J of Nuclear Medicine Technology, first published online June 14, 2022 as doi:10.2967/jnmt.122.264172

QUALITY CASE STUDY

AN UNUSUAL CAUSE OF GAMMA CAMERA CONTAMINATION

David L Francia[1], Kathy P Willowson[1,2] and Dale L Bailey[1,3]

[1]Department of Nuclear Medicine, Royal North Shore Hospital, Sydney, Australia 2065

[2]Institute of Medical Physics, University of Sydney, Sydney, Australia 2006

[3]Faculty of Medicine & Health, University of Sydney, Sydney, Australia 2006

ORCID IDs

David L Francia:	N/A
Kathy P Willowson:	0000-0002-2195-0596
Dale L Bailey:	0000-0001-9154-7957

Author for all correspondence & reprints:
Dale L Bailey *PhD*
Department of Nuclear Medicine
Royal North Shore Hospital
St Leonards, Sydney
Australia 2065
E: Dale.Bailey@sydney.edu.au

Disclaimers: None
Financial Assistance: None

Abstract

This report is of an unusual case of radioactive contamination of a gamma camera after scanning two individuals who had been treated 3 days prior with ablative doses of radioiodine (^{131}I) for thyroid cancer. A combination of observed half-life and pulse-height spectroscopy were employed to identify the radio-contaminant. The source of the contamination was eventually found to be a single human hair, presumably contaminated by the individual sucking her hair while waiting for the scan to start. This case demonstrates that hair can be contaminated by saliva and potentially other bodily fluids in the post-ablation setting and that using physical measurements, in this case the observed half-life and pulse-height spectroscopy, can be useful in identifying the radio-contaminant.

Introduction

The nuclear medicine department in our institution has three dual-detector gamma cameras and one PET/CT camera. Two of the three gamma cameras are SPECT/CT devices. Of these, one has a thicker (16 mm) detector crystal than is standard (Intevo 6, Siemens Healthineers, Hoffman Estates, IL, USA) and so is preferentially used when imaging higher energy γ photons from radionuclides such as ^{131}I (364 keV), ^{177}Lu (208 keV), ^{67}Ga (93, 185, 300 keV), ^{67}Cu (93, 185 keV) and ^{111}In (171, 245 keV). During a routine acquisition of a low-dose ^{131}I scan on this gamma camera on a Monday (the first day of our working week) a low level of contamination was noticed on one of the detectors (Fig. 1). An intrinsic uniformity image acquired using ^{99m}Tc as part of routine QC earlier that day did not show any evidence of contamination. Up to the time of the contamination being noticed only patients who had been administered ^{67}Ga and ^{131}I had been scanned.

Quality Analysis

The system was inspected and possible sources of the contamination were checked. The contamination remained fixed in location with respect to the detector when the detector heads were rotated to different angular positions suggesting that the contamination was on the collimator/detector rather than on the scanning bed, the floor or other non-detector location. The external face of the collimator was thoroughly cleaned with a decontamination solution but the contamination persisted. The collimators were removed and inspected but no obvious source of the contamination was identified. The Intevo SPECT/CT system has a combination of automated collimator exchanger for low and medium energy collimators plus an additional manual cart exchanger for the high energy collimators. Due to the persisting contamination the system was taken out of service for the rest of the day.

The following day the contamination was still present suggesting that it was not from a short-lived radionuclide such as ^{99m}Tc. Images using ^{67}Ga energy windows settings were acquired on both detectors and the contamination was clearly seen (Fig.2 top row). Count rates from the previous day's images were determined and compared with the current ones in an attempt to assess the rate of decay of the contamination. A pulse height energy spectrum was also acquired with the medium energy collimators fitted.

A region of interest (ROI) drawn over the area of contamination was corrected for background from an identical ROI on the same detector in a mirrored location on the images acquired on the successive days.

The decline in the count rate suggested a half-life of around 7-8 days. Using the system's pulse-height analyser (PHA) the energy spectrum demonstrated a slight peak above background around 360 keV. This suggested that the contamination was from ^{131}I. Further images were acquired using an ^{131}I window (Fig. 2 bottom row) which showed the contamination with better definition and higher count rate.

