Medical Consultant Report
(To be completed by medical consultant)

Medical Consultant Name: Ronald E. Goans, PhD, MD, MPH
Report Date: 12/22/2008

Signature Ronald E Goans MD

Licensee Name: Department of Veterans Affairs Medical Center, Philadelphia, PA
3900 Woodland Avenue
Philadelphia, PA 19104

License No. 03-23853-01VA
Event No. 44219
Docket No. 030-34325

Facility Name: Radiation Oncology Department, Department of Veterans Affairs, Philadelphia, PA.

Incident Date: 2/25/2002 through 5/6/2008
Date of Notification: Initial notification 5/15/2008

Individuals' / Patient Physician Name and Address:

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Individuals Contacted During Investigation:

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Records Reviewed: (General Description)

1. NRC Enclosure - Description of the Medical Event
2. NRC Preliminary Notification of Event (Event # 44219)
4. NRC Medical Event Reporting and supporting literature
5. Department of Veterans Affairs Medical Center correspondence to the NRC
6. Detailed review of patient records (underdoses and overdoses)
7. Memorandum, Director VA National Health Physics Program

Estimated Dose to Unintended Anatomic Region:
By assessment of clinical signs:

See list of cases below. This varies by case.

Probable Error Associated with Estimation: 10%

Prescribed Dose (Medical Misadministration Only):

160 Gy to prostate.

Method Used to Calculate Dose: Radiation oncology computer simulation.

Description of Incident:

The index case refers to a permanent implant prostate brachytherapy procedure performed on May 5, 2008 at the Department of Veterans Affairs Philadelphia Medical Center using I-125 seeds of a lower apparent activity than intended. The seeds were ordered in error and subsequently implanted. The activity per seed (0.38 mCi per seed instead of 0.509 mCi per seed) did not agree with the treatment plan, although the number of seeds did agree.

A CT scan of the patient was performed on May 6, 2008, and a postplan was performed after the implant procedure. The D90 dose, calculated from the postplan, was less than eighty percent of the prescribed dose and therefore triggered reporting to the NRC. It is generally agreed that postplan dosimetry provides more accurate assessment of dose to the prostate.

In most cases, the postplan is based on CT scans performed approximately one month after an implant, when swelling from the procedure has partially resolved, In the postplan performed after the index case procedure, the D90 dose was only 47% of the prescribed dose of 160 Gy to the prostate. The root cause of the index event involved not only improper physician placement, but also incorrect seed activity.

The licensee subsequently conducted a review of all cases of brachytherapy in the time period 2002-2008. A number of cases (55) were identified where the prostate was under dosed. In addition, the licensee notified the NRC that an additional 37 medical events were identified. Thirty-five of these events involved a dose to an organ or tissue site that exceeds 50 rem and 50% more than the dose expected from the administration. Fourteen cases were selected for medical review where the prostate was underdosed. An additional 10 cases were selected for review where there was improper seed placement, resulting in an overdose to certain organs. The VA Medical Center suspended its prostate brachytherapy program on June 11, 2008. The program has been under extensive internal and external review since that time.

Clinical Details

I. Cases of Underdose (Summary of D90 doses and clinical events)

Case XRT 001

Procedure date 8/13/2007
Prescribed dose 160.0 Gy 50 seeds
Procedure: I-125 54 seeds 0.38 mCi per seed
Pre-op D90 195.72 Gy (122.32%)
Post-op D90 89.07 Gy (54.4%)
Post-op D90 (6/11/08) 43.87 Gy (27.42%)
Note: Numerous seeds outside of correct region
Suspicious for failure under the Phoenix criteria ((PSA nadir + 2 ng/ml):

Case XRT 002
Procedure date 9/9/2002
Prescribed dose 160.0 Gy 38 seeds
Procedure: I-125 42 seeds 0.38 mCi per seed
Pre-op D90 194.86 Gy (121.79%)
Post-op D90 104.28 Gy (65.18%)
Post-op D90 (one month) 87.34 Gy (54.59%)
Note: Numerous seeds outside of correct region

58 yo male with low risk adenocarcinoma of the prostate who underwent brachytherapy at the PVAMC. Pt's post-brachytherapy course was then complicated by severe pancreatitis necessitating prolonged hospitalization and abdominal surgery. Patient is doing well with low, fluctuating PSA values.

