MEETING AGENDA
ADVISORY COMMITTEE ON THE MEDICAL USES OF ISOTOPES
September 11-12, 2017
Two White Flint North Building (T2-B3), Rockville, Maryland

NOTE: Sessions of the meeting may be closed pursuant to 5 U.S.C. 552(b) to discuss organizational and personnel matters that relate solely to internal personnel rules and practices of the ACMUI; information the release of which would constitute a clearly unwarranted invasion of personal privacy; information the premature disclosure of which would be likely to significantly frustrate implementation of a proposed agency action; and disclosure of information which would risk circumvention of an agency regulation or statute.

Monday, September 11, 2017 **CLOSED SESSION**			
7:30 – 8:30	**1.**	**Badging and Enrollment**	**ACMUI**
OPEN SESSION			
	2.	**Opening Remarks** Mr. Bollock will formally open the meeting and Mr. Collins will provide opening comments.	**D. Bollock, NRC** **D. Collins, NRC**
	3.	**Old Business** Ms. Holiday will review past ACMUI recommendations and provide NRC responses.	**S. Holiday, NRC**
8:30 – 10:00	**4.**	**Open Forum** The ACMUI will identify medical topics of interest for further discussion.	**ACMUI**
	5.	**Medical Events Subcommittee Report** Dr. Ennis will present the subcommittee's analysis of medical events for fiscal year 2016.	**R. Ennis, ACMUI**
10:00 – 10:30		**BREAK**	
	6.	**Medical Event Reporting and its Impacts on Safety Culture Subcommittee Report** Dr. Langhorst will discuss the subcommittee's comments on how NRC's medical event reporting criteria under 10 CFR 35.3045 impacts safety culture at medical institutions.	**S. Langhorst, ACMUI**
10:30 – 11:45	**7.**	**Patient Intervention Subcommittee Report** Dr. Dilsizian will discuss the subcommittee's recommendation for the definition of patient intervention.	**V. Dilsizian, ACMUI**
11:45 – 1:00		**LUNCH**	
	8.	**Nursing Mother Guidelines Subcommittee Report** Dr. Metter will discuss the subcommittee's comments on the nursing mother guidelines for exposure from diagnostic and therapeutic radiopharmaceuticals.	**D. Metter, ACMUI**
1:00 – 3:00	**9.**	**Patient Release Project Update** Dr. Howe will provide an update on the patient release project.	**DB. Howe, NRC**
	10.	**ACMUI Comments on Patient Release Commission Paper** Dr. Zanzonico will discuss the subcommittee's comments on the Patient Release Commission Paper.	**P. Zanzonico, ACMUI**
3:00 – 3:30		**BREAK**	
CLOSED SESSION			
3:30 – 5:00	**11.**	**Ethics Training**	**M. Clark, NRC**
	12.	**INFOSEC Training**	**R. Norman, NRC**
	13.	**Allegations Training**	**S. Hawkins, NRC**

Tuesday, September 12, 2017 OPEN SESSION			
	14.	**NRC Online Resources** Ms. Holiday will provide an overview of the resources available on the NRC Website and Medical Toolkit.	**S. Holiday, NRC**
8:30 – 10:00	**15.**	**Status Update on Source Security and Accountability Initiatives** Ms. Wu will provide an overview of source security initiatives and a status update on the evaluation of Category 3 source security and accountability.	**I. Wu, NRC** **J. Suh, ACMUI**
	16.	**Physical Presence Requirements for the Leksell Gamma Knife® Icon™ Subcommittee Report** Dr. Suh will discuss the subcommittee's recommendations on the physical presence requirements for the Leksell Gamma Knife® Icon™.	
10:00 – 10:30		**BREAK**	**K. Tapp, NRC**
	17.	**Yttrium-90 Microspheres Brachytherapy Licensing Guidance** Dr. Tapp will provide an update on the Y-90 Microspheres Brachytherapy Licensing Guidance.	
10:30 – 11:30	**18.**	**Enhancing Communications with the Medical Community** Dr. Alderson, Dr. Metter and Dr. Palestro will provide an update on ACMUI's efforts to improve communications with various medical professional societies.	**P. Alderson, ACMUI** **D. Metter, ACMUI** **C. Palestro, ACMUI**
11:30 – 1:00		**LUNCH**	
	19.	**Special Presentation for Mr. Francis (Frank) Costello** NRC Staff and Dr. Alderson will make a special presentation in memory of Mr. Costello, former Agreement State Representative on the ACMUI.	**NRC** **P. Alderson, ACMUI**
1:00 – 2:00	**20.**	**Special Presentation to Dr. Susan (Sue) Langhorst** Mr. Dapas will make a special presentation to Dr. Langhorst.	**M. Dapas, NRC**
	21.	**Thoughts on Leaving the ACMUI** Dr. Langhorst will share her thoughts on leaving the ACMUI.	**S. Langhorst, ACMUI**
2:00 – 2:30		**BREAK**	
	22.	**Open Forum** The ACMUI will discuss medical topics of interest previously identified.	**ACMUI**
2:30 – 3:15	**23.**	**Administrative Closing** Ms. Holiday will provide a meeting summary and propose dates for the spring 2018 meeting.	**S. Holiday, NRC**
3:15		**ADJOURN**	

Badging and Enrollment

NO HANDOUT

Opening Remarks

NO HANDOUT

2007 ACMUI RECOMMENDATIONS AND ACTION ITEMS

	ITEM	DATE	STATUS	
2	NRC staff should remove the attestation requirement for board certified individuals and rewrite the attestation requirement for individuals seeking authorization under the alternate pathway. The rewritten attestation should not include the word “competency” but should instead read “has met the training and experience requirements.”	6/12/07	Accepted	Open
3	NRC staff should revise the regulations so that board certified individuals, who were certified prior to the effective date of recognition or were certified by previously recognized boards listed in Subpart J of the previous editions of Part 35, are grandfathered.	6/12/07	Accepted	Open
6	NRC staff should add the words “or equivalent” so it is clear that information included in a letter is the same as that which would have been submitted in NRC Form 313A (35.12(c))	6/13/07	Accepted	Open
7	NRC staff should revise 10 CFR 35.50(c)(2) to include AUs, AMPs, or ANPs identified on any license or permit that authorizes similar types of use of byproduct material. Additionally, the AU, AMP, or ANP must have experience with the radiation safety aspects of similar types of use of byproduct material for which the individual is seeking RSO authorization.	6/13/07	Accepted	Open
8	NRC staff should remove the attestation requirement from 10 CFR 35.50(d) for AUs, AMPs, and ANPs seeking RSO status, if the AU, AMP, or ANP seeking RSO status will have responsibilities for similar types of uses for which the individual is authorized.	6/13/07	Accepted	Open

	ITEM	DATE	STATUS	
10	a) NRC staff should allow more than one RSO on a license with a designation of one RSO as the individual in charge. b) NRC should create a Regulatory Issue Summary (RIS) to inform the regulated community of NRC's interpretation. The RIS should be sent to ACMUI and the Agreement States for review and comment.	6/13/07	a) Accepted b) Accepted	a) Open b) Closed
25	NRC staff should revise the current regulations to include Canadian trained individuals who have passed the ABNM certification exam.	8/16/07	Accepted	Open
30	The Elekta Perfexion® should be regulated under 10 CFR 35.1000 until 10 CFR 35.600 is modified to be performance-based, which would allow the Perfexion® to be regulated under 10 CFR 35.600.	10/22/07	Accepted	Open *Delayed*
31	NRC staff should require experienced RSOs and AMPs to receive additional training, if the individual is seeking authorization or responsibility for new uses.	10/22/07	Accepted	Open
32	NRC staff should not require experienced RSOs to obtain written attestation to become authorized or have responsibility for new uses.	10/22/07	Accepted	Open
34	NRC staff should modify 10 CFR 35.491(b)(2) to specify 'superficial' ophthalmic treatments. Additionally, NRC staff should change the title of 10 CFR 35.491 to specify 'superficial' ophthalmic treatments.	10/22/07	Accepted	Open *Delayed*
35	NRC staff should not revise 10 CFR 35.491 (intended for ophthalmologists) to include training and experience for the new intraocular device. Instead, NRC staff should regulate the new intraocular device under 10 CFR 35.490.	10/22/07	Partially Accepted	Open *Delayed*

	ITEM	DATE	STATUS	
36	NRC staff should not require medical licensees regulated under 10 CFR 35.400, 500, or 600, as applicable, to only use the sealed sources and devices for the principle use as approved in the SSDR.	10/22/07	Accepted	Open
37	NRC staff should revise 10 CFR 35.290 to allow physicians to receive training and experience in the elution of generators and preparation of kits under the supervision of an ANP.	10/22/07	Accepted	Open

2008 ACMUI RECOMMENDATIONS AND ACTION ITEMS

	ITEM	DATE	STATUS	
2	NRC staff should pursue rulemaking to allow more than one RSO on a medical use license with the indication of one RSO as the individual in charge.	4/28/08	Accepted	Open
5	NRC staff should incorporate the subcommittee's recommendations for the Gamma Knife® Elekta Perfexion™ in future rulemaking.	4/28/08	Accepted	Open *Delayed*
19	NRC staff should accept the six recommendations of the Permanent Implant Brachytherapy Subcommittee report with one modification. Recommendation six should be modified to read, "When a Written Directive (WD) is required, administrations without a prior WD are to be reported as regulatory violations and may or may not constitute an ME."	10/27/08	Pending	Open *Delayed*
22	ACMUI encouraged NRC staff to begin the rulemaking process to move the medical use of Y-90 microspheres from 10 CFR 35.1000 to another section of the regulations, so that the training and experience requirements for AUs can be vetted though the public review process instead of residing in guidance space.	10/27/08	Partially accepted	Open *Delayed*
26	NRC staff should revise 10 CFR 35.40 to clarify that the AU should sign and date both the pre-implantation and post-implantation portions of the WD for all modalities with two part WDs	10/28/08	Accepted	Open *Delayed*

2008 ACMUI RECOMMENDATIONS AND ACTION ITEMS

	ITEM	DATE	STATUS	
27	NRC staff should revise 10 CFR 35.40 to clarify that an AU, not the AU, should sign and date both the pre-implantation and post-implantation portions of the WD for all modalities with two part WDs. [Note this allows for one AU to sign the pre-implantation portion of the WD and another AU to sign the post-implantation portion of the WD]	10/28/08	Accepted	Open *Delayed*
28	NRC staff should revise 10 CFR 35.65 to clarify it does not apply to sources used for medical use; however, NRC should not require licensees to list the transmission sources as a line item on the license. NRC staff should also revise 10 CFR 35.590 to permit the use of transmission sources under 10 CFR 35.500 by AUs meeting the training and experience requirements of 10 CFR 35.590 or 35.290.	10/28/08	Accepted	Open
29	NRC staff should revise 10 CFR 35.204(b) to require a licensee that uses Mo 99/Tc-99m generators for preparing a Tc-99m radiopharmaceutical to measure the Mo-99 concentration of each eluate after receipt of a generator to demonstrate compliance with not administering to humans more than 0.15 microcurie Mo-99 per millicurie Tc-99m.	10/28/08	Accepted	Open
30	NRC staff should require licensees to report to the NRC events in which licensees measure molybdenum breakthrough that exceeds the regulatory limits.	10/28/08	Accepted	Open

2009 ACMUI RECOMMENDATIONS AND ACTION ITEMS

	ITEM	DATE	STATUS	
2	NRC staff should revise 35.390(b)(1)(ii)(G)(3) to read "parenteral administration requiring a written directive for any radionuclide that is being used primarily because of its beta emission, or low energy photo-emission, or auger electron; and/or" and revise 35.390(b)(1)(ii)(G)(4) to read "parenteral administration requiring a written directive for any radionuclide that is being used primarily because of its alpha particle emission"	5/7/09	Accepted	Open
10	ACMUI recommends NRC staff delete the phrase "at a medical institution" from 10 CFR 35.2, 35.490(b)(1)(ii), 35.491(b)(2) and 35.690(b)(1)(ii).	10/19/09	Accepted	Open

	ITEM	DATE	STATUS		1st/2nd	Vote
1	ACMUI endorsed the draft response to NRC comments, as reflected in the meeting handout (ML110600249). ACMUI agreed if NRC believes the release criteria should be changed from a per release criteria to an annual criteria, this change would require new rulemaking, as stated in Regulatory Issue Summary (RIS) 2008-07. ACMUI recommended rulemaking to clarify that the release under 10 CFR 35.75 is per release and not per year	1/5/11	Pending	Open	Langhorst/Gilley	9, 1, 0
6	ACMUI created an action item to reevaluate its satisfaction with the reporting structure annually.	1/12/11	ACMUI Action	Open indefinitely	Welsh/Zanzonico	
11	(1) ACMUI feels ASTRO's approach to Permanent Implant Brachytherapy (handout) is correct approach for patient welfare (2) ACMUI recommends that the NRC require Post-Implant dosimetry following brachytherapy treatment (3) ACMUI believes that prostate brachytherapy is a unique subset of brachytherapy and should therefore require a separate set of rules from non-prostate brachytherapy.	4/11/11	Partially Accepted	Open	Welsh/Mattmuller	11, 0, 0

	ITEM	DATE	STATUS		1st/2nd	Vote
13	ACMUI recommends to eliminate the written attestation for board certification pathway, regardless of date of certification	4/12/11	Accepted	Open	Zanzonico/Guiberteau	11, 0, 0
14	ACMUI recommends the attestation to be revised to say … has received the requisite training and experience in order to fulfill the radiation safety duties required by the licensee	4/12/11	Accepted	Open	Langhorst/Thomadsen	11, 0, 0
15	ACMUI supports the statement that residency program directors can sign attestation letters, representing consensus of residency program faculties, if at least one member of the faculty is an AU in the same category as that designated by the applicant seeking authorized status, and that AU did not disagree with the approval.	4/12/11	Accepted	Open	Thomadsen/Welsh	11, 0, 0
16	ACMUI continues to assert that the current regulations are based on a per release limit. ACMUI does not recommend any change to the regulation and does not recommend the NRC consider this topic during the current rulemaking process, as there is no clinical advantage or advantage to members of the public for using an annual limit.	4/12/11	Pending	Open	Langhorst/Welsh	11, 0, 0

	ITEM	DATE	STATUS		1st/2nd
1	ACMUI recommended NRC staff allow use of total source strength as a substitute for total dose for determining medical events for permanent implant brachytherapy until the Part 35 rulemaking is complete.	3/5/13	NRC Action	Open	
2	ACMUI recommended that NRC staff solicit feedback from stakeholders, in Supplementary Information section IV.D, on whether the proposed ME definition for permanent implant brachytherapy would discourage licensees from using this form of therapy. This recommendation was modified the caveat that NRC may utilize the language that they think is appropriate for gaining this type of information from its stakeholders	3/5/13	NRC Action	Open	Zanzonico/Langhorst
3	ACMUI recommended the draft rule re-defining medical events in permanent implant brachytherapy be designated as Compatibility Category B.	3/5/13 3/12/13	NRC Action	Open	
4	ACMUI recommended replacing the phrasing in the literature in terms of support for the 5 cubic centimeters of contiguous normal tissue provision of the ME definition, to the specific reference cited as, Nag, et al 2004	3/5/13	NRC Action	Open	

	ITEM	DATE	STATUS		1st/2nd
5	ACMUI recommended that licensees approved to use generator systems show specific training on the requirement now listed under 35.290 (c)(1)(ii)(G) for those individuals (Authorized Users and others) who are responsible for proper operation and testing of the generator as part of their license conditions. ACMUI further recommended that Authorized Nuclear Pharmacists who have the adequate training and experience (T&E) are able to provide the supervised work experience for Authorized Users on the elution of generators.	3/5/13	NRC Action	Open	
6	ACMUI endorsed the language in the proposed rule for preceptor attestations that states a candidate is able to independently fulfill the radiation safety related duties for which authorization is being sought.	3/5/13	NRC Action	Open	
7	ACMUI recommended that the work experience for parenteral administrations under Sections 35.390 (b)(1)(2)(g), and 35.396 not be separated between parenteral administrations of a beta gamma emitting radiopharmaceutical versus an alpha emitting radiopharmaceutical, as proposed in the proposed rule.	3/12/13	NRC Action	Open	Zanzonico/Guiberteau
8	ACMUI recommended that the date of recognition of a certifying board should not impact individuals seeking to be named as an Authorized User, Authorized Radiation Safety Officer, Authorized Medical Physicist, or Authorized Nuclear Pharmacist through the certification pathway.	3/12/13	NRC Action	Open	Zanzonico/Thomadsen
9	ACMUI recommended that the NRC adopt the FDA approved package insert for breakthrough limits for radioisotope generators	3/12/13	NRC Action	Open	Zanzonico/Mattmuller

	ITEM	DATE	STATUS		1st/2nd
10	ACMUI recommended licensee reporting of out-of-tolerance generator breakthrough results to the NRC	3/12/13	NRC Action	Open	Zanzonico/Weil
11	ACMUI recommended requiring testing of molybdenum breakthrough on every elution of a molybdenum-technetium generator, rather than after only the first elution.	3/12/13	NRC Action	Open	
12	ACMUI recommended that the addition of Associate Radiation Safety Officers (ARSOs), and Temporary RSOs also be included in these exemptions in the same manner as AUs, ANPs, and AMPs.	3/12/13	NRC Action	Open	Zanzonico/Langhorst
13	In reference to the plain language requirement, the ACMUI suggested that the rule “could be shortened and improved by eliminating redundancies and consolidating related sections and eliminating identical or nearly identical passages appearing multiple times throughout the draft rule. A further improvement would be the inclusion of a detailed “executive summary”-style section summarizing, perhaps in a bullet format, the key changes introduced in the draft rule.”	3/12/13	NRC Action	Open	