The subjects that had been scanned on the day when the contamination was first noticed were individuals treated for primary thyroid cancer with ablative doses of ^{131}I (*per oral* by capsule) and subjects suspected of infection using [^{67}Ga]Citrate. It is our institution's practice to hospitalise all subjects treated with $\geq$ 1 GBq of ^{131}I and for those subjects who are treated with the largest doses that we deliver (6 GBq) to be preferentially admitted to hospital and treated on Friday and then scanned prior to discharge on Monday morning (~64 hrs later) to allow for extended decay and elimination of the radioiodine from the body compared to our normal practice which is to scan and discharge the subjects treated with 1-4 GBq ^{131}I approximately 40 hours after their treatment (admitted Monday afternoon for treatment and discharged on Wednesday morning, or admitted Wednesday afternoon and discharged on Friday morning). On the day in question post-ablation ^{131}I scans had been acquired on two female subjects each treated with 6 GBq of ^{131}I on the previous Friday afternoon. No contamination was visible in either of these subjects' scans, however, presumably because the amount of radioiodine contained within the body in these individuals remained much higher than in the diagnostic scan which demonstrated the artefact.However, while the radionuclide had been identified the source of the contamination was still not identified.

The collimators were removed to allow further inspection. On closer inspection of the detector surface a single dark human hair was found on the detector (Fig. 3). The hair was removed and placed on the bench and a handheld radiation survey meter used to test whether it was contaminated. This, in fact, turned out to be the case as it registered an increase in event rate on the meter and contamination was no longer evident on the gamma camera detector. It was therefore that the contamination had to be from one of the two radioiodine ablation subjects who had been treated and hospitalised over the weekend. In retrospect, it was noted that the younger of the two subjects who had been treated had long dark hair and was particularly anxious. One of our staff members recalled that while waiting for her scan she had been sucking the ends of her hair. We therefore presume that the contamination came from saliva from her mouth when she was sucking her hair.

This unusual source of contamination illustrates that saliva on a single human hair was able to cause contamination of the scanner. It is not clear to us how the hair came to be lodged between the underside of the collimator and the detector crystal surface.

Corrective Action

There were three observations that led to this contamination being identified. Firstly, the fixed relationship between the contamination and the location on the detector independent of the orientation of the gamma camera detectors indicated that the contamination was intrinsic to the detector and not from an external source such as the scanning bed or the floor. Secondly, the observed count rate over the first 2 days (in a ^{67}Ga PHA window) appeared to decrease with a half-life of around 7 days, which excluded some short-lived tracers such as ^{99m}Tc. It also suggested that it was not ^{67}Ga ($t_{½}$ = 78 hrs) and more likely to be ^{131}I ($t_{½}$ = 8 days). Finally, pulse-height spectroscopy using the NaI(Tl) detector and PHA of the gamma camera showed a faint peak at around 360 keV, again supporting the case for the contaminant to be ^{131}I. Once the identified hair was found and removed the gamma camera did not display any further contamination.

Verification of Effectiveness

The routine practice in our institution is to instruct all subjects treated with ^{131}I for thyroid cancer to have a shower and wash their hair thoroughly on the morning of the day that they are due to be discharged from the hospital and before they have their post-ablation ^{131}I scan as it is known that human hair can become contaminated with radioiodine (*1,2*). The subjects' hair is considered by our staff to be a possible site of contamination as well as anywhere that the subjects' saliva, sebum or other bodily fluids (*e.g.*, nasal secretions, mucous, gastric reflux) might be able to contaminate. Using the physical characteristics (half-life, positional orientation, PHA of energy of emissions) of the contamination is also more relied upon now to quickly identify contamination and location. The ability for a contamination source to be located *between* the collimator and the detector surface is also considered.

It should be borne in mind that the possibility of persisting contamination is increased when using large amounts of long-lived radiation for therapy (*3*) compared to the majority of diagnostic procedures which use lower amounts of radionuclides with typically shorter half-lives. This is likely to become more of an issue as the number of radionuclide therapies administered in nuclear medicine departments increase.

Conclusion

Contamination of the gamma camera can arise from a number of causes both external to the scanning system and of the system itself. Early assessment using translation and rotation of the detectors should determine whether the contamination has a fixed geometry relative to the system or is external. Using physical characteristics such as the photon energy of the contamination and the half-life can help to identify the radionuclide and, therefore, the potential cause of the contamination. In this case a single human hair that had become contaminated with ^{131}I, presumably due to saliva, was able to become lodged between the underside of the collimator and the detector surface.

Consent: All therapy subjects in our institution provide signed informed consent not only to undergo the treatment but also to allow their data to be used for "training, education, research, publication and audit purposes".

