Addressing Ventilation Study Covid Concerns

(800) 321-5981, (626) 960-9822
info@medinuclear.com
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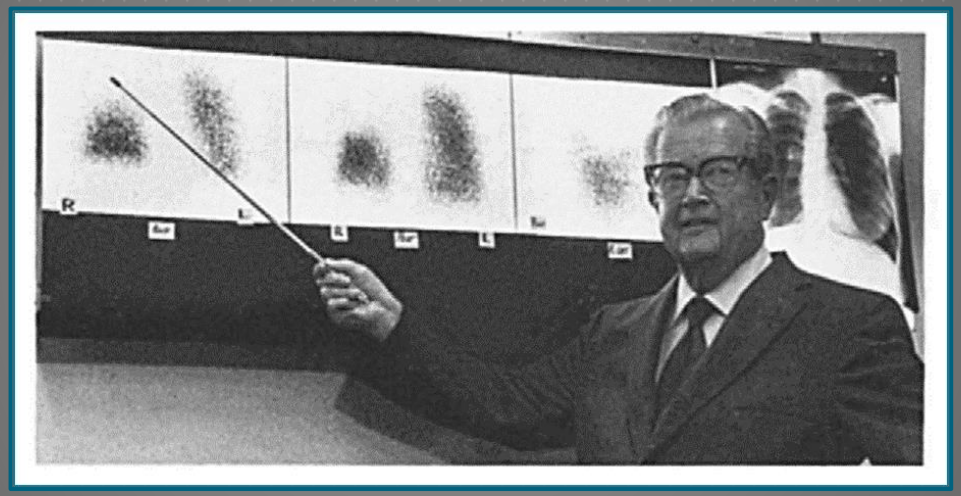
A Positive 40+ Year History

For over 40 years, radioaerosol inhalation lung imaging has proven its effectiveness and safety.

Initially developed in 1965, it took less than a year to make changes to decrease radiation in the lungs. Since then, attention to the quality of lung images and safety have been ongoing.



Early systems were designed with safety features to protect against radioactive contamination. Additional steps were taken to protect against infectious disease, such as flu and Tuberculosis, which are spread by airborne particles.

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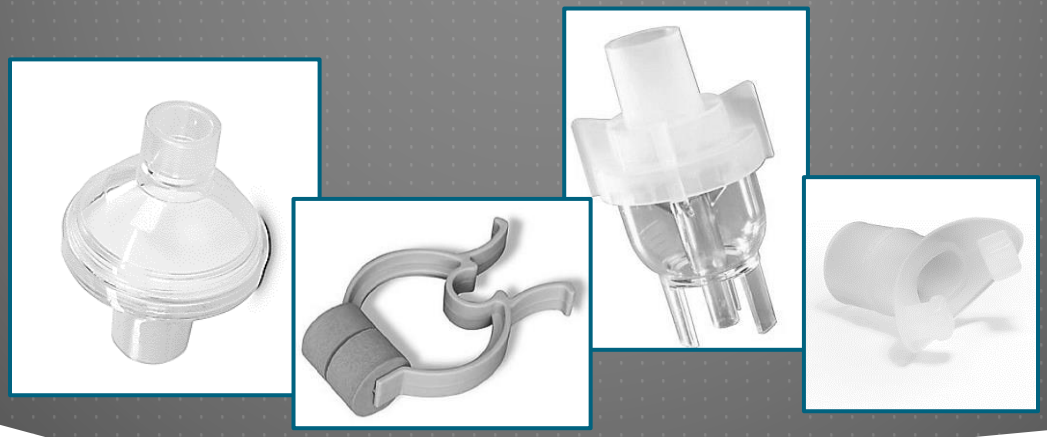
Through the years…

1. Shield designs have been improved to better protect against radioactivity and fugitive aerosols.
2. The use of bacteria filters has shifted to HEPA filters, allowing smaller particles to be trapped.
3. Radioaeorsol administration kits have been modified for faster dosing, reducing time of possible exposure.
4. Mouthpiece, nose clip and face mask options were made available to better address patient needs and concerns about possible contamination from a patient's mouth or nose.



