Practical Medical Physics
Introducing Brachytherapy Into the Clinic
TH-C-352-01
Room 352

Clinical Introduction and Use of LDR - the anatomy of a prostate case

2008 AAPM Annual Meeting

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Learning Objectives

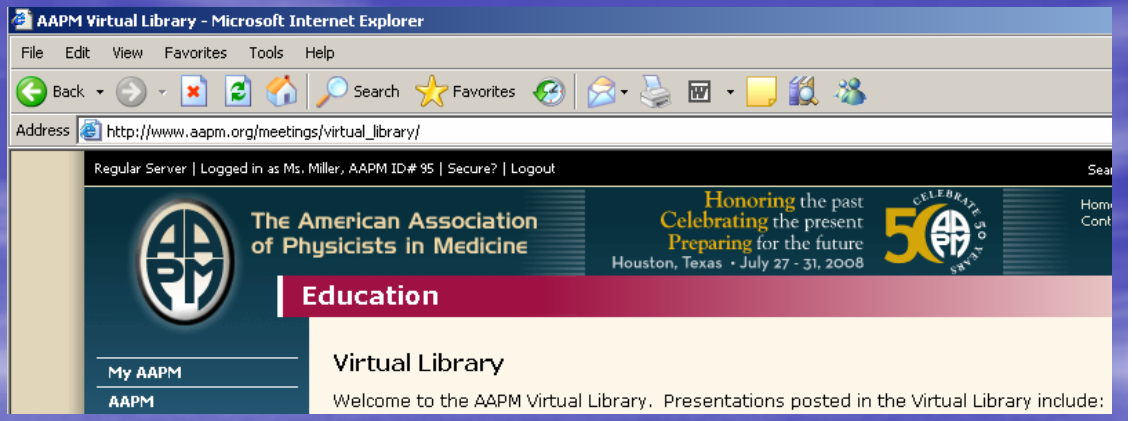
- Review the isotopes in vogue, prescription ranges, and common clinical characteristics
- Review isotope manufacturing and calibration issues
- Review of current implant techniques (Mick ® versus stranded)
- Review radiation safety and release criteria
- Review post plans and lessons learned the hard way

Some Housekeeping

- Giving other folks due credit
- What I won't talk about but is still important
  - The Manchester system, Paterson-Parker tables, the Quimby method
  - Un-sealed source & alternative particle implants: P-32 (β emitters), Gliasite™, Cf-252 (neutron sources)
- The handout **http://www.aapm.org/meetings/08AM/PRHandouts.asp** has the slides in this talk
- What is LDR (low dose rate brachytherapy)?
  - Per ICRU report #38 LDR is in the range of 0.4 to 2.0 Gy/hr compared to HDR which is > 12 Gy/hr

Resources

- The Web
  - AAPM Virtual library
  - Medical Physics list server (global & USA)
- Meetings/Symposia/ AAPM Summer Schools/Courses
- Books
- Journal articles
- Colleagues & friends
- Vendors & vendor web pages

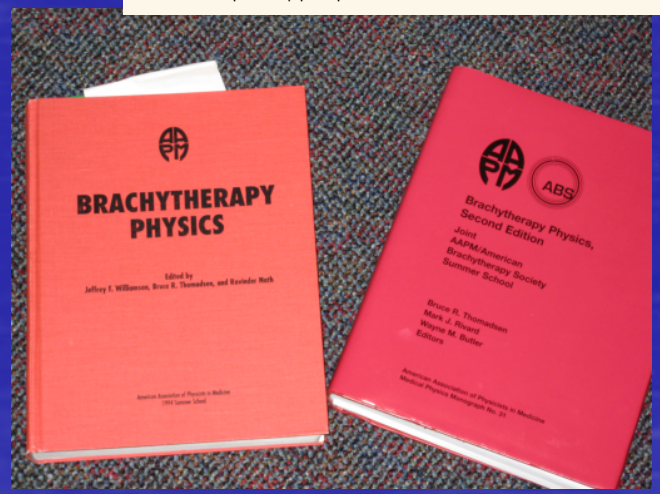


Annual Meetings:

- 49th Annual Meeting - Minneapolis, MN - 2007
- 48th Annual Meeting - Orlando, FL- 2006
- 47th Annual Meeting - Seattle, WA - 2005
- 46th Annual Meeting - Pittsburgh, PA - 2004
- 45th Annual Meeting - San Diego, CA - 2003
- 44th Annual Meeting - Montreal, CA - 2002
- **43rd Annual Meeting - Salt Lake City, UT - 2001**
  Diagnostic Track | Therapy Track

Summer School:

- AAPM Summer School - St. John's University, Collegeville, MN - 2007
  Shielding Methods for Medical Facilities: Diagnostic Imaging, PET, and Radiation Therapy
- AAPM Summer School - University of Windsor, Ontario, Canada - 2006
  Integrating New Technologies into the Clinic: Monte Carlo and Image Guided Radiation Therapy
- Joint AAPM/American Brachytherapy Society Summer School - Seattle, WA - 2005
  Brachytherapy Physics 2005



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Let's not forget AAPM reports

- Report #21, 1987:Specification of Brachytherapy Source Strength
- Report #46, 1994:Comprehensive QA for Radiation Oncology (Reprinted from Medical Physics, Vol. 21, Issue 4) aka TG40
- Report #51, 1995: Dosimetry of Interstitial Brachytherapy Sources (Reprinted from Medica Physica, Vol. 22, Issue 2) aka TG 43 **This report has been updated - see AAPM Report #84**
- Report #59, 1997:Code of Practice for Brachytherapy Physics (Reprinted from Medical Physics, Vol. 24, Issue 10)
- Report #62, 1998:Quality Assurance for Clinical Radiotherapy Treatment Planning (Reprinted from Medical Physics, Vol. 25, Issue 10)
- Report #66, 1999: Intravascular Brachytherapy Physics. Medical Physics, Vol. 26, Issue 2.
- Report #68, 1999:Permanent Prostate Seed Implant Brachytherapy (Reprinted from Medical Physics, Vol. 26, Issue 10)
- Report #69, 2000:Recommendations of the American Association of Physicists in Medicine on 103 Pd Interstitial Source Calibration and Dosimetry: implications for dose specification and prescription.
  Medical Physics, Vol. 27, Issue 4
- Report #84, 2004: Update of AAPM Task Group No. 43 Report: A revised AAPM protocol for brachytherapy dose calculations. Medical Physics, Vol. 31, Issue 3
  aka TG43U **This is an update of Report #51**
- Report #89, 2005:Recommendations of the AAPM regarding the Impact of Implementing the 2004 Task Group 43 Report on Dose Specification for 103Pd and 125I Interstitial Brachytherapy
  Medical Physics, Vol. 32, Issue 5

This list may not be wholly complete……..

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Your turn

- How many of y'all do LDR?
- Two flavors of LDR: temporary and permanent
  - Common types of Implants
  - Intracavitary, Interstitial, Intraluminal, & Surface
    - Tandem and Ovoid & cylinders (Gyn)
    - Syed implants (Gyn)
    - Eye plaques
    - IVBT
    - Surface molds
    - LDR prostate
      - Mick users
      - Stranded/pre-loaded needles
      - Strand your own
      - A combination

Low Dose Rate Brachytherapy When Did it begin?

Opening paragraph from Chapter XII, Radium and Radon Therapy, Basic Physics of Radiation Therapy by Joseph Selman, MD © 1960

"In 1901, **five** years after Becquerel discovered the emission of radiation by uranium, he accidentally incurred a skin burn while carrying a radium sample in his vest pocket. This is believed to be the first instance of biologic effect resulting from this type of radiation. Soon afterward, Pierre Curie produced an experimental skin reaction on his arm by the application of radium, proving Becquerel's accidental observation."

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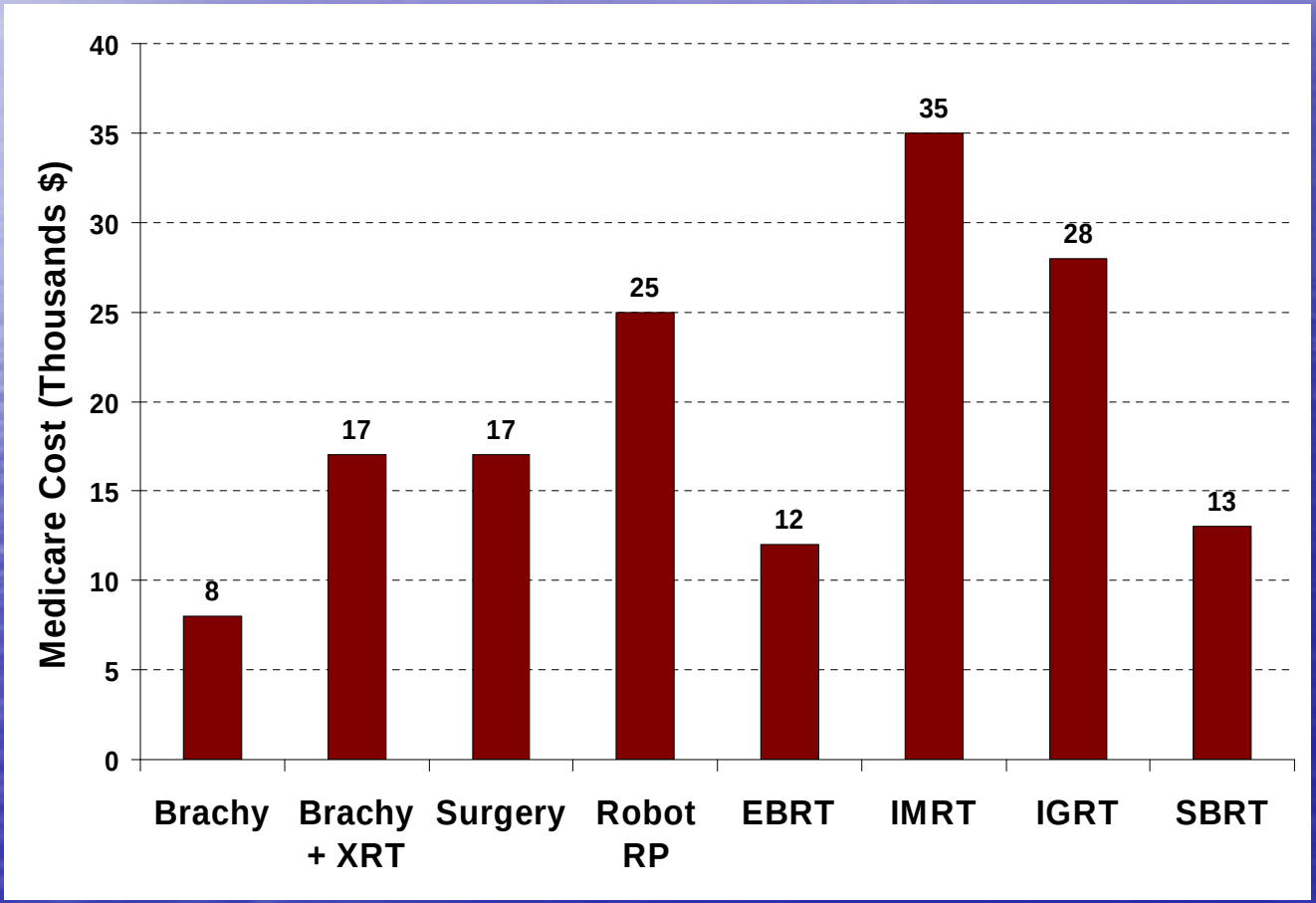
The Comparative Cost of LDR

Medicare costs for prostate treatment modalities
(TS Quang et al., Oncology, 2007;21(13))



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Common Isotopes used for prostate implants

