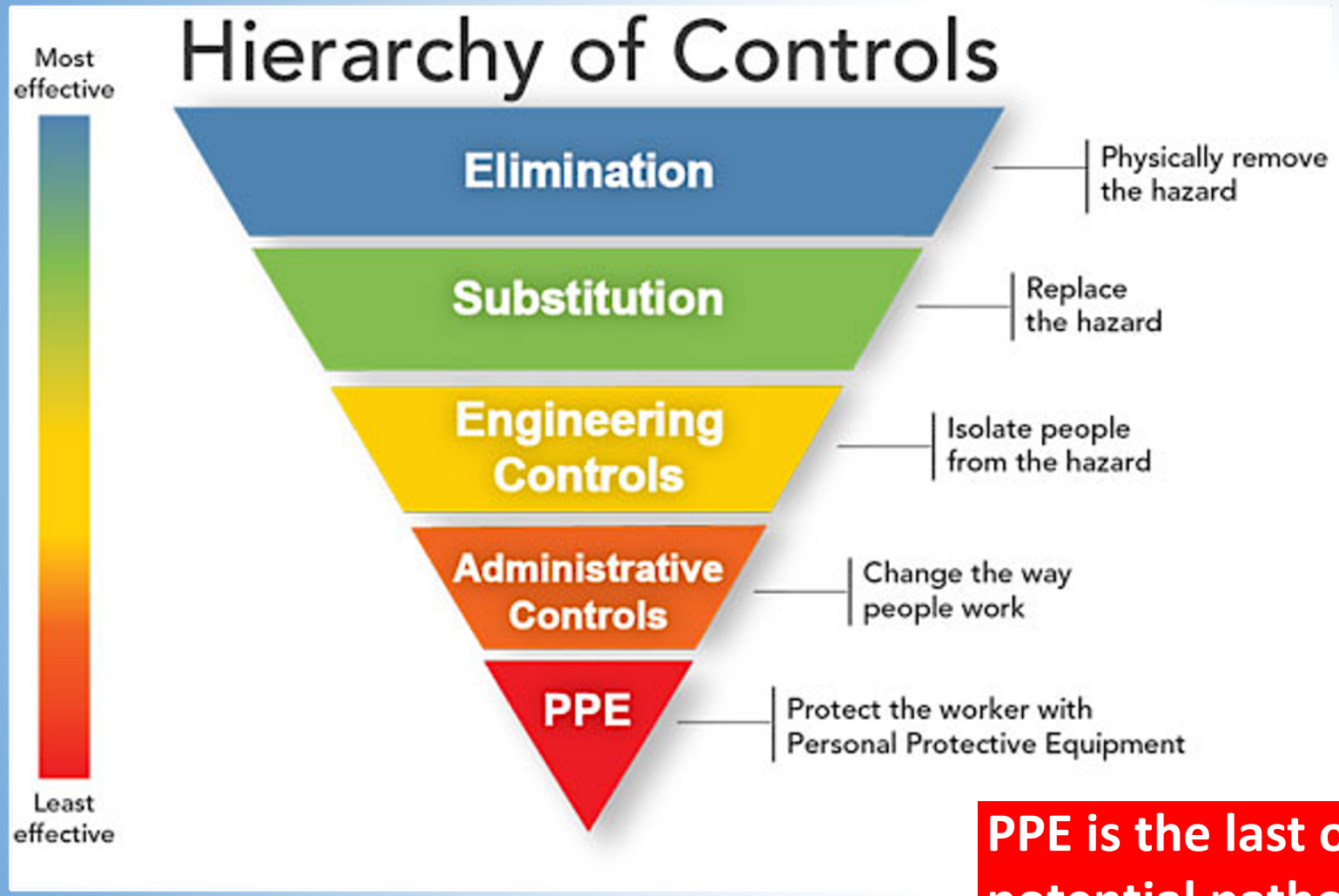

NETEC
EMORY MEDICINE
UNMC Nebraska Medicine
NYC HEALTH+ HOSPITALS
Bellevue
www.netec.org

Personal Protective Equipment – What You Don't Know CAN Hurt You

Learning Objectives:

1. Recognize and interpret standards information on commonly used PPE items
2. Explain new standard for eye protection from biological threats
3. Consider ad hoc risk assessment tools to assist in PPE selection
4. Explore improvements and progress in Personal Protective Equipment and Technologies

Jill Morgan



Tele-health

Engineering controls = ventilation, filtration

Administrative controls = staffing, policies, protocols

PPE is the last opportunity to keep known and potential pathogens off, and out, of US.

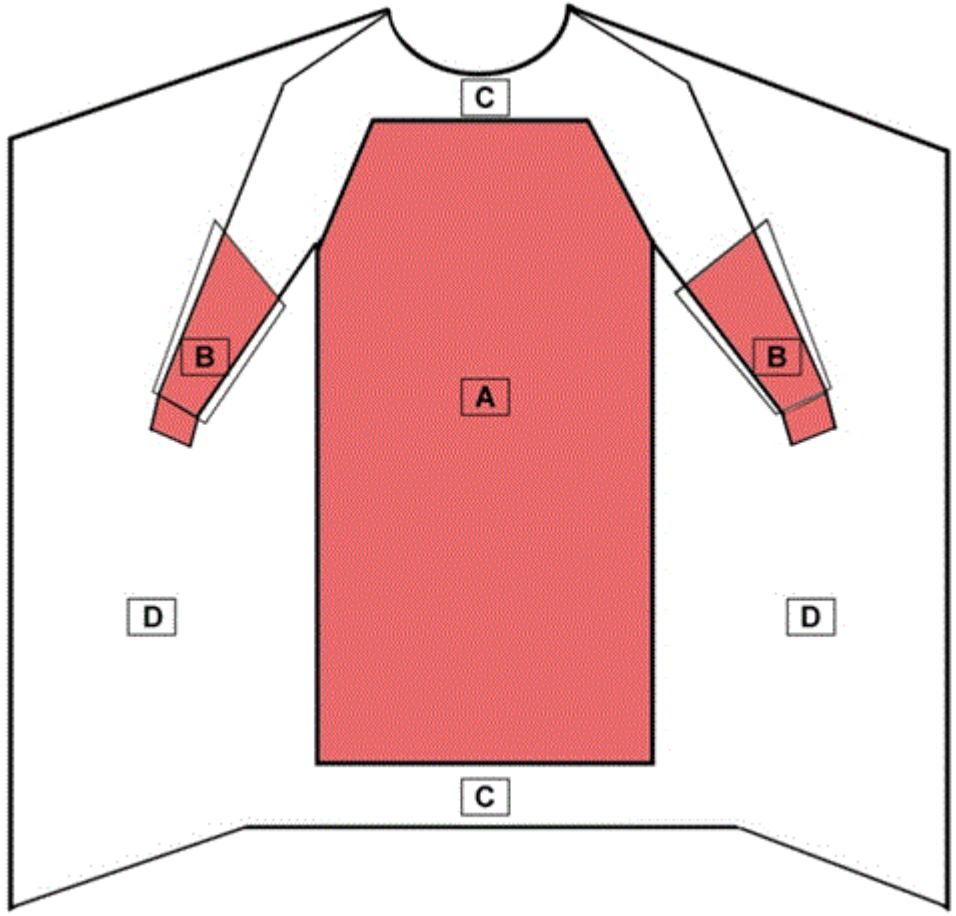
The Purpose of Precautions

NETEC

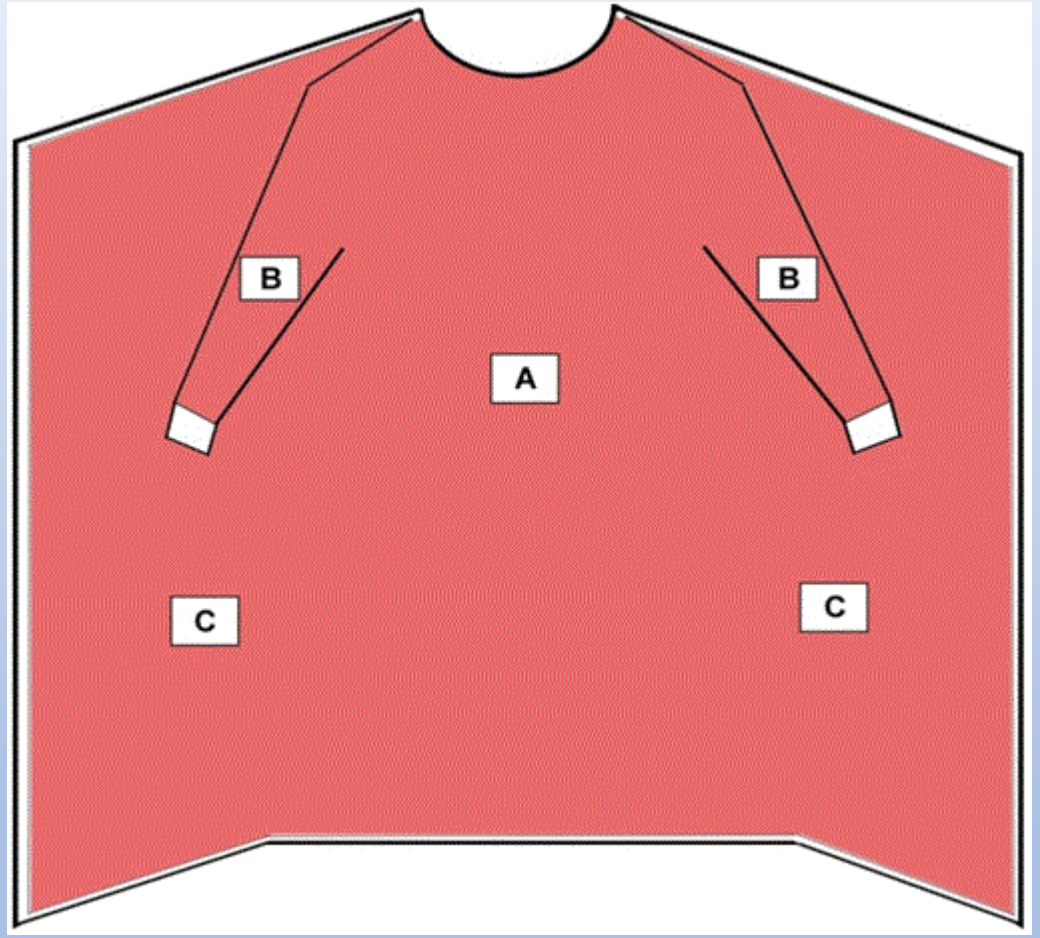
Transmission Based Precautions and Isolation Guidelines are all about preventing **entry into our mucous membranes – eyes, nose and mouth**

The gloves, the gowns, and the process for removal of our PPE is to avoid creating short-term fomites – contamination on our hands, skin, clothing or environment that we then carry into our mucous membranes ourselves.

