Gamma Camera and Computer-Assisted Wipe Tests: A Simple Method

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In order to facilitate the technologist's work, a simple method of counting the activity of wipe test samples for contamination control in the nuclear medicine department has been developed. A scintigraphic three-minute image is directly obtained from the uncollimated gamma camera with the help of a homemade plexiglas template which holds the samples. A computer program analyzes this image, simultaneously calculates the activity of a maximum of 12 samples after correcting for the background, and expresses the result as a percentage of the predetermined maximum permissible activity. The results are stored on diskette and a hard copy is produced for permanent record keeping.

External contamination control by wipe testing is a requirement of both Canadian and U.S. Nuclear regulatory agencies. In the United States, the Nuclear Regulatory Commission requires that "a licensee shall survey for removable contamination, once each week, all areas where radiopharmaceuticals are routinely prepared for use, administered or stored" (*1*). In Canada, the Atomic Energy Control Board also stipulates the use of the wipe test for external contamination control as a condition of licensure (*2*).

The method utilized to perform the wipe test should not only be practical and time efficient, but also a reproducible and valuable source of information.

MATERIALS AND METHODS

The time required for counting each wipe test using a well counter is important in busy nuclear medicine departments. In our institution, we have developed a simple method for analyzing the wipe tests which meets the above criteria. This method uses a homemade plexiglas template placed on a gamma camera. The back of the plexiglas plate is covered by a thin shield (equivalent to 0.6 mm of lead) except in sixteen 4 cm × 4 cm square areas where up to 12 wipe test samples are placed, and four free squares are left for background calculations (Fig. 1). This thin shielding is not essential, but is used to reduce the overall background and to better delineate the counting area. The plexiglas plate is placed on the gamma camera detector* facing up, without a collimator (Fig. 2). This will greatly increase the counting efficiency, for the small activities that can be found in the samples.

The distance between the wipes when placed on the plates is large enough to avoid significant cross-talk between sample and/or background area.

A simultaneous scan of all wipe tests is performed, each sample corresponding to a predetermined area of the laboratory where the contamination control is required. A three-minute image is obtained to ensure good counting statistics. The image is stored in the computer† at 256 × 256 pixels resolution for immediate processing (Fig. 3A).

Pre-determined regions of interest (ROIs) in the computer provide a permanent grid which corresponds to the different areas of the wipe tests and background regions (Fig. 3B). The program calculates the total activity of each region and subtracts the average background from the 12 samples. The four background regions are arbitrarily chosen as the four corners of the grid. The percentage of the activity found in each region is calculated from the value of a pre-established standard wipe containing 50 Bq of radioactivity. In Canada, this activity is considered the maximum permissible free contamination for a surface having an area of 100 cm^2.

If necessary, when different isotopes are to be examined several images can be obtained without moving the samples by changing the energy parameters in the camera. The image analysis is completed in less than a minute, and the results are displayed in an orderly fashion for permanent recording on diskette or printer hard copy.

Four standards containing 50 Bq (0.00135 μCi) of ^{99m}Tc are prepared monthly or as required if major camera calibrations are made. This small activity is prepared by dilution or by appropriate physical decay from a concentrated solution.

The activity is placed on four dry wipes, and an image is obtained in the same manner as the samples. A modified program permits the establishment of the 100% mean standard value, which will automatically be stored on the computer

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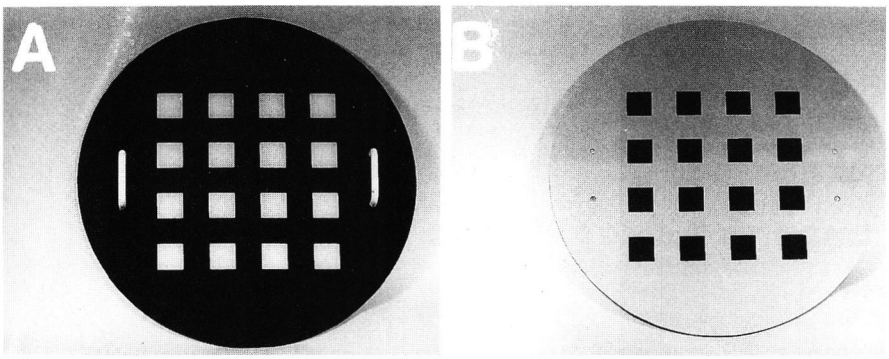

FIG. 1. Plexiglas plate front surface (A) with 16 delineated (12 central areas for the samples, and 4 corners for background) 4 × 4 cm areas and shielded back surface (B) side with 0.6 mm equivalent lead.

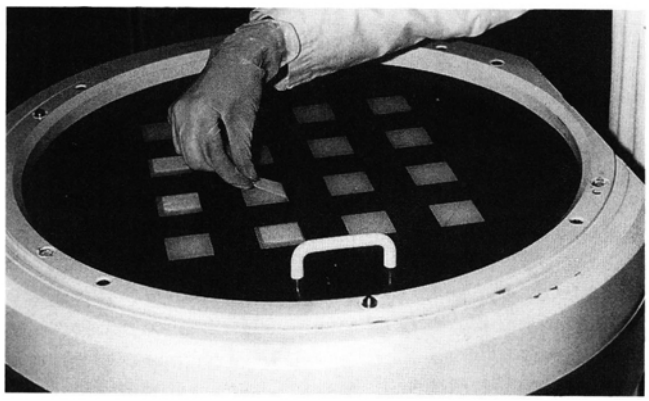

FIG. 2. Disk placed in a fixed position on the detector with no collimator. Wipe samples are counted as shown.

