Original Article

Influence of Decontaminating Agents and Swipe Materials on Laboratory Simulated Working Surfaces Wet Spilled with Sodium Pertechnetate

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Abstract

Context: Decontamination of various working surfaces with sodium pertechnetate minor spillage is essential for maintaining good radiation safety practices as well as for regulatory compliance. **Aim:** To observe the influences of decontaminating agents and swipe materials on different type of surfaces used in nuclear medicine laboratory work area wet spilled with 99m-technetium (99mTc) sodium pertechnetate. **Settings and Design:** Lab-simulated working surface materials. Experimental study design. **Materials and Methods:** Direct decontamination method on dust-free lab simulated new working surfaces [stainless steel, polyvinyl chloride (PVC), Perspex, resin] using four decontaminating agents [tap water, soap water (SW), Radiacwash, and spirit] with four different swipe material [cotton, tissue paper (TP), Whatman paper (WP), adsorbent sheet (AS)] was taken 10 samples (n = 10) for each group. **Statistical Analysis:** Parametric test two-way analysis of variance is used with significance level of 0.005, was used to evaluate statistical differences between different group of decontaminating agent and swipe material, and the results are expressed in mean ± SD. **Results:** Decontamination factor is calculated after five cleaning for each group. A total of 160 samples result calculated using four decontaminating agent (tap water, SW, Radiacwash, and spirit), four swipe material (cotton, TP, WP, and AS) for commonly used surface (stainless steel, PVC, Perspex, resin) using direct method by 10 samples (n = 10) for each group. **Conclusions:** Tap water is the best decontaminating agent compared with SW, Radiac wash and spirit for the laboratory simulated stainless steel, PVC, and Perspex surface material, whereas in case of resin surface material, SW decontaminating agent is showing better effectiveness. Cotton is the best swipe material compared to WP-1, AS and TP for the stainless steel, PVC, Perspex, and resin laboratory simulated surface materials. Perspex and stainless steel are the most suitable and recommended laboratory surface material compared to PVC and resin in nuclear medicine. Radiacwash may show better result for 99mTc labelled product and other radionuclide contamination on the laboratory working surface area.

Keywords: *Decontamination factor, direct method and indirect method for radioactive decontamination, decontamination factor radio decontamination solution, radioactive surface contamination, wet spillage of 99m technetium sodium pertechnetate*

Introduction

Radioactive contamination of work surfaces or personal occurs while handling open isotope in nuclear medicine laboratory either from normal operation or as a result of breakdown of protective measures. Decontamination protocol for radioactive contamination[1,2,6] is important for regulatory compliance and maintaining good radiation safety practices in radiopharmacy laboratory, nuclear medicine lab, and radioactive research laboratory. Gurau and Deju[4] performed to evaluate the efficacy of two chemical gel as decontaminating agent (DeconGel11O1, DeconGel 1102) used on dry contamination of ^{60}Co and ^{137}Cs radionuclide.

Type of swipe material, method used, chemical form of decontaminating agent, efficiency of measuring instruments, physical and chemical nature of the surface material, surface roughness, physical and chemical nature of the radionuclide contaminant, removal technique, human factors and specific concentration of activity are the various factors affecting removal of radioactive contamination.[2,5,6]

Study is for the "standardizing" to reduce the variability and "validating" the decontamination methods to set up the protocols for nonlabelled technetium wet spill for achieving As Low As Reasonably Achievable as good radiation safety

How to cite this article: Akchata S, Lavanya K, Shivanand B. Influence of decontaminating agents and swipe materials on laboratory simulated working surfaces wet spilled with sodium pertechnetate. Indian J Nucl Med 2017;32:173-6.

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Access this article online

Website: www.ijnm.in

DOI: 10.4103/ijnm.IJNM_1_17

Quick Response Code:

practices in our nuclear medicine laboratory set up. The purpose of this study was to standardize and validate the observe influences of the decontaminating agent and swipe material that should be effective when cleaning a wet radioactive spill from surfaces common in nuclear medicine laboratory set up in nuclear medicine department.