Gowns – Surgical and Isolation



Critical zones A & B must meet performance claims

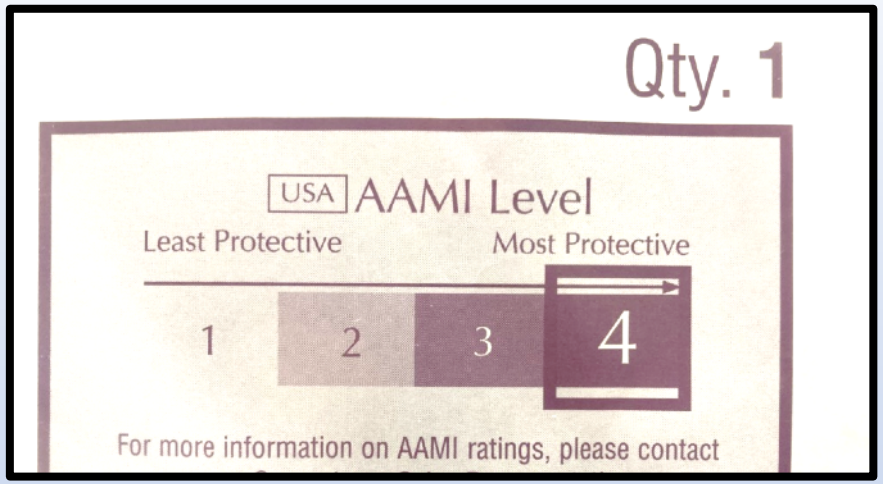


Isolation gowns do not have separate critical zones, entire garment must meet performance claims

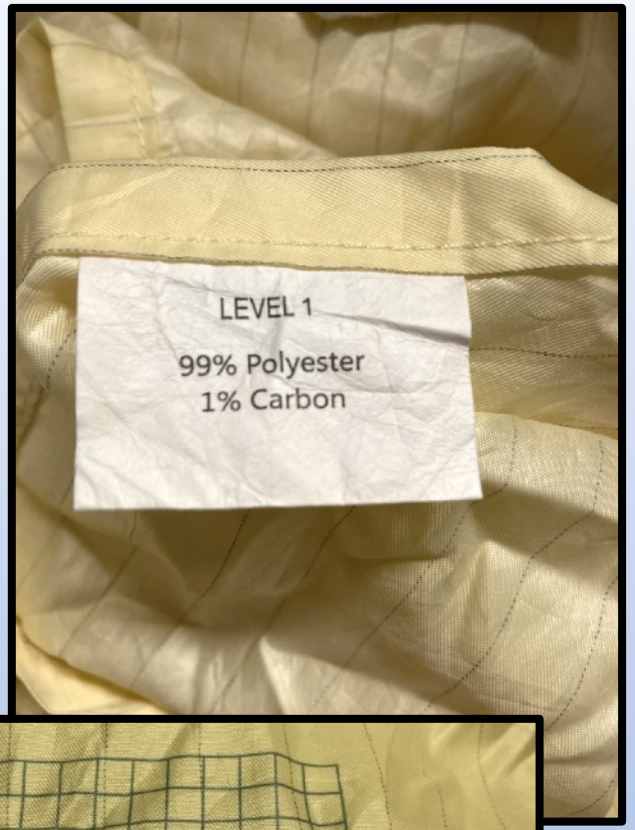
Image graphics: FDA

Gown Standards and Testing

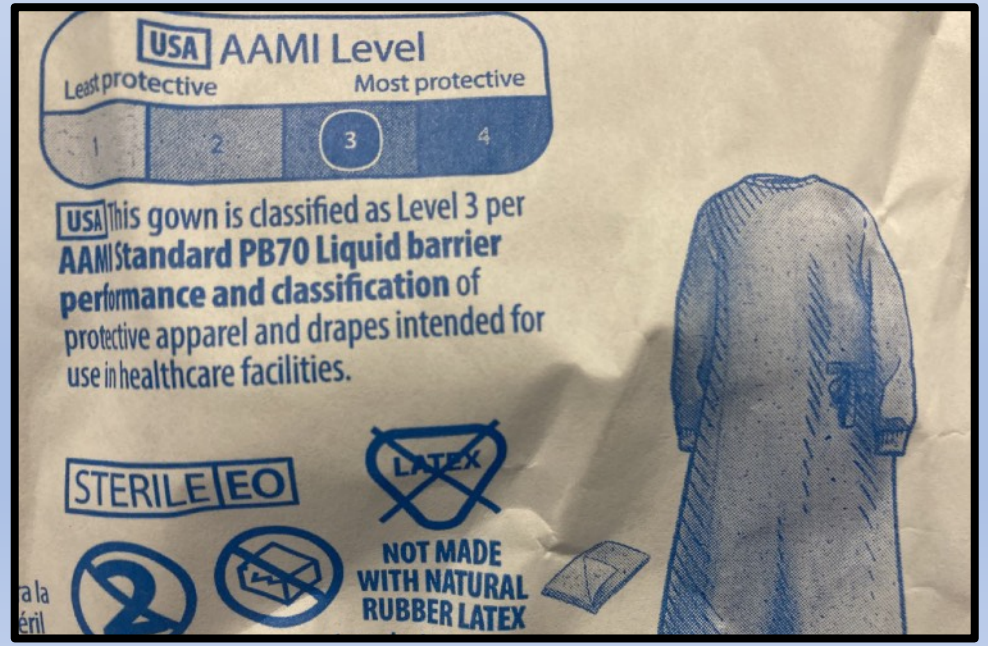
Level	Test Methods Used	Expected Barrier Effectiveness
1	Impact Penetration	Minimal water resistance
2	Impact Penetration & Hydrostatic Pressure	Low water resistance
3	Impact Penetration & Hydrostatic Pressure	Moderate water resistance
4	ASTM F1670 Synthetic Blood & ASTM F1671 Viral Penetration Test	Blood and viral penetration resistance



Surgical or procedure gowns



Isolation gowns



Both types of gowns can be single-use disposable or launderable

Evaluation of the Performance of Isolation Gowns

F. Selcen Kilinc-Balci[1], Julian Nwoko[2], and Todd Hillam[3]

[1]National Institute for Occupational Safety and Health, Pittsburgh, PA and [2]URS Corp., Aiken, SC, [3]Nelson Laboratories, Salt Lake City, UT

OBJECTIVE

To evaluate barrier and strength performance with a sample of isolation gowns in order to develop minimum performance requirements for a future American Society of Testing and Materials (ASTM) standard

BACKGROUND

- Isolation gowns are the second-most-used piece of personal protective equipment (PPE) for barrier protection following gloves (Holguin, 2011)
- Currently no standard exists specific to isolation gowns that considers not only the barrier resistance but also a wide array of end user desired attributes to guide infection preventionists to select the most appropriate gown

Fig.1. A typical isolation gown design (front and back)
Photos courtesy of NIOSH EPRO

- There is also confusion in the market place over the multiple terms used: isolation gown, cover gown, protective gown, procedure/procedural gown, non-surgical isolation gown
- ASTM F23 started a work item in collaboration with NIOSH to develop minimum performance and design criteria for isolation gowns
- A survey was conducted by ASTM in collaboration with APIC with ~2000 responses. Results emphasized the lack of knowledge about the standards and issues with the strength, design, and comfort of current isolation gowns
- The study was conducted with ASTM F23.40 Isolation Gown Task Group which consists of manufacturers, academicians, government representatives, professional organization representatives, and end users. Authors would like to acknowledge the group for their support

METHODS

- Letters inviting manufacturers to participate in the isolation gown project were sent with the testing protocol by the ASTM F23 task group on March 4, 2013
- A Federal Register Notice was published on April 11, 2013
- Only gowns currently labeled as "isolation gowns" were included in the testing. Gowns labeled as surgical gowns, cover gowns, comfort gowns, procedure/procedural gowns and open-back gowns were all out of scope for this testing
- 22 different single-use (disposable) isolation gown models from 6 manufacturers were submitted
- Test articles(*) were categorized and tested according to manufacturers labeling claims based on Association for the Advancement of Medical Instrumentation (AAMI) PB70 barrier levels (Table 1)
- Test articles were evaluated for barrier and strength properties using:
  - ASTM (D5034, D5733, D1683, F1671)
  - American Association of Textile Chemists and Colorists (AATCC) 42 and 127 test methods, and
  - AAMI PB70 liquid barrier classification standard requirements – tested only to the level claimed

Table 1. AAMI PB70 (2012) Liquid Barrier Performance Requirements

Level	Test	Result
1	AATCC 42	≤ 4.5 g
2	AATCC 42 AATCC 127	≤ 1.0 g ≥ 20cm
3	AATCC 42 AATCC 127	≤ 1.0 g ≥ 50cm
4	ASTM F1671	Pass

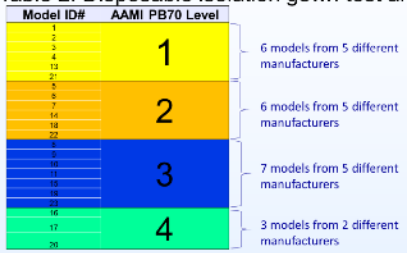
STRENGTH

(*) Sampling requirement outlined in ANSI/AAMI PB70:2012 is to assure a 4% AQL and 20% RQL per critical zone. The sampling done in this study characterizes the performance using only the RQL requirement

Disclaimer: The findings and conclusions of this poster have not been formally disseminated by the National Institute for Occupational Safety and Health and should not be construed to represent any agency determination or policy.