- **I-125**
  - circa 1970's, originally manufactured by the Lawrence Soft X-ray Company then the 3M Company who then sold to Amersham Health/MediPhysics and Oncura; models 6701, 6702, 6711 & more recently 6733*
- **Pd-103**
  - circa 1987-1988, Theragenics Corporation model 200; in 1999 NASI released model MED 3933*
- **Cs-131**
  - circa 2003, IsoRay, Inc. model CS-1+

* Robert Wallace, *Brachytherapy Physics, 2nd Ed*, 2005 Summer School proceedings, chapter 4, LDR Sources: Design & Delivery Systems

+ Mark Murphy et al., Evaluation of the new cesium-131 seed for use in low energy x-ray brachytherapy. *Med Phys* 31 (6), June 2004

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Some dosimetric history

- Changes in dosimetry parameters have led to prescription change
  - Publication in 1995 of TG 43 protocol for brachytherapy dosimetry led to change in ^{125}I prescription from 160 Gy to 145 Gy
  - A NIST WAFAC standard was not available for ^{103}Pd until 1999

Variation of ^{103}Pd delivered dose for a prescribed dose of 115 Gy which was actually 125 Gy after 2000

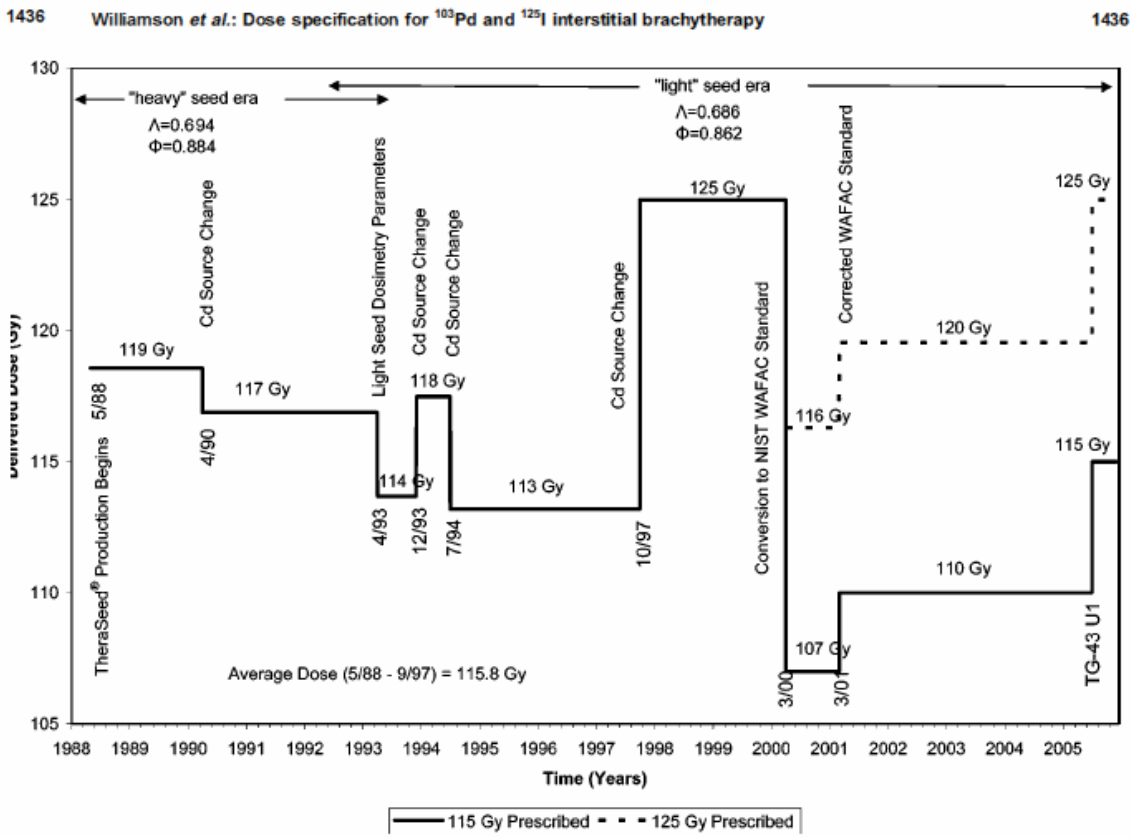

FIG. 3. Plot illustrating the variation of the delivered dose for prescribed doses of 115 and 125 Gy as a function of time for the Model 200 ^{103}Pd source. After 2000, delivered doses are plotted for prescribed doses of 115 Gy (solid line) and 125 Gy (broken line). For illustration only, we have assumed t_{TG43U1} =7/05. For post-t_{TG43U1} implants, the plot assumes that the AAPM preferred 1D dose-calculation model is used [Eq. (6)].

Wayne Butler, PhD

Variation of ^{103}Pd prescribed dose and administered doses as a function of time *(Theragenics Model 200)*

Time period	Prescribed dose (Gy)	Administered dose (Gy)	Dosimetric parameters
1987–1997	115	114–118	1995 AAPM TG-43
1997–2000	115	125	1995 AAPM TG-43
2000–2001	125	116	2000 AAPM report
2000–2005	125	120	2000 AAPM report
> 2005	125	125	2004 AAPM TG-43 U1

Comparing Isotopes

				Dose	
Isotope	T 1/2 (days)	Energy (KeV)	90% Dose delivered (days)	Implant Alone	Boost *
^{125}I	~60	28	204	145	100-110
^{103}Pd	~17	22	58	120 or 125	90-100
^{131}Cs	~10	29	33	115	85

***Boost: (not necessarily prior) XRT 40 - 45 Gy**

M J Rivard et al. ABS recommends no change for prostate implant dose prescriptions Using iodine-125 or palladium-103. *Brachytherapy*, 6: 34-37, 2007.

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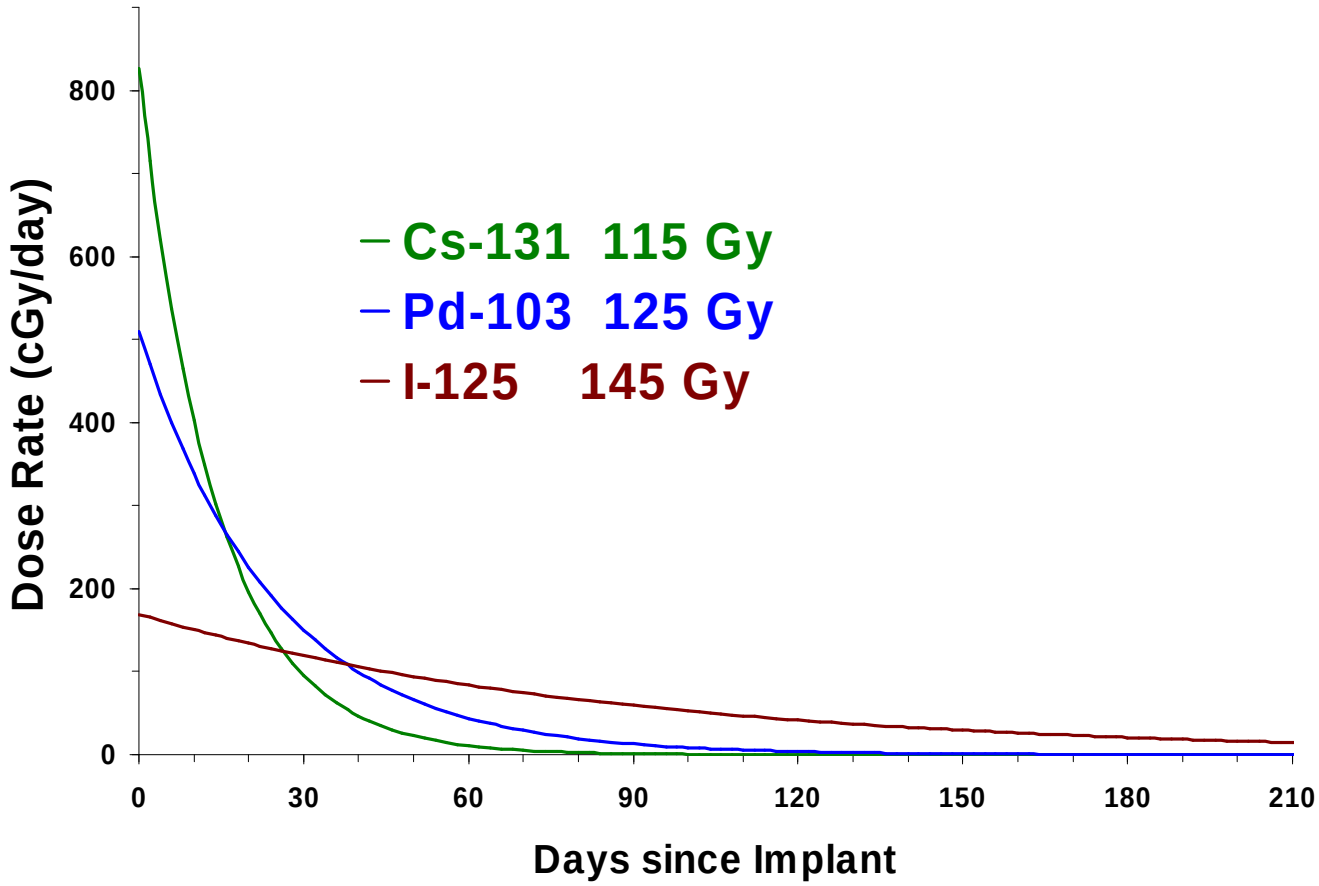
Dose rate (cGy/day) as a function of time since implant for monotherapy



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Seed Vendors

- Bard
- Theragenics
- Core Oncology (used to be Mentor)
- North American Scientific
- Best Medical
- IsoRay
- Oncura (GE Healthcare)
- IsoAid

This may not be a complete list…..

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Manufacturing

- seeds contain some sort of x-ray marker, radioactive material, and typically a titanium capsule

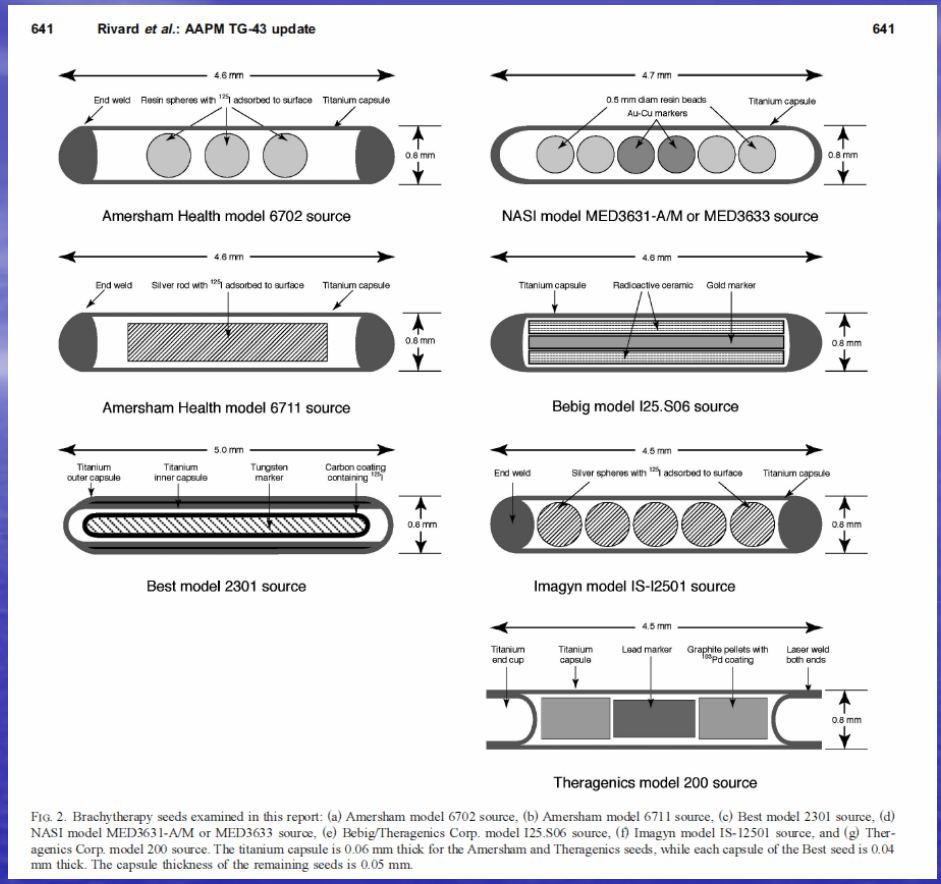


FIG. 2. Brachytherapy seeds examined in this report: (a) Amersham model 6702 source, (b) Amersham model 6711 source, (c) Best model 2301 source, (d) NASI model MED3631-A/M or MED3633 source, (e) Bebig/Theragenics Corp. model I25.S06 source, (f) Imagyn model IS-I2501 source, and (g) Theragenics Corp. model 200 source. The titanium capsule is 0.06 mm thick for the Amersham and Theragenics seeds, while each capsule of the Best seed is 0.04 mm thick. The capsule thickness of the remaining seeds is 0.05 mm.