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
7	The ACMUI recommended that events reportable under 10 CFR 35.3047 that do not result in harm to the embryo/fetus/or nursing child not be captured as AO's reported to Congress.	03/20/2015	ACMUI Action	Open		Langhorst/Costello	11, 0, 1
12	The ACMUI recommended to make the following change to the Patient Intervention Subcommittee Recommendation Issue II: Unintentional Treatment outcome due to anatomic or physiologic anomaly ~~and/or imaging uncertainty~~ falls into the category “the Art of Medical Practice” provided that the standards of medical practice are met.	10/8/15	ACMUI Action	Open	M. Ayoade	Alderson/Palestro	10, 0, 1
13	The ACMUI endorsed the Patient Intervention Subcommittee Report with the modification to Issue II (listed in item 12 above).	10/8/15	ACMUI Action	Open	M. Ayoade	Costello, Alderson	10, 1, 0
15	The ACMUI recommended that staff issue a Generic Communication (i.e. Information Notice or Regulatory Issue Summary) to licensees to inform them of the interpretation of "patient intervention."	10/8/15	NRC Action	Open	M. Ayoade		
22	The ACMUI endorsed the 2015 Abnormal Occurrence Criteria Subcommittee Report with the caveat that the report be amended to include an introductory paragraph that provides the rationale for the recommendations, as well as a summary paragraph to state that the Committee desires that the recommendations be incorporated into this revision of the NRC's Abnormal Occurrence Criteria Policy Statement.	10/9/15	ACMUI Action	Open			10, 1, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
1	The Committee endorsed that component of the current proposed rule re-defining medical events in permanent implant brachytherapy in terms of activity (i.e. source strength) rather than radiation dose).	1/6/2016	Accepted	Open			10, 0, 0
2	The Committee endorsed, with reservation, designating the current proposed rule re-defining medical events in permanent implant brachytherapy as Compatibility Category C, with activity-based medical event metrics defined as an essential program element.	1/6/2016	Accepted	Open			10, 0, 0
3	The Committee recommended changing the language for a "wrong-location" medical event in permanent implant brachytherapy from the current proposed language, "Sealed source(s) implanted directly into a location where the radiation from the source(s) will not contribute dose to the treatment site, as defined in the written directive," to **"Sealed source(s) implanted directly into a location discontiguous from the treatment site, as defined in the written directive."**	1/6/2016	Accepted	Open			10, 0, 0
4	The Committee recommended revising the passage in lines 4182-4186 on page 167 in the Draft Final Rule as follows, thereby eliminating the dose-based criteria for a leaking source" medical event: **"3) An administration that includes the wrong radionuclide; the wrong individual or human research subject; a leaking sealed source; or a sealed source or sources implanted into a location discontiguous from the treatment site, as defined in the written directive."**	1/6/2016	Not Accepted	Open			10, 0, 0
5	The Committee endorsed the elimination of the preceptor-statement requirement for Board-certified individuals for an individual seeking regulatory authorization as an authorized user, authorized medical physicist, Radiation Safety Officer, or authorized nuclear pharmacist.	1/6/2016	Accepted	Closed			10, 0, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
6	With respect to the amended requirements for preceptor attestation for an individual seeking regulatory authorization as an authorized user, authorized medical physicist, Radiation Safety Officer, or authorized nuclear pharmacist through the alternate pathway, the Committee endorsed changing the language for the preceptor attestation from the individual "…has achieved a level of competency to function independently…" for the authorization to **the individual can "…independently fulfill the radiation safety-related duties…" associated with the authorization being requested.**	1/6/2016	Accepted	Open			10, 0, 0
7	The Sub-Committee recommended that the date of recognition by the NRC of a certifying board should not impact individuals seeking to be named as an authorized user, authorized medical physicist, Radiation Safety Officer, or authorized nuclear pharmacist through the certification pathway. During the discussion, this recommendation was modified in the final report as follows: **The Sub-Committee recommends that NRC Staff consider providing guidance in the NUREG-1556, Volume 9 update to licensees on the ways individuals with board certifications prior to NRC's board recognition date may seek authorization.**	1/6/2016	Accepted	Open			10, 0, 0
8	The Committee recommended that the NRC adopt the parent-breakthrough limits for radioisotope generators specified in the relevant Food and Drug Administration (FDA)-approved package inserts. During the discussion, the Committee recommended to eliminate this recommendation and instead, revise the general comments section of the report to suggest that NRC consider, in future rulemaking, establishing conformity with the FDA breakthrough-limit regulations.	1/6/2016	ACMUI Action	Open			9, 1, 0
9	The Committee did not endorse the new requirement in the Draft Final Rule that licensees report to the NRC as well as to the manufacturer/vendor generator elutions with out-of-tolerance parent-breakthrough but, instead, recommends a single reporting requirement to the manufacturer/vendor.	1/6/2016	Not Accepted	Open			10, 0, 0
10	The Committee endorsed allowing Associate Radiation Safety Officers (ARSO) to be named on a medical license.	1/6/2016	Accepted	Open			10, 0, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
11	The Committee recommended that the designation of a board-certified authorized user, authorized medical physicist, or authorized nuclear pharmacist as the Radiation Safety Officer (RSO) or as an ARSO requires their board certification to include the designation, "RSO Eligible."	1/6/2016	Not Accepted	Open			10, 0, 0
12	The Committee did not endorse establishing a separate category of Authorized Users for parenteral administration of alpha-emitting radiopharmaceuticals but, instead, recommends deleting § 35.390(b)(1)(ii)(G)(4) in the current Draft Final Rule and revising the pertinent passage in § 35.390(b)(1)(ii)(G)(3) as follows, **"Parenteral administration of any radioactive drug for which a written directive is required."**	1/6/2016	Partially Accepted	Open			10, 0, 0
13	The Committee endorsed the elimination of the requirement to submit copies of NRC Form 313, Application for Material License, or a letter containing information required by NRC Form 313 when applying for a license, an amendment, or renewal.	1/6/2016	Accepted	Open			10, 0, 0
14	The Sub-Committee recommended changing the "medical-events" language in lines 5531-5532 (page 232) of the Draft Final Rule from, "A licensee shall report as a medical event, any administration requiring a written directive, except for an event that results from patient intervention…," back to the language in the current Draft Final Rule, "A licensee shall report any event, except for an event that results from patient intervention…" During the discussion, the recommendation was modified in the final report as follows: **The Sub-Committee recommends changing the "medical-events" language in lines 5531-5532 (page 232) of the current version of the Draft Final Rule from, "A licensee shall report any event, except for an event that results from patient intervention…" back to the language published in the Proposed Rule as presented for public comment,** **"A licensee shall report as a medical event, any administration requiring a written directive, except for an event that results from patient intervention…,"**	1/6/2016	Not Accepted	Open			10, 0, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
15	The Committee endorsed the 2016 Rulemaking Subcommittee Report with modifications as listed above.	1/6/2016	NRC Action	Open			10, 0, 0
16	Dr. Alderson formed a subcommittee to review and evaluate the training and experience requirements for all modalities in 10 CFR Part 35. Subcommittee members include: Dr. Langhorst, Dr. Metter, Dr. Palestro (chair), Dr. Suh and Ms. Weil. NRC staff resource: Maryann Abogunde.	2/25/2016	ACMUI Action	Open			
24	The ACMUI will contact their respective professional organizations to request and encourage interactions between the NRC and ACMUI with their organization.	3/18/2016	ACMUI Action	Open			
38	Dr. Alderson requested that the ACMUI discuss the nursing mothers guidelines during the Spring 2017 ACMUI Meeting.	10/6/16	ACMUI Action	Closed			
39	The Committee recommended that staff issue a generic communication (information notice) regarding tubing issues (kinking, connection, hub etc.) during the administration of Y-90 microspheres brachytherapy.	10/6/16	NRC Action	Open	Dr. Katie Tapp	Ennis/Costello	9, 0, 1
41	Dr. Alderson re-established the Patient Intervention Subcommittee. The subcommittee's new charge is to make a recommendation on what the definition of "patient intervention" should be. Subcommittee membership include: Mr. Costello, Dr. Dilsizian (Chair), Dr. Ennis, Dr. Suh, and Ms. Weil. Ms. Maryann Abogunde is the NRC resource.	10/6/16	ACMUI Action	Open	Maryann Ayoade		
42	The Committee recommended that the Pathway 2 remain for the Y-90 Microsphere Brachytherapy Licensing Guidance. The NRC/OAS working group should determine what the requirements should be for the proctoring of cases by the manufacturer(s).	10/7/16	NRC Action	Open	Dr. Katie Tapp	Langhorst/Costello	9, 1, 1
43	The Committee recommended to support the update to the waste disposal section and the review of the Y-90 radiation safety issues in autopsy and cremation in the draft revision of the Y-90 Microsphere Brachytherapy Licensing Guidance.	10/7/16	NRC Action	Open	Dr. Katie Tapp	Langhorst/Ennis	11, 0 , 0
44	For the NorthStar Guidance Subcommittee: The Committee recommended that NorthStar provide a video clip of how the system operates in the training module.	10/7/16	NRC Action	Open	Dr. Donna-Beth Howe		10, 0, 0
45	For the NorthStar Guidance Subcommittee: Given the unique design and operation of the NorthStar system, the Committee agreed that NorthStar should have sole responsibility for the content of the training course and certification.	10/7/16	NRC Action	Open			10, 0, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote (Y/N/A)
46	For the NorthStar Guidance Subcommittee: The Committee stated that it is important to clarify that a System Administrator can be any individual assigned by the AU without a specifically defined educational or training background. Given the unique role of the System Administrator, perhaps that individual should be named on the license.	10/7/16	NRC Action	Open			10, 0, 0
47	For the NorthStar Guidance Subcommittee:The Committee recommended an explicit statement regarding the System Administrator Designee, although it may not have been intended, one could infer from the description of the system administrator designee that there can be only one designee. Presumably, there can, and should, be multiple System Administrator designees.	10/7/16	NRC Action	Open			10, 0, 0
48	For the NorthStar Guidance Subcommittee:The Committee recommended that the appropriate time period allotted for training on the “changes” and the responsibility of the vendor/manufacturer to inform and train the applicants on changes in a timely manner be specified.	10/7/16	NRC Action	Open			10, 0, 0
49	For the NorthStar Guidance Subcommittee: The Committee recommended that the guidance clarify whether the generator will be “non-operational” until ALL individuals handling the generator are trained in the changes, including the AU, RSO, system administrator, etc. or does it require only the AU to be trained on the “changes.” If the latter, once the AU is trained on the “changes”, is the AU then solely responsible for training all others on these changes? This should be stated.	10/7/16	NRC Action	Open			10, 0, 0
50	For the NorthStar Guidance Subcommittee: The Committee recommended using the term, “individual tasks” throughout the document for consistency and to clarify that there is only one protocol and software program with this system.	10/7/16	NRC Action	Open			10, 0, 0
51	For the NorthStar Guidance Subcommittee: The Committee recommended that the manufacturer’s procedures be reviewed and incorporated into the Licensing Guidance itself.	10/7/16	NRC Action	Open			10, 0, 0
52	For the NorthStar Guidance Subcommittee: The Committee recommended that the term “higher than expected” be defined in terms of a maximum specific exposure or exposure-rate limit which a survey meter should be capable of measuring.	10/7/16	NRC Action	Open			10, 0, 0

	ITEM	DATE	STATUS		Assigned	1st/2nd	Vote
1	The Committee requested that the recommendations and actions pertaining to the Part 35 rulemaking be reviewed during the fall 2017 ACMUI neeting and that additional time be provided to review each item.	4/26/2017	NRC Action	*Pending*			
2	Dr. Alderson formed a subcommittee to review the recommendations from Elekta to consider amending the licensing guidance physical presence requirements for the Elekta Gamma Knife® Icon. Subcommittee membership includes Dr. Suh (Chair), Dr. Ennis, and Ms. Laura Weil. NRC staff point of contact: Ms. Sophie Holiday.	4/26/2017	ACMUI Action	Closed	Sophie		
3	Dr. Alderson requested an update, from NRC staff, on source security initiatives involving Category 3 sources at the fall 2017 ACMUI meeting.	4/26/2017	NRC Action	Closed			
4	Dr. Alderson formed a subcommittee to review the SECY Paper on Patient Release. The subcommittee will be comprised of Dr. Zanzonico (Chair), Dr. Langhorst, Dr. Palestro, and Ms. Weil. NRC staff point of contact: Dr. Donna-Beth Howe.	4/26/2017	ACMUI Action	Closed	Donna-Beth		
5	Dr. Alderson formed a subcommittee to review the nursing mother guidelines. The subcommittee charge is to review the radiation exposure from diagnostic and therapeutic radiopharmaceuticals including brachytherapy to the nursing mother and child. The subcommittee will be comprised of Dr. Metter (Chair), Dr. Dilsizian, Dr. Palestro, and Dr. Zanzonico. NRC staff point of contact: Dr. Said Daibes.	4/26/2017	ACMUI Action	Closed	Said Diabes		
8	The Patient Intervention Subcommittee will amend its Subcommittee Report and will report at the ACMUI fall 2017 meeting or by teleconference to discuss their amended report.	4/27/2017	ACMUI Action	Open			
10	The Committee tentatively scheduled the fall 2017 ACMUI meeting for September 11-12, 2017. The back-up dates are October 18-19, 2017.	4/27/2017	ACMUI Action	Closed			
11	The NRC staff will provide the Committee with information related to the escalated enforcement actions to medical licensees over a 5-year span.	4/27/2017	NRC Action	Closed	Sophie		

Open Forum

NO HANDOUT

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Medical Events Report FY 2016 Reported 10/1/15 - 9/30/16

Ronald D. Ennis, M.D.

Advisory Committee for the Medical Uses of Isotopes

September 11, 2017

U.S.NRC Subcommittee Members

- Ronald D. Ennis, M.D. (Chair)
- Susan Langhorst, Ph.D.
- Michael O'Hara, Ph.D.
- Christopher Palestro, M.D.
- John Suh, M.D.
- Pat Zanzonico, Ph.D.

U.S.NRC 35.200 Use of Unsealed Byproduct Material for Imaging and Localization

8 events: 7 ^{99m}Tc & 1 ^{18}F-FDG

1. Entire 4.74 GBq (128 mCi) multidose vial of ^{99m}Tc-diphosphonate administered to one patient

   8 cGy whole body

   Cause

   Staff member did not confirm amount of activity to be administered

   Corrective action

   Licensee will no longer prepare kits

U.S.NRC 35.200 Use of Unsealed Byproduct Material for Imaging and Localization

2. Intravenous port leak

   Skin exposure exceeded 50 (cSv)(rem)

3. 88 MBq (2.4 mCi) unfiltered ^{99m}Tc-sulfur colloid, intended for gastric emptying study, administered for lymphoscintigraphy, instead of prescribed 18.5 – 37 MBq (500 uCi-1 mCi) filtered ^{99m}Tc-sulfur colloid

   Potential 58.08 - 273.6 cSv (rem) to skin

Corrective action

Technologist must verbally confirm activity and procedure with physician prior to administration

35.200 Use of Unsealed Byproduct Material for Imaging and Localization

4. 1.11 GBq (30 mCi) ^{99m}Tc-diphosphonate, instead of 18.5 MBq (500 uCi) ^{99m}Tc administered for sentinel node procedure

   Cause

   Miscommunication

   Technologist failed to confirm patient identity with procedure

35.200 Use of Unsealed Byproduct Material for Imaging and Localization

5. 373 MBq (10.1 mCi) Tc-99m tetrofosmin administered to wrong patient

   Cause

   Not specified

   Corrective action

   Being developed

35.200 Use of Unsealed Byproduct Material for Imaging and Localization

6. 925 MBq (25 mCi) ^{99m}Tc-diphosphonate, instead of 18.5 MBq (500 uCi) ^{99m}Tc-sulfur colloid administered for gastric emptying procedure (retracted 8/2/2016, CFR dose limits not exceeded)

35.200 Use of Unsealed Byproduct Material for Imaging and Localization

7. 199.8 MBq (5.4 mCi) 99m-Tc-hepatobiliary agent, instead of 18.5 MBq (500 uCi) Tc administered for gastric emptying

   Cause

   Human error

   Corrective action

   Order capture procedure changed and technologists retrained

35.200 Use of Unsealed Byproduct Material for Imaging and Localization

8. 603.1 MBq (16.3 mCi) ^{18}F-FDG administered to wrong patient

   Cause

   Human error: Two patients with same last name

   Order & supporting documentation confusing

   Corrective action

   Technologist review with supervisor

   Workflow sheet revision

35.300 Use of Unsealed Byproduct Material, Written Directive Required

5 events

Radium-223:	**3**
Samarium-153:	**1**
Iodine-131:	**1**

35.300 Use of Unsealed Byproduct Material, Written Directive Required

^{223}Ra

1. Pt. received 4.41 MBq (119.3 uCi) Ra-223 instead of prescribed 3.21 MBq (86.7 uCi)

   Cause

   Technologist failed to confirm patient's identity and weight prior to radiopharmaceutical administration

   Corrective action

   Institution of additional administrative actions

35.300 Use of Unsealed Byproduct Material, Written Directive Required

2. Pt. received 3.7 MBq (99.4.µCi) instead of prescribed 36.3 MBq (980 µCi)

   Cause

   Failure to observe discrepancy between prescribed and calibrated activity

   Licensee believed AU intended to prescribe 98 µCi (more typical dosage)

   Corrective action

   Activity will be listed in microcuries instead of millicuries

   N.B. Licensee correct

35.300 Use of Unsealed Byproduct Material, Written Directive Required

3. Pt. received Ra-223 at a clinic that is not an authorized use location for this material. Not administered by an AU

   Clinic may, prior to merger, have been Authorized Use Location and MD previously may have been AU.

   AU review indicated that amount of activity prescribed was appropriate

   Corrective action

   All future treatments will be administered at an authorized facility with an AU

35.300 Use of Unsealed Byproduct Material, Written Directive Required

^{153}Sm

1. Patient received 3.22 GBq (86.9 mCi) instead of 2.48 GBq (67.13 mCi).

   Cause

   Dosage from pharmacy was not correctly calculated for patient weight

35.300 Use of Unsealed Byproduct Material, Written Directive Required

^{131}I

1. Pt. received 1.96 GBq (53 mCi) instead of 4.47 GBq (120.8 mCi)

   Cause

   Total activity delivered in two capsules, but only one capsule administered

   Corrective action

   Licensee to revise procedures for transfer of radioactive materials

35.400 Non-Prostate Manual Brachytherapy

Cervix Cs-137

Sources: 44.46 mCi, 33.73 mCi, 25.39 mCi, 25.39 mCi. (Unspecified which sources in tandem)

- Catheter containing sources for tandem placed in wrong well for transport to patient room
- End of catheter crushed by cover of transport shield
- Unable to insert fully into tandem
- Catheter cut off to enable fit
- Result in sources not fully inserted

35.400 Non-Prostate Manual Brachytherapy

Cervix Cs-137 cont.

Underdose of tumor 1500 cGy instead of 3460 cGy

Overdose to lower rectum and vagina of 3492 cGy

Cause – inadequate training and written procedures contributed to human error

Corrective action – revising procedures, training personnel, improved supervision

35.400 Prostate Manual Brachytherapy

- 1 hospital with 2 events with Pd-103. D90 67% and 71% of prescribed 12,500 cGy. Unclear if would be ME based on new ME definition. No additional information such as root cause analysis provided.
- This led to retrospective investigation and an additional 13 events found. No details provided re: these.

35.400 Prostate Manual Brachytherapy

- I-125. D90 70%. But, 92% of activity was implanted in prostate (16.039 mCi out of planned 17.404 mCi). So, would not have been ME based on new definition. AU gave additional external radiation. Cause attributed to human error
- I-125: D90 60%, based on activity 58% implanted in prostate. Found by hospital in 2014. Discovered by regulator on inspection in 2015. Cause: Human error. Corrective action: Procedure modification and new training

35.400 Prostate Manual Brachytherapy

- I-125: D90 67%. No comment on activity. Cause seed migration. Corrective action: New training, new technique
- 1-125: Implanted a mass mistakenly thought to be prostate due to abnormal anatomy. Corrective action: New quality management plan, new written procedures and training.

35.600 HDR Brachytherapy

Event Site	Number of Events
Prostate	2
Gynecological	2
Skin	1

35.600 HDR Brachytherapy

- 1 wrong positioning of catheter
  - Thigh (instead of vagina) treated with 1000 cGy inadvertently, resulting in skin wound. Modified procedures.
- 1 wrong patient's plan delivered
  - Instituted time out policy.

35.600 HDR Brachytherapy

- 3 Equipment failures
  - 3 partial treatments. All worked with manufacturer and fixed or no problem found. Seems that treatment was eventually completed for two patient. No information about what was done as a consequence of the event for the other. (Delivered 103 cGy of planned 600 cGy for that treatment.)

35.1000 Perfexion

Gamma Knife Perfexion – 3 events

1. Treatment of right rather than left trigeminal nerve.
2. Treatment stopped to sedate patient. After 2 mins of restarting treatment, patient moved significantly. Frame was not in position at end of treatment. Timing of frame being dislodged is uncertain (not reportable).
3. Frame adapter was in the wrong position. Displaced distance was 2 cm in the direction of one plane. Error was attributed to using a new adapter without having received proper training from the manufacturer.