MATERIALS

Table 2. Disposable isolation gown test articles



RESULTS

- Test results demonstrated there is a large variation in the barrier and strength properties of isolation gowns in the marketplace. Also nine of the isolation gown models failed to meet the AAMI PB70 requirements for the liquid barrier performance at the level specified by the manufacturer. Two of the gown models which did not meet the AAMI PB70 Level 1 requirements did not have any claims from the manufacturer

Evaluation of Strength Properties

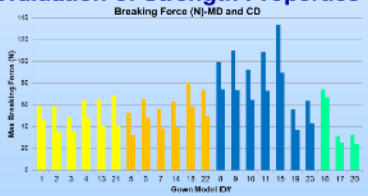


Figure 2. Tensile strength test results (Higher breaking strength is more desirable) (ASTM D5034 MD: machine direction CD: cross-machine direction) Sample size (n)=15 (MD) +24 (CD) per sample Sample #3,#10,#16,#19 coated/laminated; #17,#20 plastic

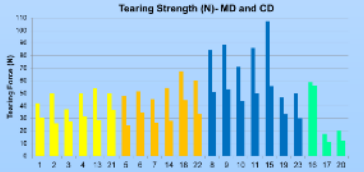


Figure 3. Tear strength test results (Higher tearing strength is more desirable) (ASTM D5733 MD: machine direction CD: cross-machine direction) Sample size (n)=16 (MD) +16 (CD) per sample

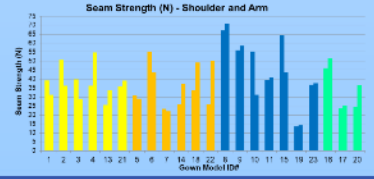


Figure 4. Seam strength test results (Higher seam strength is more desirable) (ASTM D1683 MD: machine direction CD: cross-machine direction) Sample size (n)=16 (shoulder) + 16 (arm) per sample

Evaluation of Liquid Barrier Properties

- Sampling: 39 specimens per gown model (39x22)
  - 13 Chest, 13 Sleeve Seam, 13 Tie Attachment

Barrier Performance Test Results (AAMI PB70)

- Level 1: 2 of 6 models did not meet requirements
- Level 2: 1 of 6 models did not meet requirements
- Level 3: 3 of 7 models did not meet requirements
- Level 4: 3 of 3 models did not meet requirements
- Gowns mostly failed in the sleeve seam and tie attachment areas

SUMMARY AND CONCLUSIONS

- Test results showed:
  - Isolation gown strength properties show a wide range of distribution
  - 7 models of gowns out of 22 models did not meet AAMI PB70 barrier claims made by manufacturers
  - Seam and/or tie construction may not be adequate for some isolation gowns to provide sufficient protection. Manufacturers should evaluate the technique used in construction of these critical areas

NEXT STEPS

- Further evaluation is needed to set the minimum performance requirements with ASTM F23 Committee
- Periodic post-market evaluation of isolation gowns is needed to validate that isolation gowns continue to meet the performance requirements indicated by manufacturers, with an urgency to validate that manufacturers have resolved issues identified with models not meeting stated claims on AAMI PB70

LIMITATIONS

- Study findings are limited to the gown models tested and variability of the test methods (e.g., screen type and surface tension of the carrier fluid in the ASTM F1671 viral penetration test)

FURTHER READING

- Holguin M., "Standard Precautions for Healthcare Workers and the Role of Isolation Gowns, Education & Training, http://healthvie.com Jan 2011
- Kilinc-Balci S [2015]. A review of isolation gowns in healthcare: fabric and gown properties. J Eng Fiber Fabr [in press].
- Kilinc-Balci S [2014]. How well do you think you are protected? Understanding proper use and disposal of protective gowns for healthcare workers. NIOSH science blog. National Institute for Occupational Safety and Health. http://blogs.cdc.gov/niosh-science-blog/2014/05/05/gowns

CDC Workplace Safety and Health

NIOSH

NPPTL Research to Practice through Partnerships

Evaluation of Liquid Barrier Properties

- Sampling: 39 specimens per gown model (39x22)
  - 13 Chest, 13 Sleeve Seam, 13 Tie Attachment

Barrier Performance Test Results (AAMI PB70)

- Level 1: 2 of 6 models did not meet requirements
- Level 2: 1 of 6 models did not meet requirements
- Level 3: 3 of 7 models did not meet requirements
- Level 4: 3 of 3 models did not meet requirements
- Gowns mostly failed in the sleeve seam and tie attachment areas

SUMMARY AND CONCLUSIONS

- Test results showed:
  - Isolation gown strength properties show a wide range of distribution
  - 7 models of gowns out of 22 models did not meet AAMI PB70 barrier claims made by manufacturers
  - Seam and/or tie construction may not be adequate for some isolation gowns to provide sufficient protection. Manufacturers should evaluate the technique used in construction of these critical areas

NEXT STEPS

- Further evaluation is needed to set the minimum performance requirements with ASTM F23 Committee
- Periodic post-market evaluation of isolation gowns is needed to validate that isolation gowns continue to meet the performance requirements indicated by manufacturers, with an urgency to validate that manufacturers have resolved issues identified with models not meeting stated claims on AAMI PB70

LIMITATIONS

- Study findings are limited to the gown models tested and variability of the test methods (e.g., screen type and surface tension of the carrier fluid in the ASTM F1671 viral penetration test)

Manufacturers voluntarily sent **isolation** gowns for testing

7 out of 22 models of gowns did not meet the criteria for the level of protection claimed

None of the Level 4 gowns - the only level that tests for penetration of synthetic blood - met the criteria

Sleeve seams and tie locations are particularly problematic

Isolation Gown Use, Performance and Potential Compliance Issues Identified by Infection Preventionists

R.M. Cloud, U. B. Favret, T. Cunningham, J. Daley, L.G. Harris, F.S. Kilinc, and J.A. Lewis*

Purpose and Objectives

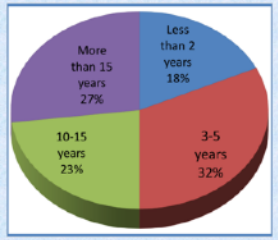
Isolation gowns are widely used in infection control, but little has been reported regarding their wear performance and issues that may affect compliance. Infection preventionists (IPs) were surveyed to determine use and wear issues with these products.

Specific Objectives

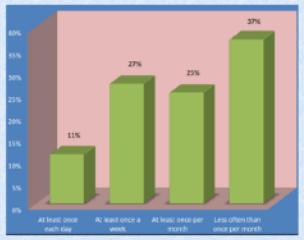
- Describe the patterns of use of isolation gowns by infection preventionists.
- Identify gown features and other gown-related issues that may impact compliance with isolation gowns.
- Explain the performance levels described in ANSI/AAMI standard PB 70:2003(R) and how these relate to isolation gowns.

Method and Respondents

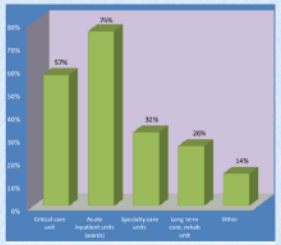
APIC members participated in an on-line survey regarding isolation gowns, providing information regarding their use of isolation gowns, risk perceptions, protection levels, compliance issues, mobility restriction and garment failures. A total of 1354 respondents are represented in the results presented. The authors gratefully acknowledge the assistance of Marilyn Hanchett, Senior Director , Research and Clinical Innovation, APIC for assistance with survey format, distribution and statistics.



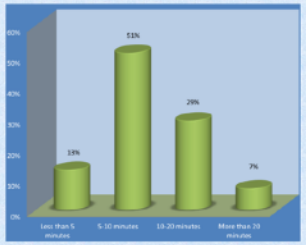
IPs Experience with Infection Prevention



IP Frequency of Isolation Gown Wear



Where IPs Wear Isolation Gowns

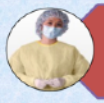


Time of Isolation Gown Wear Per Incident

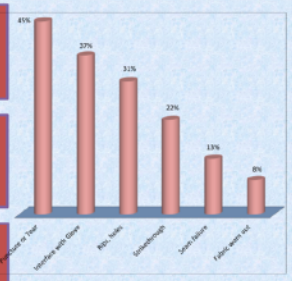
Results: Risk Perceptions, Gown Failures

90% of respondents expected isolation gowns should keep them at low or extremely low risk

82% of respondents felt that their isolation gowns were keeping them at low or extremely low risk