From TG43U

Description

Proxcelan™ Cesium-131 Brachytherapy Seeds

Sterile Implant Device containing Model CS-1, (Rev.2) Seeds:

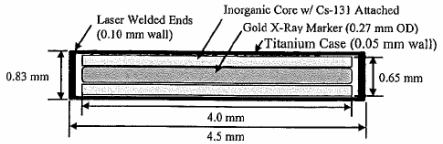
Cs-131 Strand, Model PL-1
Cs-131 Preloaded Strands in 18 Gauge Needles, Model PL-2
Cs-131 Preloaded 18 Gauge Needles, Model PL-3
Cs-131 Preloaded S-Cartridge, Model PL-4

Do not use if sterile packaging is damaged.

Non-Sterile Cesium-131 Loose Seeds

Cs- 131 Brachytherapy Seed Model CS-1, (Rev. 2)

The functional component of the Proxcelan implant devices is the Proxcelan brachytherapy seed. The Proxcelan brachytherapy seed consists of a welded titanium capsule containing the low energy gamma (X-ray) emitting isotope, Cesium-131, adsorbed onto an internal inorganic substrate. The seed configuration is designed to generate near isotropic emission of therapeutic radiation.



Physical Characteristics

Principle Radionuclide:	Cesium-131	(Cs-131)
Half-life of Cs-131:	9.69 days	(232.6 hr)
Radiation Energy:	29.5, 29.8, 33.6 keV	
Half-Value Thickness:	0.025 mm of Lead	
Average Dose Rate Constant:	1.059 cGy/U·Hr.	

Decay Mode: Cs-131 decays by electron capture with the emission of characteristic low-energy X-ray photons and electrons. The electrons are absorbed by the titanium wall of the seed.

From Cs -131 package insert

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Calibration or seed assay

- Responsibilities of the brachytherapy physicist are outlined in TG-40, TG-56, and TG-64
  - **TG40** "…it is unwise to rely solely on this [commercial suppliers] value [source strength] for patient dose calculations…."
  - **TG56** "…every institution practicing brachytherapy **shall** have a system for measuring source strength with secondary traceability for all source types used in its practice." "For groupings with a large number of loose seeds, we recommend that a random sample containing at least 10% of the seeds be calibrated…"
  - **TG64** " As recommended by AAPM TG 56, a random sample of at least 10% ***should*** be checked. Discrepancies of 3% or more between the mean of the assay & the manufacturer's calibration ***should*** be investigated. Unresolved discrepancies of 5% or more ***should*** be reported to the manufacturer…."

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Calibration

- New report coming soon
  - **Third-party brachytherapy source calibrations and physicist responsibilities: Report of the AAPM Low Energy Brachytherapy Source Calibration Working Group**

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Accredited Dosimetry Calibration Laboratory; University of Wisconsin, Madison, Wisconsin 53706
James M. Hevezi
South Texas Oncology & Hematology, San Antonio, Texas 78229
M. Saiful Huq
Chair, Task Group 100; University of Pittsburgh Cancer Institute, Pittsburgh, Pennsylvania 15232
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Radiological Physics Center; M. D. Anderson Cancer Center, Houston, Texas 77030
Jatinder R. Palta
University of Florida, Gainesville, Florida 32610
Mark J. Rivard
Chair, Brachytherapy Subcommittee; Tufts University School of Medicine, Boston, Massachusetts 02111
Jan P. Seuntjens
Chair, Calibration Laboratory Accreditation Subcommittee; McGill University, Montreal, Quebec, CANADA
Bruce R. Thomadsen
Vice Chair, Brachytherapy Subcommittee; University of Wisconsin, Madison, Wisconsin 53706

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Wayne Butler, PhD

Source strength verification – role of 3rd party assay services

- 3rd party services pre-load sources into sterile needles or as sterile strands in addition to assay of sources
- Assays are often more comprehensive (> 10% of sources) than AAPM guidance
- Assay services are not overseen by any regulatory body
  - No requirement of NIST traceability
  - No assurance of independence from manufacturers
- **Responsibility for source assay rests with the end-user medical physicist**
- Methods are available to assay some sterile assemblies
  - LA DeWerd et al, *Med Phys* 2006;**33**:3804-3813
  - S Furutani et al, IJROBP 2006;**66**:603-609

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Make your own autoradiograph

V film for 10 minutes

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TG 64

Treatment Planning

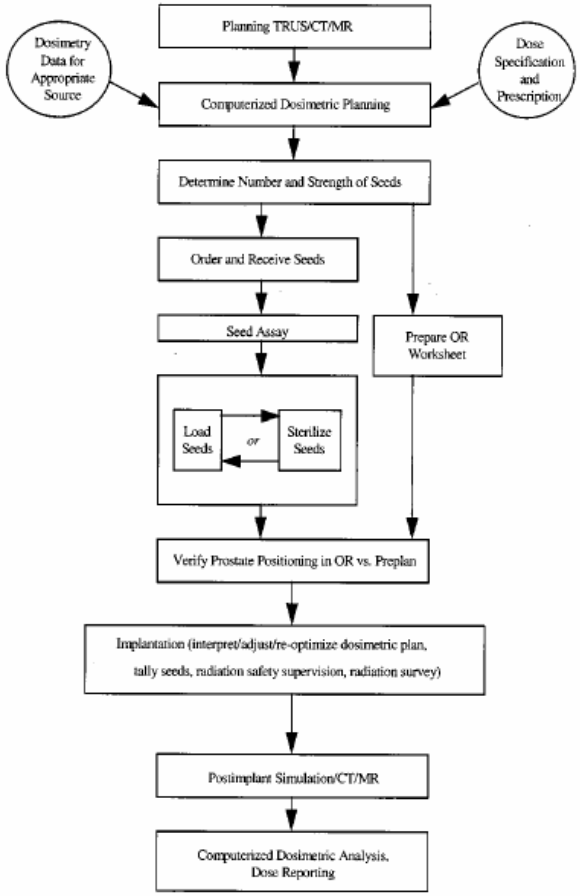

FIG. 1. Process flow diagram for a preoperatively planned prostate seed implant.

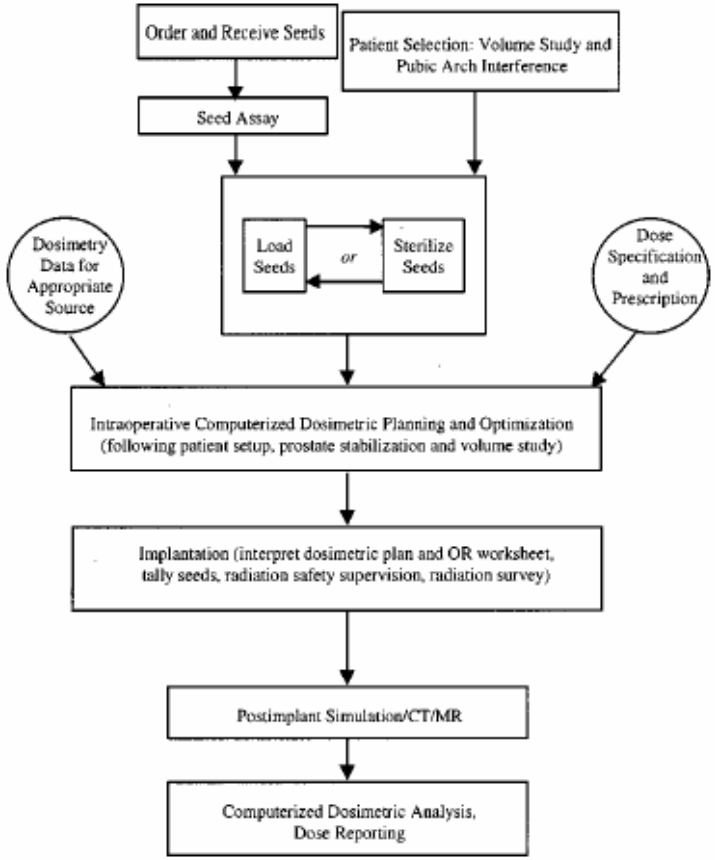

FIG. 2. Process flow diagram for an intraoperatively planned prostate seed implant.

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Pre-plan example

75) - pre plan - ok by Vu

Page | Zoom In | Zoom Out | Close

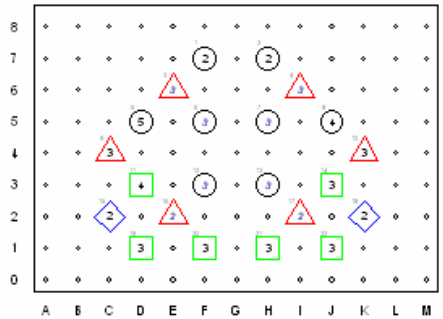
VariSeed: Needle Loading Report [Page 2]

Institute for Radiation Therapy - 1 - 1 - 7/24/2008 3:15:47 PM

Name: [redacted] PID: Dept. ID:	Study: pre plan Variation: ok by Vu Images: 10 Template: GE Standard	Source: I-125 (I25.S06) [NIST 99] Symmet Comment: Symmetra-TG43U Point Sources: 64 Anisotropy: Factors (Point Model) Source Activity: 0.399 U [0.314 mCi]
Procedure Date: 1/3/2008	Prescription Dose: 110.0 Gy	Total Activity: 25.536 U [20.107 mCi]

Needle Number	Retraction (cm)	Hole Location	Number Seeds
1	0.00	F7	2
2	0.00	H7	2
◆ 3	0.50	E6	3
◆ 4	0.50	I6	3
5	0.00	D5	5
◆ 6	0.00	F5	3
◆ 7	0.00	H5	3
8	0.00	J5	4
9	0.50	C4	3
10	0.50	K4	3
11	1.00	D3	4
◆ 12	0.00	F3	3
◆ 13	0.00	H3	3
14	1.00	J3	3
15	1.50	C2	2
◆ 16	0.50	E2	2
◆ 17	0.50	I2	2
18	1.50	K2	2
19	1.00	D1	3
20	1.00	F1	3
21	1.00	H1	3
22	1.00	J1	3

◆ = Special loading



Retraction Legend					
Plane 0	Plane 1	Plane 2	Plane 3	Plane 4	Special
0.00 cm	0.50 cm	1.00 cm	1.50 cm	2.00 cm	Other