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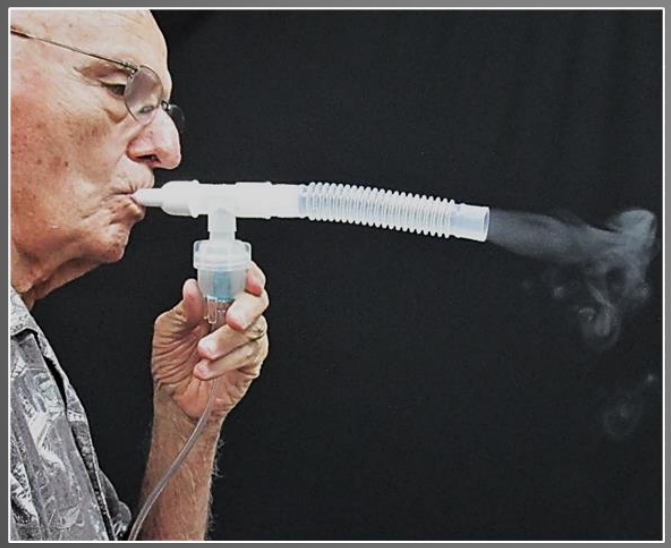
Aerosol Delivery Device Differences

During the Covid crisis, radioaerosol delivery devices and aerosol drug delivery devices for respiratory care have been lumped into the same category and treated similarly. They've been considered equally hazardous.

This is highly unfortunate as these devices ***are not comparable*** when it comes to safety and concerns about contaminated airborne particles.



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The majority of nebulizing systems used in respiratory care are **"open systems"**, meaning what goes into the system can come out. Generally, these devices are…

- Unfiltered,
- Rarely used with a nose clip,
- Often used with vented face masks,

allowing possibly contaminated patient exhalation and aerosol drug particles into the atmosphere.




When using general purpose respiratory nebulizers, the concern about possibly contaminated airborne particles is very real and completely understandable.

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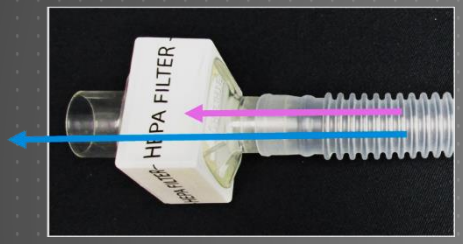
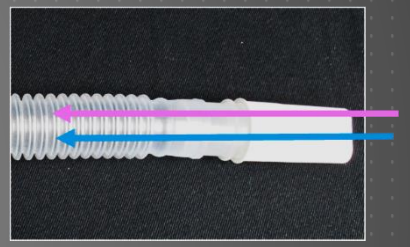
Closed Systems

Radioaerosol delivery systems are "**closed systems"**, meaning energy can flow through but matter cannot. In the case of ventilation studies…

Energy = Patient Exhalation
Matter = Trapped Particles.



- Patient exhalation enters through a protective mouthpiece or face mask at the front end of an administration set and exits through a HEPA filter, placed at the back end of an administration set.



- Particles are trapped by a HEPA filter, with **at least** 99.97% trapping efficiency of particles 0.3 µm in size. HEPA filters are even more effective at trapping particles larger AND smaller than 0.3 µm.

As a bonus, administration kits are fully disposable, thereby reducing the risk of cross-contamination.

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Making Ventilation Studies Even Safer

Keeping in mind that a ventilation study itself is a safe procedure, the risky part of performing one is the patient.

The same holds true of CTs, x-rays, intubations and any other procedure. The patient is the unknown part of any familiar procedure.

So how can we make ventilation studies even safer during the Covid crisis?

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Treat all Patients as Possibly Being Infectious

During times when infectious disease is actively spreading, it's wise to enhance safety with all patients, no matter what procedure is being performed.

Patients may be:

- Asymptomatic
- Waiting on test results to confirm illness
- Report old/inaccurate test results
- Not be infected at all

We just don't know so safety precautions should be standard.

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Addressing Concerns About Coughing

BREATHING

A deep breath by a sick patient almost guarantees coughing.

During a ventilation study, normal, tidal breathing should be encouraged as this will:

- Improve patient comfort and compliance.
- Reduce the likelihood of coughing.
- Allow very small particles to be delivered to the alveoli.

Certainly some delivery systems **require** tidal breathing, but others **require** breath holding.

What to do?

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Emphasize slower and more controlled breathing prior to a breath hold, rather than a rapid, deep breath.

This will be:

- Easier for a sick patient to accomplish.
- Help minimize possible coughing.
- Allow very small particles to reach the periphery of the lungs.
- AND prevent excess velocity from causing excessive deposition in the upper respiratory tract.

According to research, when drugs inhaled at a slow inspiratory rate and those at a faster rate are compared, faster inhalation was less effective because more drug impacted in the oropharynx and was lost[1].