35.1000 Perfexion

Corrective Actions

- Procedure modification for incorrect treatment site.
- Proper training when using new frame adapters

35.1000 Y-90 Microspheres

	FY2013	FY2014	FY2015	FY2016
All ^{90}Y Microspheres	13	23	14	19
SIR-Spheres*	10	16	6	7
TheraSpheres	3	7	8	12

* ~8,400 doses sold in US in calendar year 2016

35.1000 Y-90 Microspheres Brachytherapy

16 / 19 – Wrong dose: 3-80% (14), 119-129% (2*)

- 5 – Obstruction in tubing
- 1 – Human error: Unspecified
- 1 – Human error: Residual activity incorrectly assayed
- 1 – Human error: Liver volume incorrectly calculated*
- 1 – Human error: Activity incorrectly calculated*
- 1 – Human error: Excessive activity left in vial
- 1 – Leak through needle hole in vial septum
- 1 – Breach of procedure: 3-way stopcock in circuit
- 4 – Cause not specified (possibly stasis?)

35.1000 Y-90 Microspheres Brachytherapy

4 /19 – Wrong site (incorrect liver segment)

2 /4 – "Catheter tip moved"

1 / 19 – Wrong patient / Wrong dose/ Wrong site

- For under-doses where administered activity <75% of prescribed activity: Patients generally re-treated
- For over-dose: No clinically demonstrable liver toxicity

35.1000 Radioactive Seed Localization

2 / 2 – Radioactive seeds not removed as scheduled due to deterioration of patient condition and risk of surgery

1 – Seeds removed 2 months later; 297 cGy to 1 cm, 40 cGy dose to breast

1 – Seeds not removed as of last report (3 month post-implantation); 73 cGy dose to breast

Patient intervention, not MEs?

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Summary of MEs FY13-FY16

	FY 2013	FY 2014	FY 2015	FY 2016
35.200	2	6	4	8
35.300	2	4	7	5
Manual brachy	16	5	8	7
HDR	8	9	13	5
GK	2	2	1	3
Microspheres	13	23	14	19
RSL	1	2	0	2

30

Conclusions

- No obvious trends or patterns but there are two lead causes:
  - Errors that could be detected by a "time out" prior to treatment/procedure (N=~9)
  - Microspheres
- Each year there are ~15M diagnostic and 150K therapeutic procedures performed utilizing radioactive materials
- The tiny fraction presented here today is reassuring and confirms the generally safe fashion these materials are administered to patients in the USA

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Acronyms

- cm – centimeter
- Cs – Cesium
- FY – Fiscal Year
- Gy – Gray
- HDR – High dose-rate
- I – Iodine
- MBq – megabequerel
- mCi – millicurie
- ME – Medical Event
- Pd – Palladium
- Pt(s) – Patient(s)
- QA - Quality Assurance
- rem – roentgen equivalent in man
- Y- Yttrium

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Medical Event Reporting and Impact on Medical Licensee Patient Safety Culture – Final Report

Susan M. Langhorst, Ph.D., CHP

ACMUI

September 11, 2017

Subcommittee Members

- **Dr. Vasken Dilsizian**
- **Dr. Ronald Ennis**
- **Dr. Susan Langhorst (Chair)**
- **Ms. Laura Weil**

Special thanks to Mr. Frank Costello for his work on the interim report and Mr. Zoubir Ouhib for his professional input to the subcommittee.

Subcommittee Charge

- **Explore the impact of ME reporting and its impact on self-reporting (safety culture).**
- **Identify potential ways to improve effectiveness of self-reporting in support of a culture of safety.**
- **Suggest ways to share ME reports and lessons-learned with the medical community to promote safety.**

Interim Report

- **Provided a common perspective of:**
  - **fundamental principles of radiological protection,**
  - **NRC regulatory history regarding patient safety,**
  - **development of safety culture programs in healthcare, and**
  - **current patient safety groups influencing medical use of byproduct materials.**
- **Interim report discussed by full Committee during April 2017 ACMUI meeting**

ACMUI Discussion Topics

- NRC ME reporting criteria set at conservative levels in comparison to other types of patient safety reporting criteria – leads to inconsistent level of response.
- MEs rarely cause patient harm, but why is notification required so quickly; NRC quick to inspect looking for violations.
- Professional organization accreditation programs and their patient safety requirements should be considered.

5

ACMUI Discussion Topics [cont.]

- NRC staff suggested considering a program like the ROP to implement improvements with current Part 35 reporting regulations.
- Added Subcommittee discussion since April 2017 ACMUI meeting – requirement to report MEs to the referring physician and to the patient for most MEs serves no productive purpose and may be harmful.

6

Short-Term Recommendations

NRC develop and test program (like done with ROP) to allow medical use licensee to evaluate MEs (10 CFR 35.3045, 35.1000 guidance, and 35.3047) with an approved patient safety program – any one or combination of:

- PSO (42 CFR 3) with 10 CFR 35 expertise
- Patient safety program reviewed by a
  - CMS-approved AO or
  - Professional organization accreditation program for 10 CFR 35 use

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NRC Patient Safety Program

- Licensee to report MEs per current requirements.
- NRC will not post event report on its website, or will make posting anonymous.
- NRC will not conduct reactive inspection except in special cases.
- Licensee will develop written report of ME review for next NRC inspection.
- NRC to develop temporary inspection procedures for report reviews and to evaluate enforcement manual changes for MEs to support test program.

8

NRC Patient Safety Program [cont.]

Test out the program for a year on –

- **Two large medical centers**
- **Two community hospitals**
- **Two rural hospitals**
- **Two patient clinics**

Evaluate MEs and reports with the ACMUI

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NRC Patient Safety Program [cont.]

During test period, develop minimum criteria for patient safety program reviews

- **Incident defined, relevant facts/circumstances identified, and findings/conclusions identified and substantiated.**
- **Cause/program weaknesses or shortcomings identified, and corrective actions taken.**
- **Past procedures evaluated to determine extent of condition for similar incidents.**

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NRC Patient Safety Program [cont.]

During test period,

- **Assess how ME reporting change impacts NRC ability to protect patient health and to minimize danger to the patient's life.**
- **Evaluate the different types of patient safety programs in how lessons learned from their patient safety incident reviews are shared with the medical community.**

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NRC Patient Safety Program [cont.]

After test period completed, NRC should consider opening the program to:

- **all NRC medical use licensees who request approval of their patient safety program, and**
- **to Agreement States who request to implement the program with their medical licensees.**

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Recommendation for NRC Policy and Regulatory Changes

Medical use is different.

Redefine the NRC perspective of patient safety to be different from occupational safety and from public safety.

13

Recommendation for NRC Policy and Regulatory Changes [cont.]

How is patient safety related to public health and safety?

Partner with HHS/AHRQ and ACMUI to develop a national database taxonomy specific for reporting patient events involving medical use of byproduct material.

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Recommendation for NRC Policy and Regulatory Changes [cont.]

How should NRC regulate, or otherwise support, patient health and safety?

Update the NRC Medical Use Policy and 10 CFR 35 event reporting regulations

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Acronyms

- **ACMUI** – Advisory Committee on Medical Uses of Isotopes
- **AHRQ** – HHS Agency for Healthcare Research and Quality
- **AO** – CMS-approved Accrediting Organization
- **CFR** – Code of Federal Regulations
- **CMS** – Centers for Medicare & Medicaid Services
- **HHS** – Department of Health and Human Services

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Acronyms [cont.]

- **ME** – medical event (includes 10 CFR 35.3045, 35.1000 guidance, and 35.4047)
- **NRC** – Nuclear Regulatory Commission
- **PSO** – Patient Safety Organization
- **ROP** – Reactor Oversight Process

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Advisory Committee on the Medical Use of Isotopes (ACMUI)

Medical Event Reporting and Impact on Medical Licensee Patient Safety Culture Draft Report

Report Submitted On: August 18, 2017

Subcommittee Members: V. Dilsizian, M.D.; R. Ennis, M.D., S. Langhorst, Ph.D. (Chair), and L. Weil

Charge: To 1) explore the impact of medical event reporting and its impact on self-reporting (safety culture); 2) identify potential ways to improve effectiveness of self-reporting in support of a culture of safety; and 3) suggest ways to share medical event (ME) reports and lessons-learned with the medical community to promote safety.

I. ACMUI April 2017 Discussion of Interim Report

This ACMUI Subcommittee began its work with an interim report[1] to provide a common perspective of the fundamental principles of radiological protection, of the U.S. Nuclear Regulatory Commission (NRC) regulatory history regarding patient safety, of the development of safety culture programs in healthcare, and of the current patient safety groups influencing medical use of byproduct materials. The ACMUI and NRC Staff discussed the interim report at its April 27, 2017 meeting[2] and how the NRC could better support medical licensees in promoting a positive patient safety culture. The Committee decided to continue exploration of how NRC ME reporting impacts a licensee's patient safety culture. The ACMUI asked the Subcommittee to provide a final report for presentation at the fall 2017 ACMUI meeting which provides specific options the NRC may take to encourage a licensee's patient safety culture, while maintaining its regulatory authority to protect patients during medical use of byproduct materials.

[1] Advisory Committee on the Medical Uses of Isotopes, "Medical Event Reporting and Impact on Medical Licensee Patient Safety Culture – Interim Report", April 27, 2017 – https://www.nrc.gov/docs/ML1713/ML17138A370.pdf (last accessed 8/8/2017).

[2] Advisory Committee on the Medical Uses of Isotopes, Transcript of the April 27, 2017 ACMUI meeting, pages 66-111 – https://www.nrc.gov/docs/ML1716/ML17164A217.pdf (last accessed 8/8/17).

II. Major Topics Identified for Consideration

During the ACMUI's discussion of the interim report, issues related to ME reporting were identified as having a negative impact on a licensee patient safety culture. Additional ideas were suggested on how the NRC could make changes to better encourage a licensee patient safety culture. These were the major topics from the April 2017 ACMUI discussion which the Subcommittee considered in developing recommendations for improved patient safety review and reporting.

- NRC ME reporting criteria are set at conservative levels, which NRC describes as rarely causing patient harm[3]. Other types of patient safety events typically require that a patient is harmed or is at identified risk of harm to reach the criteria for patient safety reporting to the applicable organization (e.g., The Joint Commission, Food and Drug Administration, Centers for Medicare & Medicaid Services, etc.). These different levels of reporting criteria lead to inconsistent levels of response to a patient safety event and cause confusion in the medical community. For example, reporting an ME to the NRC compels a medical licensee also to provide information on the event to other outside organizations who oversee the licensee's patient safety program. The licensee makes this additional reporting because they do not want these outside organizations to first learn from others of the ME report made to a federal agency. This additional reporting to other organizations can lead to confusion when the patient risk from the NRC ME is insignificant and on par with other patient safety events that a licensee would normally evaluate in-house.

- Despite recognition that NRC MEs rarely cause patient harm, a licensee is required to notify the NRC Operations Center no later than the next calendar day after discovery of the MEnt. Soon after this notification, an NRC inspection generally takes place looking for violations as cause of the ME.

- In discussion of alternative ways in which byproduct material patient safety events could be evaluated consistent with other patient safety events, patient safety requirements established under professional organization accreditation programs, such as the American College of Radiology (ACR) or the American Society for Radiation Oncology (ASTRO), should be considered along with Patient Safety Organizations and Accrediting Organizations discussed in the interim report.

- Given the length of time needed to make medical use regulatory changes, the NRC staff suggested that the Subcommittee explore the Reactor Oversight Process program[4] and the

[3] NRC NMSS Newsletter, "Purpose of Medical Event Reporting", Spring 2016, NUREG/BR-0117 No. 16-02 - https://www.nrc.gov/docs/ML1609/ML16091A236.pdf (last accessed 8/8/17).

[4] NRC Reactor Oversight Process, NUREG-1649, Rev 6 – https://www.nrc.gov/docs/ML1621/ML16214A274.pdf (last accessed 8/8/17).

The NRC "does not operate nuclear power plants. Rather, it establishes requirements for the design, construction, operation, and security of commercial nuclear power plants in the United States. The agency ensures the plants are operated safely and securely within these requirements by licensing the plants to operate, licensing control room personnel, establishing technical specifications for operating each plant, and inspecting plants on a daily basis.

way in which the NRC and reactor community developed and tested this change in regulatory oversight[5] for possible methods of implementing NRC medical event oversight improvements using current regulations.

In discussing this final report preparation, the Subcommittee was reminded of past ACMUI discussions in which the requirement to report MEs to the referring physician and to the patient for most MEs serves no productive purpose and may be harmful. The reporting requirement can cause unnecessary patient worry. Discussions with referring physicians are medical and like any other medical aspect, the licensee physician will discuss with the referring physician if there is a medical impact from the event. The Subcommittee questioned the rationale of telling the referring physician that the number of millicuries delivered was 21% more or less than prescribed, but this has no medical effect.

III. Recommendations to Change NRC Oversight of Current Medical Event Criteria

Given the development of patient safety regulations[6] and other requirements[7] resulting in the establishment of patient safety programs, we recommend the NRC take the following actions to change its oversight of current medical event criteria.

- Establish a program allowing a medical use licensee to evaluate MEs as described in 10 CFR 35.3045, in NRC 10 CFR 35.1000 licensing guidance, and in 10 CFR 35.3047 with an approved patient safety program. An approved patient safety program is any one or combination of the following:

    + A licensee patient safety program which commits to reporting MEs to a Patient Safety Organization approved under 42 CFR Part 3 (Department of Health and Human Services, Patient Safety and Quality Improvement) and which has expertise in medical use defined in 10 CFR 35.
    + A licensee patient safety program evaluated by an Accrediting Organization approved by the Centers for Medicare & Medicaid Services-approved accreditation program.
    + A licensee patient safety program which is established as part of accreditation by a professional organization for medical use defined in 10 CFR 35.

The NRC uses the Reactor Oversight Process (ROP) to assess a licensee's ability to safely operate a nuclear power plant in accordance with the NRC rules, regulations, license requirements, and adopted licensee standards. If the ROP identifies problems, the NRC can provide additional inspections and other actions in order to protect public health and the environment. The ROP benefits from what the NRC has learned from 30 years of improvements in nuclear industry performance, as well as improved approaches to inspecting and evaluating the safety and security performance of NRC-licensed plants."

[5] NRC SECY-99-007, "Recommendations for Reactor Oversight Process Improvements," January 8, 1999 – https://www.nrc.gov/reading-rm/doc-collections/commission/secys/1999/secy1999-007/1999-007scy_attach.pdf (last accessed 8/8/17).

[6] Department of Health and Human Services, "Patient Safety and Quality Improvement; Final Rule" established 42 CFR 3, 73 FR 70732, November 21, 2008 – https://www.gpo.gov/fdsys/pkg/FR-2008-11-21/pdf/E8-27475.pdf (last accessed 8/8/2017).

[7] Example: The Joint Commission, "Patient Safety Systems Chapter for the Hospital program" - https://www.jointcommission.org/patient_safety_systems_chapter_for_the_hospital_program/ (last accessed 8/8/17).

- NRC licensees with an NRC-approved patient safety program will continue to report medical events as required with the following conditions:

    + The NRC will not include this event notification in the Event Notification Report posted on its website. If this is not possible, the ME notification posted on the website will leave the licensee information and location anonymous[8].
    + The NRC will not conduct a reactive inspection of the ME unless the event results or will result in death, unintended permanent harm, or unintended significant temporary harm for which medical intervention was or will be required to alleviate the harm or reduce radiation effects.
    + The medical use licensee will write a report available for the next NRC inspection describing the event cause and corrective action taken.
    + NRC will develop, with ACMUI advice, new temporary inspection procedures for NRC review of licensee patient safety event reports, and will evaluate, with ACMUI advice, need to change enforcement manual procedures regarding MEs to support a test of this program.

- NRC should test out this program with two large medical centers, two community hospitals, two rural hospitals, and two patient clinics for a year, evaluating the ME reports with the ACMUI. During this test period, the NRC, with advice from the ACMUI, should do the following:
    + Develop the minimum criteria for patient safety program reviews, such as –
        - Patient safety event and related issues are well defined, the relevant facts and circumstances are identified and collected, and the findings and conclusions are identified and substantiated by the information and evidence associated with the ME or incident
        - Cause(s) and program weaknesses or shortcomings are identified for the patient safety incident, and corrective actions taken
        - Evaluation of past patient procedures is made to determine the extent of condition for similar patient safety incidents.
    + Assess how this change in ME reporting impacts the NRC's ability to protect patient health and to minimize danger to the patient's life.
    + Evaluate the different types of patient safety programs in how lessons learned from their patient safety incident reviews are shared with the medical community.

- After completion of the test year, the NRC should consider opening the program to all NRC medical use licensees who request approval of their patient safety program, and to Agreement States who request to implement the program with their medical licensees.

[8] The NRC may want to consider the following points when deciding whether to not to post these event notifications or to keep the licensee information anonymous: (a) a medical event seldom involves more than one or a few patients and is not ongoing for the licensee; (b) the majority of medical events do not result in patient harm; (c) this change would be consistent with other patient safety event reporting and may improve reporting and near-miss reporting; (d) lack of licensee information does not diminish the medical event information provided in the event report; and (e) NRC event reports are not a very good way to share medical event information.

IV. Recommendation for NRC Policy and Regulatory Changes Regarding Patient Safety

The NRC has historically developed regulations to promote patient safety in the medical use of byproduct materials with very few ME causing patient harm. However, the NRC ME reporting criteria are inconsistent with the level of patient safety event reporting criteria established in other areas of medical practice. The focus of NRC regulatory oversight and expertise on the medical use of byproduct material does not include oversight of the practice of medicine. Regulators and the medical community continue to debate where the demarcation of NRC oversight of medical use ends and the practice of medicine begins. At the heart of this debate is the intent by both the regulators and the medical community to support patient safety and deliver effective patient care.

Given the increased complexities associated with medical use of byproduct materials, especially with regard to therapeutic procedures, and the development and sophistication of patient safety programs, we recommend the NRC take the following actions to modify the NRC Medical Use Policy and medical use regulations and guidance.

- Redefine the NRC perspective of patient safety to be different from occupational safety and from public safety. As described in the ACMUI interim report[9], the NRC has departed from the fundamental principles of radiation protection by setting patient dose limits in 10 CFR 35.3045 and 35.3047. The NRC has applied dose limits to patients which are the same as those applied to exceeding occupational dose limits. And, the NRC has explicitly stated that the Commission considers a patient to be a member of the public to be protected by the NRC. We believe the Commission should re-evaluate its perspective on patient safety to be more in line with the fundamental principles of radiation protection and the ICRP exposures categories[10] of "occupational exposures, public exposures, and medical exposures of patients (and comforters, carers, and volunteers in research)".

- Partner with the Department of Health and Human Services (HHS), specially the Agency for Healthcare and Research and Quality (AHRQ)[11], and ACMUI to develop a national database taxonomy specific for reporting patient events involving medical use of byproduct material. Due to its strong regulatory authority, the NRC has been a leader in shaping a licensee's positive safety culture. The NRC has considered its patient safety model as part of its public health and safety charge. The recent development and sophistication of patient safety laws, regulations, and programs could be utilized by NRC in reviewing patient safety events and sharing lessons learned in support of improve overall patient safety and medical outcomes.