Number of Needles	Seeds per needle
6	2
13	3
2	4
1	5

Plan Summary	
Total Activity [U]	25.54
Total Activity [mCi]	20.11
Total Needles	22
Total Seeds	64
Extra Seeds	
Total Seeds to Order	

Study Created by _____

Study Approved by _____

VariSeed 7.1 (Build 2780)

I-125 (I25.S06) [NIST 99] Symmet | Needles: 22

) - pre plan - ok by Vu

age | Zoom In | Zoom Out | Close

VariSeed: Needle Loading Report [Page 3]

Institute for Radiation Therapy - 1 - 1 - 7/24/2008 3:15:47 PM

Name: [redacted] PID: Dept. ID:	Study: pre plan Variation: ok by Vu Images: 10 Template: GE Standard	Source: I-125 (I25.S06) [NIST 99] Symmet Comment: Symmetra-TG43U Point Sources: 64 Anisotropy: Factors (Point Model) Source Activity: 0.399 U [0.314 mCi]
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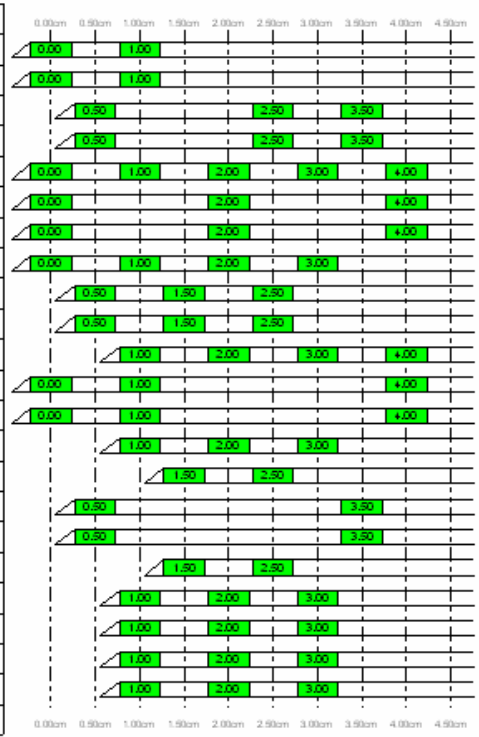
● 3	0.50	E6	3
● 4	0.50	I6	3
5	0.00	D5	5
● 6	0.00	F5	3
● 7	0.00	H5	3
8	0.00	J5	4
9	0.50	C4	3
10	0.50	K4	3
11	1.00	D3	4
● 12	0.00	F3	3
● 13	0.00	H3	3
14	1.00	J3	3
15	1.50	C2	2
● 16	0.50	E2	2
● 17	0.50	I2	2
18	1.50	K2	2
19	1.00	D1	3
20	1.00	F1	3
21	1.00	H1	3
22	1.00	J1	3

● = Special loading



VariSeed 7.1 (Build 2780)

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Seattle Prostate Institute, class notes, 2002

Seattle criteria

- Pre-plan
- Modified uniform loading
- V100: 98-100%
- V150: I-125 30-40%
  Pd-103 40-50%
- V200: 10-20%
- Uretha max: 100-125% (definitely <150%)
- Rectum point: <80%
- Margin: 3-5 mm

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Schiffler Cancer Center plan evaluation criteria

Table 3. Prostate implant plan evaluation criteria used at the Schiffler Cancer Center

Evaluated quantity	Parameter	Value
Patient specific needs	PTV, TURP dose, etc.	Primary importance
Planning volume coverage	V_{100}	>99.8% volume
Urethral volume coverage	Urethral V_{125} Urethral V_{150}	10% – 50% volume <15% volume
Urethra dose	Mean	110% – 140% mPD
Homogeneity	V_{150}	35% – 45% plan vol, ^{125}I 45% – 55% plan vol, ^{103}Pd
High dose volume	V_{200}	<15% plan volume, ^{125}I <25% plan volume, ^{125}I
Number of needles	Minimize	30±4 *,†
Number of seeds	Minimize	130±18 *,†
No. of especially loaded needles	Minimize	5±2 *
Target volume / US volume	Ratio	1.75 ± 0.22 *

V_{100}, V_{150} and V_{200} are the percentage of the planning volume covered by 100, 150, and 200% of the prescribed dose (mPD), respectively.

* There is no statistically significant difference in these parameters between radionuclides, monotherapy, or boost therapy.

† Typically, 3 or 4 extra needles and 7% extra seeds are used at the time of implant beyond those called for in the plan.

* Wayne M Butler & Gregory Merrick, *Brachytherapy Physics, 2nd Ed*, 2005 Summer School proceedings, chapter 29, Permanent Prostate Brachytherapy Treatment Planning

2008 AAPM Annual Meeting

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Chicago Prostate Cancer Center, class notes, Jan 2008

CPCC Criteria for Cs-131 for implant alone (115 Gy)

- Target D90 127-137 Gy
- Target V100 >98%
- Target V110 >95%
- Target V150 22-32%
- Urethra V150 <5%

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Implant techniques

OR Equipment:

Clean versus Sterile Procedure

U/S unit

Stepper/Stabilizer/Template

TPS (if real time planning)

Seeds (Mick gun, needles, strands, strand making system)

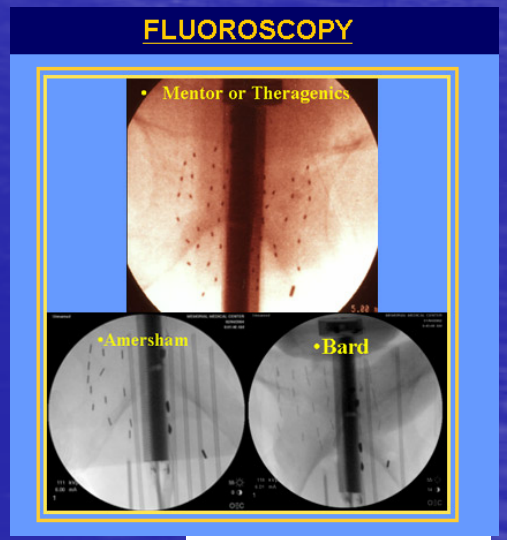
needle safe?

anchor needles?

basin for sharps

C Arm & Pb Aprons?

Survey Meter



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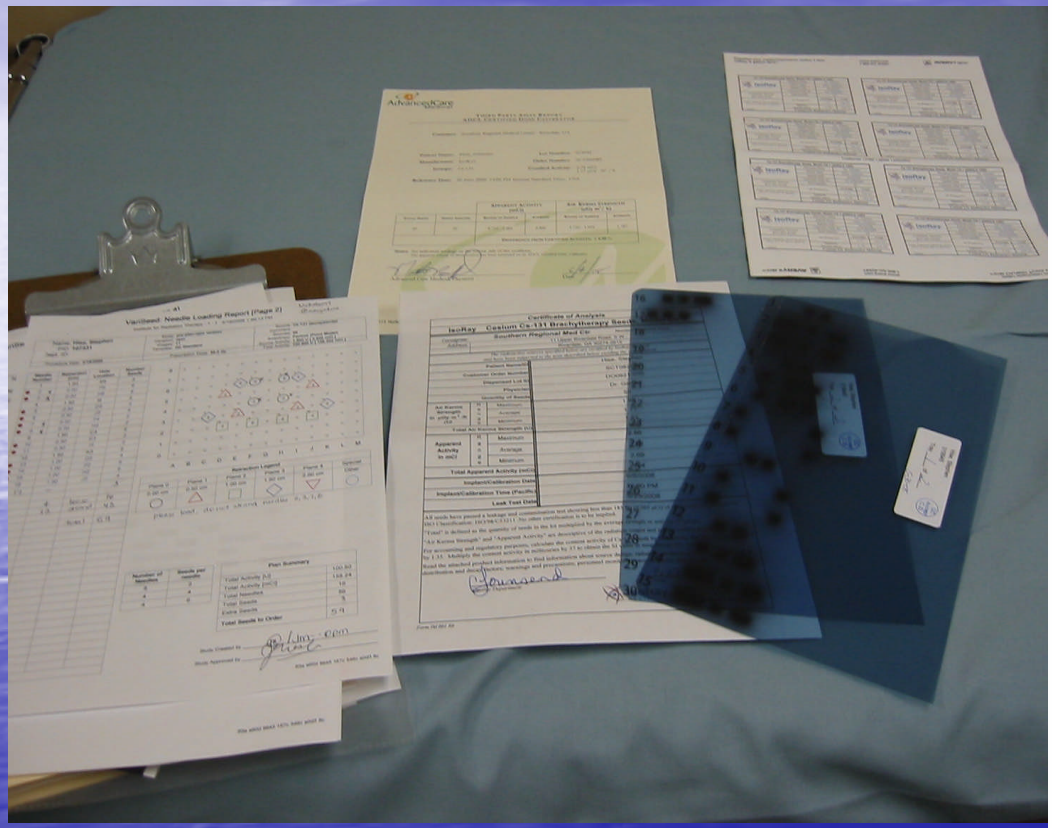
Paperwork



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PROSTATE WRITTEN DIRECTIVE AND REGULATORY COMPLIANCE DATA

PATIENT NAME: _____ Implant Date: _____

PRELIMINARY WRITTEN DIRECTIVE TO BE COMPLETED PRIOR TO IMPLANT DATE

Treatment Site: PROSTATE

Prescribed Dose: _____cGy Isotope to Implant: ☐ Pd-103 ☐ I-125 ☐ Cs-131

Physician Authorized User: _____ Date Signed: _____

(any revisions must be initialed and dated by authorized user)

FINAL WRITTEN DIRECTIVE TO BE COMPLETED PRIOR TO PROCEDURE COMPLETION

Treatment Site: PROSTATE Isotope: ☐ Pd-103 ☐ I-125 ☐ Cs-131 Total # of sources: ____

Activity per source: _____ mCi Total Activity Implanted: _____ mCi

Prescribed Total Dose: _____cGy Exposure Time: **Permanent Implant**

Physician Authorized User: _____ Date Signed: _____

ROOM SURVEY AND PATIENT RELEASE SURVEY DATA

Survey Performed By: _____ Date of Survey: _____

Meter Model and SN: _____

Patient at 1 m: _____mrem//hr (must be less than 1 mrem/hr for I-125, < 3 mrem/hr for Pd 103, <5 mrem/hr for Cs-131)

Linen: _____mrem/hr Trash: _____mrem/hr OR Table/Floor: _____mrem/hr

SEED INVENTORY DATA COMPLETED IMMEDIATELY AFTER IMPLANT

# of Seeds Ordered: _____ Isotope: ☐ Pd-103 ☐ I-125 ☐ Cs-131 Activity/seed: _____mCi

# of Seeds Implanted: _____ # Recovered: _____ # Re-implanted: _____

# of Seeds Returned to Nuclear Medicine: _____ Performed by: _____

(Returned to Hot lab = total ordered - (Implanted-Recovered+Reimplanted))

QMP REVIEW OF CASE

Review of this case showed that the written directive was prepared as required and that the implant was performed in compliance with the physician's written directive. The review included verification that the prescribed dose, source isotope, total activity, patient identity, number of seeds, and loading sequence from the treatment plan were in accordance with the administered implant. Also reviewed was documentation that correct data for the patient was contained in the treatment plan. This case review was performed after conclusion of the procedure by:

Physician: _____ **Date:** _____

Prostate Written Directive/Regulatory Compliance Data Approved 12/2007
Forms Site – Forms Folder 1 copy for licensee records, one copy for patient chart