1. Laube, BL, In Vivo Measurements of Aerosol Dose and Distribution: Clinical Relevance, Journal of Aerosol Medicine, Volume 9, Supplement 1, 1996.

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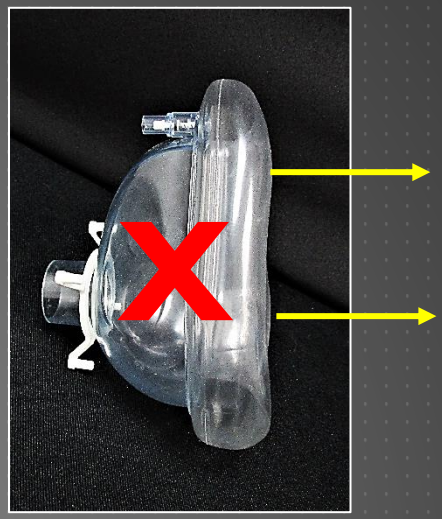
FACE MASKS

Due to concerns about coughing, a properly fitted, unvented air cushioned face mask is suggested, as it can securely cover a patient's nose and mouth, and coughs will go through the circuit into a HEPA filter.

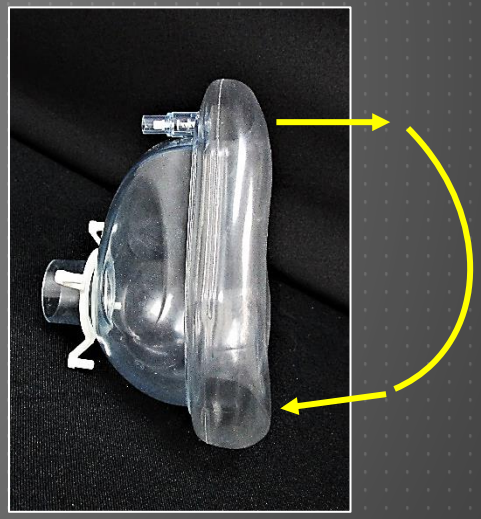


Merely placing a face mask on a face may not allow the edges to seal securely.

To properly apply a face mask;

1) Place it on the bridge of the nose.
2) Carefully roll it down toward the chin.

This process will move the soft tissues out of the way, securely sealing the edges of the face mask on the hard bones of the face.



Nose hair can strip particles from aerosol mist making dosing slightly longer. For faster dosing, have patients breathe through their mouth.

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FACE MASK HARNESS

The use of a face mask harness is suggested as it will help to secure the face mask, reducing possible contamination from a poorly fitted or loosely held face mask.

As always, when using a face mask wipe a patient's face following the procedure and discard the towel as hazardous waste.

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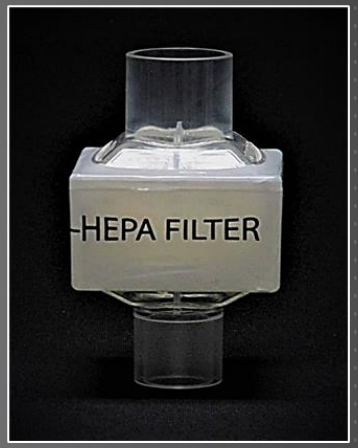
Addressing Concerns About Contamination

HEPA FILTERS

Administration sets used for ventilation studies come with a HEPA filter, as standard. During a study, patient exhalation goes through the breathing circuit and into a HEPA filter where particles are trapped, limiting escape into the atmosphere.



According to the Centers for Disease Control, by definition, a High Efficiency Particulate Air (HEPA) filter is **at least 99.97% efficient** at capturing particles 0.3 µm in size. This 0.3 µm particle approximates the most penetrating particle size (MPPS) through the filter. HEPA filters are even more efficient at capturing particles larger AND smaller than the MPPS. Thus, HEPA filters are no less than 99.97% efficient at capturing human-generated viral particles associated with SARS-CoV-2[1].

1. Ventilation in Buildings", Centers for Disease Control, https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html#refphf , June 2021.

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At roughly 0.1 µm, Covid-19 virus particles are very small, but they don't travel alone. Covid-19 particles are exhaled with salivary/mucous droplets starting from approximately 0.5 µm in size[1].

HEPA filters don't merely strain particles. They physically remove them from the air stream. As particles of various size pass through the filter at different rates, they hit and stick to filter fibers or bounce off of each other before hitting and sticking to filter fibers.

Together, these processes create a 'dynamic collision trap' as particles pass through the network of air channels between fibers at various speeds[1].