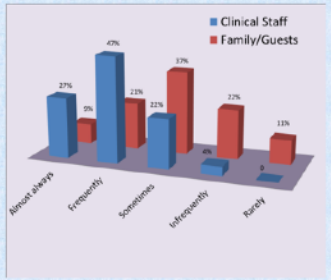


Overall positive assessment of their level of risk when wearing isolation gowns

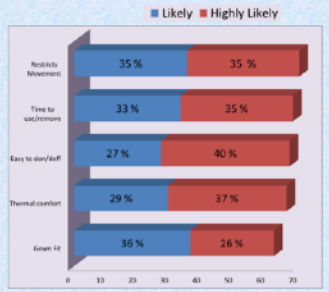


Gown Failures Encountered by IPs

Results: Compliance

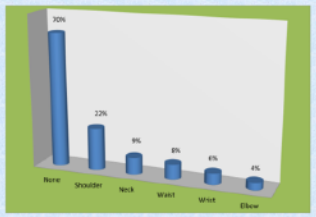


Perceived Degree of Compliance with Gowns

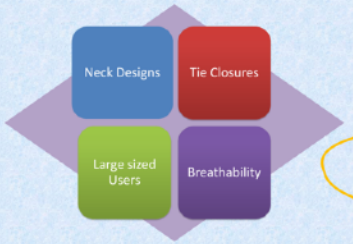


Likeliness for Factors to Impact Compliance

Results: Design and Fit Issues



Respondents Experiencing Tight Fit or Mobility Restriction in Isolation Gowns

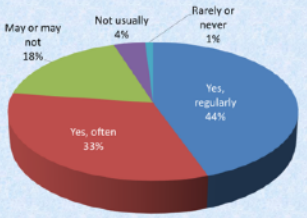


Issues Raised in Open-Ended Questions

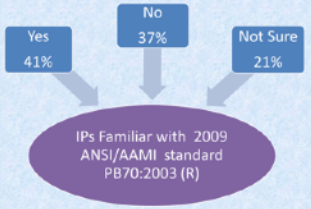
*This study was conducted by the ASTM F23.40 Isolation Gown Standard Working Group. Members of the group include:

Dion Brandt	TIDI Products, LLC
Rinn M. Cloud	Baylor University
Terrell Cunningham	FDA
Jackie Daley	Sinai Hospital, APIC
U. Benjamin Favret	Vestagen Technical Textiles, LLC
Lorraine M. Harkavy	DHHS
Linda Harris	Kimberly-Clark Corporation
David Johnson	Kimberly-Clark Corporation
F. Selcen Kilinc	CDC, NIOSH, NPPTL
Janet Lewis	AORN
Natalie O'Connor	Medline Industries, Inc.
Joe Palomo	Cardinal Health
Debra Pratt	Rochester, AORN
Joanna Esther Schneider	3M Healthcare
Nathaniel M. Terry	Burlington Labs
Howard M. Zins	Howard M. Zins Associates, LLC representing ARTA

Results: Educational Role of IPs



IPs Educate Others about Isolation Gowns



86% did not know rating of current gown

ANSI/AAMI PB 70 Rating Criteria

Level	Test	Liquid Challenge	Result*
1	AATCC 42:2000	Water	≤ 4.5 g
2	AATCC 42:2000	Water	≤ 1.0 g
	AATCC 127:1998	Water	≥ 20cm
3	AATCC 42:2000	Water	≤ 1.0 g
	AATCC 127:1998	Water	≥ 50cm
4	ASTM F1670:2003 (surgical drapes and drape accessories)	Surrogate blood	Pass
	ASTM F1671:2003 (surgical gowns and other protective apparel)	Bacteriophage Phi-X174	Pass

Conclusions

- APIC respondents expect and believe they achieve good protection with isolation gowns and report relatively high compliance, but
- Experience a fairly high level of failures.
- Fit, comfort and time to don/doff are important compliance issues to be addressed.
- Education is needed regarding the current requirements for protective performance of isolation gowns.

DISCLOSURE: The companies listed above as affiliated with this research produce isolation gowns and/or other medical PPE, however no products, services, brands or companies were promoted by or profited from this work.

On-line survey of APIC members to determine use and wear issues with isolation gowns.

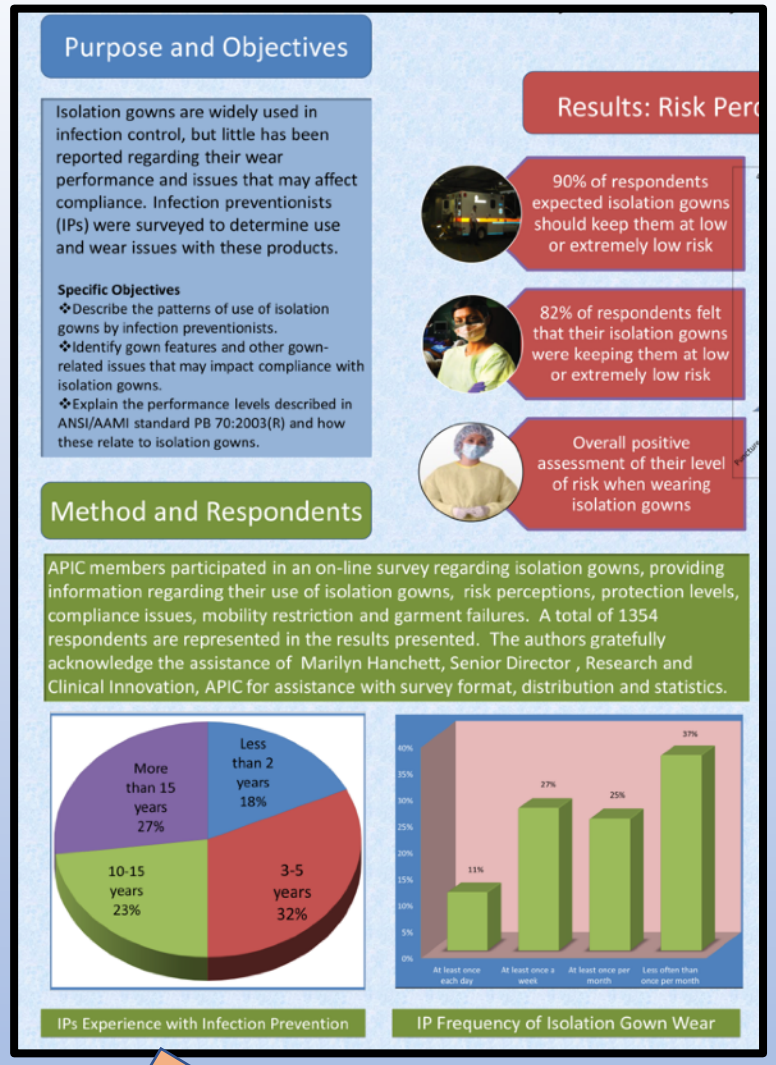
Risk perception

Perceived compliance

Design and fit issues

Educational role of IP's for PPE

Familiarity with gowns & standards at their facility



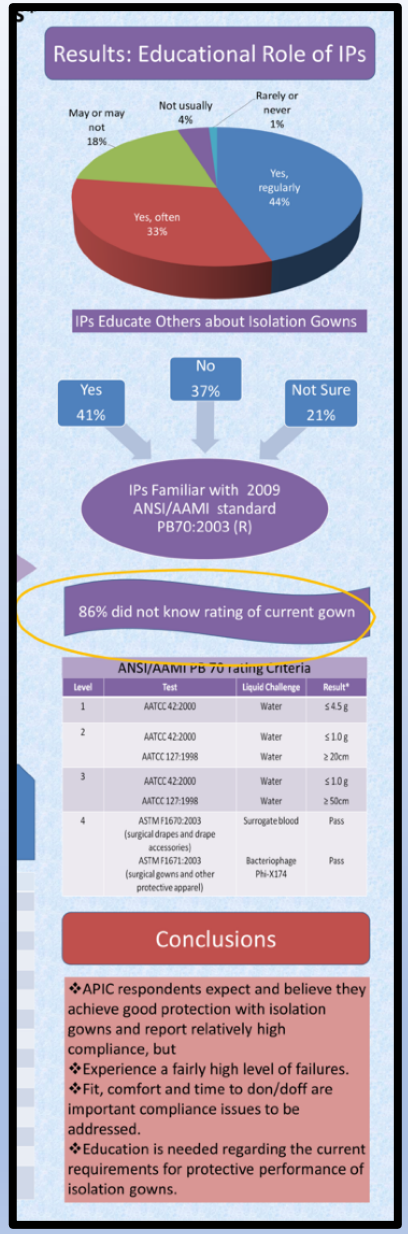
82% have been in IP for more than 3 years

77% Regularly or Often educate others about isolation gowns

58% Not familiar with the gown standard PB70

86% did not know the rating of the gown currently in use at their facility

82% believe gowns were keeping them at low or very low risk



Many isolation gowns in use right now are unrated - That doesn't mean they don't work