Case XRT 006
Procedure date 1/9/2006
Prescribed dose 160.0 Gy 63 seeds
Procedure: I-125 67 seeds 0.38 mCi per seed
Pre-op D90 186.26 Gy (116.79%)
Post-op D90 112.95 Gy (70.59%)
Post-op D90 (6/25/08) 69.39 Gy (43.37%)
Note: Numerous seeds outside of correct region

Patient is doing much better than he was back in 2007 when we saw him in f/u. He no longer has severe daytime frequency & urgency with urge incontinence. He has nocturia x1, and has a sense of incomplete bladder emptying. He has no rectal bleeding or pain. PSA (8/13/08) 0.86 IMP: PSA holding steady. Was 0.83 in 12/07, then 1.44 in 4/08. Patient to return for f/u in 6 months.

Case XRT 007
Procedure date 10/15/2007
Prescribed dose 160.0 Gy 79 seeds
Procedure: I-125 83 seeds 0.38 mCi per seed
Pre-op D90 183.90 Gy (114.94%)
Post-op D90 104.78 Gy (65.49%)
Post-op D90 (7/7/08) 50.35 Gy (31.47%)

Note: Some seeds outside of correct region

PSA: 10/6/08 0.8; 7/8/08 0.9; stable, low PSA values.

Case XRT 010

Procedure date 6/12/2006
Prescribed dose 160.0 Gy 56 seeds
Procedure: I-125 58 seeds 0.38 mCi per seed
Pre-op D90 203.87 Gy (127.42%)
Post-op D90 81.33 Gy (50.83%)
Post-op D90 (plan 2) 37.45 Gy (23.41%)
Note: Most of the seeds are outside of the prostate

Follow-up 2 years after completion of brachytherapy for a T1c Gleason 3+4=7 PSA 7.1 adenocarcinoma of the prostate. PSA-0.37; patient doing well.

Case XRT 011
Procedure date 10/3/2005
Prescribed dose 160.0 Gy 86 seeds
Procedure: I-125 45 seeds 0.38 mCi per seed
Pre-op D90 233.60 Gy (144.12%)
Post-op D90 46.77 Gy (29.23%)
Post-op D90 (plan 2) 46.80 Gy (29.25%)
Note: Most of the seeds are outside of the prostate; some are near the rectum; D1 rectum = 90.6%

On incidental rectal exam during the course of colonoscopy the patient was found to have a prostatic nodule and was subsequently diagnosed with a T2a, GS 3+3 (1/6, 10% of L mid core only) adenocarcinoma of the prostate. Dr. Kent Wallner at the Puget Sound VA reviewed his case and agreed to perform a second brahytherapy implantation which was done on 10/6/08. An additional 40 seeds were implanted to deliver a dose of 144 Gy. Prior to the implant, Mr. A reported having significant dysuria. He continues to have this although he does not think it is any worse than before.

Case XRT 013
Procedure date 5/15/2006
Prescribed dose 160.0 Gy 88 seeds
Procedure: I-125 89 seeds 0.38 mCi per seed
Pre-op D90 188.74 Gy (117.96%)
Post-op D90 102.58 Gy (64.11%)
Post-op D90 (plan 2) 62.65 Gy (39.16%)
Note: Most of the seeds are outside of the prostate
PSA
5/8/07 0.34
8/20/08 0.37
Stable and low PSA values.

