Phantom Feet on Digital Radionuclide Images and Other Scary Computer Tales

John E. Freitas, Howard J. Dworkin, Stuart M. Dees, and Richard Ponto

Nuclear Medicine Department, William Beaumont Hospital, Royal Oak, Michigan

Malfunction of a computer-assisted digital gamma camera is reported. Despite what appeared to be adequate acceptance testing, an error in the system gave rise to switching of images and identification text. A suggestion is made for using a hot marker, which would avoid the potential error of misinterpretation of patient images.

J Nucl Med 30:1559–1562, 1989

One of the most important components of quality assurance (QA) of nuclear medicine procedures is the quality control (QC) and acceptance testing of diagnostic instrumentation (*1–4*). During the installation of new equipment, acceptance testing usually identifies deficiencies and variations from purchase specifications that are corrected by the vendor prior to beginning routine service. Identified deficiencies may be difficult to isolate with the newer digital systems (software or hardware) which store the acquired data in unseen addresses on floppy or hard disk for manipulation and processing prior to re-display. However, with the increasing complexity of current instrumentation, even the most exacting acceptance testing may fail to discover equipment malfunction. This may have significant impact upon patient care. Malfunction may not have instantaneous consequences, such as were seen with the Therac 25 linear accelerator radiation therapy tragedy, but may be more subtle or delayed in appearance (*5*).

Approximately 3 mo after formal acceptance testing was performed on a computer-assisted digital gamma camera, malfunction of the system was identified. The system is a computer-controlled scintillation camera whose data, at the time of acquisition, are routed into the computer's memory, and are subsequently stored on magnetic disk. Image display for viewing or photographing is accomplished by accessing the data from the magnetic disk and reading it into the computer's display memory.

Received Dec. 16. 1988; revision accepted Apr. 18, 1989.

For reprints contact: John E. Freitas, MD, Nuclear Medicine Dept., William Beaumont Hospital, 3601 West 13 Mile Rd., Royal Oak, MI 48072.

CHRONOLOGY OF EVENTS

A computer assisted digital gamma camera (General Electric Starport 500A digital gamma camera operating with Version 3.0 software) was installed and acceptance testing completed in September 1987. No major operating problems were noted. A whole-body imaging option was added on October 16, 1987. At this time, a whole-body imaging protocol named Function 6 (Table 1) was created and stored in the system for routine use.

A 71-yr-old female was referred for a bone scan on January 6, 1988 to evaluate persistent buttock and low back pain resulting from an insulin reaction-induced fall 4 wk earlier. A pelvic fracture was suspected despite normal outpatient x-rays. No x-rays were available at the time of bone scan.

Following the i.v. administration of 21.7 mCi (803 MBq) of technetium-99m methylene diphosphonate ([^{99m}Tc]MDP), anterior and posterior whole-body scans were performed utilizing the computer assisted digital gamma camera. The protocol used for the acquisition was set up following directions provided by the vendor and is shown in Table 1. The images were recalled for display using the standard function available on the system, i.e., activating the LOAD function switch to retrieve data sets for the current patient. The anterior and posterior head to mid-femur images are presented in Figure 1. These images were initially recorded immediately after the bone scan. On review of the images, the abnormal right rib and left sacroiliac radioactivity seen on the anterior image unexpectedly did not give rise to analogous abnormal areas on the posterior image despite having the same patient name. Also, the posterior image was that of a markedly different body habitus. An attempt to "call up" this bone scan yielded the image seen in Figure 2. The fractured ribs and sacrum (and other abnormalities) seen in Figure 2 were confirmed on subsequent x-rays.

After the events reported above occurred, the vendor was immediately called. The instrument remained in routine use. Two days later, a letter was received offering a number of suggestions; however, switching of images and the patient

TABLE 1
FUNCTION 6 Function Used to Perform Whole-Body Bone Imaging

TITLE	"WHOLE BODY BONE
INCLUDE	27
PATIENT.NUMBER	?
PATIENT.NAME	?
STUDY.ID.CODE	?
DATASET.ID.CODE	?
SCAN	
MATRIX	256
ORIENTATION	?FACE.UP,HEAD,FIRST
SCAN.TYPE	CIRCULAR
SCAN.SPEED	?6
SCAN.DIRECTION	AWAY
SCAN.LENGTH	2.5
WAIT	
DATASET.ID.CODE	?
WAIT	
OPERATOR "DO MANUAL LOAD AND HARDCOPY	
*****	

identification text was observed again on January 11, 1988. In order to avoid further errors and to correctly identify each patient, a "hot" marker was introduced in each image. The "hot" marker was placed next to the patient's head for the first scan of the day and indexed a few centimeters caudally for each subsequent patient on that day. Therefore, the "hot" marker appeared in the same relative position on both the anterior and posterior image for each patient.