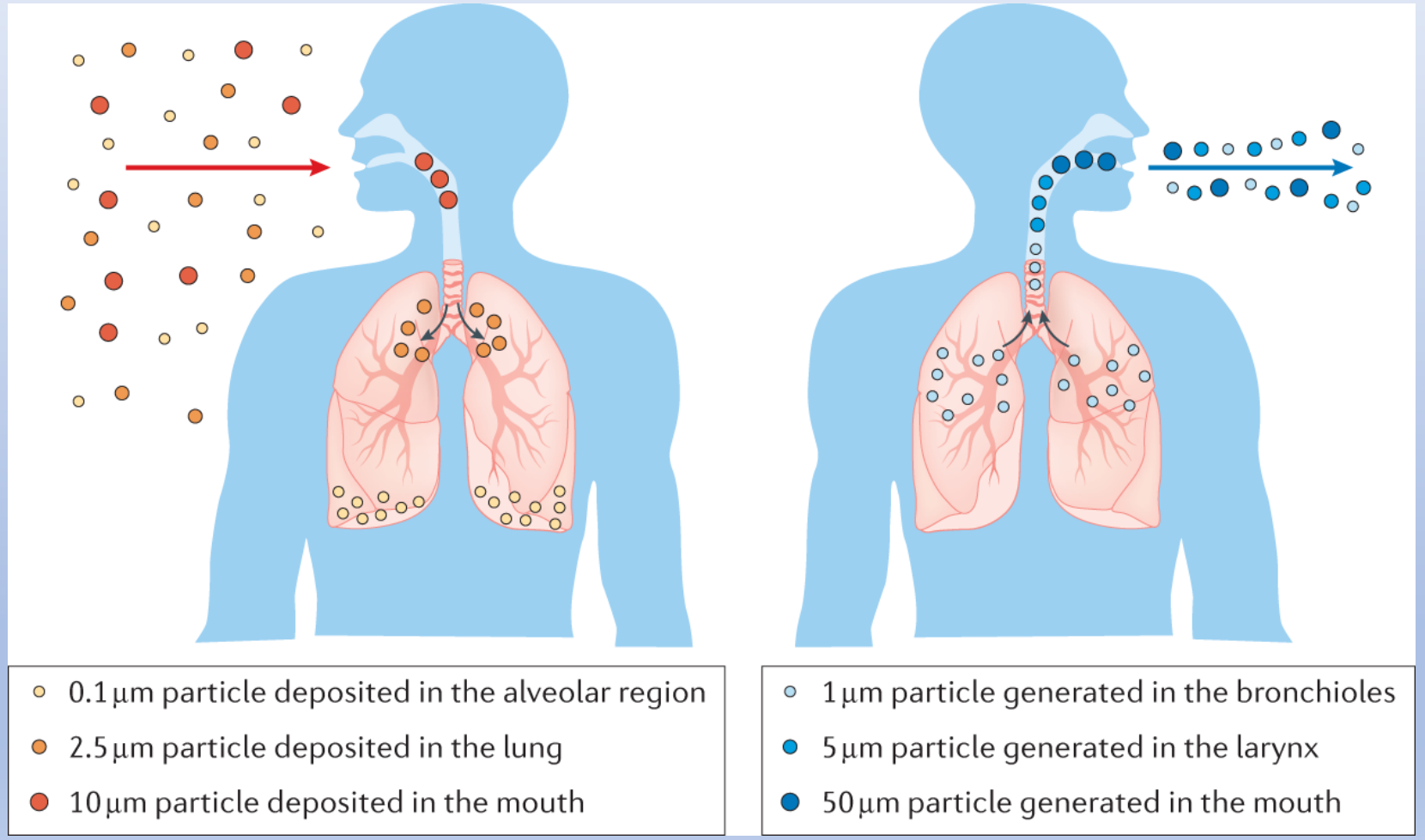
For most uses, the goal of an isolation gown is to keep fomites off our skin and clothing

No tip-toeing into rooms without a gown

When you need protection against something wet, check the rating or consider an alternative or additional garment

Fluid at increasing pressure >>>> Synthetic blood

Masks, Respirators and Respiratory Protection



Morawska, L., Buonanno, G. The physics of particle formation and deposition during breathing. Nat Rev Phys 3, 300-3001 (2021)

Understanding the Difference

	 Surgical Mask	 N95 Respirator	 Elastomeric Half Facepiece Respirator
Testing and Approval	Cleared by the U.S. Food and Drug Administration (**FDA**)	Evaluated, tested, and approved by NIOSH as per the requirements in *42 CFR Part 84**	Evaluated, tested, and approved by NIOSH as per the requirements in *42 CFR Part 84*
Intended Use and Purpose	Fluid resistant and provides the wearer protection against large droplets, splashes, or sprays of bodily or other hazardous fluids. Protects the patient from the wearer's respiratory emissions.	Reduces wearer's exposure to particles including small particle aerosols and large droplets (**only non-oil aerosols**)	Reusable device made of synthetic or rubber material
Face Seal Fit	Loose-fitting	Tight-fitting	Tight-fitting
Fit Testing Requirement	No	Yes	Yes
Designed for Reuse	No	No	Yes
User Seal Check	No	Yes. Required each time the respirator is donned (put on)	Yes. Required each time the respirator is donned (put on)
Filtration	Does NOT provide the wearer with a reliable level of protection from inhaling smaller airborne particles and is not considered respiratory protection	Filters out at least 95% of airborne particles including large and small particles	May be equipped with filters that block 95%, 99%, or 100% of very small particulates. Also may be equipped to protect against vapors/gases.
Leakage	Leakage occurs around the edge of the mask when user inhales	When properly fitted and donned, minimal leakage occurs around edges of the respirator when user inhales	When properly fitted and donned, minimal leakage occurs around edges of the respirator when user inhales

Use Limits

Surgical Masks	N95 Respirator	EHMR
Disposable. Discard after each patient encounter.	Ideally should be discarded after each patient encounter and after aerosol-generating procedures. It should also be discarded when it becomes damaged or deformed; no longer forms an effective seal to the face; becomes wet or visibly dirty; breathing becomes difficult; or if it becomes contaminated with blood, respiratory or nasal secretions, or other bodily fluids.	Reusable and must be cleaned/ disinfected and stored between each patient interaction

https://www.cdc.gov/niosh/npptl/NPPTLInfographics.html

CONSIDERATIONS FOR RESPIRATOR SELECTION IN HEALTHCARE*

	N95 FFR	Surgical N95 FFR	Loose-Fitting PAPR	Elastomeric
Complies with OSHA 1910.134 (RPP Standard)	X	X	X	X
Requires Hazard Evaluation	X	X	X	X
Requires Proper Use Training	X	X	X	X
Requires Fit Testing	X	X		X
Can be used with Sterile Field		X	?†	
Can be used for High-Risk Aerosol-Generating Procedures (additional PPE may be required)		X	X	X
Can be used with Facial Hair (that comes in contact with the sealing surface)			X	
Designed for Reuse (can be cleaned/maintained)			X	X
Can be used for Airborne Precautions	X	X	X	X

*These considerations are meant in terms of general use. Stay informed as public health guidance is updated.
†Insufficient evidence to support safe use

Source: OSHA/NIOSH Hospital Respiratory Protection Program Toolkit

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

https://www.cdc.gov/niosh/npptl/NPPTLInfographics.html

Occupational Respiratory Protection Authority by Federal Agency

Approval Requirements

NIOSH[1]

NIOSH tests and approves respirators to general construction, quality assurance, and performance requirements for use in U.S. workplaces. This includes evaluating respirators on the market to ensure that they continue to meet requirements and issuing notices[2] to clarify requirements, retract approvals, and provide other guidance.

Healthcare

NIOSH and the FDA have a collaborative and streamlined process[3] to ensure that surgical N95 respirators meet the requirements of both agencies.

Mining

NIOSH and MSHA jointly determine whether a respirator intended for mine rescue or other mine emergencies meets the requirements of both agencies. MSHA specifies the amount of time that the respirators must provide breathable air.

Workplace Use Requirements

OSHA

When respirators are needed, **OSHA** requires employers to have a respiratory protection program that includes the use of NIOSH-approved respirators, employee medical evaluations, fit testing, training, respirator maintenance, and hazard evaluations for proper respirator selection. Additional industry-specific requirements may be imposed by other federal agencies.

MSHA

Workplace use requirements within the mining industry are established by **MSHA** rather than **OSHA**.

FDA

FDA may issue Emergency Use Authorizations **during public health emergencies** to increase the supply of respirators for healthcare personnel, such as authorizing the use of respirators that are not NIOSH approved.

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

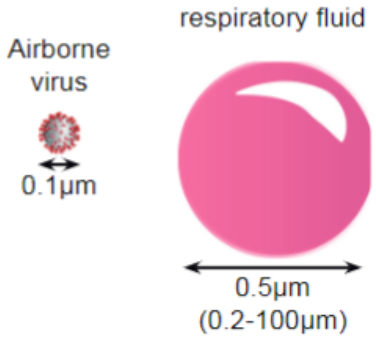
1. National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), Mine Safety Health Administration (MSHA), Food and Drug Administration (FDA)
2. NIOSH Conformity Assessment Notices: https://www.cdc.gov/niosh/npptl/resources/pressrel/letters/default.html
3. FDA/CDC NIOSH MOU: https://www.fda.gov/about-fda/domestic-mous/mou-225-18-006

September 2021

https://www.cdc.gov/niosh/npptl/NPPTLInfographics.html

Viral particles are very small, but they don't travel on their own. They are usually contained in body fluid droplets that may also contain water, salts, proteins, and mucous.

Air molecules like carbon dioxide (0.00065 micron) and oxygen (0.0005 micron) are much smaller than the tiny droplets (1 micron). This is why air molecules pass through masks much more easily.



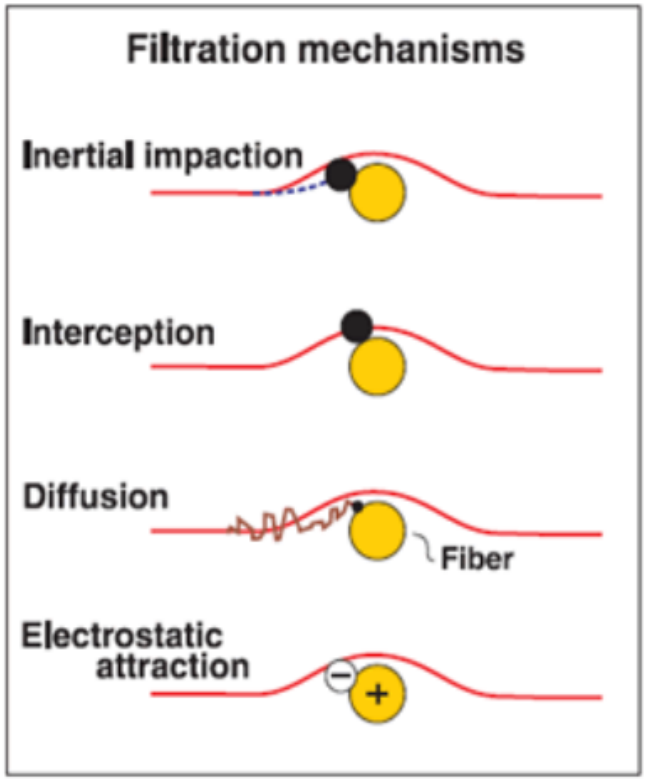
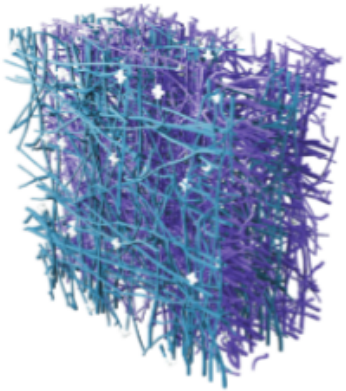
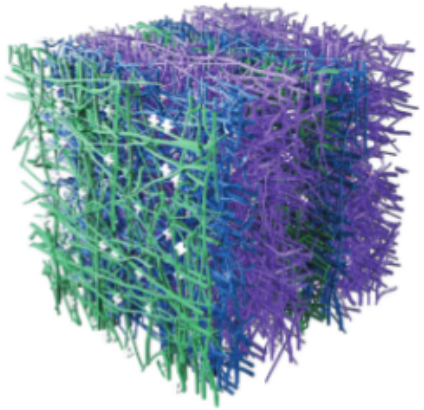


Figure 1: Filtration mechanisms

https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/



Procedure masks have multiple non-woven layers that make a tricky maze for droplets to get through. And the static charge of the fibers causes droplets to stick to them.