Materials and Methods

Four different decontaminating agents [tap water, soap water (SW), Radiacwash, and spirit] and swipe material [cotton, adsorbent sheet (AS), Whatman paper-1 (WP-1), tissue paper (TP)] are analyzed over controlled simulated wet radioactive spill on four different surfaces common to the nuclear medicine department.[2,3] Selected surfaces are stainless steel, used as working benches and sink in nuclear medicine department, polyvinyl chloride (PVC) which is most commonly used flooring material, Perspex used for many instrument as low attenuating material, e.g., liner of dose calibrator and resin material used as bed material for imaging couch. Separate pieces of 10 × 10 cm clean, dust-free surfaces are used for individual spills. Each surface was assessed for background and any prior radioactive contamination. Controlled wet radioactive contamination of 50 μci is done by using specific concentration of 0.6 mCi/ml (22.2 MBq/ml).

Time spent for decontamination was done for 10 s on controlled contaminated surfaces from outside to inside by applying moderate pressure using 1 ml of selected decontaminating agent poured on 2 × 2 cm size of cotton (Johnson and Johnson) and 8 × 8 cm AS, TP, WP-1 swipe material. These were all controlled throughout the study by single operator to avoid human error factor.[4] Precleaning and post decontamination count) are taken for 60 s for each reading using digital contamination detector (Nucleonix CM 701P) at 1 cm distance by moving pancake at speed 3-5 cm/s. Decontamination factor (DF) is calculated using formula DF = Count obtained before decontamination/count obtained after decontamination.

Each cleaning repeated for five times and mean of five cleaning considered as count obtained after decontamination (PDC). Same process is repeated for all surface using swipe material with decontaminating agent.

Parametric test two-way analysis of variance used with significance level of 0.005 was used to evaluate statistical differences between different group of decontaminating agent and swipe material and the results are expressed in mean ± SD.

Results

In this study, influence of decontaminating agent with swipe material is used to check on commonly used nuclear medicine laboratory simulated surface materials made up of stainless steel, PVC, Perspex, and resin. DF for all the surface material using decontaminating agent with swipe material is shown in Table 1.

Stainless steel is most effectively cleaned by using tap water (TW) compared to other decontaminating agents. TW with cotton swipe material is showing highest decontamination compared to TW with WP-1, AS, and TP, respectively (Plot-1 of Figure 1). PVC is also demonstrated that tap water with cotton is best suited and next to that are SW and Radiacwash. Spirit showing least decontamination compared to all other for 99m technitium - sodium pertechnetate wet spill (Plot-2 of Figure 2). For Perspex material also tap water with cotton is showing best decontamination (Plot-3 of Figure 3). In case of resin surface material, SW is showing more effectiveness with cotton (Plot-4 of Figure 4).

Table 1: DF (mean±SD) for all selected decontaminating agent and swipe material

Decontaminating agent	Swipe material	Stainless steel	PVC	Perspex	Resin
RW	Cotton	3.76±0.510	2.22±0.4450	4.12±1.440	2.79±0.590
	TP	1.83±0.280	1.49±0.210	1.78±0.250	1.33±0.050
	WP	3.09±1.36	1.73±0.250	1.80±0.220	1.73±0.150
	AS	1.96±0.290	1.56±0.150	2.66±0.900	2.20±0.510
SW	Cotton	4.00±1.20	3.16±0.720	3.90±1.800	4.68±1.33
	TP	1.88±0.44O	1.31±0.140	1.87±0.260	1.85±0.190
	WP	3.19±0.640	1.86±0.580	2.04±0.480	2.90±0.350
	AS	1.78±0.180	1.48±0.120	2.40±0.480	3.36±0.920
TW	Cotton	4.15±0.935	5.07±1320	4.99±1.590	3.19±1.120
	TP	2.19±0.7551	1.81±0.520	2.43±0.460	1.73±0.280
	WP	3.75±1.090	2.39±0.950	2.81±0.520	2.28±0.570
	AS	2.25±0.442	1.68±0.206	3.27±1.010	1.76±0.250
SPIRIT	Cotton	3.18±1.400	2.52±0.690	2.96±0.250	2.41±0.720
	TP	1.43±0.330	1.26±0.700	1.51±0.250	1.46±0.050
	WP	2.18±0.552	1.37±0.270	1.56±0.120	1.58±0.220
	AS	2.03±0.800	1.40±0.160	1.80±0.180	1.54±0.320