On January 13, 1988, after completing the morning routine daily camera system quality control procedures, the technologist left to develop the film. On return, a pair of "phantom feet" was seen on the screen (Fig. 3), along with the text from the QC procedure.

On January 25, 1988, the vendor reformatted the Winchester Drive and loaded new software (General Electric Starport Version 4.0, General Electric, Milwaukee, WI). On January 27, 1988, the problem of switching images and text recurred. Sporadically, this problem and the phantom feet continued to occur through February 1988, despite a number of attempts by the vendor to correct the problem.

On March 15, 1988, the switching of images recurred. As requested, the vendor was immediately called, and the gamma camera was left untouched by our staff. Once more, the Winchester Drive was reformatted, new software (General Electric Starport Version 4.0) was loaded, and new system functions installed. On March 16th, the same problem was observed again. On March 26, 1988, a vendor service team changed many of the systems' boards, and, by hand, reinserted the bone scan functions. On March 28, 1988, the same problem recurred, as well as the appearance of the phantom feet.

On April 29, 1988, the entire console was replaced by the vendor. Since then, the problem of switching images and patient identification text has not been observed. Hopefully,

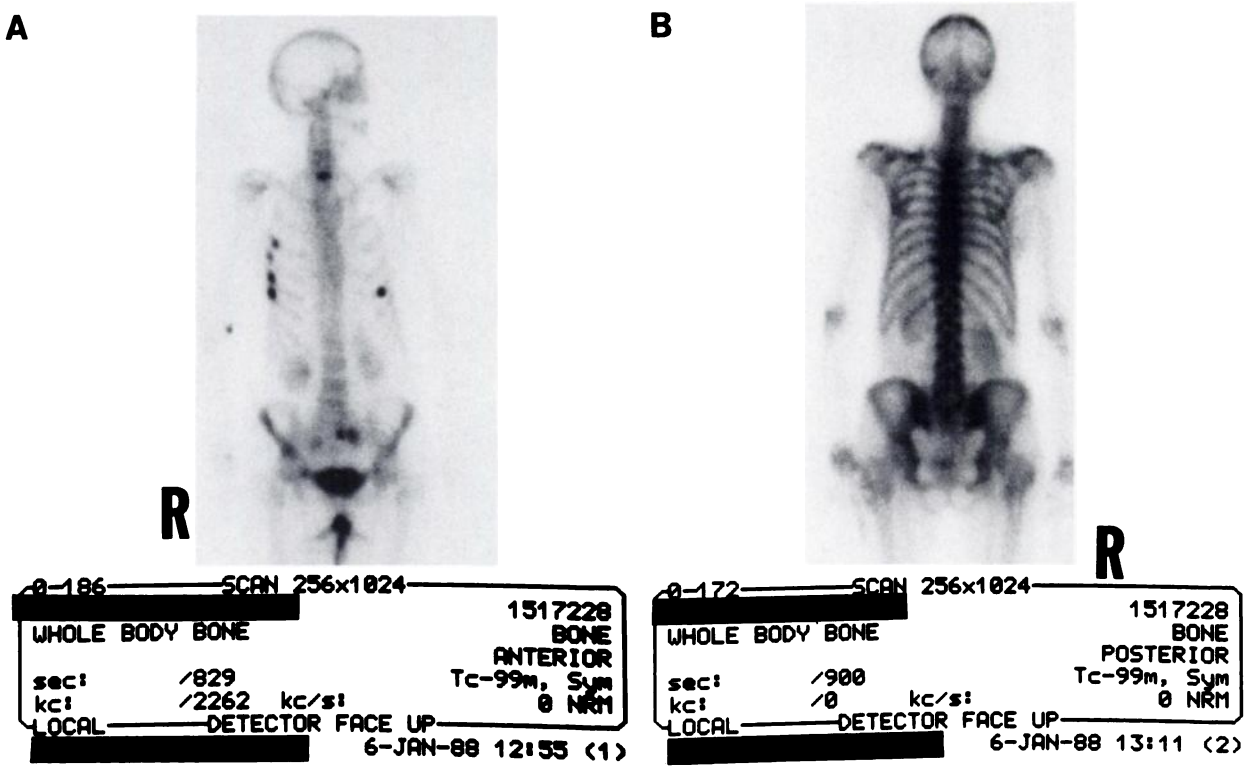

FIGURE 1
Bone scan. Initial images at 2-hr postradiopharmaceutical administration. A: Anterior view. Note increased uptake of tracer in right ribs and left sacroiliac region. B: Posterior view. Note lack of corresponding uptake in rib and sacroiliac regions. Body habitus differs from the anterior view and from that of patient in A (height 62 in.; weight 104 lb)