[9] Advisory Committee on the Medical Uses of Isotopes, "Medical Event Reporting and Impact on Medical Licensee Patient Safety Culture – Interim Report", April 27, 2017 – https://www.nrc.gov/docs/ML1713/ML17138A370.pdf (last accessed 8/8/2017).
[10] ICRP Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection" – http://www.icrp.org/publication.asp?id=ICRP%20Publication%20103 (last accessed 8/8/2017).
[11] HHS Agency for Healthcare Research and Quality – https://www.ahrq.gov/ (last accessed 8/8/17).

The long-standing Public Health Service Act[12] has recently been amended "to provide for the improvement of patient safety and to reduce the incidence of events that adversely effect [sic] patient safety" by inclusion of the Patient Safety and Quality Improvement Act of 2005[13]. The Department of Health and Human Services (HHS) implemented a final rule[14] to establish "a framework by which hospitals, doctors, and other health care providers may voluntarily report information to Patient Safety Organizations (PSOs), on a privileged and confidential basis, for the aggregation and analysis of patient safety events". The HHS is also working through its Agency for Healthcare Research and Quality[15] to develop sets of common definitions and reporting formats (Common Formats) for reporting on health care quality and patient safety as directed by the Patient Safety Act Sec. 923 to "facilitate the creation of, and maintain, a network of patient safety databases that provides an interactive evidence-based management resource for providers, patient safety organizations, and other entities"[12].

The NRC should explore partnering with HHS/AHRQ in developing a segment of the network of patient safety databases to which NRC medical use licensee patient safety programs would be required to report medical event information. The event taxonomy should include the criteria for which the licensee is required to report the event to NRC and the national database, the criteria for which the licensee is required to report the event to the national database, and the criteria for which the licensee is encouraged to report to database. In addition, the taxonomy should define the minimum specific information required to be reported by the licensee to ensure the reports are interpretable and meaningful. The information shared with the national database would be anonymous and used for the purpose of: reducing errors by identifying causes of preventable errors; developing, demonstrating, and evaluating strategies for reducing errors and improving patient safety; and disseminating effective strategies to all medical licensees.

- Update the NRC Medical Use Policy and 10 CFR 35 event reporting regulations. NRC medical use regulations should continue to support patient safety by establishing training and experience requirements, equipment requirements, radiopharmaceutical and sealed source requirements, and medical radiation safety program requirements. The NRC policy and regulations should update the requirements for patient safety programs to verify the active involvement of the licensee's patient safety program review of medical errors and reporting of reviews to the national patient safety database.

[12] Public Health Service Act, as amended through P.L. 114-255, Enacted December 13, 2016 - https://legcounsel.house.gov/Comps/PHSA-merged.pdf (last accessed 8/8/17).
[13] PUBLIC LAW 109–41—JULY 29, 2005 "Patient Safety and Quality Improvement Act of 2005" – https://www.congress.gov/109/plaws/publ41/PLAW-109publ41.pdf (last accessed 8/8/2017).
[14] Department of Health and Human Services, "Patient Safety and Quality Improvement; Final Rule" established 42 CFR 3, 73 FR 70732, November 21, 2008 – https://www.gpo.gov/fdsys/pkg/FR-2008-11-21/pdf/E8-27475.pdf (last accessed 8/8/2017).
[15] HHS Agency for Healthcare Research and Quality, "Program Brief – Network of Patient Safety Databases – Lessons From PSOs on Applying the AHRQ Common Formats for Patient Safety Reporting," November 2015 – https://pso.ahrq.gov/sites/default/files/wysiwyg/npsd-common-formats-brief.pdf (last accessed 8/8/17).

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ACMUI's "Patient Intervention" Subcommittee Report – PART III

Vasken Dilsizian, M.D.
ACMUI Nuclear Cardiologist
September 11, 2017

Charge

Clarify 2017 ACMUI recommendation from the April 27, 2017, Advisory Committee on the Medical Uses of Isotopes (ACMUI) presentation of "Patient Intervention Subcommittee Report – Part II" by specifying how Unintentional Treatment Outcome events reporting to the Nuclear Regulatory Commission (NRC) can be modified in order to be less punitive and more informative and educational.

Subcommittee Members

Vasken Dilsizian, M.D. (Chair)
Ronald Ennis, M.D.
John Suh, M.D
Laura Weil

2015 ACMUI Recommendations

Issue II: Relates to ALL Treatments and not limited to Y-90 microspheres

- **Unintentional Treatment outcome due to anatomic or physiologic anomaly and/or imaging uncertainty falls into the category "the Art of Medical Practice" provided that the standards of medical practice are met.**
- **Reporting such unpredictable and unavoidable patient-specific medical events will not help to prevent such events in the future, and therefore cannot be regulated.**

Recommendation for NRC Policy and Regulatory Changes for Unintentional Treatment Outcome Events Reporting

1. Define “High” vs “Low” Impact Events
2. High Impact events will require timely notification to NRC, NRC reactive inspection, and timely written report to NRC
3. Low Impact events will not require notification to NRC

5

Recommendation for NRC Policy and Regulatory Changes for Unintentional Treatment Outcome Events Reporting

4. Low Impact events will undergo self-evaluation and corrective action reporting through NRC-approved Patient Safety Organizations, Accrediting Organizations or institutional robust patient safety program

6

Recommendation for NRC Policy and Regulatory Changes for Unintentional Treatment Outcome Events Reporting

5. Ideally, only high impact events should be made public. Low impact events should be anonymous to licensee information and location

7

QUESTIONS?

8

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Nursing Mother Guidelines for the Medical Administration of Radioactive Materials

Darlene F. Metter, M.D.

ACMUI

September 11, 2017

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Sub-Committee Members

Vasken Dilsizian, M.D.
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Christopher Palestro, M.D.
Pat Zanzonico, Ph.D.

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Subcommittee Charge:

Review the radiation exposure from diagnostic and therapeutic radiopharmaceuticals including brachytherapy to the nursing mother and child.

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Nursing Mother

- May need a diagnostic or therapeutic nuclear medicine procedure
- Concern: Radiation exposure to the nursing mother and nursing child

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10 CFR 35.75

- Patient released if the total EDE to any individual will not exceed 5 mSv (0.5 rem)
- If nursing child dose could exceed an EDE of 1 mSv (0.1 rem), written instructions must be given on consequences and guidance on the discontinuation of nursing

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Nursing or Breastfeeding

- Infant feeding from the breast
- Lactation: milk production driven by: Prolactin (suckling) and milk removal
- Lactation cessation: 6 weeks from last feeding

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Interruption Period

- Milk breast pumped before radiopharmaceutical given: feed during interruption period
- Milk breast pumped after radiopharmaceutical given: decay for feeding or discard

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Breast Milk & Drugs

- Many drugs enter the maternal circulation allowing for secretion into breast milk
- Radiopharmaceutical breast uptake peaks at 3-4 hr post administration

Radiation: Lactating Breast

- Radiopharmaceutical uptake in lactating breast > non-lactating breast
- Radiation exposure in lactating > non-lactating breast

Absorbed Dose: Lactating Breast

- Most radiopharmaceuticals <10% excretion into milk, most 0.3– 5%
- Exceptions: ^{67}Ga-citrate and ^{131}I-NaI, >10% into breast milk, high absorbed dose to breast

^{131}I-NaI Lactating Breast

- Lactating breast ^{131}I-NaI uptake > than non-lactating breast
- Before ^{131}I-NaI therapy: stop nursing 6 wks after last breast feeding to cease lactation & lower breast dose

Radiation to Nursing Child

- **External**: Maternal exposure
- **Internal**: Ingestion of radioactive milk

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External: Maternal to Child

- Mother: radiation source
- Close proximity of mother to child: nursing, child care
- Dose can be very significant
- $Dose_{child}$ = $breast_{mother}$ + $whole\ body_{mother}$

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Internal: Milk ingestion

- < 10% excretion into milk, usually 0.3 -5.0%
- $Dose_{child}$ = Milk ingested

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Total Dose: Nursing Child

- $Dose_{child}$ = external + internal
- No breast feeding interruption
- Most radiopharmaceutical doses exceed 0.1 rem to the nursing child

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Radiotherapy & Other

- Brachytherapy
- Radioembolic therapy
- Radioactive seed localization

Brachytherapy

- Boost radiation dose for early stage breast cancer (lumpectomy site)
- Recent decrease use; complex
- Mammosite: simpler, 2 treatments per day x 5 days

Radioembolic Therapy (^{90}Y)

- ^{90}Y-labeled microspheres, pure beta emitter
- Intra-arterial embolism for liver tumors

Radioactive Seed Localization

- Pre-operative localization of non-palpable breast lesions for surgical excision
- Usually ^{125}I seed(s)
- Seed(s) removed at surgery

Recommendations for Nursing Mothers

- Maximum $dose_{child}$ of 1 mSv (0.1 rem)
- Current NRC and ICRP recommendations
- Incorporates breast feeding and proximity interruption time periods

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Breast Feeding Interruption

- ^{99m}Tc-labeled: 24 hr
- ^{18}F or ^{68}Ga-labeled: 12 hr
- ^{11}C, ^{13}N, ^{15}O, ^{82}Rb: None
- ^{123}I-NaI: 7 days

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Breast Feeding Interruption

- ^{111}In leukocytes: 7 days
- ^{201}Tl-chloride: 14 days
- ^{89}Zr: 28 days
- ^{177}Lu (diagnostic): 35 days

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Breast Feeding Cessation

- ^{131}I-NaI*
- ^{67}Ga-citrate
- ^{177}Lu (therapeutic)
- ^{223}Ra and all alpha emitters

*For the current child, 6 weeks before ^{131}I-NaI therapy

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Brachytherapy & Radioactive Source/Seeds

- ^{90}Y does not enter the systemic circulation, breast tissue nor breast milk: No nursing interruption
- No radioactivity when source or seed(s) are removed

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Patient Information

- Nuclear medicine & nuclear cardiology clinics post signage to alert the nursing mother to inform staff so that radiation safety precautions with respect to nursing can be implemented.

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Acronyms

- CFR: Code of Federal Regulations
- EDE: Effective dose equivalent
- ICRP: International Commission on Radiological Protection
- NRC: Nuclear Regulatory Commission

Advisory Committee on Medical Uses of Isotopes (ACMUI)
Sub-Committee on Nursing Mother Guidelines for the Medical Administration of Radioactive Materials

Subcommittee Members:

Vasken Dilsizian, M.D., Darlene Metter, M.D. (Chair), Christopher Palestro, M.D.,

Pat Zanzonico, Ph.D.

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Introduction

Nursing or breastfeeding is the feeding of an infant from the female breast. Breast milk is a perfect source of nutrition for infants and lactation is the process of milk production. Shortly after delivery, along with the initiation of supply and demand and the maintenance of lactation, milk production soon becomes relatively constant. Approximately 140 mL is consumed per feeding, with a total of 800 mL produced per day[1]. Lactation is most abundant when the infant is suckling[2] and will continue as long as milk is being removed. Involution or the cessation of milk production generally occurs six weeks after the last breastfeeding[3].

Diagnostic or therapeutic radiopharmaceuticals may at times be needed in the medical management of the nursing mother, but these radiopharmaceuticals often appear in breast milk[4]. Thus, the use of radioactive material during nursing raises radiation exposure concerns for both the nursing infant and mother. To the nursing infant, this exposure comes from internally ingested radioactive milk and external maternal exposure, as the nursing mother is a radiation source and is often in close proximity to the infant. Therefore the charge of this subcommittee is "To review the radiation exposure from diagnostic and therapeutic radiopharmaceuticals including brachytherapy to the nursing mother and child."

Current Guidance

Breastfeeding is not regulated. A nursing mother, which has been administered unsealed byproduct material, can be released by a licensee if the total effective dose equivalent to any other individual, including her nursing child, will not exceed 5 mSv (0.5 rem). If a nursing mother continues to breastfeed after receiving a radiopharmaceutical, and the nursing child's radiation exposure could exceed an effective dose equivalent of 1 mSv (0.1 rem), written instructions must be given to the mother regarding the potential adverse consequences if breastfeeding is not interrupted or ceased, and guidance given on the discontinuation of breastfeeding (10CFR 35.75)[5].

Radiation Safety

The ALARA (As Low As (is) Reasonably Achievable) principle is the Nuclear Regulatory Commission's (NRC) guidance on radiation safety (10 CFR 20.1003). ALARA directs the licensee and individuals to take every reasonable effort to decrease ionizing radiation exposure as far below the dose limits as practically possible. Such instructions should be individualized to include the consideration of available resources and value. Considering these factors, many nuclear medicine procedures are semi-elective, and for the nursing mother such studies can often be delayed or cancelled to allow for the interruption or cessation of breastfeeding[6].

Radiopharmaceuticals

Radiopharmaceuticals consist of two components: the radioisotope and the non-radioactive carrier targeted for a specific metabolic pathway. Once administered, these agents circulate and undergo both radioactive decay of the radioisotope and biologic elimination of the carrier component. This pharmacokinetic clearance is termed the effective half-life. The radiopharmaceutical's effective half-life is represented by a formula combining both the radioactive decay (physical half-life) and the metabolic elimination (biologic half-life) of the radiopharmaceutical. The physical half-life is defined as the time interval for radioactive material to decrease to ½ of its original radioactivity, and the biologic half-life as the time interval for a substance to lose ½ of its pharmacologic, physiologic, or radiologic activity. Ten physical half-lives of a radionuclide approximate 0.001 of the original radioactivity or 99.999% of a radioisotope's radioactive decay[7]. Alternatively, five biologic half-lives of most non-radioactive drugs account for 97% of drug clearance, and presumably this clearance also applies to breast milk[8].

Lactation and Breastfeeding Cessation

Once established, milk production is influenced by many hormones and driven by the effective removal of milk from the breasts. Prolactin is the most important lactation hormone. Suckling stimulates feedback mechanisms which promote the release of prolactin and an increase in milk production. Without prolactin, lactation does not occur. The cessation of lactation involves a decrease in prolactin and an increase in a protein, known as "Feedback Inhibitor of Lactation", which also helps slow milk production. The cessation of lactation generally occurs six weeks after the last breastfeeding[9].

Due to feedback mechanisms, if a mother receives a radiopharmaceutical and temporarily ceases breastfeeding, she is advised to breast pump during this "interruption period." Breast milk can also be expressed before such a procedure, and the expressed milk can be used to feed the nursing child until breastfeeding can be resumed[10].

Since many radiopharmaceuticals are secreted into breast milk, during this interruption period, the mother may also express and store her milk to be used after the milk is no longer

radioactive[11]. This radioactive waiting time is usually 10 physical half-lives of the radiopharmaceutical (i.e., ^{99m}Tc physical half-life is 6 hours equating ten half-lives to 60 hours). Alternatively, the nursing mother may choose to discard the expressed milk.

It is advised that nursing mothers inform their healthcare provider of their breastfeeding status so that if a medical procedure is needed, decisions can be made to maximize patient outcomes while minimizing overall risk to the nursing mother and infant[12]. Appropriate signage should also be posted in the nuclear medicine clinic/waiting room alerting women to notify the nuclear medicine staff if they are breastfeeding before their procedure.

Breast Milk and Drugs

When substances enter the maternal circulation via ingestion or parental routes, this vascular delivery allows for diffusion of material from the glandular breast alveoli into maternal milk. Many factors control the regulation of this diffusion to include the 400-500 times increase in blood flow to the lactating breast. A brief period of greater alveolar diffusion occurs shortly after child delivery, thereby permitting a higher level of antibodies, antibacterial factors and other substances to concentrate in breast milk. These diffusion factors are facilitated by low molecular weight, low protein binding and high lipid solubility[13].

Although the exact mechanism of radiopharmaceutical uptake into breast milk is unknown[14], a drug's concentration in the maternal circulation is generally proportional to its concentration in breast milk. In other words, higher serum levels usually equate to a higher drug level in breast milk.

Radiopharmaceutical uptake by the breast is fairly rapid with peak concentrations at 3-4 hours after administration. Studies on breast milk uptake have reported a high variation for the same radiopharmaceutical, and at times within the same patient. The biologic half-time clearance however appears less variable[15].

Radiation Exposure: Maternal Lactating Breast from Diagnostic and Therapeutic Radiopharmaceuticals

Systemically administered radiopharmaceuticals will localize in variable amounts to all body tissues, including the breasts. In lactating breasts, there may also be enhanced uptake and secretion into breast milk of certain radiopharmaceuticals and possibly their radioactive metabolites[16 17 18 19 20 21 22 23 24 25 26 27 28]. This greater uptake would result in an increased radiation dose to the lactating relative to the non-lactating breast. Due to the relatively high sensitivity of the female breast to radiation carcinogenesis[29], this enhanced radiation dose to the lactating breast warrants consideration. This section therefore addresses the radiation dose to lactating breasts and provides absorbed dose estimates for commonly used radiopharmaceuticals (Table YY1).

The time-integrated activity (also known as the cumulated activity or residence time) in the lactating breasts results from radiopharmaceutical secretion into breast milk and was estimated by Stabin and Breitz[30]. These investigators assumed a linear filling of milk into the breast to a milk volume of 142 ml over 4 hours and then instantaneous emptying at feeding or pumping. The absorbed breast dose was calculated by using the breast-to-breast S values for the Reference Adult female anatomic model of Stabin et al[31]. No attempt was made to model the effect of a temporary interruption of breast-feeding since the mother would likely express/pump milk from her breasts at regular intervals, and the net effect would be comparable to actual breast-feeding.

The 2 to 5 time increase in breast mass that occurs during pregnancy and lactation was also considered. Due to individual variability, these changes were difficult to model with certainty. However, the overall effect of a larger lactating breast would be a decrease in the absorbed breast dose since the radioactivity will be deposited over a larger mass. Stabin and Breitz used a standard breast mass (400 g for both breasts) which produced a conservative upper breast dose estimate for most women and a reasonable though less conservative estimate for smaller breasts.

For ^{18}F-FDG in positron emission tomography (PET), the individual breast activity, expressed as the standard uptake value (SUV), was measured by Hicks et al[32] in a series of oncology patients at one hour after ^{18}F-FDG injection. Since the biokinetics of FDG are well known, the one hour SUV was assumed to reflect the maximum breast activity. Conservatively, the kinetics of FDG breast uptake were ignored (i.e.,. uptake was considered instantaneous) and elimination of activity was assumed to occur only by physical decay (i.e., ignoring the effect of actual breast feeding or pumping); given the short physical half-life of ^{18}F (1.2 hours), the latter assumption is likely not overly conservative. The ^{18}F-FDG breast-to breast absorbed dose was calculated using the *OLINDA* computer program[33], again assuming breast-to-breast S values for the Reference Adult Female model[34]. The absorbed-dose estimates for the lactating breasts thus correspond to self-irradiation (i.e., breast-to-breast) values.

The majority of administered radiopharmaceuticals report less than 10% excretion into breast milk, with most estimates at 0.3 to 5% of the injected dose[35]. Several authors have reported higher radiopharmaceutical concentrations and cumulative excretions in patients with greater milk production. Only with ^{67}Ga-citrate and ^{131}I-NaI have cumulative excretions greater than 10% been reported[36]. Consequently, except for ^{67}Ga-citrate and ^{131}I-NaI, the highest absorbed dose estimates to the lactating breasts for typical diagnostic administered activities are usually well under 1 rad (0.01 Gy). ^{67}Ga-citrate and ^{131}I-NaI are both actively secreted into breast milk, and result in notably higher absorbed doses to the lactating breasts: 1.1 rad (0.011 Gy) for an administered activity of 5 mCi (185 MBq) of ^{67}Ga-citrate and 200 rad (2 Gy) for a therapeutic administered activity of 150 mCi (5,550 MBq) of ^{131}I-NaI. The exceptionally high ^{131}I-NaI dose to the lactating breasts is worrisome, and has led to recommendations for lactating women for whom radioiodine therapy is planned to discontinue breast-feeding six weeks prior to therapy[37 38]. Breast-feeding stimulates lactation and the involution or the cessation of lactation generally

occurs six weeks after the last breastfeeding. The absence of lactation will minimize radioiodine concentration in the breast and the absorbed breast dose[39].