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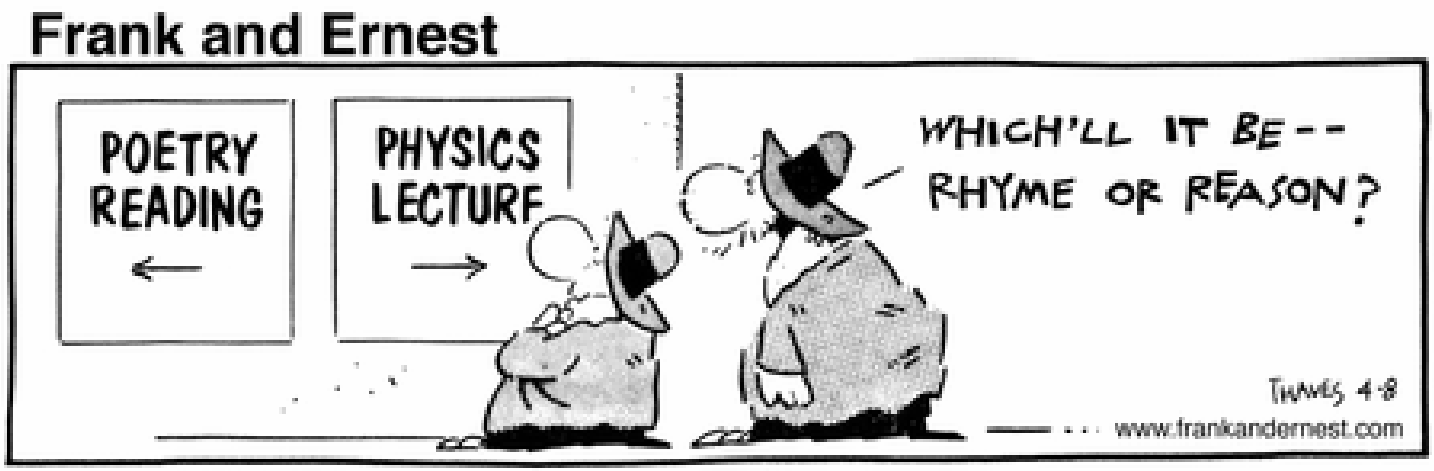
In the OR



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http://www.micknuclear.com/page_prostate_ldr/prostate_ldr.asp

Mick applicator

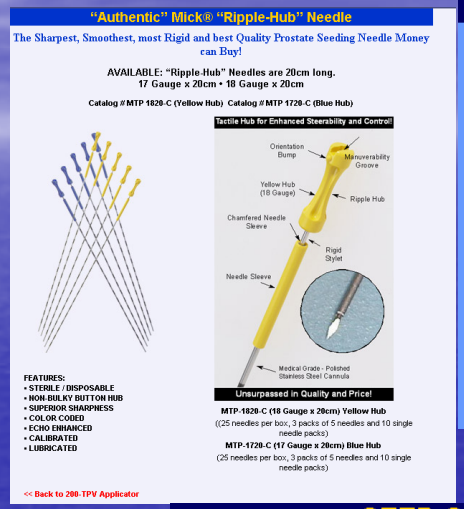
Mick® 200-TPV Applicator

The "Third" Generation of Mick Applicators

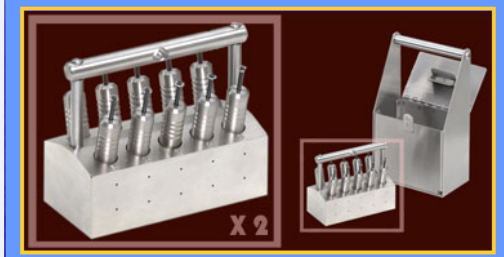
The Complete Instrumentation Package for
"Real-Time" Transperineal / Ultrasound-Guided
I-125 / Pd-103 Prostate Seed Implantations.

Photos Courtesy: Jay Friedland, M.D., Tampa, Fl

The "Optimal" and Clinically Proven
Prostate Seeding System Utilized Worldwide,
Enhancing Seed Placement Accuracy,
Efficiency and Radiation Protection!



SEED CARRIER



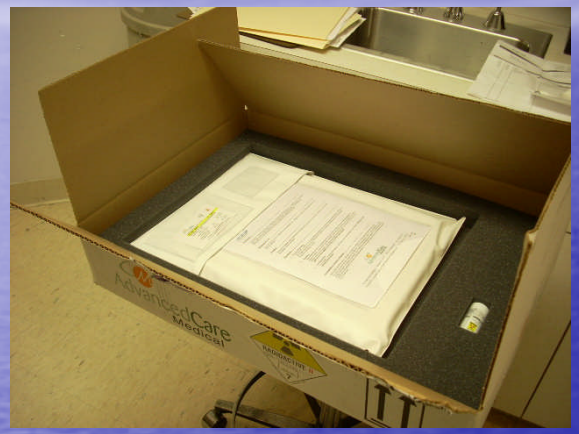
SEED CARTRIDGES

- Come loaded from factory
- 15 seeds/ cartridge
- Disposable
- Auto-clavable
- No staff preparation
- Can assay seeds in cartridge

radiation oncology SERVICES

New in the Mick world

Stranded Pre-loaded (3rd party)



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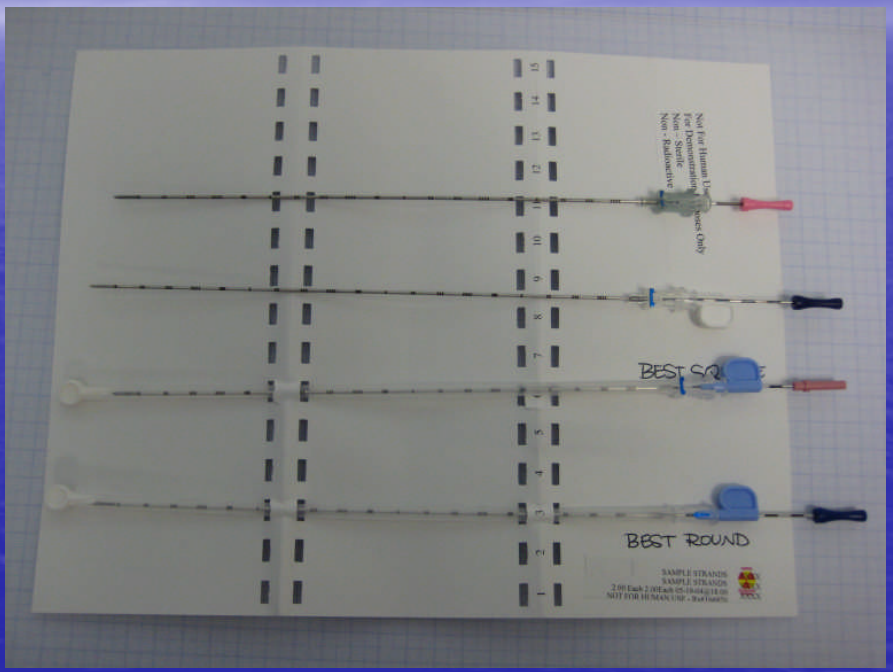
Types of needles

- Choices: Round or Square hub?
- Steering a needle
  - Grid position/time
- Obdurators have ruler markings
- Needles have ruler markings



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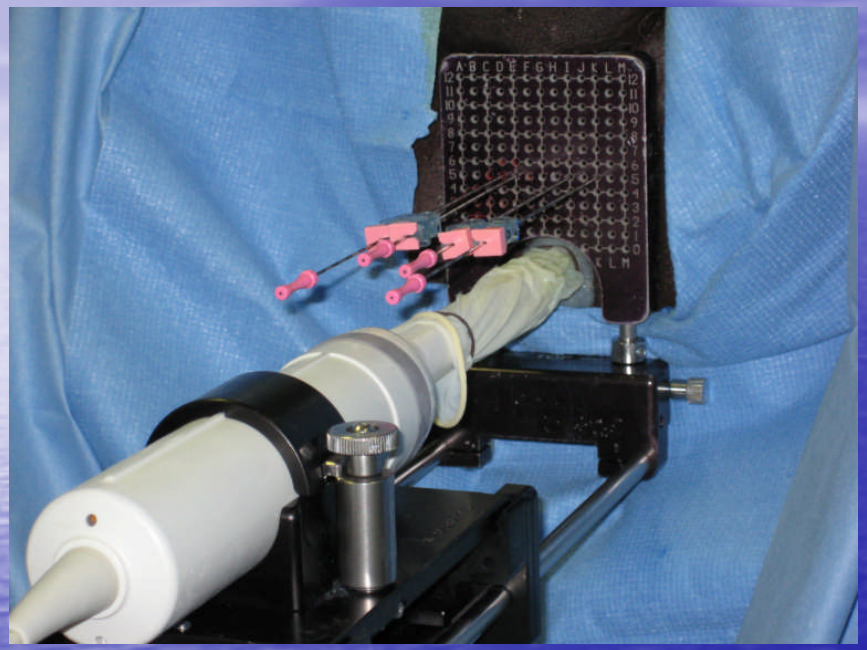
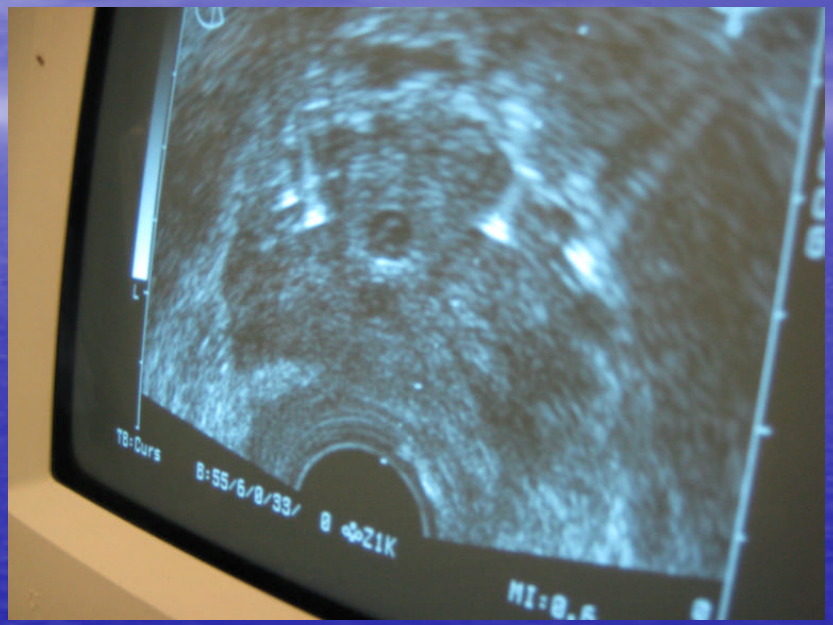
Start Anterior





Our process:

Reproduce/verify height, width, and length of prostate

One row at a time, the urologist puts in the needles to mid-gland

Less "diddling" if the template is snug against the perineum

Prostate swells during the procedure; verify base plane

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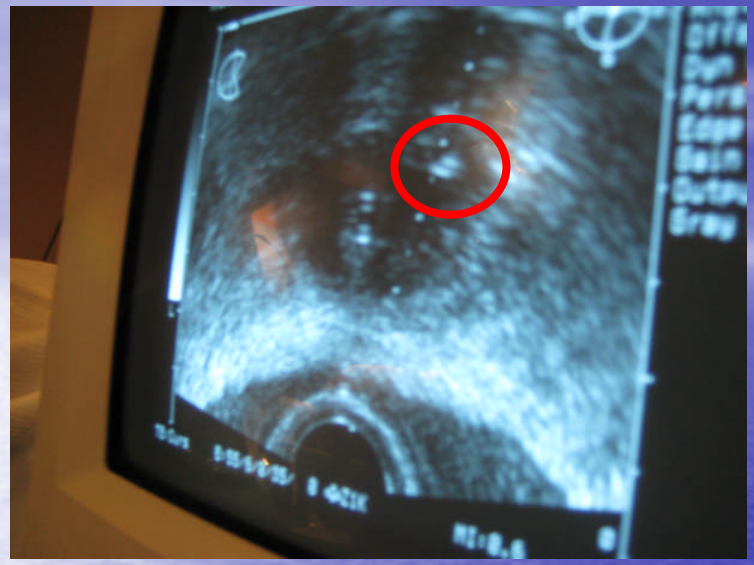
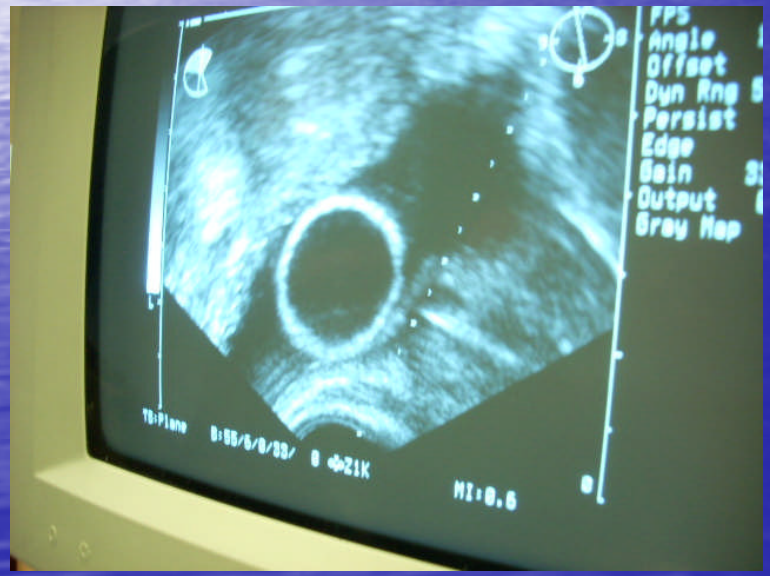


Look for the “hamburger” sign on the axial or transverse slice (this is the needle bevel edge) – per Peter Grimm, MD



Visualize the needle on the sagittal slice

Know where the first seed is – bone wax versus “plug” in needle tip

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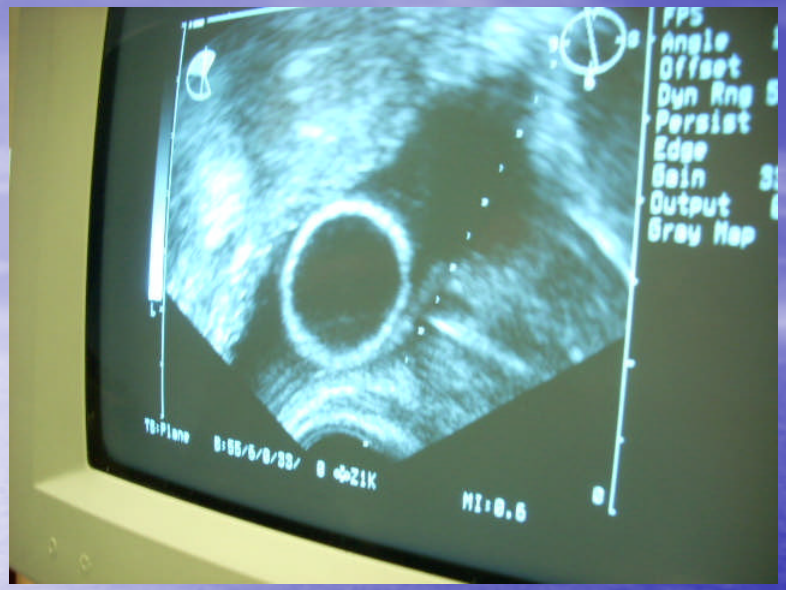
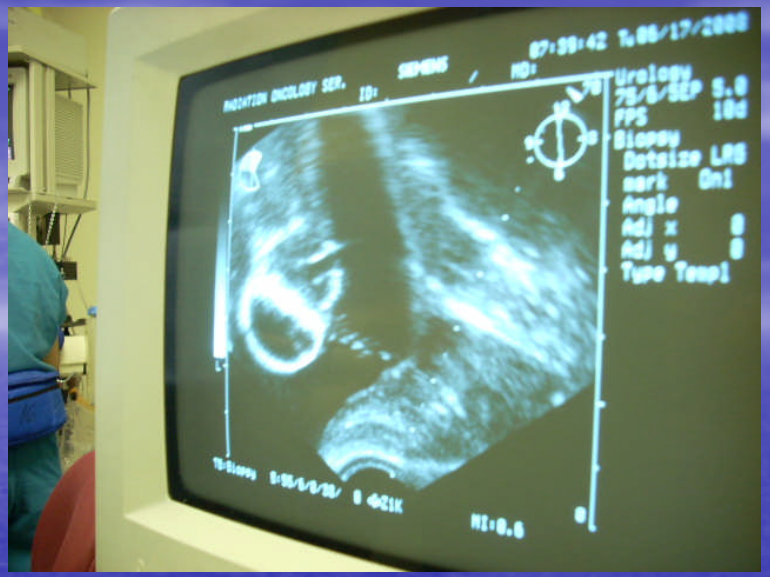
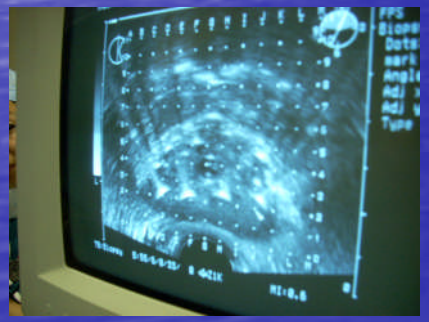




Seattle uses aerated KY in a catheter in the urethra for better visualization; we use a Foley catheter and fill the balloon with 150-180 cc's of water. You may need to push the balloon away from prostate lest you pop it.



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To Cysto or not

Can visualize evidence of bladder trauma (optimally you “tent” the bladder)

“Plugs” or Bone wax are not an issue

Spacers are not an issue

Our spacers are purple

Seeds are silver

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Fishing for "treasure"

Planning technique tips:

Load, but do not strand needles around the urethra

Baseline loading option

- Disconnect leading spacers

"Tenting" the bladder

If you pull a seed or strand from the bladder or prostatic urethra: what to do with those seeds

- Decay? Return to vendor?

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Learning Objectives

- Review the isotopes in vogue, prescription ranges, and common clinical characteristics
- Review isotope manufacturing and calibration issues
- Review of current implant techniques (Mick ® versus stranded)
- **Review radiation safety and release criteria**
- Review post plans and lessons learned the hard way

Radiation Safety and release criteria

- Release criteria are based on exposure to the general public
- Where to measure @ 1 meter?
- What meter are you using?
- Who wears a badge

A quick note on RAM licenses

Georgia Department of Natural Resources
4220 International Parkway, Suite 100, Atlanta, Georgia 30354
Noel Holcomb, Commissioner
Environmental Protection Division
Carol A. Couch, PhD, Director
404/362-2675

RADIOACTIVE MATERIALS PROGRAM
GEORGIA RADIOACTIVE MATERIALS LICENSE

Pursuant to the Georgia Radiation Control Act O.C.G.A. 31-13 (H.B. 947) 1990 and the Georgia Department of Natural Resources Rules and Regulations, designated Chapter 391-3-17, and in reliance on statements and representations heretofore made by the licensee designated below, a license is hereby issued authorizing such licensee to transfer, receive, possess, and use the radioactive material(s) designated below; and to use such radioactive materials for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules and regulations of the Georgia Department of Natural Resources and orders issued by the Department, now or hereafter in effect, and to any condition specified below.

Page 1 of 5 Pages
License Number GA [redacted]
Amendment Number .02

License (1. Name and 2. Address)
[redacted]

3. In accordance with letter dated [redacted] 21, 2006, **License Number** [redacted] 1 is hereby amended in its entirety to read as follows:

4. **Expiration Date:** August 31, 2009

5. **Telephone Number:** [redacted]

6. RADIOACTIVE MATERIAL (ELEMENT AND MASS NUMBER)	7. CHEMICAL AND/OR PHYSICAL FORM	8. MAXIMUM QUANTITY LICENSEE MAY POSSESS AT ANY ONE TIME
A. Iodine 125	A. Sealed sources (Models which are registered in accordance with Rule 391-3-17.02(11)(l) or equivalent regulations of the US NRC or another Agreement State)	A. 500 millicuries
B. Palladium 103	B. Sealed sources (Models which are registered in accordance with Rule 391-3-17.02(11)(l) or equivalent regulations of the US NRC or another Agreement State)	B. 500 millicuries

9. **AUTHORIZED USE**

A. and B. Brachytherapy procedures as permitted by (55) of Rule 391-3-17-.05 for the interstitial treatment of cancer.

Georgia Department of Natural Resources
4220 International Parkway, Suite 100, Atlanta, Georgia 30354
Noel Holcomb, Commissioner
Carol A. Couch, Ph.D, Director
Environmental Protection Division
404/362-2675

RADIOACTIVE MATERIALS PROGRAM
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Page 1 of 5 Pages [redacted]
License Number G[redacted]
Amendment Number .03

License (1. Name and 2. Address)
[redacted]

3. In accordance with letter dated February 22, 2007, **License Number** [redacted] is amended in its entirety to read as follows:

4. **Expiration Date:** August 31, 2009

5. **Telephone Number:** [redacted]

6. RADIOACTIVE MATERIAL (ELEMENT AND MASS NUMBER)	7. CHEMICAL AND/OR PHYSICAL FORM	8. MAXIMUM QUANTITY LICENSEE MAY POSSESS AT ANY ONE TIME
A. Any radioactive material permitted by (55) of Rule 391-3-17-.05	A. Any therapeutic sealed source permitted in (55) of Rule 391-3-17-.05	A. 6 curies

9. **AUTHORIZED USE**

A. Brachytherapy procedures as permitted by (55) of Rule 391-3-17-.05.

CONDITIONS

10. Radioactive material shall be used at the licensee's address stated in item 2 above.

11. The licensee shall comply with the provisions of Georgia Department of Natural Resources Rule 391-3-17-.03, "Standards for Protection Against Radiation. Amended.", Rule 391-3-17-.05, "Use of Radionuclides in the Healing Arts. Amended.", Rule 391-3-17-.06, "Transportation of Radioactive Material. Amended.", and Rule 391-3-17-.07, "Notice, Instructions and Reports to Workers: Inspections. Amended."