Case XRT 017
Procedure date 9/25/2006
Prescribed dose 160.0 Gy 78 seeds
Procedure: I-125 82 seeds 0.38 mCi per seed
Pre-op D90 190.84 Gy (119.27%)
Post-op D90 108.92 Gy (68.08%)
Post-op D90 (plan 2) 59.55 Gy (37.22%)
Note: Many seeds are outside of the prostate and anterior.

72 year old male with T1c prostate adenocarcinoma had initial PSA of 6 with 1/6 sextants (R base) involved with Gleason 6 cancer. The patient's PSA has been rising.

SERUM	9/18 2008	6/30 2008	10/29 2007	04/20 2007	01/11 2007	09/14 2006	04/26 2006
PSA	1.37	1.16	0.71	0.27	0.32	1.09	4.31

Patient is currently stable, had a negative biopsy and awaits repeat PSA.

Case XRT 052
Procedure date 9/30/2002
Prescribed dose 160.0 Gy 53 seeds
Procedure: I-125 54 seeds 0.38 mCi per seed
Pre-op D90 183.74 Gy (114.84%)
Post-op D90 62.69 Gy (39.18%)
Post-op D90 (plan 2) 37.04 Gy (23.15%)
Many seeds lateral to the bladder.

Stable PSA. To be followed clinically.

Case XRT 058
Procedure date 7/11/2005
Prescribed dose 160.0 Gy 73 seeds
Procedure: I-125 77 seeds 0.38 mCi per seed
Pre-op D90 202.65 Gy (126.65%)
Post-op D90 102.26 Gy (63.91%)
Post-op D90 (plan 2) 68.69 Gy (42.93%)

Stable PSA. PSA 5/3/07 0.9 1/3/08 0.9

Case XRT 078

Procedure date 3/15/2004
Prescribed dose 160.0 Gy 65 seeds
Procedure: I-125 68 seeds 0.38 mCi per seed
Pre-op D90 193.20 Gy (120.75%)
Post-op D90 75.09 Gy (46.93%)
Post-op D90 (plan 2) 50.69 Gy (31.68%)
Many seeds anterior and lateral to the bladder.
Clinically stable; possible second reimplant if signs of recurrence.

Case XRT 096
Procedure date 3/15/2004
Prescribed dose 160.0 Gy 79 seeds
Procedure: I-125 71 seeds 0.38 mCi per seed
Pre-op D90 195.21 Gy (122.01%)
Post-op D90 18.05 Gy (11.28%)
Post-op D90 (plan 2) 71.48 Gy (44.68%)
Many seeds lateral to the bladder and near the rectum; rectal D1=186.80%

Stable PSA. 6/10/08 1.16 9/10/08 1.02

Case XRT 102
Procedure date 2/25/2008
Prescribed dose 160.0 Gy 56 seeds
Procedure: I-125 58 seeds 0.38 mCi per seed
Pre-op D90 228.13 Gy (142.58%)
Post-op D90 127.21 Gy (79.51%)
Post-op D90 (plan 2) 24.23 Gy (15.14%)
Many seeds inferior to the prostate and near the rectum; rectal D1=123.24%
Stable, low PSA.

Case XRT108
Procedure date 7/17/2006
Prescribed dose 160.0 Gy 83 seeds
Procedure: I-125 86 seeds 0.38 mCi per seed
Pre-op D90 176.71 Gy (110.44%)
Post-op D90 90.74 Gy (56.71%)
Post-op D90 (plan 75.35 Gy (47.09%)
Many seeds anterior and lateral to the bladder
Stable, low PSA.