1. Tang, J.W. et al, Dismantling Myths on the Airborne Transmission of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), Journal of Hospital Infection 110, pg. 89-96, 2021.

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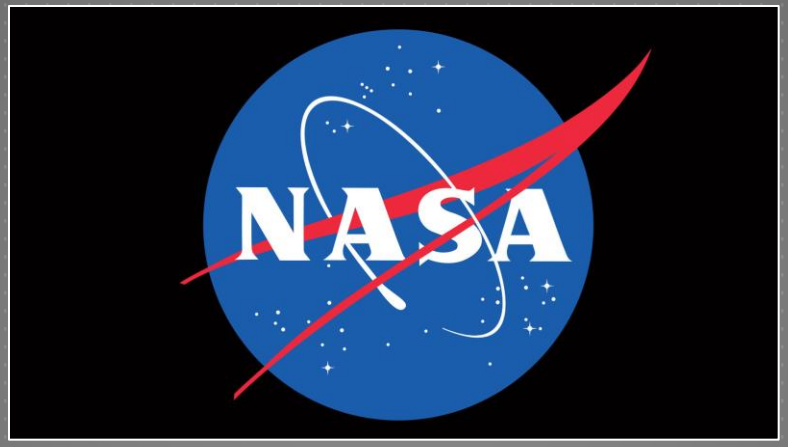
According to research performed by the National Aeronautics and Space Administration (NASA), when used alone, HEPA-rated media provides superior performance for **removing virtually 100% of particulates**[1].



Those doubting this should keep in mind that very few, if any particles will pass through a HEPA filter but should they, not every exhaled particle will be virus laden or carry a significant viral load. If desired, a second HEPA filter may be added.

1. Perry, JL et al, Submicron and Nanoparticulate Matter Removal by JEPA-Rated Media Filters and Packed Beds of Granular Materials, National Aeronautics and Space Administration (NASA) Marshall Space Flight Center, Huntsville, Alabama, May 2016.

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Xenon delivery systems are open systems.

While disinfecting the inner workings of a Xenon delivery system is extremely difficult, if not impossible, minimizing the risk of system contamination is possible.

A HEPA filter, and preferably two, is suggested for placement between a patient's face mask and the system. This will allow the majority, if not all, particles to be trapped prior to entering the system.

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MOUTHPIECES

If a mouthpiece is to be used, a scuba style or flanged mouthpiece is suggested as it:

1. Covers the corners of a patients mouth where contaminated leakage often occurs.
2. Is less likely to slip from a patient's mouth than a straight mouthpiece.
3. Features bite wings which open teeth slightly for improved airflow.

With select mouthpieces or problematic patients, an additional layer of protection may be added by wrapping a moist cotton/cotton blend cloth around the mouthpiece.

The moisture will fill the pores in the cloth allowing it to capture escaped particles, if any. The cloth may be discarded as hazardous waste following the procedure.

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NOSE CLIPS

Placing a nose clip is a simple and yet very important part of patient prep. If placed improperly contaminated leakage will occur through a patient's nose.

To place a nose clip properly, ensure the nose pads are located on the lower part of the nose, keeping nostrils closed tightly.

NOTE: If a patient is placing the nose clip, check to make sure it is located properly. This will enhance safety and speed up dosing.

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SHIELD

- Placing a table top shield on absorbent paper will help to protect surfaces from possible contamination and make clean-up faster and more convenient.
- Cleaning and disinfecting a shield and study area is recommended following each patient.
- Lead shield surfaces are non-porous and may be gently wiped down with rubbing alcohol or other disinfectant, and then left to air dry.

NOTE: If one more layer of protection is desired, a damp cotton or cotton blend cloth may be placed around the outside of a shield, covering the mouthport opening and/or filter exhaust port. The moisture will fill the pores in the cloth allowing it to capture escaped particles, if any. The cloth may be discarded as hazardous waste following the procedure.

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WRAPPING UP

After a procedure, before removing a mouthpiece or face mask, allow the patient to continue breathing room air via the kit for an additional 20-30 seconds (4-5 breaths).

This will maximize the clearance of any remaining activity in the tubing, and reduce the possibility of inadvertent contamination to the patient, Tech or room by allowing particles to be captured in the HEPA filter.

Have the patient put on a personal face mask following the procedure.

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Many Thanks

Medi/Nuclear® would like to acknowledge and thank all of the Nuclear Techs that contributed tips and words of wisdom to this presentation.

Thank you to SNMMI for the opportunity to share this information. And thanks to you for your time and interest in safely resuming ventilation studies.

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