Documents for Mr. Steven Courtemanche

From: ~~Miles McCord~~, RSO

Howard University

4/23/2003

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Mr. Steven Courtemanche
NRC Inspector
Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, Pennsylvania 19406

Dear Mr. Courtemanche:

This is a follow-up to the preliminary calculations by the Radiation Safety Officer (RSO) of the March 19, 2003 shallow dose exposure to the Nuclear Medicine technologist due to contamination of the skin from Tc-99m. It is the belief of the RSO that the exposure occurred only on Wednesday as described in previously submitted material. The results of the calculation indicate a shallow dose exposure ranging from 9 to 29.5 Rem, note that this is a conservative estimate. The exposure range reflects the estimates on the amount of contaminating Tc-99m on the skin of the technologist (250 – 750 microCi). Additionally, it is the belief of the RSO that the exposure is limited to contamination that occurred only on Wednesday and not from the previous day. There is no evidence that the activities on Tuesday resulted in any direct skin contamination of a technologist. Management concurs with the findings of the RSO.

Also included with this letter is documentation on the exposure calculation that has been up-dated to include the Tc-99m contamination to the skin based on the NRC's estimate of activity.

Sincerely,

Thomas Gaiter, M.D., Medical Director
Howard University Hospital

Cc: Victor Scott, M.D.
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Calculation of skin exposure from Tc-99m skin contamination

On Wednesday, March 19, 2003 a nuclear medicine technologist was found to have contamination on 2 fingers of his right hand. A survey of the contaminated hand indicated an exposure rate of approximately 5 mR/hr @ 10 cm. The tech began the process of decontaminating shortly after discovery of the contamination. A check of the progress of the decontamination with the GM meter revealed an exposure rate of 0.5 mR/hr. The tech continued to decontaminate his finger, but could not completely eliminate the contamination. He stated that there was some measureable exposure with the GM meter on the lowest scale. This is conservatively estimated to be 0.17 mR/h.

A test was performed to estimate the amount of activity that would produce the exposures indicated above. An outline of the tech's hand was used to model the distribution of contamination by spreading drops across the outline of his two fingers. Exposure rate measurements (with a GM meter w pancake probe) were made at 10 cm above the contaminated outline. This test was repeated for 3 different amounts of activity spread on the outline. The amount of activity was determined from the difference between assays taken of a syringe before and after marking the hand outline. The activity was estimated to be 0.250 mCi of Tc-99m.

Skin contamiation is believed to occur only on Wednesday, March 19, 2003. Contaminated areas were discovered on Tuesday afternoon. However, there is no indication that there is any association between this contamination and contamination of a technologist's skin on Tuesday.

tech's tasks on Tuesday - 3/18:

730 generator prep
945 dosed thyroid pt.
1000 tech prepared HDP kit
1000 tech dosed pt w HDP
1030 tech prepared MAA kit
1200 dosed thyroid pt.
1415 tech prepared SC kit
1530 tech dosed pt w MAA
1900 - techs called at home &
2000 informed to thoroughly wash hands

tech's tasks on Wednesday - 3/19:

1000 tech prepared HDP kit
1020 tech dosed first pt w HDP
1030 tech dosed second pt w HDP
1100 tech's finger discovered to be contaminated
exposure at 10 cm is 5 mR/hr
1130 tech completes decontamination of his finger
residual amount of activity remains,
approx. exposure level is < .17 mR/hr
a reduction of (5/.17 =) 29.4 times

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Calculation of maximum dose to 2 fingers:

assumptions:

1) contamination directly to the exposed skin occurred on Wednesday morning
2) test measurements provide an estimate of 250 μCi of Tc-99m that contaminated 2 fingers on Wednesday when the contamination was discovered.
3) The area of the tech's hand for two fingers tip-to-first knuckle covered an area of 40.5 - 52 cm2. The contaminated area was estimated from an outline drawn of tech's hand on graph paper and counting the squares bounded by the outline.
4) Hand contamination was based on the amount of activity spread on the hand outline, which produced an exposure rate of 5 mR/hr at 10 cm above the contaminated outline.
5) Contamination remaining on tech's hand at the end of decontamination on Wednesday estimated as [0.17 mR/hr / 5 mR/hr] x 250 μCi = 8.5 μCi
6) The NRC has noted that their estimate of activity indicates 750 microCi of Tc-99m was present at the time of discovery of contamination.
   For a contamination of 750 microCi the amount of activity remaining after cleaning is estimated as 25 microCi.