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Written directive/QMP

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PROSTATE WRITTEN DIRECTIVE AND REGULATORY COMPLIANCE DATA

PATIENT NAME: _____Implant Date: _____

PRELIMINARY WRITTEN DIRECTIVE TO BE COMPLETED PRIOR TO IMPLANT DATE

Treatment Site: PROSTATE

Prescribed Dose: _____cGy Isotope to Implant: ☐ Pd-103 ☐ I-125☐ Cs-131

Physician Authorized User: _____Date Signed:_____
(any revisions must be initialed and dated by authorized user)

FINAL WRITTEN DIRECTIVE TO BE COMPLETED PRIOR TO PROCEDURE COMPLETION

Treatment Site: PROSTATE Isotope: ☐ Pd-103 ☐ I-125 ☐ Cs-131 Total # of sources:____

Activity per source: _____ mCi Total Activity Implanted: _____ mCi

Prescribed Total Dose: _____cGy Exposure Time: **Permanent Implant**

Physician Authorized User: _____Date Signed:_____

ROOM SURVEY AND PATIENT RELEASE SURVEY DATA

Survey Performed By: _____ Date of Survey: _____

Meter Model and SN: _____
Patient at 1 m: _____mrem//hr (must be less than 1 mrem/hr for I-125, < 3 mrem/hr for Pd 103, <5 mrem/hr for Cs-131)
Linen: _____mrem/hr Trash: _____mrem/hr OR Table/Floor: _____mrem/hr

SEED INVENTORY DATA COMPLETED IMMEDIATELY AFTER IMPLANT

# of Seeds Ordered: _____Isotope:☐Pd-103 ☐I-125 ☐Cs-131 Activity/seed:_____mCi

# of Seeds Implanted: _____ # Recovered:_____ # Re-implanted:_____

# of Seeds Returned to Nuclear Medicine: _____Performed by:_____
(Returned to Hot lab = total ordered - (Implanted-Recovered+Reimplanted))

QMP REVIEW OF CASE

Review of this case showed that the written directive was prepared as required and that the implant was performed in compliance with the physician's written directive. The review included verification that the prescribed dose, source isotope, total activity, patient identity, number of seeds, and loading sequence from the treatment plan were in accordance with the administered implant. Also reviewed was documentation that correct data for the patient was contained in the treatment plan. This case review was performed after conclusion of the procedure by:

Physician:_____ **Date:**_____

Prostate Written Directive/Regulatory Compliance Data Approved 12/2007
Forms Site – Forms Folder 1 copy for licensee records, one copy for patient chart

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Integral dose calculation

NUREG -1556 vol 9 (2005) supersedes reg guide 8.35

You can release based on activity or dose rate (appendix U) for I-125 it is 1 mrem/hr @ 1 meter

1 rmem/hr X (60 days/9.69 days)x(115 Gy/145Gy) = 4.9 mrem/hr at one meter for Cs -131

Assuming a 25% occupancy factor (per appendix U recommendations)

I-125

1 mrem/hr X 24 hrs/day X (60 days/0.693) X 0.25 OF
=519.48 mrem

Cs-131

4.9 mrem/hr X 24 hrs/day X (9.69 days/0.693) X 0.25 OF
=411.1 mrem

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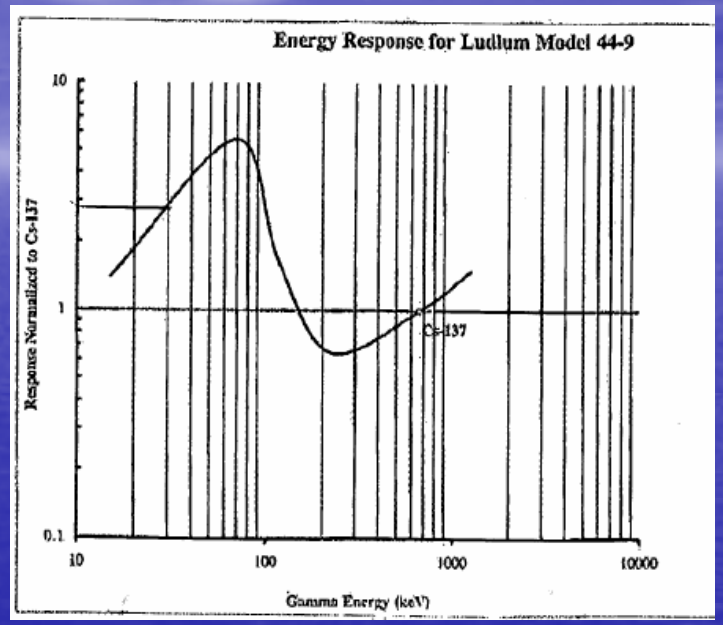
Let's talk about meters



MODEL 44-9 Pancake G-M Detector

PART NUMBER:47-1539

The Model 44-9 is a pancake G-M that can be used with several different instruments including survey meters, scalers, ratemeters, and alarm ratemeters

CE

INDICATED USE: Alpha beta gamma survey; Frisking
DETECTOR: Pancake type halogen quenched G-M
WINDOW: 1.7 ± 0.3 mg/cm² mica
WINDOW AREA:
Active - 15 cm²
Open - 12 cm²
EFFICIENCY(4pi geometry): Typically 5%-^{14}C; 22%-^{90}Sr/^{90}Y; 19%-^{99}Tc; 32%-^{32}P; 15%-^{239}Pu
SENSITIVITY: Typically 3300 cpm/mR/hr (^{137}*Cs gamma*)
ENERGY RESPONSE: Energy dependent
DEAD TIME: Typically 80 microseconds
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers
OPERATING VOLTAGE: 900 volts
CONNECTOR: Series "C" (*others available*)
CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint
TEMPERATURE RANGE: -4° F(-20° C) to 122° F(50° C)
May be certified for operation from -40° F(-40° C) to 150° F(65° C)
SIZE: 1.8" (4.6 cm)H X 2.7" (6.9 cm)W X 10.7" (27.2 cm)L
WEIGHT: 1 lb (0.5kg)

radiation oncology SERVICES

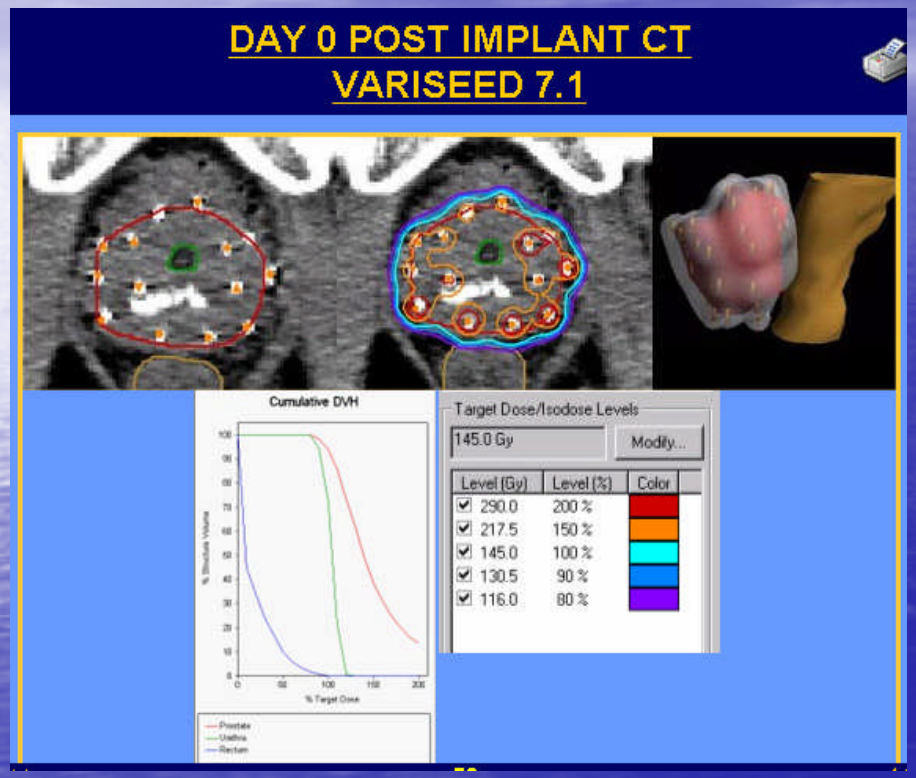
Learning Objectives

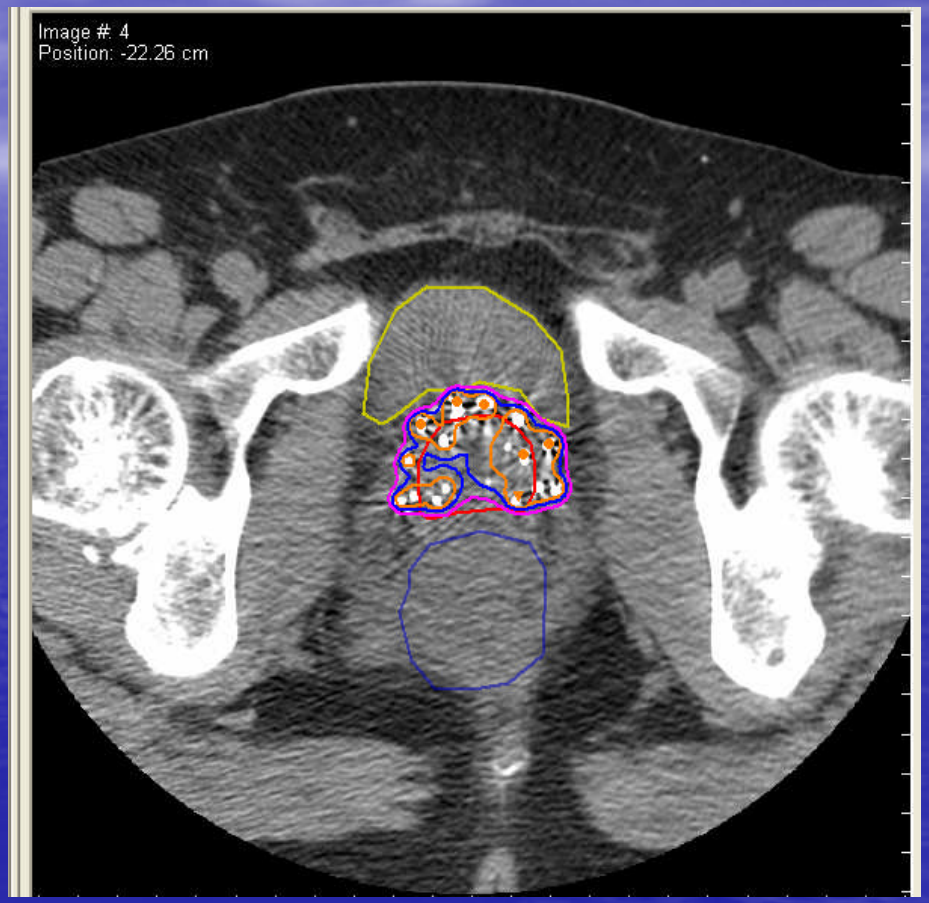
- Review the isotopes in vogue, prescription ranges, and common clinical characteristics
- Review isotope manufacturing and calibration issues
- Review of current implant techniques (Mick ® versus stranded)
- Review radiation safety and release criteria
- **Review post plans and lessons learned the hard way**

Post Plans

- CT day 0, day 1, day 15, day 30? Stereo shift films?
- Chest X-ray?
- Correlation with the U/S?
  - Who draws the prostate
  - Post plan evaluation (statistics)