KF94, N95, and KN95 have a dense mesh work of static-charged fibers that filter in both directions and allow you to breathe. Check the NIOSH website list of up-to-date respirators.

ASTM F2100 STANDARDS	ASTM LEVEL 1	ASTM LEVEL 2	ASTM LEVEL 3
BACTERIAL FILTRATION EFFICIENCY (BFE) @3µm	≥ 95%	≥ 98%	≥ 98%
SUB-MICRON PARTICAL FILTRATION (PFE) @0.1 µm	≥ 95%	≥ 98%	≥ 98%
DIFFERENTIAL PRESSURE (DELTA P) (mm H_2O/cm^2)	< 5	< 6	< 6
RESISTANCE TO PENETRATION BY SYNTHETIC BLOOD (mmHg)	80	120	160
FLAMMABILITY	CLASS 1	CLASS 1	CLASS 1

Filtering Facepiece Respirators

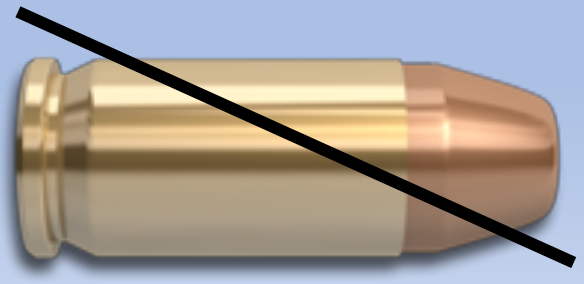
- **N - Not resistant to oil**
- **R - Somewhat resistant to oil**
- **P - Strongly resistant to oil**

- **95 - 95% of airborne particles**
- **99 - 99% of airborne particles**
- **100 - 99.97% of airborne particles**

The protection offered by a tight-fitting respirator is dependent upon an intact seal to the wearers face.

User seal checks should be done **every** time a tight-fitting respirator is put on

PAPR's and CAPR's do not require fit-testing



Fit Testing

- **Fit testing is one of the most important parts of the respirator program. It is the only recognized tool to assess the fit of a specific respirator model and size to the face of the user**
- **OSHA requires employers to make available a sufficient number of models and sizes of respirators so that staff can be provided with a respirator that is comfortable and fits well**
- **Staff are only allowed to use the make, model, style, and size of respirator or respirators for which they have been successfully fit tested**

CDC Frequently asked questions about respiratory protection: https://www.cdc.gov/niosh/docs/2018-129/pdfs/2018-129.pdf

A fit test is conducted to verify that a respirator correctly fits the user and is comfortable. Fit test methods are classified as either qualitative or quantitative.

Qualitative testing: ability to taste bitter/sweet solution. Particles of these aerosols should be trapped by respirator.

Quantitative testing: uses a particle counter to detect and measure the number of particles inside the respirator face piece.

Image Credit: TSI

Medical clearance records must be maintained for 30y after termination of employment

Qualitative testing may not be possible in those with impaired taste post-COVID

Quantitative fit testing of FFR's can deplete crucial supplies during shortages.

NETEC

Program Administrator

- Compliance and reporting
- Supply chain
- Hazard assessment
- Long-term records
- Process for medical clearance

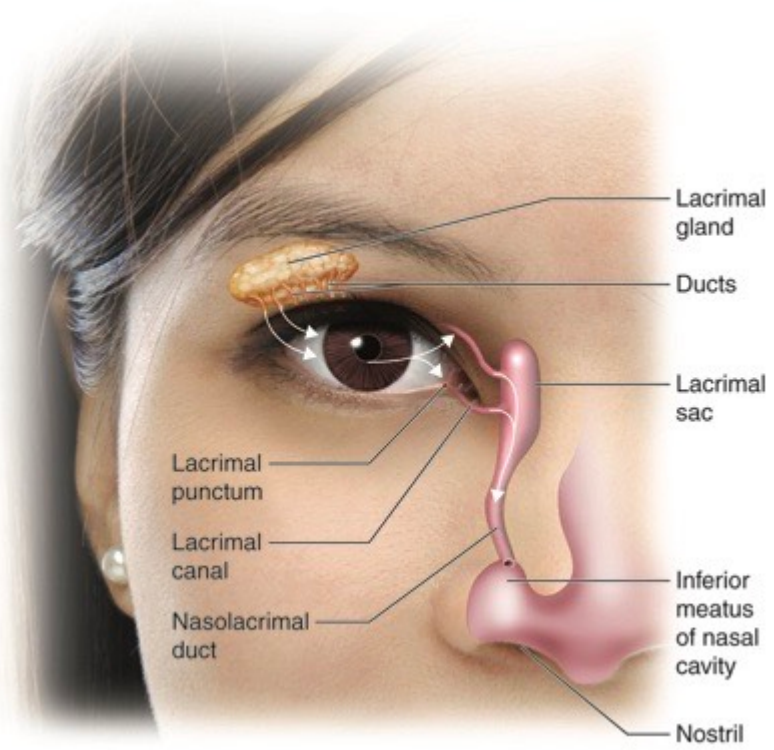
Program Supervisor

- Ensure implementation
- Process for new and existing staff
- Local supply maintenance
- Audits and records
- Teaching / training

Staff

- Participate in medical screening
- Comply with fit testing
- Know equipment
- User seal check
- Inform supervisor of changes to health

"It is evident that numerous respiratory viruses, of both human and zoonotic origins, are capable of using the eye as both a site of virus replication as well as a portal of entry to mount a productive respiratory infection."



- Blood/body fluids on protective glasses only noticed half of the time it was present (intraoperatively)
- Despite ALL the laparoscopic cases resulting in lens contamination, during NONE of these cases was the lens contamination noted during the procedure
- "In all cases where there was blood/body fluid found on the mask, there was also blood/body fluid found on the lens of the protective glasses."

"…protective devices showed an overall contamination rate of 98%. The side protector flap on the standard loupes was hit 70% of the time…in the inner position (the side of the head closer to the osteotomy site) and 40% of the time in the outer position."

Belser JA, Rota PA, Tumpey TM. Ocular tropism of respiratory viruses. Microbiology and Molecular Biology Reviews : MMBR. 2013 Mar;77(1):144-156.

Mansour, Alfred A. III, MD1; Even, Jesse L., MD1; Phillips, Sharon, MSPH2; Halpern, Jennifer L., MD1 Eye Protection in Orthopaedic Surgery, JBJS: May 01, 2009 - Volume 91 - Issue 5 - p 1050-1054

Davies CG, Khan MN, Ghauri AS, Ranaboldo CJ. Blood and body fluid splashes during surgery--the need for eye protection and masks. *Ann R Coll Surg Engl*. 2007;89(8):770-772.

To solve the difficulty of separating ocular exposure from that of the respiratory tract, ferrets were fitted with goggles that blew influenza spiked air across their eyes.

Belser JA, Gustin KM, Katz JM, Maines TR, Tumpey TM. Influenza virus infectivity and virulence following ocular-only aerosol inoculation of ferrets. Journal of Virology. 2014 Sep;88(17):9647-9654

New Eye Protection Standard for Manufacturers – ANSI Z87.62

American National Standard for Occupational and Educational Eye and Face Protection Devices for Preventing Exposures Caused by Sprays or Spurts of Blood or Body Fluids

Isolation stethoscopes are kept inside isolation rooms, increasing the risk to staff when they have to be placed underneath PPE