RW: Radiachwash, SW: Soap water, TW: Tap water, TP: Tissue paper, WP: Whatman paper, AS: Absorbent sheet

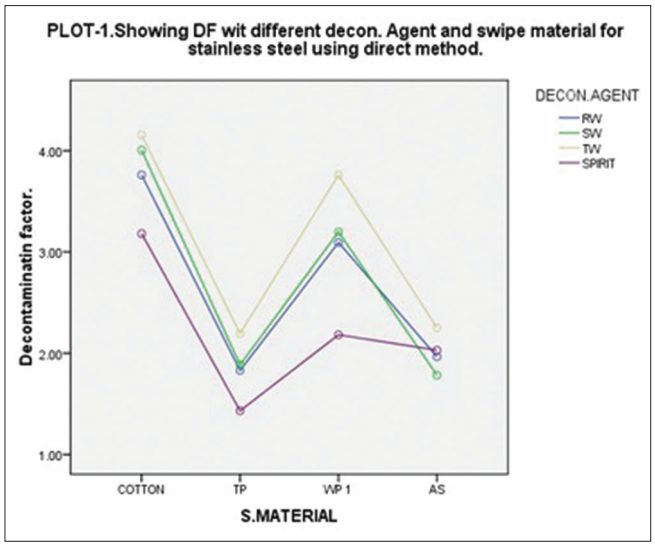

Figure 1: DF for Stainless Steel

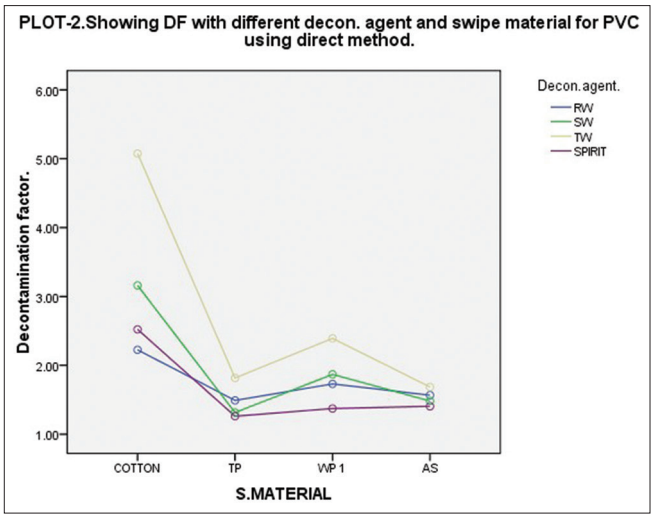

Figure 2: DF for PVC

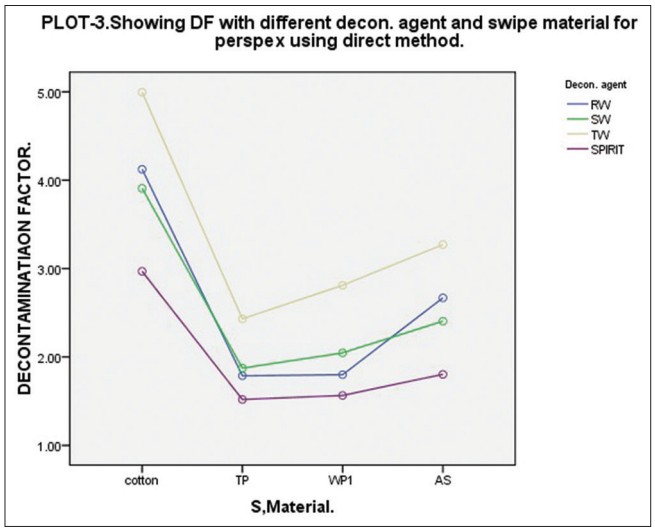

Figure 3: DF for Perspex

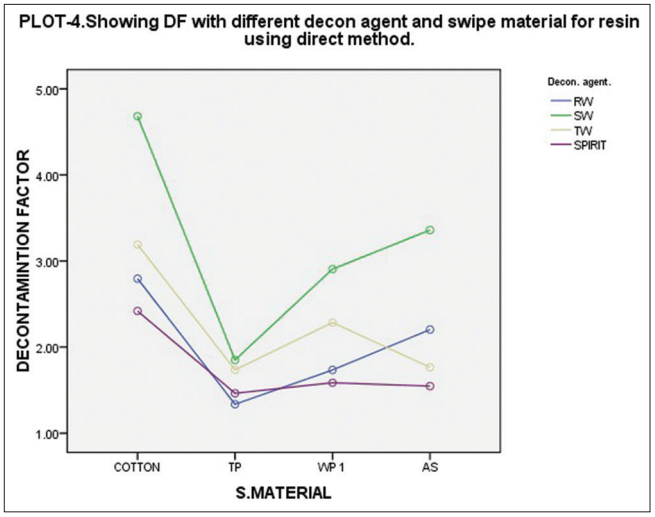

Figure 4: DF for Resin

Discussion

TW and SW along with any swipe material used in this study show high DF,[5] may be because 99mTc dissolved in saline easily, so the contamination may also easily come out with tap water. SW is found effective in case of resin,may be because non smooth surface of alkaline matrix interacts with highly alkaline fatty acid molecule of soap increase abrasion of surface material so that absorbed contamination can be easily cleaned by using SW. Radiacwash does not show better result over TW and SW pertechnetate in the oxidation state of +7 remains inert so it may be possible that chemical nature of commercially available agent is not able to form any kind of bond with the 99mTc contamination and removing it. Radiacwash may show better result for other 99mTc labelled product and other radionuclide. Cotton swipe material was showing highest DF. Cotton matrix having more air phase which is easily displaced by liquid contamination present on the surface materials. Reason of the uncertainty may be because of variation in hand or arm pressure considering as human factor, although moderate pressure is maintained over study suggested in U.S. Environmental Protection Agency, Washington, DC, (EPA/600/R-11/122, 2011 EPA guideline) for manual decontamination method, remove such type of uncertainty, use of automated swipe sampler/ smear sampling apparatus suggested.