II. Cases with overdose (Summary of prostatic D90 and clinical notes)

Case XRT 011

Procedure date 10/3/2005
Prescribed dose 160.0 Gy 86 seeds
Procedure: I-125 45 seeds 0.38 mCi per seed
Pre-op D90 233.60 Gy (146.0%)
Post-op D90 46.77 Gy (29.23%)
Post-op D90 (plan 2) 49.64 Gy (31.03%)
Essentially all seeds outside of prostate; many near and in bladder.
D1 to bladder 370.80 (231.75%); D5 168.89 Gy (105.56%)

Case XRT 012

Procedure date 7/11/2005
Prescribed dose 160.0 Gy 83 seeds
Procedure: I-125 88 seeds 0.38 mCi per seed
Pre-op D90 212.66 Gy (132.91%)
Post-op D90 91.58 Gy (57.24%)
Post-op D90 (plan 2) 139.87 Gy (87.42%)
Many seeds anterior to prostate, resulting in unanticipated dose to the perineum.
D5 to perineum 289.11 Gy (180.69%)
Patient with gross hematuria and mass within ureter; PSA WNL at 0.36; mass suspected to be bladder tumor sent to pathology.

Case XRT 018

Procedure date 2/3/2003
Prescribed dose 160.0 Gy 70 seeds
Procedure: I-125 100 seeds 0.38 mCi per seed
Pre-op D90 249.01 Gy (155.63%)
Post-op D90 26.96 Gy (16.85%)
Post-op D90 (plan 2) 208.06 Gy (130.04%)
Many seeds lateral to the bladder and near rectum.
D1.33 - 328 Gy

Patient with rectal bleeding; possible inflammatory bowel disease complicated by radiation effects. Sigmoidoscopy: Impression: Granular rectal mucosa suggesting edema with patches of erythematous mucosa. 2 biopsies obtained. Prominent blood vessels but no well-formed telangectasia. Note pANCA positive and ASCA negative favoring a diagnosis of ulcerative colitis rather than Crohns disease.

FINAL DIAGNOSIS
BIOPSY RECTUM: FRAGMENTS OF REACTIVE COLONIC MUCOSA WITH MILD CHRONIC INFLAMMATION INCLUDING LYMPHOID FOLLICLES, SCATTERED ACUTE CRYPTITIS, SUPERFICIAL ULCERATION WITH ACUTELY INFLAMED FIBRINOUS DEBRIS; SEE COMMENT.

COMMENT: THE ABOVE HISTOLOGICAL FEATURES WITH A CRYPT ABSCESS FAVOR AN INFLAMMATORY BOWEL DISEASE OVER RADIATION AFFECT. CLINICAL CORRELATION IS RECOMMENDED.

Case XRT 019

Procedure date 8/30/2004
Prescribed dose 160.0 Gy 84 seeds
Procedure: I-125 100 seeds 0.38 mCi per seed
Pre-op D90 207.68 Gy (129.80%)
Post-op D90 135.01 Gy (84.38%)
Many seeds anterior to the bladder and near rectum.
D1 120.99 Gy (75.62%)

Patient essentially doing well and tumor free.

Case XRT 022

Procedure date 7/22/2002
Prescribed dose 160.0 Gy 67 seeds
Procedure: I-125 100 seeds 0.38 mCi per seed
Pre-op D90 189.09 Gy (118.18%)
Post-op D90 60.43 Gy (37.77%)
Post-op D90 (follow-up) 137.27 Gy (85.79%)
D1.33 56.41 Gy (35.26%)
D7 rectum: 116.83 Gy (73.02%)

Patient doing well and tumor free.

Case XRT 067

Procedure date 7/2/2007
Prescribed dose 160.0 Gy 50 seeds
Procedure: I-125 100 seeds 0.38 mCi per seed
Pre-op D90 197.00 Gy (123.13%)
Post-op D90 167.43 Gy (104.64%)
Post-op D90 (follow-up) 167.59 Gy (104.74%)
D1.33 47.48 Gy (29.68%)
Post-op D 1.33cc 98.11 Gy (61.32%)

PSA values are low and stable. Some symptoms of dysuria.

Case XRT 088

Procedure date 5/15/2006
Prescribed dose 160.0 Gy 79 seeds
Procedure: I-125 83 seeds 0.38 mCi per seed
Pre-op D90 193.59 Gy (120.99%)
Post-op D90 154.60 Gy (96.62%)
Post-op D90 (follow-up) 130.79 Gy (81.74%)
Radiation dose to perineum; many seeds anterior and lateral to the prostate.
Some significant dysuria and also complaints of impotence. Some seeds are in the periprostatic tissue.