Radiation Exposure: Nursing Child from Nursing Mother

The dosimetric analyses in this section assume that there was no interruption of breast-feeding following administration of the radiopharmaceutical to the mother.

(a) External Maternal Radiation to the Nursing Child

The most apparent mode of radiation exposure to a nursing child from radiopharmaceutical administration to the child's mother is ingestion of maternal milk containing radioactivity. In addition, the nursing child will be exposed externally from radioactivity in the mother, and this exposure may be significant given the proximity of the mother and child during nursing and child care. Given the general lack of pertinent data in the literature, the external absorbed dose to the nursing child has been estimated by the following model calculations:

$$D_{\text{nursing child}}\big|_{\text{ext}} = D_{\text{nursing child}\leftarrow\text{maternal breast}}\big|_{\text{ext}} + D_{\text{nursing child}\leftarrow\text{maternal rem}}\big|_{\text{ext}} \quad (1)$$

where

$D_{\text{nursing child}\leftarrow\text{maternal breast}}\big|_{\text{ext}}$ = the external absorbed dose to the nursing child from activity in the maternal breast

and

$D_{\text{nursing child}\leftarrow\text{maternal rem}}\big|_{\text{ext}}$ = the external absorbed dose to the nursing child from activity in the maternal remainder of body (assumed to be equivalent to the maternal torso).

The external absorbed dose to the nursing child from activity in the maternal breast, $D_{\text{nursing child}\leftarrow\text{maternal breast}}\big|_{\text{ext}}$, and in the maternal remainder of body, $D_{\text{nursing child}\leftarrow\text{maternal rem}}\big|_{\text{ext}}$, can be calculated by Equations (2) and (3), respectively:

$$D_{\text{nursing child}\leftarrow\text{maternal breast}}\big|_{\text{ext}} = \tau_{\text{maternal breast}} \bullet A \bullet \Gamma \bullet \frac{1}{r_{\text{breast-to-child}}^2} \bullet CF_{\text{point-to-line}|\text{breast}} \bullet 0.5 \bullet [1-\phi(\text{breast-to-breast})] \bullet E_{\text{nursing}} \quad (2)$$

and

$$D_{\text{nursing child}\leftarrow\text{maternal rem}}\big|_{\text{ext}} = \tau_{\text{maternal rem}} \bullet A \bullet \Gamma \bullet \frac{1}{r_{\text{maternal rem-to-child}}^2} \bullet CF_{\text{point-to-line}|\text{maternal rem}} \bullet 0.5 \bullet [1-\phi(\text{maternal WB}\leftarrow\text{maternal WB})] \bullet E_{\text{nursing}} \quad (3)$$

where $\tau_{\text{maternal breast}}$ = the radionuclide residence time in the maternal breast (in h),

$\tau_{maternal\ rem}$ = the radionuclide residence time in the maternal remainder of body (in h),

A = the administered activity (in μCi),

Γ = the radionuclide specific gamma-ray constant (in R-cm^2/μCi-h),

$r_{breast\text{-}to\text{-}child}$ = the maternal breast-to-child distance (in cm), that is, the distance from the mid-line of the maternal breast to the mid-line of the nursing child,

$r_{maternal\ rem\text{-}to\text{-}child}$ = the maternal remainder of body-to-child distance (in cm), that is, the distance from the mid-line of the mother's torso to the mid-line of the nursing child,

$CF_{point\text{-}to\text{-}line|breast}$ = the point source-to-line source conversion factor for the breast,

$CF_{point\text{-}to\text{-}line|maternal\ rem}$ = the point source-to-line source conversion factor for the maternal remainder of body (corresponding to the maternal torso),

ϕ(breast-to-breast) = the breast-to-breast photon absorbed fraction,

ϕ(maternal WB-to-maternal WB) = the maternal whole body (WB)-to-maternal whole body (WB) photon absorbed fraction,

and $E_{nursing}$ = the occupancy factor for nursing.

The radionuclide residence times in the breast milk, $\tau_{maternal\ breast}$, and in the maternal remainder of body, $\tau_{maternal\ rem}$, can be calculated by Equations (4) and (5), respectively:

$$\tau_{breast\ milk} = 1.44 \bullet F_{breast\ milk} \bullet \sum_{i=1}^{n} f_{i|breast\ milk} \bullet (T_e)_{i|breast\ milk} \quad (4)$$

and

$$\tau_{maternal\ rem} = 1.44 \bullet F_{maternal\ rem} \bullet \sum_{i=1}^{n} f_{i|maternal\ rem} \bullet (T_e)_{i|maternal\ rem} \quad (5)$$

where $F_{breast\ milk}$ = the cumulative fraction of the administered activity in breast milk,

$f_{i|breast\ milk}$ = the fraction corresponding to component i of the exponential function describing the time-activity data for breast milk,

$(T_e)_{i|breast\ milk}$ = the effective half-time of component i of the exponential function describing the time-activity data for breast milk,

$F_{\text{maternal rem}}$ = the fraction of the administered activity in maternal remainder of body,

$f_i|_{\text{maternal rem}}$ = the fraction corresponding to component i of the exponential function describing the time-activity data for the maternal remainder of body,

and $(T_e)_i|_{\text{breast milk}}$ = the effective half-time of component i of the exponential function describing the time-activity data for the maternal remainder of body.

Implicit in equations (2) and (3) is the assumption that the beta particle contribution to the external dose from the mother to the nursing child is negligible; given the very short range of beta particles in tissue, this is a reasonable assumption. The factor, 0.5, in equations (2) and (3), reflects the fact that radiations emitted from within the mother have an equal probability of traveling either towards or away from the nursing child. Further, rather than modeling the maternal breast and torso as point sources, they have been modeled as line sources as described by Siegel et al[40]); this provides a more accurate approach to estimating the distance-dependence of the mother-to-child doses than the conventional point-source model.

(b) Internal Radiation Dose to the Nursing Child from Ingestion of Radioactive Milk

The second major pathway for radiation exposure to a nursing child resulting from radiopharmaceutical administration to the child's mother is the ingestion of radioactive maternal milk. As noted above, generally less than 10% of an administered radiopharmaceutical activity is excreted into breast milk, and typical estimates range from 0.3% to 5% of the initial injected activity[41]. Only with ^{67}Ga-citrate and ^{131}I-NaI have higher cumulative excretions been reported, up to ~10 and ~25%, respectively[42]. Based on the cumulative fraction of the administered activity in breast milk and the half-time(s) of clearance from breast milk (Table YY3), radiopharmaceutical residence times can be calculated using equation (4).

Assuming complete ingestion of the radioactive milk by the nursing child and ignoring the subsequent kinetics of absorption of and clearance from the child, the whole-body residence time of the radiopharmaceutical in the child can be equated with its residence time in the breast milk, $\tau_{\text{breast milk}}$. An upper limit of the whole-body absorbed dose to the nursing child (specifically, for the Reference Newborn anatomic model) from ingestion of radioactive milk, $D_{\text{nursing child}}|_{\text{int}}$, can then be derived using equation (6):

$$D_{\text{nursing child}}\big|_{\text{int}} = \tau_{\text{breast milk}} \bullet DF(WB \leftarrow WB)_{\text{newborn}} \qquad (6)$$

where

$DF(WB \leftarrow WB)_{\text{newborn}}$ = the whole body-to-whole body dose factor (in rad/mCi-h) for the Reference Newborn anatomic model

Implicit in the dose estimates shown in Table YY3 is that breast-feeding was *not* interrupted following administration of the radiopharmaceutical to the nursing mother.

(c) Total Radiation Dose to the Nursing Child

The total radiation doses to a nursing child for various radiopharmaceuticals administered to the mother, calculated by summing the respective external and internal radiation doses, are presented in Table YY4; these represent the mean whole-body absorbed doses to the child. The calculated absorbed doses to the nursing child if breast-feeding were *not* interrupted uniformly exceed 0.1 rad (= 100 mrad) and thus the 100-mrem (1-mSv) maximum recommended dose limit for a nursing child.

Despite the conservative assumptions implicit in estimating the doses for ^{18}F-FDG and ^{99m}Tc-labeled radiopharmaceuticals, these doses only slightly exceed the 100-mrem dose limit. ^{67}Ga-citrate and ^{131}I-NaI doses however, exceed the 100-mrem dose limit by more than an order of magnitude and with ^{131}I-NaI therapy by several orders of magnitude. Therefore, excluding ^{67}Ga-citrate and ^{131}I-NaI, a temporary discontinuation of breast-feeding following maternal radiopharmaceutical administration is required to maintain the radiation doses to the nursing child below the 100-mrem (1-mSv) dose limit.

The magnitude of the doses to the nursing child for ^{131}I-NaI, especially for therapy, reinforces the need for permanent discontinuation of breast-feeding for the current child following ^{131}I-NaI administration to the mother. Breast feeding, however, is allowed for future pregnancies. The radiation dose to the nursing child's thyroid will be considerably higher than that to the whole-body (in addition to potential damage to the child's thyroid), therefore, reinforcing the need to cease breast-feeding for any ^{131}I administration.

Radiation Exposure to the Nursing Child from Implanted Sources: Brachytherapy and Radioactive Seed Localization

Brachytherapy is an important type of radiation therapy for breast cancer, especially in breast conservation surgery for early-stage cancer[43 44 45], where the purpose is to deliver a localized boost dose to the lumpectomy bed after whole-breast radiation. Recently, a decline in the use of brachytherapy has been noted. The rationale for this observation may be related to a wider access of external-beam electron radiotherapy, which can deliver this boost, and controversy as to whether a boost dose is needed in all early-stage breast cancer after breast conservation and whole-breast radiation therapy. Brachytherapy nevertheless remains the preferred boost technique in certain patients.

In early-stage breast cancer, brachytherapy may be the sole radiation after lumpectomy and in combination with local excision as an alternative to mastectomy for local recurrence after breast-conservation and the initial radiation therapy.

Historically, multi-catheter-based implants were the most commonly used approach to such partial-breast brachytherapy[46 47]. In properly selected patients, data for these implants suggested high success rates of local control and excellent cosmesis. Despite these results, the use of

interstitial brachytherapy has been limited due its procedural and treatment planning complexity and a steep learning curve.

The MammoSite RTS™ balloon brachytherapy applicator (originally marketed by Proxima Therapeutics, Alpharetta, GA) was developed as a simpler, more reliable method for localized breast brachytherapy[48 49 50 51]. The MammoSite device accommodates a high-dose-rate source at the center of an inflatable balloon that is placed uninflated into the lumpectomy cavity, generally at the time of but not always at lumpectomy, to deliver a high localized dose to the lumpectomy bed. This device is a silicone balloon containing catheter (0.6 cm wide X 15 cm length) with dual channels, one for saline balloon inflation with an injection port and a larger treatment channel for passage of a high-dose iridium source with a Luer fitting. The balloon is inflated with sterile saline, often with radiographic contrast, to conform to the lumpectomy cavity and targeted cavity lining. The radioactive seed is advanced into the catheter and the radiation dose is delivered over five days with two treatments per day.

The typical treatment plan for MammoSite RTS™ monotherapy is 34 Gy delivered at 1 cm from the balloon surface with a minimum of six hours between same-day fractions. After each treatment, the seed is removed and no radioactivity remains in the breast. Accordingly, Mammosite RTS™ does not present limitations for breast-feeding, which can be continued immediately before or after the five day course and between treatment fractions. Breast-feeding should be suspended while the sources are in place.

Radioembolic therapy using ytrrium-90 (^{90}Y)-labeled microspheres (SirSpheres™, TheraSperes™) is a safe and effective treatment for unresectable liver tumors[52 53]. These microspheres are labeled with ~100 mCi or more of ^{90}Y and under fluoroscopic guidance are infused intra-arterially to selectively treat tumors, thereby relatively sparing normal tissue. The ^{90}Y microsphere system is considered a medical device (i.e., a brachytherapy device) and is licensed under 10CFR35.1000 ("Other medical uses of byproduct material or radiation from byproduct material"). As a pure beta emitter, ^{90}Y does not cause a significant external radiation hazard from the resulting *bremsstrahlung* which produces only a negligibly small external dose[54]. For lactating mothers who receive ^{90}Y -SirSpheres™ or -TheraSpheres™, breast-feeding does not need to be interrupted, as the ^{90}Y does not enter the systemic circulation, breast tissue nor breast milk.

The purpose of radioactive seed localization (RSL) is to preoperatively localize suspicious non-palpable breast lesions for surgical excision[55 56]. RSL is an alternative to the traditional needle-wire- preoperative localization, wherein a non-radioactive percutaneous wire is placed into the breast to guide surgical excision of suspicious tissue. RSL has several advantages over the wire-implantation technique. These include: post-localization mammographic lesions are not obscured by localizing wires; more flexible scheduling, as RSL can be performed for up to a week (or longer) before surgery; no protruding wires from the skin; and improved cosmesis as the RSL incision is generally smaller and more direct.

RSL uses iodine-125 or less often palladium-103 brachytherapy seeds (usually one but up to four seeds of 200-300 μCi each) implanted percutaneously by a radiologist employing a needle under mammographic or ultrasound guidance. The surgical procedure and seed removal are performed 2 to 7 days post-implantation, although seed implantation and same day surgery are sometimes performed. The radioactive seed(s) and thus lesion(s) are localized for excision with an intra-operative gamma probe. This technique is identical to sentinel lymph node biopsy which results in minimal trauma to normal tissue. The seed(s) may be removed intra-operatively from the tissue specimen or, more commonly, the tissue specimen containing the seed(s) are sent to Pathology for seed removal, analysis and documentation. The seed(s) are then disposed in accordance with 10 CFR 35.92 or the equivalent Agreement-State regulations. Breast-feeding should be suspended while the sources are in place. No radioactivity remains in the breast once all seeds have been surgically removed and accounted for. Breast-feeding can be continued up to seed implantation and resumed immediately after seed removal.

Precautions for Nursing Mothers: Recommendations and Rationale

Existing recommendations for nursing mothers promulgated by the NRC[57], the International Commission on Radiological Protection (ICRP)[58], and others[59] are based on a maximum dose (i.e., dose equivalent) to the nursing child of 100 mrem (0.1 rem). As summarized in Table YY5, the extant recommended precautions for nursing mothers are somewhat variable for both the actual radiopharmaceutical and the time interval for breast feeding interruption following radiopharmaceutical administration to the nursing mother. The cited NRC and the ICRP recommendations are the most current and up-to-date.

In formulating the current recommendations – listed in the last column in Table YY5 – our Sub-Committee generally selected the most conservative existing recommendation, which was usually the longest interruption period for each radiopharmaceutical. To the extent that is practical, expressed radioactive milk can be held for decay in storage for the same length of time as the recommended interruption period and then used for feeding the child. The Sub-Committee's recommended interruption periods apply not only to breast-feeding but also to the close physical proximity of the nursing mother to the nursing child (i.e., caressing or holding the child with a similar distance to the mother as for breast-feeding).

The following are seven Sub-Committee recommendations for the nursing mother:

1. For ^{99m}Tc-labeled radiopharmaceuticals, rather than a radiopharmaceutical-specific interruption period, a single interruption period of 24-hours is recommended. Although this time interval may be excessive for some ^{99m}Tc-labeled radiopharmaceuticals, it will be compliant with the 100-mrem dose limit and will simplify the guidance and avoid confusion and possible errors.

2. For ^{18}F-FDG, other ^{18}F-labeled and all gallium-68 (^{68}Ga)-labeled radiopharmaceuticals, a 12-hour interruption period is recommended. This conservative recommendation is cautious and simplifies safety instructions for patients and medical professionals. 12-hours is recommended for ^{68}Ga since it has a comparable physical half-life with ^{18}F, the marked uptake of any free radiogallium in breast milk, and the lack of relevant data on ^{68}Ga-labeled agents in nursing mothers.

3. For positron-emitting radionuclides used in PET, carbon-11 (^{11}C) (physical half-life: 20.4 min), nitrogen-13 (^{13}N) (9.97 min), and oxygen-15 (^{15}O) (2.04 min), and generator-produced rubidium-82 (^{82}Rb) (1.27 min), no interruption of breast-feeding is recommended. These short-lived isotopes have no significant activity remaining in the patient after departure from the imaging facility.

4. For iodine-123 in the form of NaI (^{123}I-NaI), an interruption period of 7 days is recommended. This is in marked contrast to the past, where complete cessation of breast-feeding for the current child was recommended. This older, more stringent ^{123}I-NaI recommendation was largely based on contamination (up to 2.5% of the total activity) with long-lived iodine-125 (^{125}I) (physical half-life: 60 days) that occurred with older methods of ^{123}I production[60]. Such contamination of ^{123}I with ^{125}I no longer occurs, and the restrictions on breast-feeding following ^{123}I-NaI administration to the mother may therefore be justifiably relaxed to an interruption period of seven days.

5. For indium-111 (^{111}In) labeled white cells, an interruption period of 7 days is recommended, and for thallium-201 (^{201}Tl-chloride), a 14 day interruption period is recommended.

6. For zirconium-89 (^{89}Zr), a 28-day (i.e., 4-week) interruption period was set equal to the maximum recommended interruption period for ^{67}Ga. The rationale for this recommendation are the comparable physical half-lives of ^{89}Zr (3.27 days) and ^{67}Ga (3.26 days), both ^{89}Zr and ^{67}Ga are radiometals and may share some common chemical properties, and lastly, there is a lack of relevant data on ^{89}Zr-labeled agents in nursing mothers.

   For lutecium-177 (^{177}Lu), based on the ^{89}Zr rationale and a longer physical half-life (6.65 days), an interruption period of 35-days (i.e., 5 weeks) is recommended for ^{177}Lu-labeled radiopharmaceuticals used *diagnostically*. For ^{177}Lu-labeled radiopharmaceuticals used *therapeutically*, much higher therapeutic activities are administered, and thus, permanent discontinuation of breast-feeding for the current child is recommended. As like ^{68}Ga-labeled radiopharmaceuticals, one would not expect the same uptake of ^{89}Zr or of ^{177}Lu into breast milk for the structurally complex radiopharmaceuticals into which these radionuclides are incorporated as opposed to that seen with ^{67}Ga-citrate.

7. For radium-223 (^{223}Ra), actinium-225 (^{225}Ac), and all other alpha particle-emitting radionuclides, permanent discontinuation of breast-feeding for the current child is recommended. Alpha particles are densely ionizing, have high-linear energy transfer (LET) radiations that potentially incur far more significant biological effects than beta-

particles, and are of particular concern in the young child in whom rapid growth and development are occurring. In the absence of relevant data and out of an abundance of caution, permanent discontinuation of breast-feeding for the current child is therefore recommended.