This study was limited to the 99m sodium pertechnetate ($Na99mTcO_4$ contamination) wet type spill consisting the low activity concentration (<120 μci/ml) only. Spill occurred with 99mTc - labelled radiopharmaceuticals and other radionuclides were not assessed in this experiment. All the surface material checked for decontamination as new and smooth surfaces. Few other surfaces like Formica, which make the surface of many counter tops and injection stands in nuclear medicine department; glass used as window door/tables; ceramic tiles and marbles used as

flooring material; grooved plastic, which is used on the few imaging beds; wood used as working table, skin surface contamination were not checked for the decontamination of 99m-technetium sodium pertechnetate.[5]

Entire experiment was done by a single operator, so variation of the human factor is not tested to see the influences of the decontaminating agent with the swipe materials on different working surfaces. After analyzing the data obtained from 99m technetium wet spill; this study concludes that tap water is the best decontaminating agent compared to SW, Radiac wash and spirit for the laboratory simulated stainless steel, PVC and Perspex surface material, whereas in case of resin surface material, SW decontaminating agent is showing better effectiveness. Cotton is the best swipe material compared to WP-1, AS, and TP for the stainless steel, PVC, Perspex and resin laboratory simulated surface materials. Perspex and stainless steel are the most suitable and recommended laboratory surface material compared with PVC and resin. Radiacwash has not shown good results with the sodium pertechnetate spill, but it may show better result for the contamination occurred other 99mTc labelled product and other radionuclide on the laboratory working surface area.

Acknowledgement

The authors thank Prof. Dr. Rajesh Kumar, Head of Department, Department of Nuclear Medicine, Dean and Institute Research Committee, School of Allied Health Sciences, Manipal for providing permission and facility to complete the work.

Financial support and sponsorship

Nil

Conflicts of interest

There are no conflicts of interest.

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