Post Plans





http://www.micknuclear.com/

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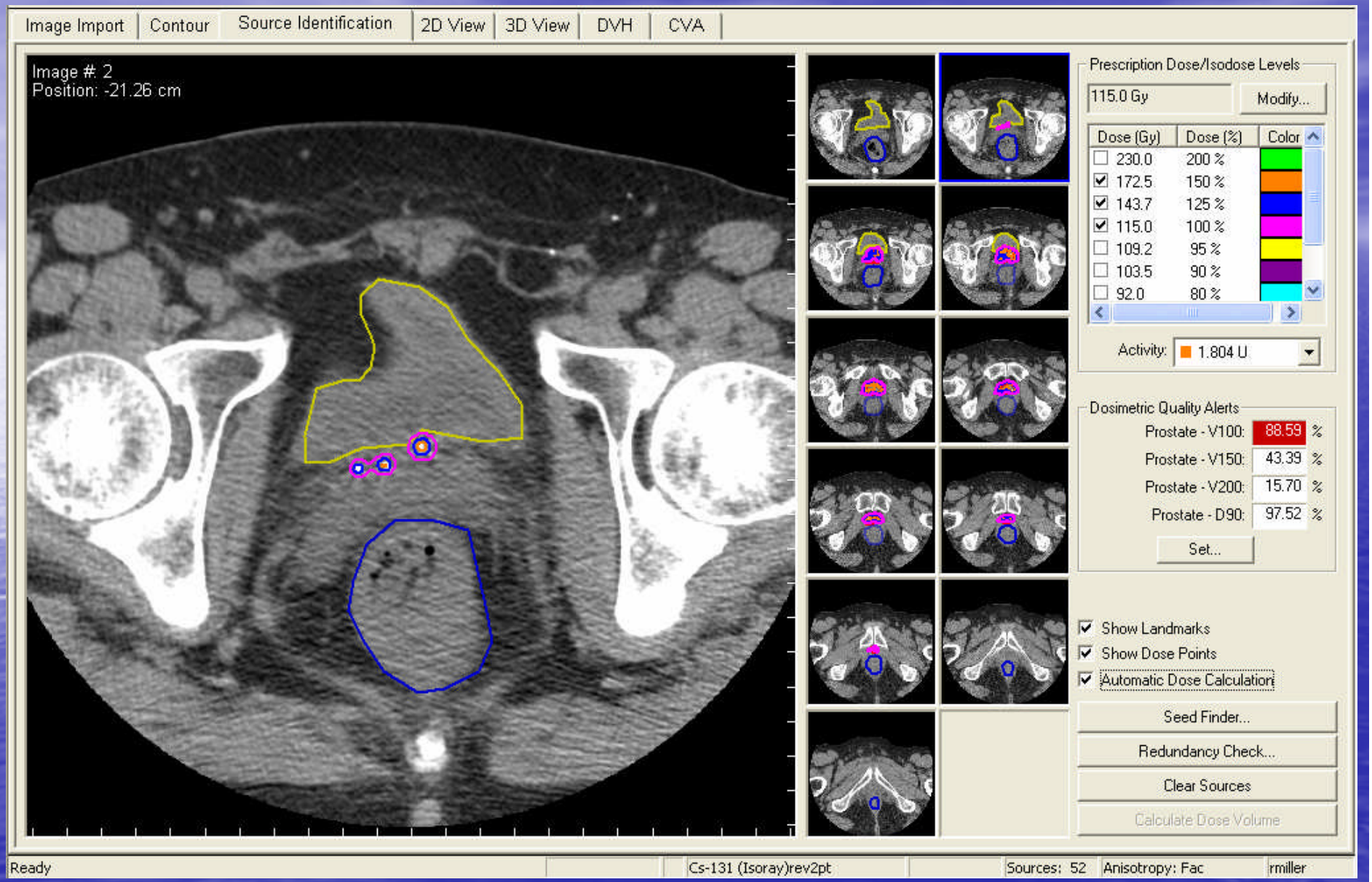

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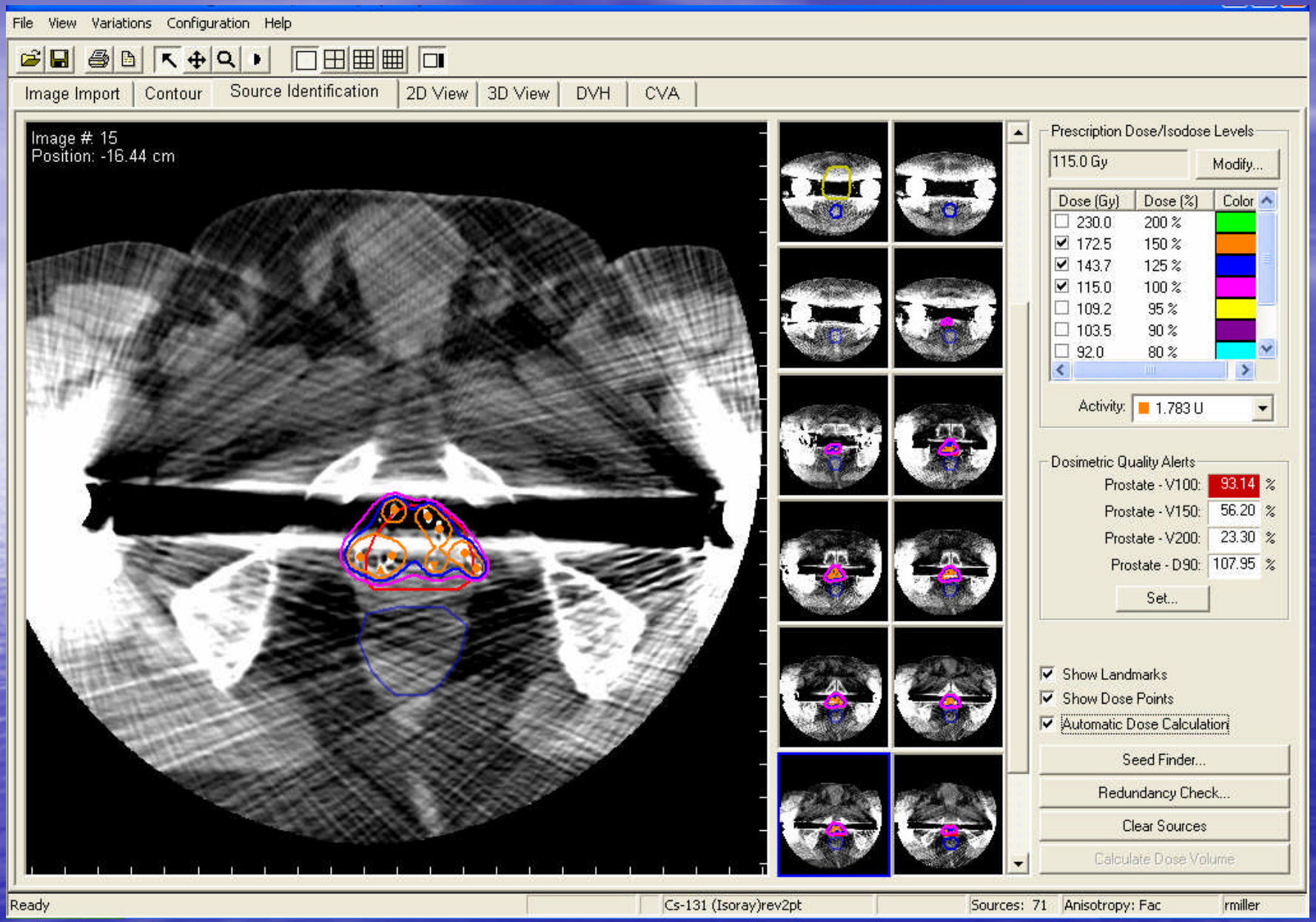

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Post plan evaluation form

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PROSTATE BRACHTHERAPY
POST IMPLANT DATA ANALYSIS

Patient Name: _____ **Center:** _____

Implant Date: _____ Physician: _____ Dosimetrist: _____
Isotope: ☐ I-125 ☐ Pd-103 ☐ Cs-131

# of Seeds Implanted: _____ # of Seeds Found: _____

Midpoint Activity (U): _____

Tx. Plan: ☐ Implant Alone ☐ Combined

Dose Prescribed: _____

Volume History:

Pre-Implant CT: _____cc's Date: _____

Pre-Implant U/S: _____cc's Date: _____

Real Time: _____cc's Date: _____

Post Implant: _____cc's Date: _____

V-100= The Volume that received 100% of the planned dose.
D-90= The Dose given to 90% of the gland

V-100: _____ V-125: _____

V-150: _____ D-90: _____ **SCORE:** _____

Comments:

_____
_____
_____
_____

DOSIMETRIST:_____**DATE:**_____

PHYSICIAN: _____**DATE:**_____

Prostate Brachytherapy Post Implant Data Approved 12/2007
Forms Site – Forms folder

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Self Assessment

Date of Implant	isotope	Rx Gy	# of seeds	activity mCi	volume cc's	post plan V100	V150	D90 (Gy)	D90 (%)	V100 rectum	cc's	D30 rectum		VS size	post plan size	urologist
1/14/2008	I-125	110	103	0.313	60.21	91.46%	42.66%	112.95	102.68%	0.24%	1.30	22.47%		60.21	59.44	
3/24/2008	Cs-131	115	106	3.19	57.73	90.11%	45.33%	115.30	100.26%	0.15%	0.05	26.62%		57.73	58.05	
3/24/2008	Cs-131	115	85	2.89	39	84.17%	44.65%	103.61	90.10%	2.53%	1.24	30.79%		39.00	39.21	
3/31/2008	Cs-131	85	63	2.863	31.53	80.51%	36.57%	71.66	84.31%	1.79%	1.18	30.53%		31.53	31.90	
4/1/2008	I-125	110	67	0.31	25	92.61%	38.30%	113.96	103.60%	0.60%	0.25	26.12%	c	25	25.11	
4/1/2008	Cs-131	115	90	2.857	43.17	90.65%	57.11%	116.94	101.68%	1.79%	0.80	38.44%	c	43.17	43.1	
4/1/2008	Cs-131	85	61	2.806	27.86	84.85%	50.57%	71.50	84.12%	1.64%	1.26	27.55%	c	27.86	27.21	
4/14/2008	Cs-131	85	81	3.18	54.58	87.28%	50.94%	81.24	95.57%	0.00%	0.00	33.65%		54.58	51.06	
4/14/2008	Cs-131	115	99	3.14	53.27	92.69%	49.13%	121.51	105.66%	0.28%	0.11	38.73%		53.27	53.99	
4/15/2008	Cs-131	85	49	2.826	25.39	87.85%	70.03%	80.20	94.35%	0.03%	0.02	21.12%	c	25.39	25.94	
4/15/2008	Cs-131	115	97	3.14	48.49	80.03%	56.08%	97.47	84.76%	0.48%	0.24	33.44%	c	48.49	48.72	
4/15/2008	Cs-131	85	79	3.14	52.88	88.38%	56.05%	82.86	97.48%	0.20%	0.07	36.05%	c	52.88	53.4	
4/28/2008	Cs-131	85	67	3.21	49.72	91.40%	60.62%	87.33	102.74%	0.98%	0.46	29.57%		49.72	49.25	
5/19/2008	I-125	145	91	3.14	36.49	82.84%	40.48%	128.66	88.73%	0.00%	0.00	18.94%		36.49	36.23	
5/19/2008	Cs-131	115	72	2.796	30.22	86.70%	55.58%	108.97	94.76%	0.54%	0.41	22.24%		30.22	30.19	
6/9/2008	Cs-131	85	59	2.806	36.11	88.80%	45.56%	82.91	97.54%	0.00%	0.00	26.85%		36.11	34.41	
6/17/2008	Cs-131	115	71	2.799	28.75									28.75		
6/17/2008	Cs-131	115	52	2.832	16.8									16.8		
7/7/2008	Cs-131	85	63	3.18	46.63									46.63		
7/7/2008	Cs-131	115	67	2.88	24.29									24.29		
7/8/2008	Cs-131	115	83	3.18	44.9								G	44.9		

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Cautionary tales

- Medical mistakes are common
  - misadministration
- Anticipate mistakes
- Have a process in place

radiation oncology SERVICES

An actual case

- New prostate brachytherapy implant program—physician and physicist attend Seattle course
- An early patient received an implant as a boost to external beam radiation
- Following 45 Gy of external beam, the physician prescribed a full dose implant (145 Gy) rather than a boost dose (108 Gy)
- Patient developed severe urethral and rectal complications
- The physician defendant admitted fault and settled quickly with the plaintiff
- The physicist / hospital defendants were left "holding the bag"
- Eventually all defendants settled
- Lessons
  - No BFF among co-defendants
  - The physicist was "negligent" for delivering the wrong dose, even though it was prescribed by the physician
    - AAPM Report 38 The Role of a Physicist in Radiation Oncology (1993)
    - AAPM Report 79 Academic Program Recommendations for Graduate Degrees in Medical Physics (Revision of AAPM Report No. 44)

Thank you

radiation oncology SERVICES