Subcommittee Recommendations for the Nursing Mother

Radiopharmaceutical	**Breast Feeding Cessation**
^{11}C, ^{13}N, ^{15}O, ^{82}Rb	None
^{18}F-labeled	12-hours
^{68}Ga-labeled	12-hours
^{99m}Tc-labeled	24-hours
^{123}I-NaI	7 days
^{111}In-leukocytes	7 days
^{201}Tl-chloride	14 days
^{89}Zr	28 days
^{177}Lu, diagnostic	35 days
^{131}I-NaI	Stop breast feeding
^{67}Ga-citrate	Stop breast feeding
^{177}Lu, therapeutic	Stop breast feeding
^{223}Ra and all alpha emitters	Stop breast feeding

Patient Information: Departmental Signage for Nursing Mothers

Nursing mothers undergoing a nuclear medicine or nuclear cardiology procedure may be unaware of the potential dosimetric impact of such procedures on themselves and their nursing child. It is important that nuclear medicine and nuclear cardiology facilities alert nursing mothers that certain radiation safety precautions with respect to breast-feeding may be required before and after they receive a radiopharmaceutical. Analogous to the signage used to alert pregnant and potentially pregnant patients to possible hazards from nuclear medicine and

radiological procedures, the following or equivalent signage should be prominently displayed in all patient areas of a nuclear medicine or nuclear cardiology facility: “If you are currently breast-feeding a child or plan to begin doing so in the near future, inform the technologist, nurse or doctor immediately.” Depending on the patient demographics in a particular facility, posting such signage in various foreign languages as well as in English should be considered.

Table YY1

Radiopharmaceutical Absorbed Doses to the Lactating Breast

			Breast Absorbed Dose[61 62]			
	Administered Activity		Lowest Estimate		Highest Estimate	
Radiopharmaceutical	mCi	MBq	rad	Gy	rad	Gy
^{18}F-FDG	10	370	1.2E-01	1.2E-03	2.0E-01	2.0E-03
^{51}Cr-EDTA	0.05	1.85	4.2E-07	4.2E-09	2.5E-06	2.5E-08
^{67}Ga-citrate	5	185	2.2E-02	2.2E-04	1.1E+00	1.1E-02
^{99m}Tc-DTPA	20	740	6.1E-04	6.1E-06	1.2E-02	1.2E-04
^{99m}Tc-DTPA aerosol	1	37	1.2E-05	1.2E-07	2.5E-04	2.5E-06
^{99m}Tc-DISIDA	8	296	2.0E-03	2.0E-05	6.0E-03	6.0E-05
^{99m}Tc-glucoheptonate	20	740	3.6E-03	3.6E-05	7.4E-03	7.4E-05
^{99m}Tc-HAM	8	296	8.5E-03	8.5E-05	2.3E-02	2.3E-04
^{99m}Tc-MAG3	5	185	3.0E-04	3.0E-06	6.0E-03	6.0E-05
^{99m}Tc-MAA	4	148	1.6E-03	1.6E-05	1.2E-01	1.2E-03
^{99m}Tc-MDP	20	740	2.7E-03	2.7E-05	3.8E-03	3.8E-05
^{99m}Tc-MIBI	30	1110	5.5E-04	5.5E-06	5.1E-03	5.1E-05
^{99m}Tc-PYP	20	740	4.2E-03	4.2E-05	2.2E-02	2.2E-04

^{99m}Tc-RBCs - in vitro labeling	20	740	9.3E-04	9.3E-06	1.6E-03	1.6E-05
^{99m}Tc-RBCs - in vivo labeling	20	740	2.5E-04	2.5E-06	1.1E-01	1.1E-03
^{99m}Tc-pertechnetate	30	1110	1.9E-03	1.9E-05	2.5E-01	2.5E-03
^{99m}Tc-sulfur colloid	12	444	3.2E-03	3.2E-05	4.6E-02	4.6E-04
^{99m}Tc-WBCs	10	370	1.1E-02	1.1E-04	1.5E+00	1.5E-02
^{111}In-WBCs	0.5	18.5	5.0E-04	5.0E-06	2.5E-03	2.5E-05
^{123}I-MIBG	10	370	-	-	2.7E-02	2.7E-04
^{123}I-NaI	0.4	15	-	-	4.7E-02	4.7E-04
^{123}I-OIH	2	74	5.5E-03	5.5E-05	5.8E-02	5.8E-04
^{125}I-OIH	0.01	0.37	-	-	8.5E-05	8.5E-07
^{131}I-OIH	0.3	11	5.0E-03	5.0E-05	3.2E-02	3.2E-04
^{131}I-NaI	150	5,550	-	-	2.0E+02	2.0E+00
^{201}Tl-chloride	3	111	2.4E-03	2.4E-05	4.1E-03	4.1E-05

Table YY2

Estimation of the External Radiation Dose from the Mother to the Nursing Child Assuming No Interruption of Breast-feeding: Model Parameters

	^{18}F-FDG	^{67}Ga-citrate	^{99m}Tc "Worst case"	^{131}I-NaI
Photon energy (keV)	511	93, 185, 300	140	364
Physical half-life (h)	1.2	78.2	6.04	193
Specific Gamma-ray Constant, G (R-cm^2/mCi-h)[63]	0.0057	0.00080	0.00060	0.0022
Administered Activity (mCi), A - Assumed	10	5	30	5 (imaging), 150 (therapy)
Cumulative fraction of activity in breast milk, $f_{breast\ milk}$	0.040[64]	0.10[65]	0.05[66]	0.25[67]
Fraction of activity in remainder of body, $f_{maternal\ rem}$[68]	0.96	0.90	0.95	0.75
Maternal whole body-to-whole body photon absorbed fraction, f(maternal WB¬maternal WB)[69]	0.34	0.31	0.31	0.31
Maternal breast-to-breast photon absorbed fraction, f(Br¬Br)[70]	0	0	0	0
Effective half-time of activity in breast, $(T_e)_{breast\ milk}$ (h)[71]	1.2	78.2	6.02	10.4 (99%) 81.8 (1%)
Effective half-life of activity in maternal remainder of body, $(T_e)_{maternal\ rem}$ (h)[72]	1.2	78.2	6.02	38.4

Distance from mother's breast to nursing child, $r_{breast\text{-}to\text{-}child}$ (cm)[73]	7.5
Point source-to-line source conversion factor for maternal breast-to-child exposure, $CF_{point\text{-}to\text{-}line\|breast}$[74]	0.32
Distance from mother's torso to nursing child, $r_{maternal\ rem\text{-}to\text{-}child}$ (cm)[75]	15
Point source-to-line source conversion factor for maternal torso-to-child exposure, $CF_{point\text{-}to\text{-}line\|maternal\ rem}$[76]	0.54
Occupancy factor for nursing, $E_{nursing}$[77]	0.33

Table YY3

Internal Radiation Dose to the Nursing Child from Ingestion of Radioactive Milk Assuming No Interruption of Breast-feeding: Model and Kinetic Parameters and Radiation Dose Estimates

Radiopharmaceutical	Assumed Administered Activity (mCi)	Cumulative Fraction Excreted in Breast Milk, ($f_{breast\ milk}$)	Effective Half-Time in Breast Milk, $(T_e)_i$ [1] hours	Residence Time in Breast Milk $t_{breast\ milk}$[78] (µCi-h/µCi)	Reference Newborn Whole Body-to-Whole Body Dose Factor ($DF(WB \neg WB)_{newborn}$ [79]rad/µCi-h)	Newborn Whole-Body Absorbed Doses, $D_{nursing\ child|int}$	
						rad/mCi	rad/Administered Activity
^{18}F-FDG	10	0.04[80]	1.2[81]	0.048	2.44E-04	0.012	0.12
^{67}Ga-citrate	5	0.10[82]	78.2[83]	7.8	3.68E-05	0.29	1.4
^{99m}Tc, "Worst case"	30	0.05[84]	6.02[85]	0.30	2.16E-05	0.0065	0.19
^{131}I-NaI	5 (imaging), 150 (therapy)	0.25[86]	10.4 (99%)[87] 81.8 (1%)	2.78	1.53E-04	0.43	2.2, 65

Table YY4

Total Radiation Dose to the Nursing Child Assuming No Interruption of Breast-feeding

Radiopharmaceutical	Assumed Administered Activity mCi	Whole-Body Absorbed Dose to Nursing Child rad		
		External	Internal	Total
^{18}F-FDG	10	0.027	0.12	0.15
^{67}Ga-citrate	5	0.17	1.4	1.6
^{99m}Tc, "Worst case"	30	0.044	0.19	0.23
^{131}I-NaI	5 (imaging)	0.2	2.2	2.4
	150 (therapy)	5.3	65	70

Table YY5

Recommendations for Cessation of Breast-feeding in Nursing Mothers Undergoing Nuclear Medicine Procedures

Radiopharmaceutical	NRC NUREG 1556 Vol 9 Rev 3, Appendix U	ICRP Publication 106, Annex D	Hazel and Breitz, J Nucl Med 41: 863-873, 2000	MSKCC Recommendations, 2017	Current ACMUI Sub-Committee Recommendations, 2017
All ^{11}C-labeled radiopharmaceuticals	Not included	No interruption	Not included	Not included	No interruption
All ^{13}N-labeled radiopharmaceuticals	Not included	No interruption	Not included	Not included	No interruption
All ^{14}C-labeled radio-pharmaceuticals, including ^{14}C-urea	Not included	No interruption	Not included	Not included	No interruption
All ^{15}O-labeled radiopharmaceuticals	Not included	No interruption	Not included	Not included	No interruption
All ^{18}F-labeled radio-pharmaceuticals, including ^{18}F-FDG	Not included	No interruption	Not included	12 h	No interruption
^{51}Cr-EDTA	No interruption	No interruption	No interruption	Not included	No interruption
^{67}Ga-citrate	1 month for 4 mCi, 2 weeks for 1.3 mCi, 1 week for 0.2 mCi	> 21 d	Complete cessation for current child for 5 mCi	21 d	21 d
All ^{68}Ga-labeled radiopharmaceuticals	Not included	Not included	Not included	12 h	12 h
^{81m}Kr-gas	Not included	No interruption	Not included	Not included	No interruption
^{82}Rb-chloride	Not included	Not included	Not included	Not included	No interruption
^{89}Zr-antibodies	Not included	Not included	Not included	21 d	21 d
^{99m}Tc-DMSA	Not included	No interruption	Not included		
^{99m}Tc-DTPA	No interruption	No interruption	No interruption		
^{99m}Tc-DTPA aerosol	No interruption	No interruption	No interruption		
^{99m}Tc-DISIDA	No interruption	No interruption	No interruption		
^{99m}Tc-ECD	Not included	No interruption	Not included		
^{99m}Tc-gluconate	Not included	No interruption	Not included		
^{99m}Tc-glucoheptonate	No interruption	No interruption	No interruption		
^{99m}Tc-HAM	Not included	No interruption	No interruption		
^{99m}Tc-MAG3	No interruption	No interruption	No interruption		
^{99m}Tc-MAA	13 h for 4 mCi	12 h	12 h for 4 mCi	24 h	24 h
^{99m}Tc-MDP	No interruption	No interruption	No interruption		
^{99m}Tc-MIBI	No interruption	No interruption	No interruption		
^{99m}Tc-PYP	No interruption	No interruption	No interruption		
^{99m}Tc-RBCs - in vitro labeling	No interruption	No interruption	No interruption		
^{99m}Tc-RBCs - in vivo labeling	6 h for 20 mCi	12 h	12 h for 20 mCi		
^{99m}Tc-pertechnetate	24 h for 30 mCi, 12 h for 12 mCi	12 h	4 h for 5 mCi		
^{99m}Tc-sulfur colloid	6 h for 12 mCi	No interruption	No interruption		
^{99m}Tc-tetrofosmin	Not included	No interruption	Not included		
^{99m}Tc-WBCs	24 h for 30 mCi, 12 h for 12 mCi	12 h	No interruption		

^{99m}Tc-WBCs	24 h for 30 mCi, 12 h for 12 mCi	12 h	No interruption		
^{111}In-antibodies	Not included	Not included	Not included	Not included	7 d
^{111}In-octreotide	Not included	No interruption	Not included	Not included	24 h
^{111}In-WBCs	7 d for 0.5 mCi	No interruption	No interruption	7 d	7 d
^{123}I-MIBG	24 h for 10 mCi, 12 h for 4 mCi	> 3 weeks	48 h for 10 mCi	7 d	48 h
^{123}I-NaI	No interruption	> 3 weeks	Complete cessation for current child	7 d	48 h
^{123}I-OIH	No interruption	12 h	No interruption	7 d	No interruption
^{124}I-NaI	Not included	Not included	Not included	Complete cessation for current child	Complete cessation for current child
^{124}I-antibodies	Not included	Not included	Not included	Complete cessation for current child	Complete cessation for current child
^{125}I-OIH	No interruption	12 h	No interruption	Not included	No interruption
^{131}I-OIH	No interruption	12 h	No interruption	Not included	Complete cessation for current child
^{131}I-NaI	Complete cessation for current child	>3 weeks to complete cessation for the current child	Complete cessation for current child	Complete cessation for current child	Complete cessation for current child
^{133}Xe-gas	Not included	No interruption	Not included	Not included	No interruption
All ^{177}Lu-labeled radiopharmaceuticals	Not included	Not included	Not included	28 d for diagnostic activity, Complete cessation for the current child for therapeutic activity	28 d for diagnostic activity, Complete cessation for the current child for therapeutic activity
^{201}Tl-chloride	14 d for 3 mCi	48 h	96 h for 3 mCi	14 d	14 d
All alpha particle-emitting radiopharmaceuticals, including ^{223}Ra-dichloride	Not included	Not included	Not included	Complete cessation for current child	Complete cessation for current child

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[67] Robinson PS, Barker P, Campbell A, et al.: Iodine-131 in breast milk following therapy for thyroid carcinoma [see comments]. J Nucl Med. 35:1797-801, 1994.

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[73] The distance from the mother's breast to the nursing child, $r_{breast\text{-}to\text{-}child}$, corresponds to the assumed approximate distance from the mid-line of the mother's breast (i.e., for the Reference Adult Female anatomic phantom) to the mid-line of the child (i.e., the Reference Newborn anatomic model). This is the sum of the one-half of the "a" parameter value, $1/2 \cdot 5$ cm =2.5 cm, tabulated for the Reference Adult Female and the "B_T" parameter value, 2.5 cm, for the Reference Newborn referenced in Cristy M and Eckerman K, Specific absorbed fractions of energy at various ages from internal photon sources (I-VII). Oak Ridge National Laboratory Report ORNL/TM-8381/V1-7. 1987, Springfield, VA: National Technical Information Service, Dept of Commerce.

[74] In order to model the maternal breast activity as a line source, rather than a point source, a conversion factor is required to appropriately adjust the inverse-square dependence on distance of the point-source dose rate. This conversion factor depends on the length of the line source, which is 5 cm for the breast line source, and the distance from the line source, which is $r_{breast\text{-}to\text{-}child}$ = 7.5 cm for the mid-line of the nursing child.

The length of the breast line source is equated with parameter "c" tabulated for the Reference Adult Female anatomic model referenced in Cristy M and Eckerman K, Specific absorbed fractions of energy at various ages from internal photon sources (I-VII). Oak Ridge National Laboratory Report ORNL/TM-8381/V1-7. 1987, Springfield, VA: National Technical Information Service, Dept of Commerce.

The conversion factor is taken from Siegel JA, Marcus CS, and Sparks RB: Calculating the absorbed dose from radioactive patients: the line-source versus point-source model. J Nucl Med. 43:1241-4, 2002, Table 1.

[75] The distance from the mother's torso to the nursing child, $r_{maternal\ rem\text{-}to\text{-}child}$, corresponds to the assumed approximate distance from the mid-line of the mother (i.e., for the Reference Adult Female anatomic phantom) to the mid-line of the child (i.e., the Reference Newborn anatomic model). This is the sum of the "B_T" parameter values, 5 and 10 cm res[ectively to include conversion factor referenced in Cristy M and Eckerman K, Specific absorbed fractions of energy at various ages from internal photon sources (I-VII). Oak Ridge National Laboratory Report ORNL/TM-8381/V1-7. 1987, Springfield, VA: National Technical Information Service, Dept of Commerce.

[76] See Note 74. For the point source-to-line source conversion factor for the maternal torso-to-child exposure, the length of the line source is 63 cm for the maternal torso and the distance from

the line source is $r_{mother\text{-}to\text{-}child} = 15$ cm. The length of the maternal torso line source is equated with parameter "C_T" tabulated for the Reference Adult Female anatomic model referenced in Cristy M and Eckerman K, Specific absorbed fractions of energy at various ages from internal photon sources (I-VII). Oak Ridge National Laboratory Report ORNL/TM-8381/V1-7. 1987, Springfield, VA: National Technical Information Service, Dept of Commerce.

[77] An occupancy factor for nursing, $E_{nursing}$, of 0.25 conservatively assumes that the child will actually be nursing for 6 hours out of each day (24 hours).

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Patient Release Project Update

Donna-Beth Howe, Ph.D.
Medical Radiation Safety Team
September 11, 2017

April 28, 2014

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

STAFF REQUIREMENTS – COMAMM-14-0001/COMWDM-14-0001 – "BACKGROUND AND PROPOSED DIRECTION TO NRC STAFF TO VERIFY ASSUMPTIONS MADE CONCERNING PATIENT RELEASE GUIDANCE"

Commission Direction/ Objectives

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Input from wide spectrum of stakeholders - the public, patients, patient groups, physicians, professional societies, licensees, ACMUI, and Agreement States

- Federal Register Notice
- Public Meeting(s)

Part 1 - 2016 November to February Information Collection

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- What patients believe will help them understand the I-131 treatment procedures.
- Physician's or licensee's best practices when making informed decisions on releasing I-131 patients.
- Instructions provided to patients on how to reduce radiation doses to others.
- Brochures.

Part 2 Commission Direction/ Objectives

- Explore with the public, licensees, and state partners whether the agency should change 10 CFR Part 35.75 for specific reasons.
- Six questions were provided in the April 11, 2017 Federal Register Notice.
- Open questions, explain why, provide new criterion, resulting health and safety benefits, or lack of benefits, to the individual being released, the licensee and the public
- Results will form basis for SECY paper on whether to pursue changes to 10 CFR 35.75.

132 Responders (41 repeat responses)

47 Sodium Iodine-131 patients,

3 Patient relatives,

6 Professional medical and medically related organizations

5 Medical facilities

65 Medical personnel (including nurses, technologist, medical physicists, and doctors) (9, 24, 6, 2,1 repeat)

4 Agreement States

Not all responders commented on each question. Some provided professional and life experiences

Part 2 Commission Direction/ Objectives

April – May 2017 Public Views/Comments

Should the Agency change 10 CFR Part 35.75 to:

1. Require an activity-based patient release threshold under which patients would be required to be maintained in a clinic-sponsored facility (e.g., a medical facility or facility under the licensee's control) until the standard for release is met..
2. To clarify the time frame for the current dose limit in 10 CFR 35.75(a) for releasing Individuals?

Part 2 Commission Direction/ Objectives cont.

3. Should the NRC continue to apply the same dose criteria of 5 mSv (0.5 rem), to all members of the general public, including family members, young children, pregnant women, caregivers, hotel workers, and other members of the public when considering the release of patients.
4. Have a new requirement for the release of a patient who is likely to expose young children or pregnant women to doses above the 10 CFR Part 20 public dose limit.

Part 2 Commission Direction/ Objectives Staff Addition

5. Have a specific requirement for the licensee to have a patient isolation discussion with patients in sufficient time prior to the administration to provide the patient time to make isolation arrangements or the licensee to make plans to hold the patient, if the patient cannot be immediately released. and
6. Have NRC explicitly include the time frame for providing instructions in the regulations (e.g., the instructions should be given prior to the procedure).

