A ^{133}Xe Ventilation Administration System for the Small Hospital

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The value of ^{133}Xe ventilation scintiphoto studies has long been established (1–5). The use of this procedure is routine in most large institutions with a sufficiently large patient load to justify the expense of accessory equipment. Smaller institutions usually have trouble justifying this expense for occasional use.

In the small institution (100–200 beds) where the author has been employed, the need for an occasional ventilation study with the Anger camera has caused a search for a satisfactory, inexpensive method of administering ^{133}Xe and a standard procedure which would give the maximum information available.

Research of the problems involved revealed the following facts:

1. Xenon-133 has a decided tendency to adhere to rubber which limits the usefulness of rubber for any such apparatus.
2. Large airspaces and soda-lime CO_2 absorbents dilute and trap large amounts of the administered ^{133}Xe dose. Therefore they should be kept to minimum volumes.
3. Bolus injections of ^{133}Xe were not always acceptable for breath-holding photos. Some physicians desire the radionuclide to be mixed evenly with air before a vital-capacity breath is taken for the scintiphoto.
4. Many patients requiring the study are unable to sit erect for the administration of the radionuclide and photos; therefore the apparatus for administering the gas should be adjustable to allow variation in positioning.
5. Expense of building and operating such a system must be kept to a minimum.

The System

From the materials available in our department, the inhalation therapy department and their suppliers, and a local department store, a system was assembled which met the qualifications set forth. The system is easily operated to conduct the following study on a cooperative patient:

1. Single breath-holding.
2. Rebreathing.
3. Washout.

The heart of the system is the Collins five-way valve which allows a single knob to direct the patient's breathing through any of four different circuits. To this valve is attached a bag with an attachment which allows a pre-charge of oxygen and additional radionuclide gas (if desired) and forms a rebreathing circuit when attached through a small soda-lime CO_2 adsorbent. To the next valve opening a third circuit incorporating a Hans Rudolph valve is attached which allows the patient to inhale room air while exhaling into a collecting system (absorbent column, vent, or simple weather balloon). Radiographer's lead aprons are placed strategically around the apparatus for shielding.

The apparatus was originally designed to use rubber breathing bags. The attraction and porosity of these for ^{133}Xe proved unsatisfactory. An inexpensive (and colorful) substitute for the rubber bags was found at the toy department in the form of a small vinyl beachball (14-in. diam or approximately 5-liter capacity). With slight modification these could be fitted to polyvinyl pipe fittings with vinyl tape to be gas tight. The material showed much less attraction for the ^{133}Xe gas.

The apparatus was designed to use New England Nuclear Calidose vials and administration atomizer to supply the ^{133}Xe. Any system which would allow administration of the radioactive gas through a hypodermic needle would work with the system.

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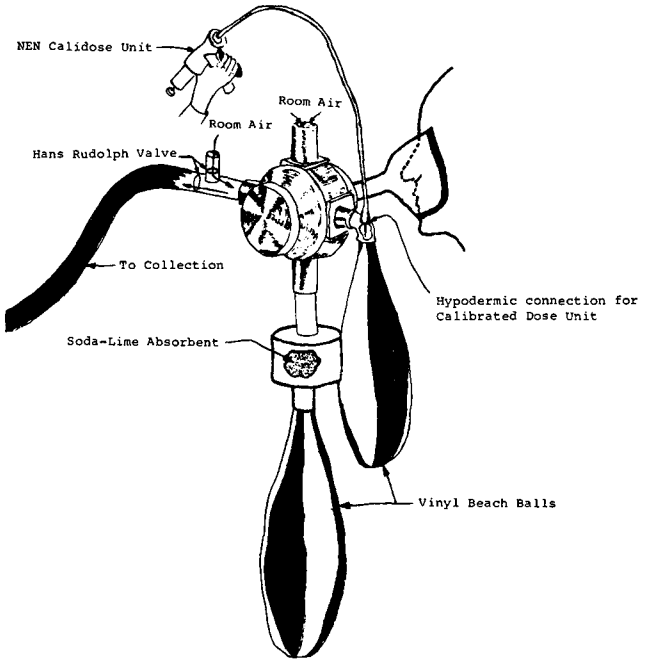

FIG. 1. ^{133}Xe ventilation administration system.

Operation

The apparatus is attached to an i.v. pole or similar support with a clamp similar to a ring stand clamp. The rebreathing bag is usually charged with a small volume of oxygen. With the Calidose applicator loaded, the patient is placed in position and instructed. The mask is then tested for leaks. The patient is allowed to breath room air while he becomes accustomed to breathing through the apparatus. A short practice period often relieves a great deal of apprehension and is usually well worth the time and effort.

Single breath-holding. With the instrument in readiness, the position of the patient is checked. The patient is made fully aware of the part he must play, and the study is begun. The patient is instructed to take a deep breath and hold it momentarily while the valve is switched from the "room-air" position to the "dose" position. While the patient exhales into the bag in this position, the ^{133}Xe is mixed into the stream of exhaled air by the Calidose unit. By this system, the dose is mixed with a vital capacity breath from the patient. The patient is then instructed to take a deep breath and hold it as long as he can, but to signal when he can not hold any longer. A picture is started as soon as the breath is taken. Usually a 15-sec exposure will give a clear, usable photo.

Rebreathing to equilibrium. From the breath-holding, the valve is switched to the rebreathing position. Here the patient has a small additional supply of oxygen, and then rebreathes through a *small* container of soda-lime CO_2 absorbent. Pictures are taken to a preset time (15–30 secs as desired by the ordering physician). This series is continued until the gas has equilibrated in the patient's lungs.

Washout. The valve is then switched to the "washout" mode, and pictures are taken to a preset time (15–30 secs, again as desired by the ordering physician). The pictures are continued until the lungs are emptied of ^{133}Xe.

The instrument has proven to be quite useful. The scintiphoto studies obtained with it have been diagnostic in most cases. It has been assembled from parts readily available to most hospitals with a need for the examination. The apparatus has proven itself to be versatile with adequate studies obtained with the patient supine. In our institution, it has provided an acceptable means of performing ventilation scintiphotography with ^{133}Xe.

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