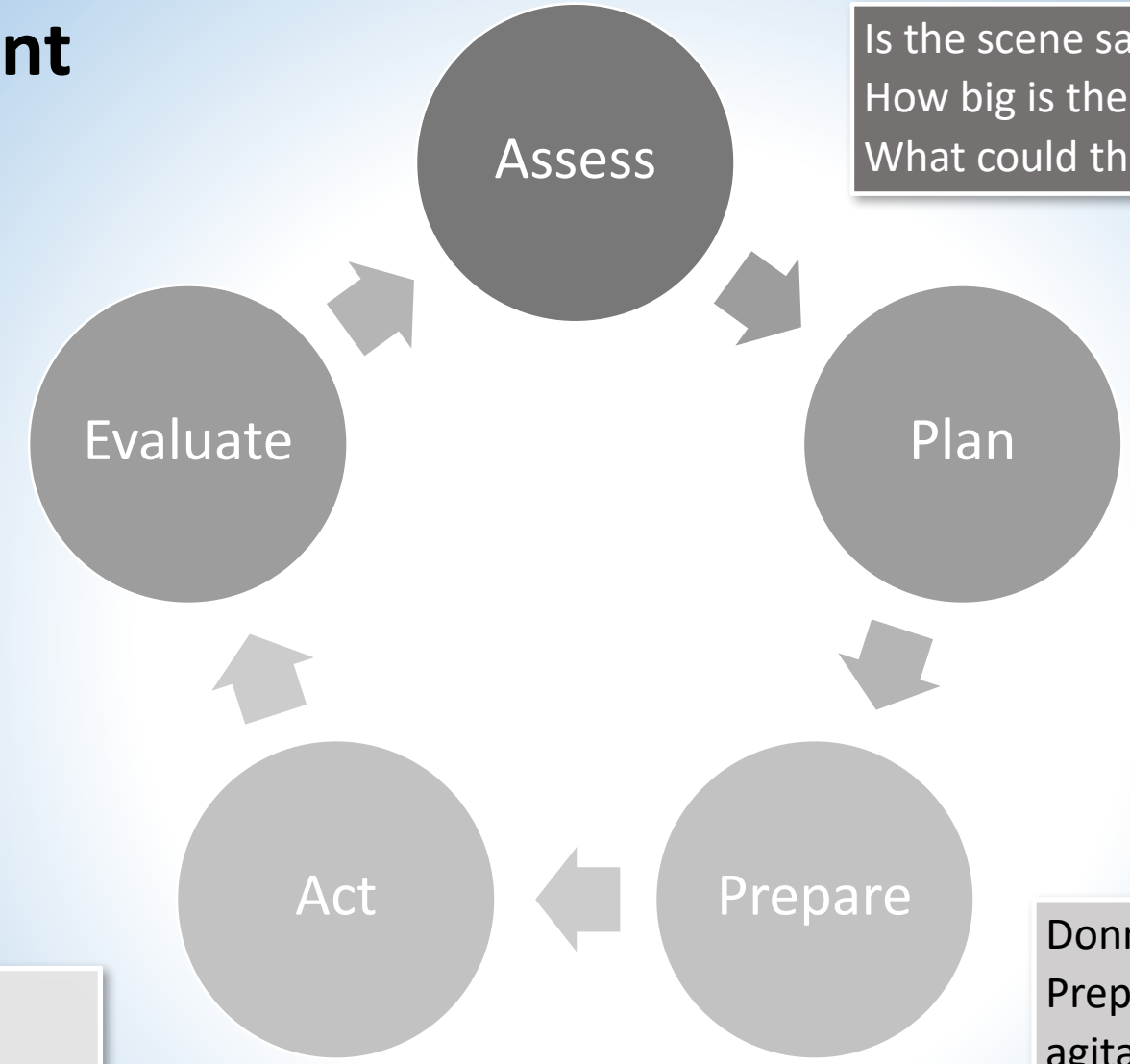
”Personal protective equipment will be considered “appropriate” only if it does not permit blood or other potentially infectious materials to pass through to or reach the … skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used.”

OSHA https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030

- Fit snugly (not easy to dislodge in use)
- Seal to the forehead (no gap above or to the sides of eyes)
- Visual clarity, optical quality
- UV protection (for outdoor or intraoperative use)
- Anti-glare
- Anti-static
- Anti-fog
- Full face from top of forehead to chin, to **front** of each ear
- Space to allow masks or respirators, prescription eyewear
- Able to be removed safely, without self-contamination

Raymond J. Roberge (2016) Face shields for infection control: A review, Journal of Occupational and Envir
Hygiene, 13:4, 235- 242, DOI: 10.1080/15459624.2015.1095302

Risk Assessment



Is the scene safe?
How big is the mess?
What could this person have?

What do I need?
Who could help?
Do I have everything?
Can the patient cooperate/fight?

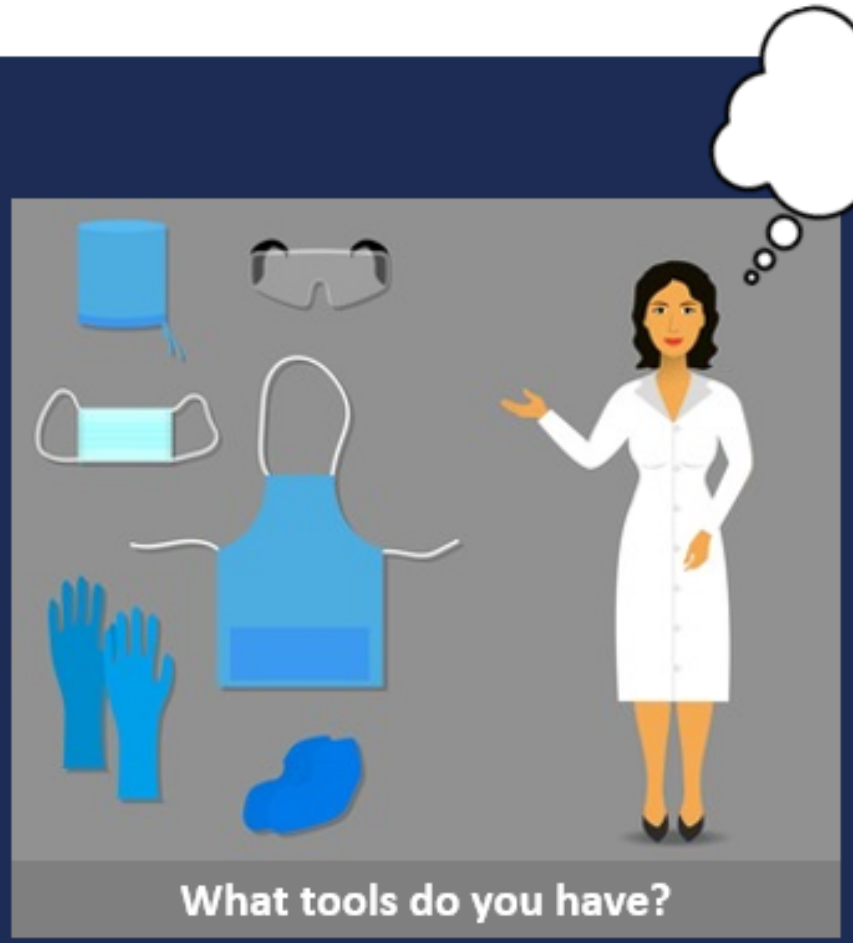
Donning PPE
Preparing for worst-case – immobility, agitation, large splash zone
Check for **stuff** and **staff**

Patient care
Cleaning
Source control
Situation Control
Mitigation

What mess is left?
Am I safe?
Are they safe?
Can I doff safely?

What tools do you have?

NETEC



What kind of isolation might this patient need?

- Contact
- Droplet
- Airborne
- Enhanced Contact

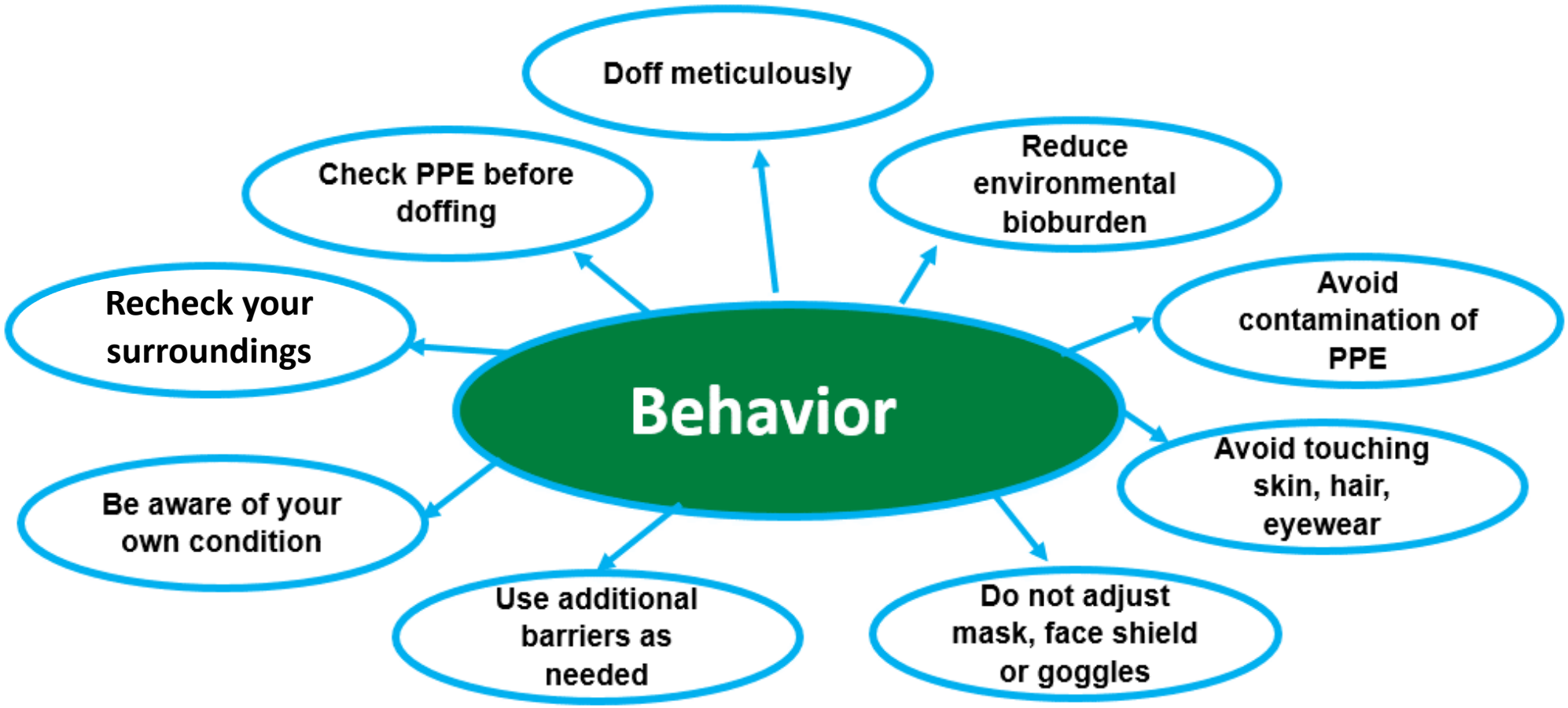
What might I be doing in the patient care area?

