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A Brief Review of Technegas™ and Aerosol Delivery

Below are past and present claims made by Cyclomedica regarding Technegas™. Responses to those claims are based on available research, current Cyclomedica information sources and first-hand experience with diverse aerosol delivery systems.

1. **Technegas™ is hydrophobic therefore particles remain small for better lung deposition.**
   Nano-size Technegas™ particles averaging 30-60nm[1] are produced. Prolonged storage of Technegas™ promotes aggregation into larger particles and the migration of those particles to the walls of the chamber[2]. For best results, Technegas™ must be administered to the patient as soon as possible after being generated, and certainly within the 10 minutes allowed[3].

   Since Technegas™ particles aggregate, one must wonder what size particle is actually delivered to a patient at any given time. Documented research shows larger particles than the initial 30-60nm at different points during the administration process. Assuming that the growth is linear, the particles actually administered to the patient could be in the 0.3µM to 0.5µM range, making them comparable to aerosol delivery systems. By contrast, the size of a delivered particle to a patient can be confirmed when using an aerosol delivery system with unidirectional airflow.

   The only found head-to-head comparison of Technegas™ with ^{99m}TcDTPA aerosol used the Mallinkrodt UltraVent™. The UltraVent™ produces particles of less than .3µM, but because it is a single tube device rebreathing (two-way air flow) allows the hygroscopic particles to grow before they ever reach the patient. This fact eliminates the equality of the head-to-head testing.

2. **Technegas™ has reduced radiation exposure to operator and to patient.**
   Available research most often compares Technegas™ to something unequal. When compared to Technegas™ radiation exposure from ^{133}Xenon appears elevated because of its beta particles. Radiation levels with CT appears elevated due to the prolonged use of x-rays and with UltraVent™ higher levels are the result of a lengthy administration time.

   Early on, Cyclomedica claimed “moderate/high” radiation exposure to operators using DTPA aerosol, as compared to being “low” with Technegas™. This was seemingly based on research done using UltraVent™, which doesn’t adequately represent modern rapid dosing aerosol delivery systems. Additionally, Cyclomedica claimed that radiation exposure to a patient was similar with either Technegas™ or aerosol. These early claims have been dropped. Today Cyclomedica simply states that Technegas™ has 27 to 36 times less radiation dose to the patient breast as compared with CTPA[4]. While this is both positive and comparable to V/Q SPECT with aerosol, it doesn’t instill confidence of low level radiation exposure to patient and/or operator during routine administration.

3. **Technegas™ set-up is quick and easy.**
   Technegas™ administration consumes approximately 10 minutes of valuable operator time, unless there’s a delay during set-up or a patient isn’t ready within the 10 minute window of availability. At 10 minutes, the TechnegasPlus Generator inhibits the delivery to the patient and the chamber is automatically purged through a filter system to trap any excess Technegas™[2]. At that point the administration process must start over. Most aerosol delivery systems have a preparation time of approximately 1-3 minutes and include just 3-4 simple steps.

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4. **Technegas™ can be administered in 3-4 breaths only[4, 5], is easy to breathe, and aids patients and compliance[4].**
The first part of this claim has to do directly with the concentration level of ^{99m}Tc. Cyclomedica states that a high concentration level of ^{99m}Tc (100-250mCi/mL) must be used. If the same ^{99m}Tc concentration were used with a small particle, rapid dosing aerosol delivery system, rather than the usual 20mCi/mL, it would most likely administer a patient dose in 3-4 breaths as well.

   To administer Technegas™, patients are given specific breathing instructions which may include slow, deep or rapid breathing, with our without pauses. Although the required breathing techniques are vital for administering a patient dose in in approximately 3-4 breaths (approximately 20-30 seconds) they may be challenging or uncomfortable for some patients. Additionally, research shows that dizziness and nausea related to hypoxia may occur during the inhalation of Technegas™ which initially contains no oxygen[6]. By contrast, aerosol may be delivered with an advanced system in as few as 8-10 breaths (approximately 30 seconds) with normal tidal breathing. Interestingly, Cyclomedica used to claim 1-2 breaths was sufficient for administration.

