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Radioaerosol Deposition in the Normal Patient

The rate at which the radioaerosol deposits in the patient's lungs is determined, essentially, by two factors:

1. Nebulizer generation rate.
   The NEB-3A+ Nebulizer used in the Insta/Vent™ is designed to operate at an oxygen or air flow rate of 10L/min, +/- 2L/min. At this flow rate, the generation rate is approximately 0.14mL/min. This is, for all practical purposes, a constant.
2. Radioactive concentration (mCi/mL).
   The deposition rate in the patient's lungs is inversely proportional to the concentration of the radioactivity placed in the nebulizer reservoir. That is, if the radioactive concentration is doubled, the breathing time will be halved.

Nominally, at the suggested radioactive concentration of 20mCi/mL, it will take approximately 2 minutes of breathing to deposit 1mCi in the lungs. If the concentration is doubled to 40mCi/mL, the breathing time will be reduced to approximately 1 minute. Conversely, if the concentration is reduced to 10mCi/mL, the breathing time will increase to approximately 4 minutes.

The process of determining the volume appropriate to put into the nebulizer reservoir requires the knowledge of both the nebulizer generation rate and the 'dead volume'. The 'dead volume' is that volume remaining in the nebulizer at the conclusion of nebulization. The conclusion of nebulization is generally defined as the onset of sputter. At this point, the generation of aerosol becomes sporadic and unpredictable. In the NEB-3A+ nebulizer, the 'dead volume' is approximately 0.7mL.

With knowledge of the radioactive concentration, the generation rate and the 'dead volume', it is now possible to determine the liquid volume required to complete a study. If we begin with a concentration of 20mCi/mL, a generation rate of 0.14mL/min. and a 'dead volume' of 0.7mL, and we want to have the patient breathe on the unit for 2 minutes, it will require approximately 1mL to accomplish this goal.

$$2\text{min.} \times 0.14\text{mL} + 0.7\text{mL} = 0.98\text{mL}$$

A volume of 2mL is generally recommended in order to compensate for any unexpected problem with the patient and to avoid being tripped up by the residual volume remaining in the syringe after the material is injected into the nebulizer reservoir. This will insure the completion of the study.

It has been observed that the distribution of radioactivity in the patient's lungs is the most even when slow tidal volume breathing is employed. While deep breathing may, theoretically, increase deposition, it must be closely monitored and controlled to prevent excess velocity from causing excessive deposition in the upper respiratory tract.

Ross Potter, Technical Director, Medi/Nuclear® Corp., Inc.

October 29, 1998