Testing Optimum Viewing Conditions for Mammographic Image Displays

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The viewbox luminance and viewing room light level are important parameters in a medical film display, but these parameters have not had much attention. Spatial variations and too much room illumination can mask real signal or create the false perception of a signal. This presentation looks at how scotopic light sources and dark-adapted radiologists may identify more real diseases.

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ALL IMAGING TECHNOLOGIES create transparent or cathode ray tube (CRT) images, which contain diagnostic information that allow trained medical readers to determine the presence or absence of disease. Little attention has been given to the viewbox luminance or room illumination conditions that all trained physicians use to read the images. To fully use the information contained in the transparent image, optimum lighting conditions must be achieved.

THEORETICAL BASIS

The light emitted by a viewbox must be of sufficient intensity to allow perception of the smallest density variation in the darkest part of a film. The American College of Radiology (ACR) recommends 3,500 nits or 1,022 footlamberts. Illumination in the reading room must be low enough that it does not mask "signal" light from the lowest image signals. The viewbox must have minimal spatial luminance variation so as not to create a false reading. We have previously tested methods of masking a viewbox to allow uniform luminance over the entire light-emitting surface.¹ We also believe that current lightbox luminance levels may prove satisfactory if scotopic vision is used. Dark adaption increases the sensitivity of the eye by about 7 orders of magnitude and scotopic light bulbs help maintain this high eye sensitivity in spite of high levels of light from less opaque areas of the film. Also, holographically constructed screens over the viewbox surface can increase the signal to the radiologist's eye by a factor of two or more. The controversial element is can scotopic vision compete with photopic vision for image resolution. Some of these principles we investigate also apply

to viewing digital images displayed on CRTs, which also have low luminance. This latter case, however, potentially could be aided by computer signal processing.

MEASUREMENT METHODS

Luminance measurements of the viewbox show that many have light output near 3,500 nits in the center, but much lower readings near the edges. This spatial variation can be smoothed by our previously described method.¹ Also, a holographic diffuser (which directs more of the scattered photons toward the eye) increases the luminance by a factor of two enabling the center of a viewbox to average 7,000 nits or more. Evaluations of films with density greater than $D = 4.0$, have only a few milli-footlamberts of luminance available to the eye, even with recommended luminance. Chapanis et al² have presented data that show that the brightness threshold for a dark-adapted eye is more than 7 orders of magnitude lower than that for an eye that has looked at strong light. This means that a dark-adapted eye may be able to see smaller gradations of signal in a breast image. The higher the value of signal (ie, light from film image) to noise (ie, reflected room light plus film noise), the better the ability to detect a target and the finer the detail that can be detected.

SUMMARY

We have evaluated the importance of lightbox luminance, viewing room illuminance, spatial uniformity of lightbox luminance, the effects of dark adaptation, and the use of scotopic bulbs. Effects of these variables were determined by the perfor-

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mance of trained radiologists viewing a set of known true mammographs.

Considerable care must be used to prepare for optimum viewing. The viewing room must be able to control all light and to be made completely dark. A uniform luminance viewbox should also be used and a holographic deflector should be used to increase the signal available to the eye. The observer's eyes should be dark adapted for 30 minutes before reading films and scotopic bulbs should be used to maintain this dark adaption.

CONCLUSIONS

The detailed effects of these changes in viewbox luminance and viewing illumination on the detection of medical abnormalities will be presented in this poster. The problem of whether scotopic vision has sufficient resolution to detect smaller density variations than photopic vision when evaluating high-density images remains and will be investigated shortly. Dark adaption is easier and cheaper to carry out than increasing the luminance of viewboxes.

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