Case XRT 089

Procedure date 7/22/2002
Prescribed dose 160.0 Gy 84 seeds
Procedure: I-125 84 seeds 0.38 mCi per seed
Pre-op D90 not available
Post-op D90 83.47 Gy (52.17%)
Post-op D90 (follow-up) not available

Case XRT 092

Procedure date 7/2/2007
Prescribed dose 160.0 Gy 71 seeds
Procedure: I-125 72 seeds 0.38 mCi per seed
Pre-op D90 196.26 Gy (122.66%)
Post-op D90 133.37 Gy (83.36%)
Post-op D90 (follow-up) 161.41 Gy (100.88%)
Rectum D5 199.24 Gy (124.52%)
PSA values are low and stable. Pt worried re impotence.

Case XRT 103

Procedure date 7/2/2007
Prescribed dose 160.0 Gy 79 seeds
Procedure: I-125 81 seeds 0.38 mCi per seed
Pre-op D90 177.98 Gy (111.24%)
Post-op D90 167.43 Gy (104.64%)
Post-op D90 (follow-up) 168.63 Gy (105.39%)
Rectum D11 80.92 Gy (50.57%)

PSA values are low and stable. No history of rectal symptoms.

Assessment of Probable Deterministic Effects of the Radiation Exposure on the Individual(s):

Fourteen cases in the underdose category and 10 cases in the overdose category were evaluated. In the underdose category, the postplan soon after the procedure indicated a prostate D90 approximately 59 ± 14 % of the planned value of 160 Gy. In the overdose cases, the prostate D90 at the post-treatment evaluation was approximately 67 ± 3% of the planned value. However, in these cases erratic seed placement caused a number of cases to have elevated dose to either the rectum, bladder or perineum.

The seed placement in these cases is quite erratic and not consistent with current medical standards. E. Lynn McGuire, Director of the Department of Veterans Affairs National Health Physics Program, has provided an analysis of the seed placement in 36 events. These have been verified wherever possible. The relevant details for the reviewed cases are presented below:

XRT 011 (over) - Rectal dose 112.9 Gy; 20 seeds in perineum; 6 seeds in the bladder; 20 seeds> 1cm from the prostate.
XRT 012 (over) – Rectal dose 120 Gy; 8 seeds in perineum; 9 seeds > 1cm from the prostate.
XRT 019 (over) – Rectal dose 129.4 Gy; 20 seeds in perineum and 20 seeds > 1 cm from the prostate.
XRT 022 (over) – Rectal dose 122 Gy; 5 seeds in bladder.
XRT 067 (over)– 106 Gy to rectum; 6 seeds > 1 c; 5 seeds in peritoneum; 1 seed in bladder.
XRT 088 (over) – Rectal dose 114.7 Gy; 20 seeds > 1 cm; 11 seeds in the perineum.
XRT 089 (over) – Rectal dose 128.4 Gy; 9 seeds > 1 cm; 8 seeds in peritoneum.

Briefly describe the current medical condition of the exposed individual:

I requested that Dr. Maity provide patient records for these 24 cases so that any adverse reactions could be evaluated. In both dose categories, a number of patients experienced post-procedure nocturia, dysuria, and, in some cases, hematuria. This is a fairly routine event after brachytherapy and is not thought to be specifically related to seed placement. In one overdose case, XRT018, the patient experienced rectal bleeding and a directed biopsy of the colon mucosa indicated an inflammatory condition, Labs suggest that this is very likely ulcerative colitis. However, Dr. Maity felt that the increased dose to the colon could be a contributing factor. I would concur with this statement.

However, most of the overdose cases are clinically reasonably well, with stable PSA values, and seem not to have had particularly any significant adverse reactions.