Next Steps

- ACMUI subcommittee report
- Agreement State Review of SECY
- Regional Review of SECY
- SECY due December 2017

Acronyms

ACMUI – Advisory Committee on the Medical Uses of Isotopes
CFR – Code of Federal Regulations
I-131 – Iodine-131
NRC – U.S. Nuclear Regulatory Commission
SECY – Office of the Secretary

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

ACMUI Comments on the Draft Patient Release Commission Paper

Pat Zanzonico, PhD
ACMUI

September 11, 2017

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Sub-Committee Members

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Sub-Committee Charge

To review and provide recommendations on the draft SECY paper, "Staff Recommendations for Revisions to the Patient Release Program."

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Background

- **The current "dose-based" Patient Release Rule (10CFR35.75) replaced the "activity-based" rule (the "30 mCi" rule) in 1997.**
- **The current dose-based Rule allows a licensee to release a patient if the TEDE to any other individual, from exposure to the patient, is not likely to exceed 5 mSv (0.5 rem).**

Background *cont*

- **COMGBJ-11-0003 (June 23, 2011): Evaluate whether there are gaps in the available data regarding doses received by members of the public from released patients and, if gaps were found, to provide a recommendation on whether and how such data could be accrued.**
- **SECY-12-0011, "Data Collection Regarding Patient Release" (Jan 25, 2012): Gaps identified related to (1) internal doses to members of the public and (2) internal and external doses to members of the public from patients released to locations other than their primary residences (hotels and nursing homes).**

Documents Reviewed

- **Draft SECY paper: "Staff Recommendations for Revisions to the Patient Release Program"**
- **Licensee survey: "Assessment of Where Patients Reside Immediately Following Their Release Report"**
- **Literature review + Model calculations: "Patient Release Following Radioiodine Therapy: A Review of the Technical Literature, Dose Calculations, and Recommendations"**

Sub-Committee Comments and Recommendations 1

- **The literature review was thorough and the model calculations sound.**
- **The current dose-based approach to assessing patient releasability validated as more protective of public safety than the activity-based approach.**

Sub-Committee Comments and Recommendations 2

- **The current 5-mSv (500-mrem) and 1-mSv (100-mrem) projected dose limits for family members and the general public, respectively, should remain a per-event limit and are appropriate for all potentially exposed cohorts, including pregnant women and children, and all radionuclide administrations.**
- **The 1-mSv (100-mrem) dose limit for requiring patient safety instructions should remain in place.**

Sub-Committee Comments and Recommendations 3

- The assumption in regulatory guidance that the internal dose contribution is negligible has been validated.
- Other assumptions and methods in regulatory guidance are excessively conservative → NCRP Report No 155.
- A patient staying at a hotel following radionuclide therapy is not a widespread practice and is unlikely to result in doses to workers and others > 1 mSv (100 mrem).

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Sub-Committee Comments and Recommendations 4

- Instructions must be provided to the patient well in advance of a planned therapy (ie not on the day of administration), without compromising patient care. Specification of a regulatory time interval for pre-therapy instructions is not recommended → NCRP Report No 155.
- The NRC should consider updating Appendix U (NUREG 1556) to reference Regulatory Guide 8.39 rather than eliminating 8.39 or maintaining two separate guidance documents.

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Concluding Remarks

- The Committee upholds its recommendations in the ACMUI's "Patient Release Report" (Dec 13, 2010)
- The Patient Release Program should be applicable to all radionuclides, flexible, and not overly conservative, so as to not encumber the development of new medical procedures.

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Abbreviations and Acronyms

- ACMUI: Advisory Committee on Medical Uses of Isotopes
- NCRP: National Council on radiation Protection and Measurement
- TEDE: Total effective dose equivalent

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Nuclear Regulatory Commission (NRC)
Advisory Committee on the Medical Use of Isotopes (ACMUI)
Report of the Patient Release Draft SECY Paper Subcommittee
Submitted on August 18, 2017

Subcommittee Members

Susan Langhorst, PhD, Laura Weil, Christopher Palestro, MD, Pat Zanzonico, PhD (Chair)

Charge

To review and provide recommendations for the draft SECY paper entitled, "Staff Recommendations for Revisions to the Patient Release Program."

Summary Statement

The recommendations of our Subcommittee for the draft SECY paper entitled, "Staff Recommendations for Revisions to the Patient Release Program," are consistent with those in the ACMUI's "Patient Release Report," dated December 13, 2010. The most notable of these include the following.

- The current dose-based approach for assessing patient releasability is more protective of public safety than the older activity-based approach.

- The 5-mSv (500-mrem) and the 1-mSv (100-mrem) dose limits should remain per-event, rather than annualized, limits and are appropriate for all potentially exposed cohorts, including pregnant women and children.

- The 5-mSv (500-mrem) and 1-mSv (100-mrem) dose limits are *not* radionuclide-specific but apply to all diagnostic as well as therapeutic radionuclide administrations. Importantly, the 1-mSv (100-mrem) limit for requiring patient safety instructions should not be changed for any such administration.

- The assumptions for dose calculations for patient release, which are set forth in Regulatory Guide 8.39, "Release of Patients Administered Radioactive Materials," are overly conservative. Application of more realistic, individualized assumptions in the assessment of patient releasability is recommended.

- The projected doses to hotel workers from released patients residing at hotels immediately post-therapy are unlikely to exceed the regulatory dose limit for the general public (i.e., 1 mSv (100 mrem)).

- Written and oral instructions must be provided to the patient far enough in advance of treatment, without compromising patient care, to ensure that the patient has sufficient

time to determine whether or not he/she can actually comply with the instructions and to make whatever arrangements may be necessary for compliance.

Introduction

The current requirements in 10 CFR 35.75, often referred to as the "Patient Release Rule," were instituted in 1997 and establish the regulatory framework for the release of individuals from licensee control who have received unsealed byproduct material or implants containing byproduct material. The current "dose-based" Patient Release Rule replaced the longstanding "activity-based" rule, namely, that such individuals could not be released from licensee control until their total-body activity was less than 30 mCi or the measured dose rate one meter away from the patient was less than 5 mrem/hour. The dose-based regulations allow a licensee to authorize the release of a patient from its control if the total effective dose equivalent (TEDE) to any other individual, from exposure to the released patient, is not likely to exceed 5 mSv (0.5 rem). The guidance for dose calculations and calculation methods for patient release is set forth in Regulatory Guide 8.39, "Release of Patients Administered Radioactive Materials," in NUREG-1492, "Regulatory Analysis on Criteria for the Release of Patients Administered Radioactive Material," and in NUREG-1556, Volume 9, "Consolidated Guidance about Materials Licenses: Program-Specific Guidance About Medical Licenses," Appendix U, "Model Procedures for Release of Patients or Human Research Subjects Administered Radioactive Materials."

Summary of Draft SECY Paper

In COMGBJ-11-0003, dated June 23, 2011, the Commission directed the NRC staff to evaluate whether there are gaps in the available data regarding the doses received by members of the public from released patients and, if gaps in the available data were found, to provide a recommendation to the Commission on whether and how such data could be accrued. The NRC staff responded in SECY-12-0011, "Data Collection Regarding Patient Release," dated January 25, 2012, stating that gaps were identified. These gaps were specifically related to (1) internal doses to members of the public and (2) internal and external doses to members of the public from patients released to locations other than their primary residences (such as hotels and nursing homes). In SRM-12-0011, "Data Collection Regarding Patient Release," dated April 9, 2012, the Commission directed the NRC staff to revisit patient release calculations and methods and to conduct a limited amount of relevant data collection and analysis to address the identified data gaps.

In SRM-COMAMM-14-0001/COMWDM-14-0001, "Background and Proposed Direction to NRC Staff to Verify Assumptions made Concerning Patient Release Guidance" dated April 28, 2014, the Commission directed NRC staff to complete four tasks, the first two of which have now been completed: (1) develop a standardized set of guidelines that licensees can use to provide instructions to patients to minimize their radiation exposure to other individuals; (2) develop a website that provides information and links to relevant medical organizations and patient advocacy groups to enable patients to access relevant information; (3) evaluate whether regulatory changes to the patient release program are warranted; and (4) revise Regulatory Guide 8.39, and subsequently NUREG-1556 to specify guidelines for patient information and guidance.

The draft SECY paper, which addresses task (3), evaluation of whether regulatory changes to the patient release program are warranted, is the subject of this ACMUI Subcommittee Report. With respect to task (4), NRC staff does not intend to update patient release guidance at this time, pending further direction from the Commission.

As directed in SRM-12-0011, NRC staff conducted an evaluation of guidance for patient release calculations and methods and of the adequacy of current patient release regulations. This research consisted of (1) evaluation of licensees' responses to a questionnaire to determine patients' behavior following release; (2) a literature review of peer-reviewed scientific articles; and (3) model-based calculations to estimate doses to members of the general public potentially exposed to released patients (e.g., hotel workers). The draft SECY paper is largely based on two reports which resulted from this empirical evaluation: "Assessment of Where Patients Reside Immediately Following Their Release Report" and "Patient Release Following Radioiodine Therapy: A Review of the Technical Literature, Dose Calculations, and Recommendations." These two reports were examined as part of our Subcommittee's review of the draft SECY paper. NRC staff concluded that collection "in the field" of actual dose and other pertinent data to exposed and potentially exposed cohorts was impractical, in light of relevant logistical, ethical, and cost considerations, and thus opted for the approach adopted based on a literature review and model calculations.

The options considered by NRC staff for revisions to the patient release program were: (1) propose rulemaking on the patient release program; (2) update guidance associated with the patient release program; (3) take no action.

Comments and Recommendations

Our general comments on and recommendations for the draft SECY paper are as follows.

- The literature review conducted by NRC staff was thorough and the model calculations conceptually and technically sound.

- Based on the literature review and model calculations, the current dose-based approach to assessing patient releasability has been validated as scientifically sound and more protective of public safety than the older activity-based approach (sometimes referred to as the "30-mCi rule").

- The 5-mSv (500-mrem) and 1-mSv (100-mrem) dose limits apply to each radionuclide administration or implant to a particular patient and are not a cumulative annual limit.

- The draft SECY paper states that it "…focused on exposures from patients who received I-131 administrations as I-131 is the most frequently used therapeutic radionuclide and other medical isotopes have lower volatility, are generally administered in smaller dosages, and have lower external radiation than I-131." The applicable regulations, that is, the 5-mSv (500-mrem) and 1-mSv (100-mrem) dose limits, however, are *not* radionuclide-specific. It is important, therefore, that radiation

safety guidance is generalizable, that is, applicable to all diagnostic as well as therapeutic radionuclide administrations. Furthermore, the 1-mSv (100-mrem) limit for requiring patient safety instructions should not be changed for any such administrations.

- The 5-mSv (500-mrem) dose limit applies to all potentially exposed cohorts and there is no need to establish a lower dose limit for pregnant women and children.

- The assumption, in the regulatory guidance for implementation of the dose-based approach, that the dose contribution to family members and other exposed individuals from internalized activity is negligible, has been validated by the literature review.

- Other assumptions and methods in the relevant regulatory guidance are in general excessively conservative, tending to yield overestimates of the actual doses to family members and other individuals in most cases. The guidance should be sufficiently flexible to allow incorporation of more realistic assumptions for assessing patient releasability. NRC staff is encouraged to re-visit NCRP Report No 155, entitled, "Management of Radionuclide Therapy Patients," dated December 11, 2006. This report includes a flexible, generally applicable algorithm for determining the releasability of therapy patients and the duration of post-release precautions; an EXCEL™ file for practical implementation of this algorithm is available from the NCRP.

- A patient staying at a hotel rather than their primary residence following radionuclide therapy is not a widespread practice, as documented in the report "Assessment of Where Patients Reside Immediately Following Their Release Report".

- Projected doses to hotel workers from released patients residing at hotels immediately post-therapy do not approach the regulatory dose limit for the general public, even with dose projections based on conservative assumptions and even for workers servicing hotel rooms of released patients multiple times per year. As stated in the document "Patient Release Following Radioiodine Therapy: A Review of the Technical Literature, Dose Calculations, and Recommendations," "…neither the 1 mSv (100 mrem) nor the 5 mSv (500 mrem) are exceeded in any credible hotel scenario…"

- In the past, the NRC has suggested retiring Regulatory Guide 8.39 and providing the applicable guidance exclusively in NUREG 1556, Volume 9, Appendix U. The Subcommittee recommends maintaining Regulatory Guide 8.39 or a suitable revision thereof, as it is more familiar and more accessible to the stakeholder community than Appendix U. Furthermore, any necessary updates could be implemented more readily in Regulatory Guide 8.39 than in NUREG 1556. The NRC may consider updating Appendix U to reference Regulatory Guide 8.39 rather than attempting to maintain these two separate documents. The Subcommittee noted that NRC staff is not currently considering any rulemaking related to the Patient Release. Any such rulemaking, if warranted, would therefore not be instituted for a number of years.

This reinforces the need for continuation of guidance familiar to the stakeholder community.

- The current regulation, 35.75(b), addressing instructions provided to patients released in accordance with 10 CFR 35.75 is:

> "A licensee shall provide the released individual, or the individual's parent or guardian, with instructions, including written instructions, on actions recommended to maintain doses to other individuals as low as is reasonably achievable if the total effective dose equivalent to any other individual is likely to exceed 1 mSv (0.1 rem)."

In order to ensure that radiation exposure to family or other caregivers and the general public is ALARA, written and oral instructions must be provided to the patient far enough in advance, without compromising patient care, to ensure that the patient has sufficient time to determine whether or not he/she can actually comply with the instructions and to make whatever arrangements may be necessary for compliance. Giving the patient prior instructions in advance also provides the licensee with the opportunity to determine whether or not the patient is able to follow the instructions and how best to manage the radiation safety aspects of the planned treatment. The Subcommittee does not believe it is realistic to modify patient release regulations to require prescriptive timing for providing patient instructions since these regulations apply to all diagnostic and therapeutic radionuclide administrations. The applicable guidance should emphasize, however, that whenever possible patients should be provided with these instructions prior to the day of a radionuclide therapy administration. Staff is again encouraged to re-visit NCRP Report No 155, entitled, "Management of Radionuclide Therapy Patients." This Report includes a generally applicable template of written instructions for therapy patients.

Concluding Remark

With the rapid emergence of new forms of targeted radionuclide diagnostic and therapeutic procedures, it is of the utmost importance that while the Patient Release Program not compromise the safety of the public, it must be appropriately flexible and not overly conservative, so as to not encumber the development and implementation of such promising medical procedures.

Closed Session

Ethics Training

Information Security Awareness Training

Allegations Training

NO PUBLIC HANDOUT

NRC Online Resources

Ms. Holiday will conduct a live demonstration on the computer

NO HANDOUT

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Physical Presence Requirements for the Leksell Gamma Knife® Icon™

John Suh, M.D.
ACMUI Radiation Oncologist
September 12, 2017

Subcommittee Members

- **Ronald Ennis, M.D.**
- **John Suh, M.D. (Chair)**
- **Laura Weil**

- **NRC Staff Resource: Sophie Holiday**

Subcommittee Charge

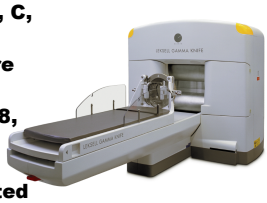
To propose the appropriate physical presence requirement for the Leksell Gamma Knife® Icon™ radiosurgery unit.

Background about Gamma Knife®

- **One of the major stereotactic radiosurgery systems used to treat various vascular malformations, benign brain tumors, malignant brain tumors, and functional disorders.**
- **Worldwide, over 1,000,000 patients have been treated with Gamma Knife®.**
- **In the United States, there are 77 Perfexion™ units and 22 Icon™ units in operation.**

Leksell Gamma Knife®

- Gamma Knife ® Model B, C, and 4C
  - 201 Co-60 sources are stationary
  - External helmets (4, 8, 14 and 18 mm)
  - Manual trunnions (Model B) or Automated Positioning System (Model C, 4C)



5

Leksell Gamma Knife® Perfexion™

- Gamma Knife ® Perfexion ™ (2006)
  - 192 Co-60 sources move within 8 permanently installed, independent movable sectors for 4, 8, and 16 mm beams
  - One collimator body with different diameter of holes corresponding to the different positions of the sectors
  - Automated movement of the robotic treatment table

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Leksell Gamma Knife® Icon™

- Perfexion™ features plus:
  - Integrated stereotactic Cone-beam CT imaging
  - Online Adaptive DoseControl™
  - Frameless mask-based treatment

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Background About Current Regulation

- Gamma Knife ® Model B, C, and 4C under 10 CFR Part 35, Subpart H (10 CFR 35.600)
- Gamma Knife Perfexion ™ and Gamma Knife Icon ™ under 10 CFR Part 35, Subpart K (10 CFR 35.1000)
- All Gamma Knives, regardless of model type, must adhere to the provisions under 10 CFR 35.615(f)(3).

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Physical Presence

- **Requirement via 10 CFR 35.615 f(3) that "an authorized user (AU) and an authorized medical physicist (AMP) are physically present throughout all treatments involving the unit".**
- **NRC defines "physical presence" as the distance "such that each can communicate with the other within hearing distance of normal voice".**

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Rationale for AU Presence

- **AU has the knowledge and appropriate training to ensure the safe and effective delivery of stereotactic radiosurgery.**
- **The current physical presence definition is not ambiguous and ensures the AU is present for the all the critical portions of the procedure, able to address any medical issues that may arise during treatment, and verify the correct dose will be delivered to the target(s).**

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Rationale for AU Presence cont.

- **AU has the competency to recognize and respond to any aberration of treatment and ensure response times within seconds if needed.**
- **Medical issues during the Gamma Knife® treatment may include pain from the frame, nausea, vomiting, and seizures.**
- **Incorrect dose of radiation may result secondary to system failure which could be software, hardware, or combination of both.**

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Rationale for AU Presence cont.

- **Immediately available for critical decision making.**
- **Remove the patient from the machine in case of malfunction**
- **Provide greater confidence to the patient and family during treatment by being present near the console area**

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Rationale for Departure

Given the advances with the Icon™ unit, the subcommittee examined the physical presence requirements.

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Number of Medical Events

- **Review of NMED event search from CY 2006-2017 revealed 12 reportable events for Gamma Knife Perfexion™**
- **Only a minority were identified during treatment.**

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Number of Medical Events cont.

Categorized into four areas:

1) **Incorrect position (EN 51442, 50011, 46921, and 45716)**
2) **Training deviation, machine malfunction, computer issue, and image process error (EN 45160, 46286, 49203, and 51735)**
3) **Patient issues (EN 47790, 50823, 51713)**
4) **Failure to use correct service procedures during maintenance (EN 50868)**

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Subcommittee Recommendations

Based on the very low number of MEs and the advances with the Icon™ unit, the subcommittee recommends:

1. **AU and AMP be physically present during the initiation of all treatments involving the unit.**
2. **AMP be physically present throughout all patient treatments involving the unit.**

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Subcommittee Recommendations

3. **The current physical presence requirements for the AU be modified by allowing the AU to be present in the department during treatment, which is defined for the Icon™ as within a two minute walk to the console area, and immediately available to come to the treatment room.**

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Subcommittee Recommendations

In addition to the AU and AMP, we recommend as a matter of good medical practice, that appropriately trained nursing or auxiliary staff be present at Gamma Knife® treatment to respond to any immediate medical needs.

