

Purpose:

To describe the results of IROC Houston's international and domestic end-to-end QA phantom irradiations.

Materials:

Whether for quality assurance or required for protocol credentialing, IROC Houston has various anthropomorphic phantoms, ranging from lung, liver, head and neck, SRS, prostate and spine (Fig 1.). The phantom construction varies; for example, materials such as high impact polystyrene, solid water and acrylic form, respectively, the insert, target, and organ at risk for our head and neck phantoms, while the lung phantom is constructed of cork (lung) and high impact polystyrene (target). The materials are chosen to closely mimic each organ's imaging and dose absorption attributes. Motion tables are used to mimic breathing (12 or 10 breathes per minute or breath hold) for some lung and liver phantoms.

Methods:

Dose measurement features of these phantoms include double-loaded TLD for measurements within the PTV and organ at risk. Specifically, the lung phantom contains two TLDs inside the PTV with additional TLDs representing the heart and spine, while the head and neck phantom contains two PTVs totaling six TLDs and 2 TLDs representing the spine. In addition to TLDs, radiochromic film is used within various planes of the PTV; for example, both the lung and head and neck phantom contain an axial and sagittal slice while the lung has an additional slice in the coronal plane.



Fig. 1: Image of available phantoms. From Left to Right: Lung, Liver, and Head and Neck Phantoms

Using a CCD camera and 2D-Gamma analysis¹ for the film in combination with TLD measurements gives the phantoms a pass-fail criterion for quality assessment. Dosimeter results are compared to the institution's treatment plan using the criteria of 7% for PTV TLD doses for both phantoms and $\geq 85\%$ pixels must pass 7%/4 mm global gamma analyses for head and neck phantoms, while $\geq 80\%$ pixels must pass 7%/5 mm global gamma analyses for each plane in the lung phantoms with an average global gamma analysis of $\geq 85\%$.

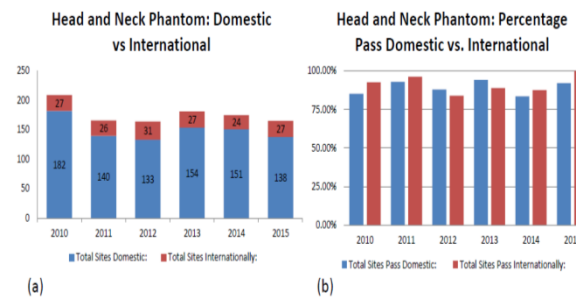


Fig. 2: For the years between 2010 and 2015, (a) Domestic and International totals for Head and Neck Phantoms totals and (b) pass rates of domestic and international Head and Neck Phantoms

Results:

The most common phantom requested is the head and neck followed by the lung phantom. The head and neck phantom was sent to 800 domestic and 148 international sites between 2011 and 2015 (Fig. 2a), with average pass rates of 89% and 92%, respectively (Fig. 2b).

During the past five years, a general upward trend exists regarding demand for the lung phantom for both international and domestic sites with international sites more than tripling from 5 (2011) to 16 (2015) and domestic sites doubling from 66 (2011) to 152 (2015) (Fig. 3a). The pass rate for lung phantoms has been consistent from year to year despite this large increase in the number of phantoms irradiated with an average pass rate of 85% (domestic) and 95% (international) sites (Fig. 2b). The percentage of lung phantoms used in combination with motions tables increased from 38% to 79% over the 5 year time span (Fig. 2c).

For 2016 (not shown), current totals for head and neck and lung phantoms are 111 and 112 with pass rates of 94 % and 83%, respectively, with 63% utilizing the motion platform for the lung phantom.

Conclusion:

The number of domestic and international sites irradiating the head and neck and lung phantoms continues to increase and the pass rates remained constant. These end-to-end QA tests continue to be a crucial part of clinical trial credentialing and institution quality assurance. From our current totals in 2016, the expected number of lung phantoms shipped should continue to increase to approximately 200, while the head and neck is projected to increase, also to approximately 200, despite being stagnant for the past several years.

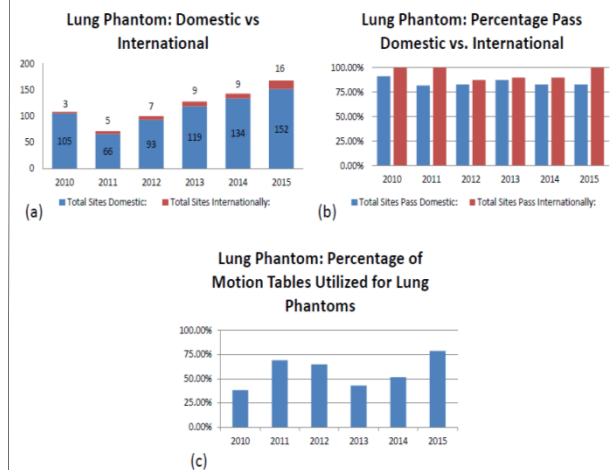


Fig. 3: For the years between 2010 and 2015, (a) Domestic and International totals for Lung Phantoms totals and (b) pass rates of domestic and international Lung Phantoms. Differing from the Head and Neck, (c) shows the utilization of motion tables with the lung phantom irradiation

References:

1. Low, D. A., et al. "A technique for the quantitative evaluation of dose distributions." *Medical Physics* 25 (5) (1998): 656-661.

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