Financial Disclosure: None to declare

Disclaimer: None to declare

References

1. Zakavi SR, Kakhki VD. Exercise-induced radio-iodine accumulation in scalp and hair during admission of 131I therapy for thyroid cancer. *Thyroid.* 2006;16:1185-1186.

2. Yan D, Doss M, Mehra R, Parsons RB, Milestone BN, Yu JQ. False-positive scalp activity in 131I imaging associated with hair coloring. *J Nucl Med Technol.* 2013;41:43-45.

3. Dhingra J, Santana C, Harvey J, et al. Root Cause Analysis of $Na^{131}I$ Contamination. *Journal of Nuclear Medicine Technology.* 2021;49:350-353.

Figures

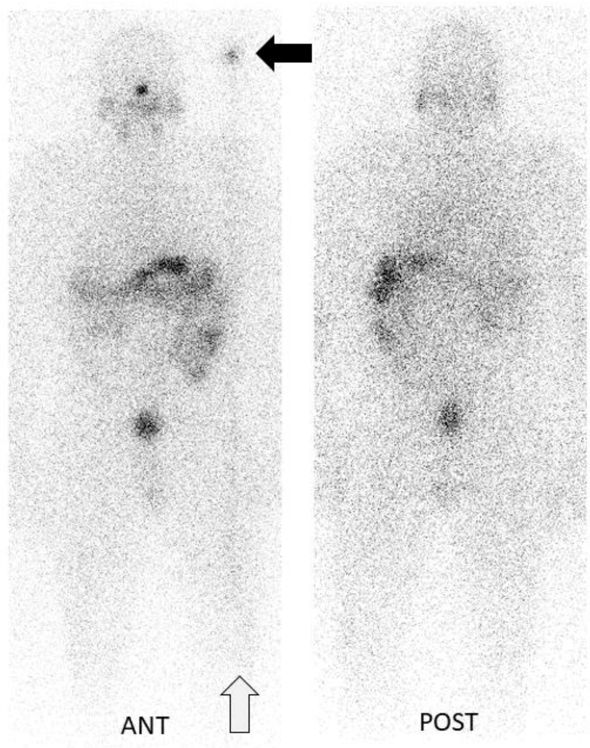

Figure 1. Whole body planar scans of a post-rTSH stimulation ^{131}I (80 MBq) scan demonstrating the contamination (solid arrow) on the anterior projection (Detector 1). The effect of the fixed site of contamination in the whole body scan where the body moves continuously under the detectors the z-direction is to introduce a "streak" down the image in line with the site of contamination (outlined arrow).

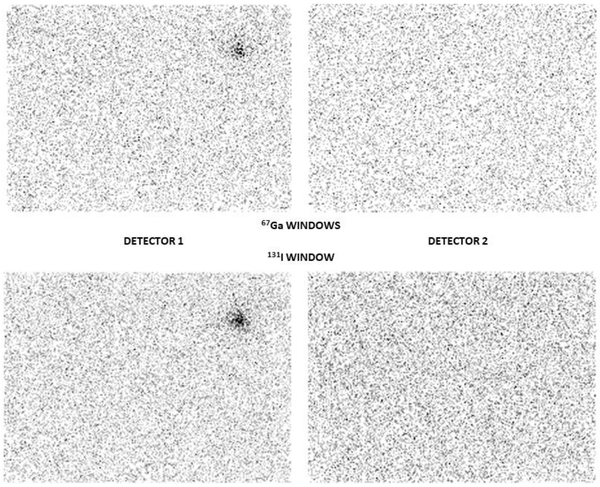

Figure 2. Images on both detectors without any source of radioactivity present and collimators in place demonstrating the contamination on detector 1. Images in both the summed triple window PHA settings for ^{67}Ga (top row) and a single window for ^{131}I (bottom row) are shown.

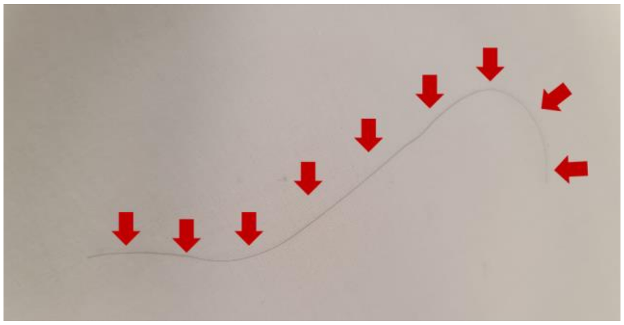

Figure 3. The hair that was found to be the source of the contamination.