READING DATA SHEET

Radiologic Technology: Vol. 80, No. 5, May/June 2009

“Effects of AEC Chamber Selection on Patient Dose and Image Quality”

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RADSC 204

02 November 2009
The field of radiography is at a turning point in medical history as advances in technology have allowed for the traditional film-screen image receptors to be replaced with digital computer-based systems. As with any change, there are many advantages and disadvantages to this new approach at obtaining diagnostically useful images. One advantage technologists have when using digital imaging is the Automatic Exposure Control setting, which allows a fixed kVp to be set and a variable mAs to be determined by the computer once the x-rays have adequately penetrated the part being radiographed. However, it is now believed that altering the suggested AEC chamber selection will not only reduce patient exposure but yield more interpretable images.

AEC systems were first introduced to radiography in the 1960s. Veteran techs may refer to AEC as “phototiming,” as it was once called. The term “phototiming” was coined because older AEC systems used a fluorescent screen that emitted light which would create an electrical current to turn the x-rays “off.” More modern AEC systems are a lot more complex. The detectors on the AEC system are known as ionizing chambers that house a plate which intercepts the patient and image receptor. After an AEC system is installed, phantoms are used to take exposures and calibrate the system. Instead of a fluorescent screen emitting light to create an electrical current, the exposed x-rays create an electrical charge within the gas-filled AEC chamber. When the electrical current reaches a certain level, the x-rays are turned “off”, much like the aforementioned phototiming system. This is why AEC systems are still sometimes called “phototimers”, because they operate in a similar fashion.

The AEC system allows the radiographer to choose from three different ion chambers to select when taking an exposure. What ion chambers are selected varies dependent on what part of the anatomy is being radiographed. Technologists may fail to realize that this decision is vital to image quality and patient dose. Medical imaging texts do not all agree on which AEC ion
chambers should be utilized for each study. For instance, some say all three ion chambers should be selected for an anteroposterior image of the pelvis while others say only the two outside ion chambers should be used. Most radiographic texts dictate that the AEC ion chamber directly above the part being radiographed should be selected to obtain optimal density. It is also noted that when using film-screen image receptors the proper technique and AEC ion chambers must be more carefully chosen than with digital imaging because the latent image produced in film-screens becomes the manifest image; whereas by utilizing post-processing, digital imaging is more forgiving because it allows for density changes by window and leveling.

Acceptable image quality for film-screen based image receptors is expressed as a nominal integer referred to as the optical density value while computed radiography equates these variables as the exposure index. The optical density value for film-screen image receptors ranges from 0.25 to 2.5 base plus fog. Exposure index numbers for computed radiography vary dependent on the manufacturer of the system being used. Vendors such as Fuji, Phillips and Minolta use what they call the 'S' numbers, abbreviated for Sensitivity. The S number is inversely related to the amount of contrast on the image, such that lower S numbers produce a lower image exposure. On the other hand, the relationship of the exposure index number that Kodak uses is directly proportional the the amount of radiation exposure. Kodak computed radiography plates are comparable to the relative speed of a 200-speed film-screen cassette. Optimal exposure index ranges for Kodak CR image receptors vary between 1700-1800. The exposure index is determined when processing the latent image by calculating how much light is emitted from the image receptor and converting that light into a digital signal. More advanced digital radiography systems not only have an AEC but also an APR function, or Automatically Programmed Radiography. This tool allows the radiographer to simply select which part of the anatomy is being radiographed and the APR will select the predetermined mAs, kVp, and AEC.
These factors can be adjusted by the radiographer as needed to employ the ALARA principle. Radiologic technologists have a basic working knowledge of the concepts involved with AEC systems but based on typical department protocols, should realize that the AEC function not only effects image quality but also the patients' dose to ionizing radiation. If the proper AEC ion chambers are not selected the patient is susceptible to unnecessary exposure and image quality can be affected too.

Extensive research was conducted at two different clinical locations to answer the question, “Can a patients entrance skin exposure be reduced by manipulating the configuration of the AEC chambers while maintaining image quality?” (Hawking and Elmore 413). An Odyssey high-frequency generator and Kodak CR850 processing system were used at one location while the other location used a 3-phase generator with a 200 relative speed film-screen processing system. Abdomen and pelvis studies were performed on phantoms using the three different AEC ion chambers (center chamber, two outside chambers, and all three chambers) while maintaining a constant 400mA and 70kVp. The mAs, optical density/exposure index, and entrance skin exposure was recorded in milliroentgens. The results of the study for the anteroposterior abdomen procedure when using the film-screen imaging system indicate that the lowest entrance skin exposure was obtained using the two outside AEC ion chambers (351.88mR) while when using only the center AEC ion chamber the patient dose was more than doubled (908.86mR). The image quality obtained using the two outside AEC ion chambers was adequate but the image quality of the image obtained using the center AEC ion chamber was overexposed. The lowest entrance skin exposure for the anteroposterior pelvis when using the film-screen imaging system had similar results. The lowest dose was obtained using the two outside AEC ion chambers (298.82mR) with acceptable image quality. When only the center AEC ion chamber was selected, the dose was significantly increased (645.42mR). As with the previous abdomen study,
when only the center AEC ion chamber was selected for the pelvis study, the image quality deteriorated and produced an overexposed manifest image.

The anteroposterior abdomen and pelvis phantom procedures were performed using the computed radiography system and similar results were gained. When the two outside AEC ion chambers were selected, the entrance skin exposure was reduced and produced optimal image quality yet when only the center AEC ion chamber was selected, the entrance skin exposure more than doubled and the image was overexposed.

The results of this study are phenomenal. It appears that often times, more now than ever, the medical community relies too much on computers without attempting to understand the logic of what is actually happening within the circuitry. This experiment has proven that computers are programmed by an imperfect populous allowing computer systems themselves to be just as prone to error. Given these results, whoever maintains and is responsible for the AEC chamber selection standard will need to update the current textbooks accordingly.