Proper Use of a Neck Phantom for Thyroid Uptakes

The use of a phantom mimicking a thyroid in a neck is recommended to determine the sensitivity of the measuring device during in-vivo thyroid uptake assessments. Several sources of inaccuracy and inconsistency have been recognized over the years with this procedure. Construction of the thyroid neck phantom to simulate the absorption and scatter characteristics of a human neck was one of the first steps towards adequate standardization of the thyroid uptake test. For a realistic representation, the phantom material should have radiation absorption and scatter characteristics similar to those of human soft tissue, and the calibration depth should be about 2 to 2.5 cm.

Differences in neck-phantom characteristics, changes in geometry of measurements, and HV fluctuation may introduce significant errors, including uptakes exceeding 100%, into any thyroid uptake measurement. Surprisingly, even today, the test is carried out in some laboratories with very little attention to these factors.

The neck phantom that is recommended for use today has met the specifications of the International Atomic Energy Agency (IAEA) or the American National Standard Institute (ANSI). It is a solid right cylinder 5 inches in diameter, 5 inches in height and made of polymethyl methacrylate (ie. Lucite or Plexiglas). It shall have a cylindrical cavity that extends partially through the phantom and is offset toward the anterior surface. This cavity accepts the plastic insert to accommodate a capsule or 30 ml liquid bottle. The radial distance from the surface of the phantom to the surface of the cavity shall be 0.2 inches. The central axis of the cavity shall be 0.8 inches from the surface of the phantom. There shall be a flat surface on the phantom located 180 degrees from the cavity that has a width of 1.0 inch, which keeps the phantom from rolling when performing horizontal measurements on a table or stretcher.

A polymethyl methacrylate holder should support the center of a capsule at the geometrical center of a liquid sample within the neck phantom. The phantom has marked centering lines on its surface that correspond to the geometrical center if a liquid is used. The phantom is designed to permit a liquid or a capsule to be placed only at the proper position within the neck phantom. The phantom minimizes air gaps within the neck phantom when either a liquid or capsule is in place. The standard neck phantom includes the phantom, bottle insert, a capsule holder and 30 ml polyethylene bottles.
Differences in geometry throughout each measurement during the study are a major cause of errors. The distance between the patient and the detector must be the same as the phantom-detector distance. The distance should be measured from the surface of the detector to the skin overlying the inferior margin of the patient’s thyroid cartilage or to the surface of the neck phantom. The most commonly used distance is 10 inches (25cm).

![Diagram of phantom and neck with probe measurements.](image)

Probe measurements of a phantom and a neck with identical geometry.

Maintain the cleanliness of the neck phantom as needed by wiping it with a damp rag and mild detergent solution. Do not use organic solvents to clean the phantom as they may damage the plastic. Most decontaminating solutions may be used safely.

References:

1. Glen A. Vahjen, Robert C. Lange and Tracy Fair; Thyroid Uptake Neck Phantoms are Not Created Equal; J Nucl Med. 1992; 33: 304-305.
