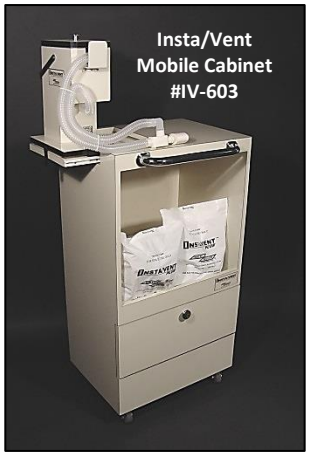
Comparison of Aerosol and Xenon Delivery Methods

4610 Littlejohn Street, Baldwin Park, CA 91706
800.321.5981 / 626.960.9822 / 626.960.8700 Fax
info@medinuclear.com / www.medinuclear.com

Aerosol Benefits



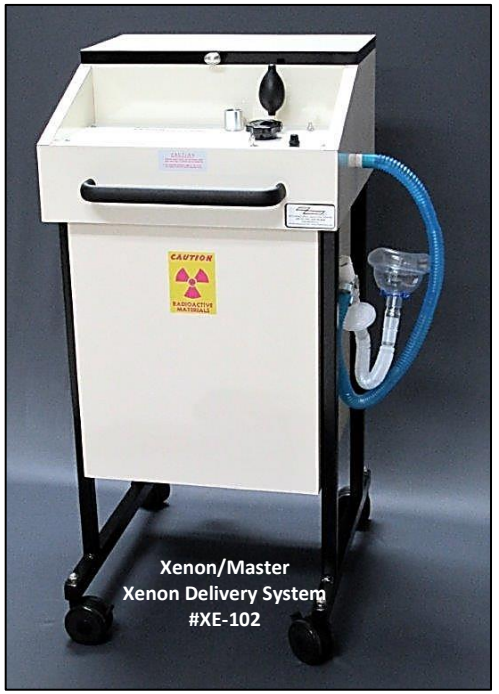
- Can be used with SPECT. Note: For a longer dwell time than DTPA, PYP or other equivalent alternatives may be used.
- 140-keV gamma photon provides high quality images[2].
- Very little patient cooperation is required since radiotracer deposition takes place during normal tidal breathing[2].
- Because the particles remain in the lungs, particles have the advantage of allowing for imaging in multiple projections, which can be more easily compared with the perfusion images[4].
- More sensitive to partial obstruction.
- Lower radiation dose than ^{133}Xe.
- Multiple projections may be obtained with a single administration of the aerosol[2].
- Patient dosing may be done in less than 2 minutes when using a delivery system that features unidirectional airflow and a conserving reservoir.
- Aerosol systems that deliver particles as small as .28µM are readily available and virtually eliminate central airway deposition and 'hot spots'.
- Two tube systems with unidirectional airflow provide faster dosing than single tube systems and minimize breathing resistance to support shallow breathers.
- Every breath is fully medicated when using a two tube system with unidirectional airflow.
- The patient may be vented in a room separate from the camera room[2].
- Aerosol studies may be readily performed on patients undergoing mechanical ventilation.
- ^{99m}Tc-DTPA labeled aerosol offers the advantage of being rapidly cleared from the lungs, thereby reducing radiation exposure[2].
- Fine DTPA aerosol particles easily cross the alveolar-capillary membrane and enter the pulmonary circulation[2].
- Once in circulation, DTPA is rapidly cleared by the kidneys, similar to intravenously administered DTPA[2].
- Studies may be performed with DTPA, PYP, MDP, MIBI, SC or other equivalent alternatives. Note: Their use for lung imaging is considered off label and will require appropriate approval.
- No particular monitoring required.
- Equipment costs and maintenance are minimal.
- Particles are inhaled and stay where they initially land. In the case of COPD, this results in a mottled image with 'hot spots' and central deposition. This appearance is sometimes thought of as "clumping". It isn't, rather it is simply an accurate representation of the condition of the lungs[5].

Aerosol Disadvantages

- Not all radioaerosol delivery systems are equal. Selecting a system requires careful consideration.
- In single tube systems, inhalation and exhalation are done in the same tube. The humid environment inside the tube allows particles to grow prior to being inhaled. The larger particles increase the possibility of central airway deposition, thereby reducing image quality.
- Some radioaerosol delivery systems produce particles as large as .5µM and grow from there. Deep or rapid inhalation of these large particles may cause them to stick in the back of the throat, often causing central airway deposition and poor image quality.
- Single tube systems allow medication to be diluted prior to inhalation as it's mixed with exhaled breath. Because of this, dosing will be slower than with a two tube system with unidirectional airflow. Longer dosing times may be difficult for shallow breathing patients.
- Systems with straight mouthpieces may be difficult for some patients to use and allow leakage from the corners of the mouth.
- Some systems utilize a packed filter which causes severe breathing resistance.

^{133}Xenon-Benefits

- The physical half-life of 5.3 days makes ^{133}Xe easy to keep and supply[1].
- Allows for the assessment of all phases of regional ventilation: instantaneous (single breath), wash-in (equilibrium), and wash-out[2].
- Single breath image represents instant ventilation to the lungs[2].
- Wash-in images to equilibrium are proportional to aerosolized lung volume[2].
- Wash-out phase images show clearance of activity from the lungs, usually within a few minutes of wash-out[2].
- Regions of prolonged ^{133}Xe retention correspond to obstructive lung disease[2].



^{133}Xenon - Disadvantages

- Cannot be used with SPECT.
- No matching views available.
- Higher radiation dose due to Beta particles.
- Imaging studies require a considerable amount of patient cooperation, especially for the single breath image[2].
- Patient must be able to tolerate breathing on a closed spirometer system for several minutes in order to reach equilibrium[2].
- A rebreathing phase of at least 3-5 minutes is needed as ^{133}Xe retention will not be detected in regions that exchange air slowly unless adequate time has been allowed for the tracer to enter those regions during the equilibrium phase[3].
- Wash-out images must be carried out for a sufficient amount of time (>5-6 minutes) in order to obtain maximum diagnostic information[2].
- The 80-keV photons, plus Beta particles, result in increased soft tissue absorption and decreased image resolution, thereby making single posterior projection images difficult to interpret.
- The low energy necessitates that ^{133}Xe ventilation be performed prior to perfusion imaging[2].
- Cannot be used with mechanically ventilated patients.
- Equipment requires continual effluent monitoring.
- Equipment requires routine maintenance and trap replacement.
- ^{133}Xe requires that special consideration be given to room design, regarding negative pressure.
- Maintaining the camera room at a negative pressure relative to outside hallways and the use of a dedicated trap or exhaust vent to remove xenon gas is necessary in order to comply with regulatory policies[2]. This may upset air conditioner balance.

[1] *Nuclear Medicine: The Requisites (Fourth Edition),* Chapter 10: Pulmonary System, 2014; 10:204-226
[2] Hanson, Paul C., Ventilation Scintigraphy. *Journal of Nuclear Medicine Technology*, 1987; 15:193-197
[3] Alderson PO, Scintigraphic evaluation of regional pulmonary ventilation. *Semin Nucl Med* 1980; 3:218-242
[4] *Radiology Secrets Plus (Third Edition),* Chapter 55: Ventilation-Perfusion Scans, 2011; 55:382-388
[5] Potter, Ross, *Troubleshooting Problems with COPD Images (white paper),* Medi/Nuclear® Corporation, 2015.