The following calculations are based on data taken from reference;
Health Physics & Radiological Health Handbook B. Shleien, 1992, Table 13.10 p.528.

Electron Dose Rate Factors in Skin from Radionuclides Deposited on Body Surface.
Factors for Tc-99m

Depth ->	4 mg/cm2	7 mg/cm2	8 mg/cm2	40 mg/cm2
(Sv/y)/(Bq/cm2) ->	0.0029	0.0021	0.0018	0

Activity (μCi)	Average Activity per area[1] (μCi/cm^2)	Average Activity per area[2] (μCi/cm^2)	Sv/y[1]	Sv/y[2]	Sv/y[1]	Sv/y[2]	Sv/y[1]	Sv/y[2]	Sv/y[1]
1	0.025	0.019	2.6	2.1	1.9	1.5	1.6	1.3	0.000
10	0.247	0.192	26.5	20.6	19.2	14.9	16.4	12.8	0.000
8.5	0.210	0.163	22.5	17.5	16.3	12.7	14.0	10.9	0.000
25	0.617	0.481	66.2	51.6	48.0	37.4	41.1	32.0	0.000
100	2.469	1.923	264.9	206.3	191.9	149.4	164.4	128.1	0.000
250	6.173	4.808	662.3	515.9	479.6	373.6	411.1	320.2	0.000
280	6.914	5.385	741.8	577.8	537.2	418.4	460.4	358.6	0.000
300	7.407	5.769	794.8	619.0	575.6	448.3	493.3	384.2	0.000
750	18.519	14.423	1987.0	1548	1438.9	1121	1233.3	960.6	0.000
841	20.765	16.173	2228.1	1735	1613.5	1257	1383.0	1077.1	0.000

1 - at an area of 40.5 cm^2
2 - at an area of 52 cm^2

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Contamination occurred only on Wednesday. (Contamination found on Tuesday did not result in any additional personnel contamination.)

Further assumptions:

1) 0.250 mCi of contamination at 1100
2) initial contamination of 280 μCi occurred at 1000
3) decontamination completed by 1130 with 8.5 μCi residue remaining
4) 0.750 mCi of contamination at 1100
5) initial contamination of 841 μCi occurred at 1000
6) decontamination completed by 1130 with 3x8.5 = 25 μCi residue remaining

exposure time estimates

surface contamination remained until decontamination completed at 1130 - 1.5 hrs
residual activity cleared in average time of 1.44*T1/2(1-exp(-λt)(1+λt)) = 3.48 hrs

The **dose rate** for shallow dose (7 mg/cm2) **for an area of 40.5 cm^2**

due to 280 μCi is	537	Sv/y	>	6.1	Rem/hr
due to 8.5 μCi is	16	Sv/y	>	0.2	Rem/hr

The shallow dose

due to 280 μCi of Tc-99m from 1.5 hrs of exposure is	9.2	Rem
due to 8.5 μCi of Tc-99m for 8.7 hrs of exposure is	0.6	Rem
Total	9.8	Rem

The **dose rate** for shallow dose (7 mg/cm2) **for an area of 40.5 cm^2**

due to 841 μCi is	1613	Sv/y	>	18.4	Rem/hr
				27.6	Rem
due to 25 μCi is	48	Sv/y	>	0.5	Rem/hr
				1.9	Rem
			Total	29.5	Rem

The **dose rate** for shallow dose (7 mg/cm2) **for an area of 52 cm^2**

due to 280 μCi is	418	Sv/y	>	4.8	Rem/hr
due to 8.5 μCi is	13	Sv/y	>	0.1	Rem/hr

The shallow dose

due to 280 μCi of Tc-99m from 1.5 hrs of exposure is	7.2	Rem
due to 8.5 μCi of Tc-99m for 8.7 hrs of exposure is	0.5	Rem

Range of Total Dose: 9.2 - 29.5 Rem

Revised on 4/23/03

4/23/2003