- Handling an IV?
- Wound Care?
- Wet linens?
- Drawing Blood?

What might the patient do while I am there?

- Cough
- Sneeze
- Vomit
- Toileting
- Want to get up
- Grab, tug, pull

Risk and In-room behavior while in PPE



What's ahead for gowns?

ASTM working on standards

WK80991 - Revision of F2407-20 Standard Specification for Surgical Gowns Intended for Use in Healthcare Facilities

WK80990 - Revision of F3352-19 Standard Specification for Isolation Gowns Intended for Use in Healthcare Facilities

Research:

Glove-gown interface: https://www.ajicjournal.org/article/S0196-6553(21)00547-2/pdf

Effect of adding a layer: Kahveci, Zafer, F. Selcen Kilinc-Balci, and Patrick L. Yorio. "Barrier resistance of double layer isolation gowns." *American Journal of Infection Control* 49.4 (2021): 430-433.

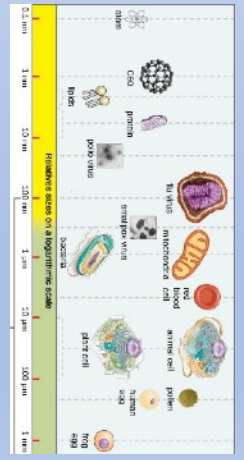
What is ahead in respiratory protection?

Recommendations

"…the absence of an OSHA standard for airborne infectious disease agents and the outdated nature of the existing standard for particulate matter (PM) impede efforts to institute respiratory protection measures for workers.
OSHA should develop new standards and guidelines for inhalation hazards like wildfire smoke and airborne infectious agents to indicate when respiratory protection is needed."

https://www.nationalacademies.org/ocga/briefings-to-congress/frameworks-for-protecting-workers-and-the-public-from-inhalation-hazards

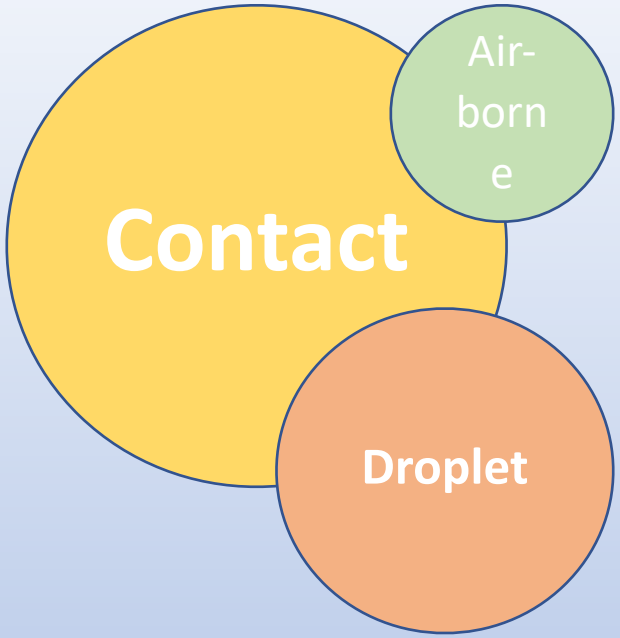
Research



Recent findings in fluid dynamics of respiratory emissions also support the view that the framework of "droplet" vs "aerosol" routes of transmission is not a perfect dichotomy with a sharp boundary in particle size and distance, and make clear that **a 1-2 m distance is not compatible with the physics of respiratory emissions**.

In contemporary recommendations about droplet transmission, including those regarding COVID19, both the WHO and the CDC define a distinction between "droplets" and "aerosols" based on a size threshold of 5 µm. Despite the prominence of this size threshold in the literature, **a 5 µm threshold to distinguish between "droplets" and "aerosols" is not scientifically grounded.**

Randall, Katherine, et al. "How did we get here: What are droplets and aerosols and how far do they go? A historical perspective on the transmission of respiratory infectious diseases." *Interface focus* 11.6 (2021): 20210049.

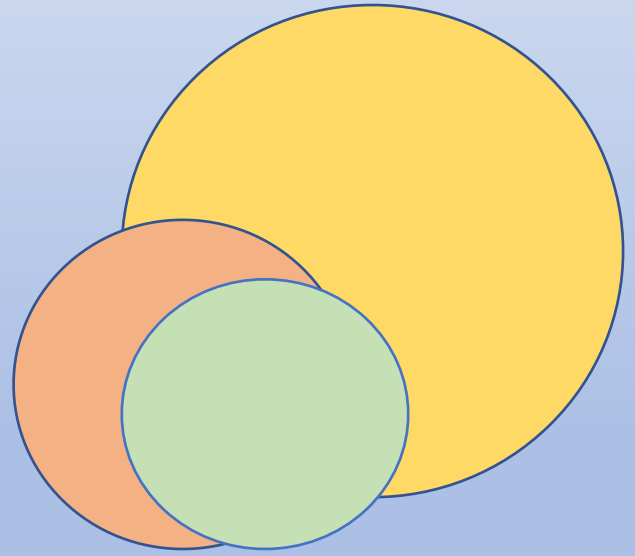


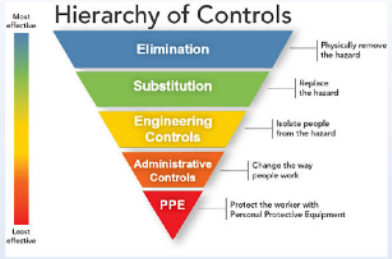
There is no magic 3’ or 6’ barrier

There is no hard line between droplets and aerosols

There is no perfect PPE

The choices you make and the precautions you take keep you as safe as possible in an inherently dangerous and unpredictable environment.





Doffing is dangerous

If PPE is the last piece in the Hierarchy of Controls pyramid, doffing PPE is the very tip of that point. It is our last chance to leave the kooties/germs/fomites behind.

Doffing is a skill that can be taught and should be practiced.

Competency is not a once-a-year thing.

It's an **every day** thing.

Know what tools you have – what's in your quiver/backpack/inventory?

Recognize potential dangers based on symptoms and stories – don't wait for confirmation to protect yourself

In 2019, U.S. hospitals recorded 221,400 work-related injuries and illnesses, a rate of 5.5 work-related injuries and illnesses for every 100 full-time employees. This is almost twice the rate for private industry as a whole.

You don't have to be self-sacrificing to be a healthcare hero.

Protect yourself and your family by anticipating risk, wearing PPE correctly and consistently, and by doffing meticulously.

Get involved!
ASTM needs end-users input
Join APIC
NIOSH Centers of Excellence in PPT

https://www.osha.gov/hospitals#:~:text=In%202019%2C%20U.S.%20hospitals%20recorded,private%20industry%20as%20a%20whole.

NETEC Vision

NETEC sets and advances the gold standard for special pathogen preparedness and response across health care delivery systems with the goals of driving best practices, closing knowledge gaps, and developing innovative resources.

For more information

Please visit us at www.netec.org
or email us at info@netec.org

References

Kilinc-Balci, F. Selcen, Julian Nwoko, and Todd Hillam. "Evaluation of the performance of isolation gowns." *American Journal of Infection Control* 43.6 (2015): S44.

Cloud, R. M., et al. "Isolation gown use, performance and potential compliance issues identified by infection preventionists." *APIC 39th Annual Educational Conference and International Meeting*. 2012.

Morawska, L., Buonanno, G. The physics of particle formation and deposition during breathing. Nat Rev Phys 3, 300-301 (2021). http://doi.org/10.1038/s42254-021-0037-4

https://www.cdc.gov/niosh/npptl/NPPTLInfographics.html

https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/

Belser JA, Rota PA, Tumpey TM. Ocular tropism of respiratory viruses. Microbiology and Molecular Biology Reviews : MMBR. 2013 Mar;77(1):144-156.

Mansour, Alfred A. III, MD1; Even, Jesse L., MD1; Phillips, Sharon, MSPH2; Halpern, Jennifer L., MD1 Eye Protection in Orthopaedic Surgery, JBJS: May 01, 2009 - Volume 91 - Issue 5 - p 1050-1054.

Davies CG, Khan MN, Ghauri AS, Ranaboldo CJ. Blood and body fluid splashes during surgery--the need for eye protection and masks. *Ann R Coll Surg Engl*. 2007;89(8):770-772.

Belser JA, Gustin KM, Katz JM, Maines TR, Tumpey TM. Influenza virus infectivity and virulence following ocular-only aerosol inoculation of ferrets. Journal of Virology. 2014 Sep;88(17):9647-9654

OSHA https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.1030

Roberge, Raymond J. "Face shields for infection control: A review." *Journal of occupational and environmental hygiene* 13.4 (2016): 235-242.

https://www.astm.org/catalogsearch/result/index/?q=gown&product_list_order=last_updated&p=1

Kahveci, Zafer, F. Selcen Kilinc-Balci, and Patrick L. Yorio. "A simulation study to assess fluid leakage through the glove-gown interface in isolation settings." *American Journal of Infection Control* 49.12 (2021): 1481-1487.

Kahveci, Zafer, F. Selcen Kilinc-Balci, and Patrick L. Yorio. "Barrier resistance of double layer isolation gowns." *American Journal of Infection Control* 49.4 (2021): 430-433.

https://www.nationalacademies.org/ocga/briefings-to-congress/frameworks-for-protecting-workers-and-the-public-from-inhalation-hazards

Randall, Katherine, et al. "How did we get here: What are droplets and aerosols and how far do they go? A historical perspective on the transmission of respiratory infectious diseases." *Interface focus* 11.6 (2021): 20210049.

https://www.osha.gov/hospitals#:~:text=In%202019%2C%20U.S.%20hospitals%20recorded,private%20industry%20as%20a%20whole