5. **Technegas™ provides a clinical track record and demonstrated efficacy over a long period of time[9].**
Of concern are the carbon particles used for Technegas™ administration. Available research has not adequately answered what happens to them after a procedure or how they impact smokers or someone with lung disease. One must wonder if the Technegas™ procedure is safe enough to be used routinely for patient monitoring. If so, at what frequency can it be safely performed? Aerosol can be used repeatedly to monitor patient progress.

6. **Technegas™ has good image quality while aerosol images are of variable quality[9].**
This early Cyclomedica claim has been dropped as consistently high quality SPECT images obtained with aerosol may be easily acquired without a significant financial investment.

7. **The long residence time of Technegas™ makes SPECT easy to obtain.**
This is true. With a 6 hour dwell time performing SPECT shouldn't be a problem. Also available are high quality, cost effective aerosol delivery systems that allow SPECT but with a shorter dwell time.

8. **Technegas™ is available 24/7[9].**
This is true for aerosols that utilize ^{99m}Tc, as well as Technegas™ when high specific ^{99m}Tc is available.

9. **Technegas™ allows accurate and quick decisions[5].**
This is true for aerosols that utilize ^{99m}Tc with SPECT, as well as Technegas™.

10. **Technegas™ has minimal exclusion criteria[4].**
This is true for aerosols that utilize ^{99m}Tc, as well as Technegas™. Both delivery techniques may be safely performed on almost all patients, including young women of child-bearing age, pregnant women and those with renal impairment, iodinated contrast allergy and chronic lung obstruction disease.

11. **The cost to deliver both Technegas™ and aerosol is moderate[9].**
This claim is no longer being made as even without considering start-up and maintenance costs (TechnegasPlus Generator, infrastructure modifications, dedicated power supply, service contracts, etc.), the routine per patient cost for Technegas™ far exceeds that of aerosol delivery systems. Each Technegas™ procedure requires a crucible, pure argon gas, absolute alcohol, lengthy prep time, an administration set and high specific activity ^{99m}Tc (100 - 250mCi/mL). Aerosol delivery systems can deliver a patient dose within minutes using just an administration kit and lower specific activity ^{99m}Tc (20mCi/mL).

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If there is a delay during Technegas™ production or a patient isn't ready within the 10 minute window of availability, a new procedure will have to be done. This will double per patient cost of administration. Available research has not shown how often this occurs.

When using the Easy Breather Attachment, Cyclomedica recommends that two persons, one of whom must be qualified and experienced with positive pressure breathing systems, are needed to deliver these radioactive gas-like tracers with minimum risk of creating leakage into the camera room and causing significant airborne contamination[7]. Aerosol can be delivered to a mechanically ventilated patient with either a kit adapter or special kit and just one nuclear technician.

12. V/Q SPECT with Technegas™ is the only logical choice as a screening test for the potentially life-threatening condition of Pulmonary Embolism[9].

Studies have shown that when compared to Xenon, Krypton and inferior aerosol delivery systems this is true. It remains to be seen how Technegas™ stacks up against small particle, rapid dosing aerosol delivery systems readily available to nuclear departments with minimal investment.

Final Thoughts

Aerosol delivery systems producing small particles, excellent lung deposition and high quality images, both Planar and SPECT, have been available in the United States for decades. These easy-to-use systems feature rapid dosing, no breathing resistance and are safe for both patient and operator. The demand for images of predictable and superior quality can be met without financial burden.

While Cyclomedica'sTechnegas™ has enjoyed relatively little competition from comparable systems in global markets, there can be no denying that its hype has mesmerized some in the United States. However, many are unfazed as its high cost and questionable superiority make it unattractive to budget conscience nuclear departments and those already performing VQ/SPECT.

To be sure, infinite diagnostic possibilities are available with VQ/SPECT. Therefore, it should be the standard of care whenever possible. Elevating nuclear departments to this level will require the understanding of challenges and the delivery of appropriate solutions. Readily available aerosol delivery systems, at a fraction of the cost for Technegas™, are already doing this by providing high quality SPECT images, choices, and ample opportunities for improvement and success.

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