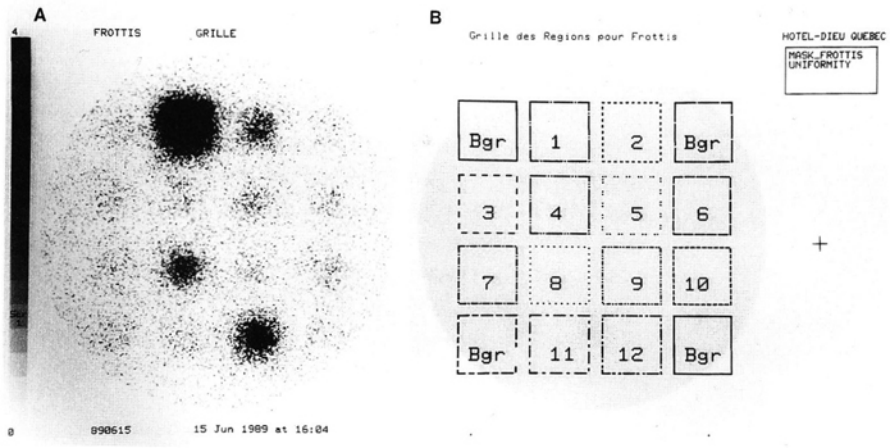

FIG. 3. (A) Example of a static digital image of wipe tests obtained in 3 min at 256 × 256 pixels. (B) Computer grid of 16 ROIs corresponding to each area on the plexiglas plate.

to be used in the routine procedure. Other standards can be counted for different isotopes (gallium-67, iodine-131).

RESULTS

The result of each sample is given as a percentage of the maximum permissible level, and areas above 100% must be decontaminated and tested again. The entire test is performed weekly. The computer displays an image of the wipe tests for easy visual inspection, and displays the results on the screen as shown in Figure 4.

The sensitivity of the uncollimated gamma camera and computer counting method is sufficient to detect decimal fractions of the maximum permissible free contamination level. Net counts between 2,000 cpm and 2,500 cpm are usually obtained in the region for the 50 Bq standards compared to a background of 300–600 cpm.

During the year that the method has been used in our institution, no contamination other than ^{99m}Tc has been

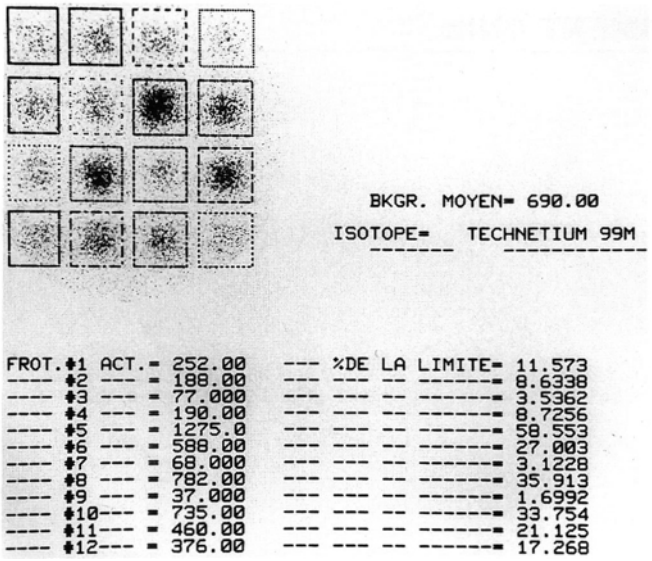

FIG. 4. Computer's final display. Results are expressed for each sample (1–12) as percentage of the maximum permissible contamination level (50 Bq). Note significant contamination in samples 5, 6, 8, and 10 are, however, below 100% permissible limits.

found. For practical purposes we are now currently using a large energy window setting (130–200 keV) to include ^{99m}Tc, ^{123}I and ^{67}Ga (medium-energy peak) energies in a single image. Thallium-201 is purchased in unidose injections, and ^{131}I is not used by us in diagnostic procedures.

Variations in the standard and background count values are also followed as an aid for quality control of the gamma camera.

DISCUSSION

The purpose of the described method is primarily to satisfy regulatory requirements concerning radiation safety. It will provide a relative percentage of contamination compared to a pre-established standard, rather than a precise, absolute quantity of activity below the nanocurie range.

The utilization of an uncollimated gamma camera and a computer for wipe test analysis offers a practical alternative and decreases the time needed for counting, analyzing and recording the results. With this method, all wipe tests of the pre-selected areas of the laboratory can be analyzed and recorded simultaneously. To obtain the same results utilizing the well counter, each wipe test, having a very low activity, must be counted for several minutes to have good statistical significance. Dedicated wipe test counters are more practical, than well counters, but also require individual counting and manual record keeping.

The "twice the background" limit criteria for contamination detection is simple, but not accurate. The possibility with the proposed method having the results expressed as a fraction of a maximum permissible level is a more valuable tool in a long-term contamination survey program. The gamma camera gives accurate and reproducible results and the computer program gives a consistent pictorial result that is used directly as the final document for record keeping.

In summary, this method is simple, easily accepted by the personnel and provides a rapid external contamination control program as stipulated by regulatory agencies.

NOTES

* General Electric 400 AT gamma camera detector, GE Medical Systems, Milwaukee, WI.

† Star-View G.E. computer, GE Medical Systems, Milwaukee, WI.

REFERENCES

1. Nuclear Regulatory Commission. Publication 10CFR35. *Medical use of by-product material*, 35.70, *Surveys for contamination and ambient radiation exposure rate.*

2. Atomic Energy Control Board requirements. *Radioisotopic licensure.* Ottawa, Canada.