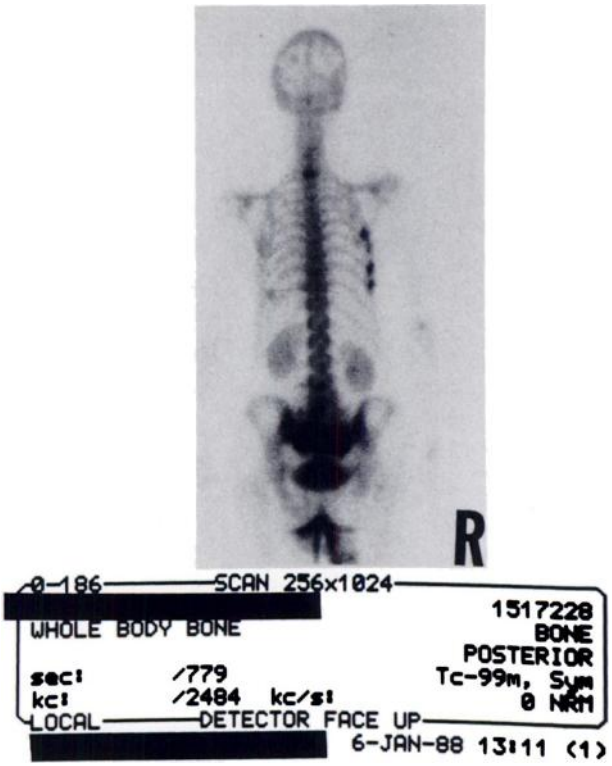

FIGURE 2
Bone scan. Posterior view as retrieved from disk file for patient in Figure 1A.

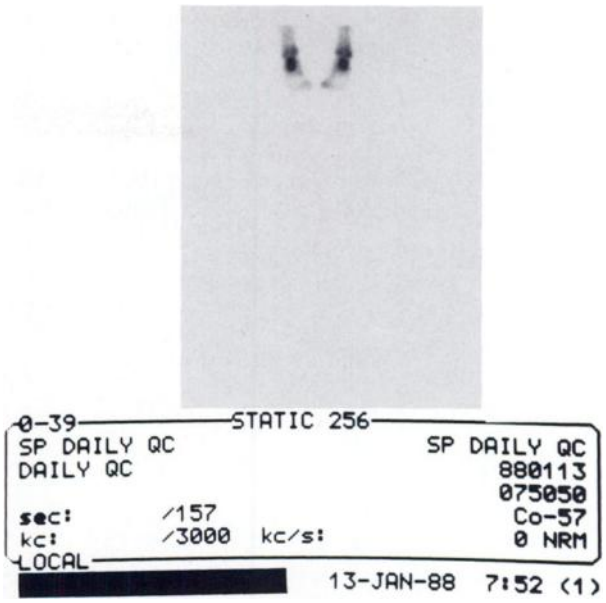

FIGURE 3
Routine QC text and phantom feet which appeared spontaneously.

the phantom feet have danced their way out of our lives and will no longer return to haunt us.

DISCUSSION

Quality assurance programs are carried out in most nuclear medicine facilities. These are required for Joint Commission on Accreditation of Hospitals (JCAH) accreditation (*4*) and recommendations for QA have been published by the Center for Devices and Radiological Health of the FDA (*2*). However, little mention is made of QA procedures for either computer hardware or software in these publications or in the current literature pertaining to computers or gamma cameras (*1,3,6,7*). Validation of diagnostic software (*8*) and QA (*3,9,10*) has been called for by some authors, but such approaches would have fallen short in our case.

The importance of adequate QA is brought to our attention by our experience. Failure to recognize the problem could have yielded an incorrect scan interpretation with possible medical and legal consequences. The importance of maintaining adequate records of problems, service calls and ultimate solutions is obvious.

The vendor indicates to us that our device is the only one they know of which has malfunctioned in this way. Their claim of adequate program documentation and device testing is not disputed by us, and although it took over 3 mo to correct the problems noted above, the vendor was diligent in working with us to the point of resolution.

To this date, we have no explanation of the nature of the problem. We are aware that certain console controlled sequences could give rise to the switch in images and text. These sequences were permissible with regard to instructions in the User's Manual provided and were not excluded by the existing software.

Thus, an additional acceptance procedure is recommended. Use of the hot marker mentioned above during the first 2 mo of use of such a device seems warranted. If no switching of images and text is identified, it is highly unlikely that the problem reported will occur; however, the possibility of sporadic occurrence of computer malfunction must be kept in mind.

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