In the underdose category, three cases were felt to be treatment failures with either stable high PSA values or rising PSA values. I am told that four cases have gone to retreatment, but these data were not provided. However, these patients appear to be doing well.

References

LF Fajardo L-G, M Berthrong, and RE Anderson. *Radiation Pathology*. Oxford Press. 2001.

GH Fletcher. Textbook of Radiotherapy. 3rd edition. Lippincott, Williams & Wilkins. 1980.

RE Goans. Clinical Care of the Radiation Accident Patient: Patient Presentation, Assessment, and Initial Diagnosis. In The *Medical Basis for Radiation-Accident Preparedness. The Clinical Care of Victims.* Eds. Robert C. Ricks, Mary Ellen Berger, and Frederick M. O'Hara, Jr. Proceedings of the Fourth International REAC/TS Conference on the Medical Basis for Radiation-Accident Preparedness, March 2001, Orlando, FL. The Parthenon Publishing Group, 2002.

KM Snyder, et al. Defining the Risk of Developing Grade 2 Proctitis Following I-125 Prostate Brachytherapy using a Rectal Dose-Volume Histogram Analysis. Int. J. Rad. Oncology Bio. Phys. 50⊗2), pp335-341, 2001.

Was individual or individual's physician informed of DOE Long-term Medical Study Program?

No

If yes, would the individual like to be included in the program?

No patient contact resulted from this consult.

COMPLETE FOR MEDICAL MISADMINISTRATION
(To be completed by Medical Consultant)

1. Based on your review of the incident, do you agree with the licensee's written report that was submitted to the NRC pursuant to 10 CFR 35.33 in the following areas:

a. Why the event occurred – Yes. Circumstances of this event were largely documented in the Department of Veterans Affairs National Health Physics Program memorandum.

b. Effect on the patient – Yes. Patient health records were evaluated.

My independent dose estimates generally agree with those provided by the hospital.

c. Licensee's immediate actions upon discovery – There was immediate reporting of the event to the NRC, once the index case was noted. Many cases go back to 2002. It is clear that there was poor review of treatment results during that period.

d. Improvements needed to prevent recurrence - Yes.

This is a human factors issue, correctable by education and improved procedures. I am satisfied that the internal and external review has identified the relevant issues and I anticipate that they are being resolved at this time.

2. In areas where you do not agree with the licensee's evaluation (report submitted under 10 CFR 35.33, provide the basis for your opinion: N/A

3.

Did the licensee notify the referring physician of the misadministration? Yes

Did the licensee notify the patient's or the patient's responsible relative or guardian? Yes

If the patient or responsible relative or guardian was not notified of the incident, did the licensee provide a reason for not providing notification consistent with 10 CFR 35.33? N/A

Explain rationale for response.

4. Provide an opinion of the licensee's plan for patient follow-up. If available.

The patients will be followed clinically at the Philadelphia VA and by private physicians as indicated. I believe that the VA system will institute an effective program to prevent a recurrence of this event. The information in the preliminary notification has also been reviewed with licensee management.

Ms. E. Lynn McGuire, Director, Health Physics Program, Department of Veterans Affairs noted a number of deficiencies in a memo to the NRC of October 16, 2008. These include:

1. Lack of proper local Quality Control and Management of the brachytherapy program.
2. Lack of policies to address post-implant management of patients and patient dosage.
3. Interruption of connectivity between radiation oncology and radiology for a 1 year period.
4. Lack of program oversight with inadequate review surrounding past trigger events.

It is clear that seed placement during these past events does not remotely meet current medical and physician standards. From what I observe in this review, I would concur with the above statements and the corrective actions listed by Ms. McGuire. I have personally interviewed Ms. Mary Moore, RSO, Ms. Paula Salanitro, Medical Physicist, and Dr. Amit Maity, Director, Radiation Oncology. All were very cordial and helpful in discussing the I-125 brachytherapy

situation and in providing patient clinic notes for review. I am very impressed with the current staff and would not foresee a recurrence of the situation seen in the time frame 2002-2008.