18

Subcommittee Recommendations

4. **At the conclusion of treatment, the AU must be present at the Gamma Knife® console to discuss any treatment or patient issues with the patient, physicist, and nurse.**

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Acronyms

- **ACMUI – Advisory Committee on the Medical Uses of Isotopes**
- **AMP- Authorized Medical Physicist**
- **AU – Authorized User**
- **CFR – Code of Federal Regulations**
- **CY – Calendar Year**
- **ME – Medical Event**
- **NMED – Nuclear Medical Events Database**
- **SRS – Stereotactic radiosurgery**

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Nuclear Regulatory Commission (NRC)
Advisory Committee on the Medical Use of Isotopes (ACMUI)

Subcommittee on

Physical Presence Requirements for the Leksell Gamma Knife® Icon™

***Draft* Report Submitted On:**
August 17, 2017

Subcommittee Members:
Ronald Ennis, M.D.
John Suh, M.D. (Chair)
Laura Weil

NRC Staff Resource: Sophie Holiday

Charge to subcommittee: To propose the appropriate physical presence requirement for the Leksell Gamma Knife® Icon™ radiosurgery unit.

Subcommittee Process

The subcommittee and its Chair were appointed by ACMUI Chair, Phil Alderson, at the regularly scheduled ACMUI meeting April 26, 2017. This subcommittee was formed after a presentation on April 26, 2017 by Elekta, Inc. requesting that consideration of amending the Title 10 Code of Federal Regulations (10 CFR) 35.1000 licensing guidance for the Leksell Gamma Knife® Icon™ be modified to allow the authorized user (AU) to be physically present in the department during patient treatment and immediately available to come to the treatment room to respond to an emergency based on the very small number of medical events (MEs) that have occurred with modern Gamma Knife® units. This report summarizes the subcommittee's recommendations, which will be presented on September 12, 2017 at the ACMUI meeting.

Summary of Subcommittee Recommendations

- The AU and authorized medical physicist (AMP) need to be physically present during the initiation of all treatments. This allows independent confirmation that the correct plan is being used for treatment and that the correct site is being treated during the initiation of treatment.

- The current physical presence requirements for the AU be modified by allowing the AU to be present in the department during treatment, which is defined as within a two minute walk to the console area, and immediately available to come to the treatment room. An AMP needs to be physically present during the entire treatment. While we recognize the NRC does not have regulations for nursing or auxiliary staff, we recommend as a best

practice that appropriately trained nursing or auxiliary staff be present at Gamma Knife treatment to respond to any immediate medical needs. It should be the responsibility of the AU to determine the necessary training and experience required of the nursing staff.

- At the conclusion of treatment, the AU must be present at the Gamma Knife console to discuss and review any treatment or patient issues with the patient, physicist, and nurse.

Introduction

Gamma stereotactic radiosurgery is a very effective and well established treatment for patients with various benign and malignant brain tumors, vascular malformations and some functional disorders such as trigeminal neuralgia. The shielded unit utilizes 192 or 201 Cobalt-60 (Co-60) sources that simultaneously converge to a central target in the brain by the use of different sized collimator channels that are positioned around the patient's skull. The first Gamma Knife® in the United States was installed at the University of Pittsburgh in 1987 (Model U). Over the next 12 years, the model B and model C units were introduced. These three systems, licensed under 10 CFR 35.600, (Models U, B and C) have tungsten collimators that are external to the Co-60 sources and are placed on the treatment unit manually. All these units required frame-based immobilization and have fixed beam geometry to maximize reliability and minimize quality assurance checks.

In 2006, the Perfexion™ unit was introduced. Unlike the model U, B, and C units, the collimators are inside the treatment unit with sources that can be shielded while the treatment helmet is being switched to another size collimator, which can decrease treatment times and manual intervention by the treatment team. The Perfexion™ also uses five different positions (16 mm, 4 mm, off, 8 mm, and home, which is an off position) to turn the beam on and off. These sectors allow for rapid change (within 1 second) of the collimators of each sector. Along with engineering differences that would not meet the provisions under 10 CFR 35.600, the NRC decided to license the Perfexion™ under 10 CFR 35.1000. In 2016, the Icon™ system was introduced, which allowed for treatment with a thermoplastic frameless mask unlike the Perfexion™ unit. In addition, the Icon™ unit has a cone-beam computed tomography (CT) which provides stereotactic reference for patient setup and high definition motion management for mask-based treatments. Since the introduction of the Gamma Knife® in 1987 in the United States, the use of gamma stereotactic radiosurgery has greatly increased in the United States. Based on information from Elekta, there are 77 Perfexion™ units and 22 Icon™ units. Worldwide, over 1 million patients have been treated with the Gamma Knife®.

Given the many advances in gamma stereotactic radiosurgery, the delivery has become more efficient allowing for treatment of multiple patients each day and treatment of multiple targets in a single session, which have increased the treatment times for some patients. Given the evolution of the Gamma Knife® over the past decade from the Model C to Perfexion™ and now Icon™, the physical presence requirements were examined by the subcommittee.

Current Physical Presence Requirement

In October 2002, the NRC modified the regulations in 10 CFR Part 35 to include a section[1] regarding gamma stereotactic radiosurgery to include the requirement that "For gamma stereotactic radiosurgery unit require an Authorized User with appropriate training and experience in radiation oncology and Authorized Medical Physicist to be physically present throughout all patient treatments involving the unit." This regulation provided for an appropriate response to an emergency and to ensure that the correct dose of radiation is delivered to the patient. The term[2] "physically present" was defined as "within hearing distance of normal voice".

The NRC issued a Regulatory Issue Summary (RIS) to clarify the definition of "physically present" as a result of an event at one of the Gamma Knife centers. The RIS (RIS-2005-23)[3], "Clarification of the Physical Presence Requirement During Gamma Stereotactic Radiosurgery Treatment," stated that this meant speaking in a normal conversational tone and not a raised voice. As a result, a distance of 20 feet may not be close enough to adequately hear and respond to an emergent situation. This also ensures the correct dose of radiation was delivered.

Rationale for change

The current definition ensures that an emergent situation will be addressed immediately by the AU and that the correct dose is delivered. The AU has the knowledge and appropriate training to ensure the safe and effective delivery of stereotactic radiosurgery. The current physically presence definition is not ambiguous and ensures the AU is present for the all the critical portions of the procedure, able to address any medical issues that may arise during treatment, and verify the correct dose will be delivered to the target(s). The AU will have the competency to recognize and respond to any aberration of treatment and ensure response times within seconds if needed.

Medical issues during the Gamma Knife® treatment may include pain from the frame, nausea, vomiting, and seizure. Incorrect dose of radiation may result secondary to system failure which could be software, hardware, or combination of both. As serious medical issues and/or significant aberrations in treatment can result in reportable MEs, rules regulating physician presence exist to ensure patient safety.

Over the past ten years of NMED, there are 12 reportable events involving the Perfexion™. Of the 12 Perfexion™ reportable events, only a minority were identified during treatment. The Icon unit has significant enhancements over the Perfexion unit. Specifically, three features are important: 1) treatment with a thermoplastic frameless mask rather than a frame, 2) ability to perform integrated stereotactic cone-beam computed tomography (CT) which provides stereotactic reference for patient setup, and 3) high definition motion management for mask-based treatments. These enhancements re-open the question regarding the physical presence requirements of the AU for the entire treatment. A review of the 12 events for Perfection reveals that none of these events would have escaped detection on an Icon unit using the thermoplastic frameless mask and high definition motion management for mask-based treatments even if the

AU was not physically at the console and could have been rapidly and effectively addressed as long as the AU was immediately available.

Proposal by Elekta, Inc. on April 26, 2017 for Gamma Knife Icon™

1. *We will have an Authorized User and Authorized Medical Physicist physically present during the initiation of all treatments involving the unit.*

2. *We will have an Authorized Medical Physicist physically present throughout all patient treatments involving the unit.*

3. *We will have an Authorized User physically present in the department during patient treatment and immediately available to come to the treatment room to respond to an emergency.*

Recommendations

Based on the extremely low number of MEs with the Perfexion™ unit coupled with the modifications with the Icon™, the subcommittee recommends modifying the current physical presence requirements for the Icon™ unit. The major differences between the Icon™ versus the Perfexion™ is 1) treatment with a thermoplastic frameless mask rather than invasive frame for some patients, 2) ability to perform integrated stereotactic cone-beam computed tomography (CT) which provides stereotactic reference for patient setup, and 3) high definition motion management for mask-based treatments which allows for online adaptation. Although we respect the proposal by Elekta, Inc., we believe their proposal needs to be more stringent to ensure safe and accurate delivery of gamma stereotactic radiosurgery. Physical presence would utilize a similar definition used by Section V, Summary of changes of the 2002 revised 10 CFR Part 35 in Federal Register[4]. The following recommendations remain consistent with federal regulations and requirements governing physician supervision from CMS and federal regulations.

1. Authorized User and Authorized Medical Physicist be physically present during the initiation of all treatments involving the unit.

   This will allow independent confirmation that the correct plan is being used for treatment and that the correct site is being treated at the initiation of treatment. This will also allow the authorized user to be part of the universal timeout, which should help prevent the wrong plan from being delivered or the incorrect side from being treated initially.

2. Authorized Medical Physicist be physically present throughout all patient treatments involving the unit.

   The physical presence of an AMP is essential for the safe and accurate delivery of gamma stereotactic radiosurgery. The addition of a medical physicist would ensure that any software, hardware, or combination of software/hardware failure be recognized

immediately and addressed promptly (i.e. at the console or within normal hearing voice) of the AU.

The current physical presence requirements for the AU can be modified by allowing the AU to be close enough to the to the console to respond quickly to any issue that arises which is defined as within a two minute walk to the console area, **and** immediately available to come to the treatment room. An AMP needs to be physically present during the entire treatment.

In addition to the AU and AMP, as a matter of good practice, we recommend that appropriately trained nursing or auxiliary staff be present at Gamma Knife treatment to respond to any immediate medical needs. It will be the responsibility of the AU to determine the necessary training and experience required of the nursing staff, who will be present throughout the procedure.

3. At the conclusion of treatment, the AU must be present at the Gamma Knife console to discuss any treatment or patient issues with the patient, physicist, and nurse.

The AU will be physically present close to the console, which is defined in this report as *within 2 minutes from the console area*, during patient treatment **and** immediately available to furnish assistance and direction throughout the performance of the procedure. Specifying time rather than presence in the department mitigates any misinterpretation of the regulations which has happened in the past[5]. This definition would be more stringent than the ASTRO white paper[6] and how "on campus" will be defined for centers that do not have the Gamma Knife® present within the department.

The subcommittee felt that a time rather than distance ought to be used to define "physically present in the department". Depending on the configuration of the department, distance may not be easily measured, i.e. the department may be located on multiple floors, not necessarily in close proximity. In addition, the subcommittee believes that physically present in the department can be ambiguous especially if the Gamma Knife® center is distant from the radiation oncology department or if the Gamma Knife® is not present within the radiation oncology department such as a neurosurgery department or free standing center. Since a medical physicist would be physically present for the duration of treatments, medical and software/hardware incidents could be addressed during the 2 minute interval before the AU would arrive.

Summary:

The subcommittee recommends that for the Leksell Gamma Knife® Icon when used with the frameless mask and the high definition motion management system:

- The AU and AMP need to be physically present during the initiation of all treatments. This allows independent confirmation that the correct site is being treated, confirm that the correct plan is being used for treatment and particularly important for functional cases, all of which are components of the universal time outs It also provides an

opportunity to visualize the movement of the treatment table to the correct position via treatment room cameras.

- The current physical presence requirements for the AU be modified by allowing the AU to be within a 2 minute walk of the console area **and** immediately available to come to the treatment room after initiation of treatments. An AMP needs to be physically present by the console area during the entire treatment. (i.e. at the console or within normal hearing voice) of the AU.
- At the conclusion of treatment, the AU must be present at the Gamma Knife® console to discuss any treatment or patient issues with the patient, AMP and nurse.

We believe that the recommendations would allow for the safe and effective delivery of gamma stereotactic radiosurgery while allowing the AU more flexibility to be available for other medical issues, other than those requiring personal supervision, in a radiation oncology department if warranted. We also believe that the recommendations will allow the licensee to determine if a medical event (ME) has occurred, would allow the regulator to inspect and regulate a Gamma Knife® center, would not unfavorably encroach on the practice of medicine, and are consistent with regulations governing physician supervision. As a subcommittee, we believe it is inappropriate for the AU to be more than a 2 minute walk from the console under any circumstance as the AU needs to be immediately available and needs to ensure the correct radiation dose is delivered. In addition, we recommend that the AU work with their radiation safety officer to determine how long it will take for the AU to return to the Gamma Knife® console area from another location at which he/she wishes to work. The center will need to determine best method to contact the physician as paging a physician can take time. Since any change can be subject to interpretation, it is important that each Gamma Knife® center determine what area would be within 2 minutes of the console. Ultimately, each AU will need to decide if he or she wishes to adopt the revised physical presence proposal or maintain the current physical presence rules, which is more stringent.

Given the proposed change, it is imperative that a culture of safety and quality with checks and balances at every level exists to ensure that the safest and most effective care is delivered to patients while simultaneously protecting the public. Licensees are encouraged to continue to audit and monitor their programs and adopt best practices including a high reliability system approach[7] to mitigate MEs.

Respectfully submitted, August 17, 2017

Subcommittee on Physical Presence Requirements for Leksell Gamma Knife® Icon™,
Advisory Committee on the Medical Uses of Isotopes (ACMUI),
Nuclear Regulatory Commission (NRC)

References

1. 10 CFR 35.615(f)(3).

2. Section V, Summary of changes of 2002 revised part 35 in Federal Register (67 FR 20355)

3. NRC-issued Regulatory Issues Summary (RIS) 2005-23- October 2005

4. 42 C.F.R. § 410.32

5. Mastroianni A, McCaffrey JF. Target tumors, not yourself: A review of False Claims Act allegations against radiation oncologists. Appl Radiat Oncol 4(2): 14-21, 2015

6. Solberg TD, Balter JM, Benedict SH, et al. Quality and safety considerations in stereotactic radiosurgery and stereotactic body radiation therapy: Executive summary. Pract Radiat Oncol 2:2-9, 2012.

7. Reason J. Human error: models and management. BMJ 32:768-770, 2000

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Yttrium-90 Microspheres Brachytherapy Licensing Guidance

Katie Tapp, Ph.D.
Medical Radiation Safety Team
September 12, 2017

Working Group Members

- **Katie Tapp, co-chair, NRC NMSS**
- **Bob Dansereau, co-chair, New York State**
- **Victor Diaz, New Mexico**
- **Sara Forster, NRC RIII**
- **Penny Lanzisera, NRC RI**

Licensing Guidance History

- **First issued Y-90 microsphere LG in 2002**
- **Issued Revision 9 in February 2016**
- **ACMUI Subcommittee reviewed draft Revision 10 and discussed on October 7, 2017**

Draft Revision 10 Changes

- **T&E Section**
- **Waste and Disposal Section**
- **Autopsy and Cremation Information**
- **Added definition for the term "shunting"**

Training and Experience

- Two Components
  - Radiation Safety T&E, and
  - Specific Clinical Experience for Y-90 Microspheres, including
    - operation of delivery system,
    - safety procedures,
    - clinical use, and
    - 3 supervised in-vivo cases completed under supervision

5

Clinical Experience

- Currently, supervision maybe by:
  - an Authorized User or
  - manufacturer representative (alternative pathway)
- Alternative pathway:
  - was introduced in 2008 due to limited number of AUs to provide supervision
  - Unique to Y-90 microsphere brachytherapy

6

Draft Revision 10 LG

- Draft Revision 10 LG recommends removing the alternative pathway
  - After 10 years of licensing AU for Y-90 microspheres, there should be adequate number of AUs available to provide supervision
  - 2 year grace period

7

ACMUI Recommendations

- Alternative pathway should remain because:
  - uncertainty if there is sufficient T&E opportunities for new AUs, and
  - manufacturer training provides a uniform standard of didactic and in-vitro clinical training
- WG should consider additional requirements for proctors

8

Draft Revision 10 LG updates

- Recommending alternative pathway be removed, with a grace period
- Recommending AU supervision for work experience in:
  - evaluation of treatments, and
  - administrative controls to prevent ME.

9

During Grace Period

- 6 month limit for completing 3 supervised in-vivo cases after AU is licensed
  - Avoid significant time between training and actual clinical experience
  - LG recommending case-by-case basis allowance of longer time period

10

Lung Shunting

- Revision 9 excluded reporting lung shunting as a ME if lung shunt was evaluated prior to treatment
- Definition of shunting to LG
- Shunting is defined as an unexpected blood flow causing the Y-90 microspheres to flow to an unwanted location.

11

Public Comment

- Federal Register soliciting public comments on draft Revision 10 of the LG
- 60 day public comment period

12

Public Comment (cont.)

Several questions asked for public consideration

- T&E
  - Minimum clinical experience
  - Switching manufacturers
  - Written attestation
  - Removal of the alternative pathway
  - Timeliness of in-vivo case completion
- ME definition

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Acronyms

- AU: Authorized User
- LG: Licensing Guidance
- ME: Medical Event
- RI: Region I
- RIII: Region III
- T&E: Training and Experience
- WG: Working Group
- Y-90: Yttrium-90

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United States Nuclear Regulatory Commission
Protecting People and the Environment

Enhancing Communications with the Medical Community

D. Metter, M.D.
C. Palestro, M.D.
September 12, 2017

Enhancing Communications with the Medical Community

- Inaugural sessions: Speak to the Regulator
  Presented at the annual meetings of
  ACR: May 2017 (Washington, D.C.)
  SNMMI: June 2017 (Denver, CO)

U.S.NRC

Enhancing Communications with the Medical Community

- Inaugural sessions
  Overview: D. Metter
  Current Topics: C. Palestro
  NRC: About the Regulator
  ACR: D. Bollock
  SNMMI: S. Daibes Figueroa
  Q & A

U.S.NRC

Enhancing Communications with the Medical Community

- Inaugural sessions
  Modest turnout, but good dialogue
  Not CME/SAM sessions
- Future sessions
  Session timing
  Organize as CME & possibly SAM sessions
  Interactive scenarios (issues & resolutions)
  Consider additional venues (PD meetings)
  Solicit pre-meeting topics/concerns
  Suggestions welcome!

U.S.NRC

Acronyms

- ACR: American College of Radiology
- CME: Continuing Medical Education
- SAM: Self Assessment Module
- SNMMI: Society of Nuclear Medicine and Molecular Imaging
- PD: Program Directors
- Q & A: Question and Answer

Special Presentation

for

Mr. Francis (Frank) Costello

NO HANDOUT

Special Presentation

to

Dr. Susan (Sue) Langhorst

NO HANDOUT

Thoughts on Leaving the ACMUI

NO HANDOUT

Open Forum

NO HANDOUT

March 2018

Monday	Tuesday	Wednesday	Thursday	Friday
			1	2
5 x	6 x	7 x	8 x	9 x
12	13	14	15	16 x
19 x	20 x	21 x	22 x	23 x
26 x	27 x	28 x	29 x	30 x

April 2018

Monday	Tuesday	Wednesday	Thursday	Friday
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9	10	11 x	12 x	13 x
16 x	17 x	18 x	19 x	20 x
23 x	24 x	25 x	26 x	27 x
30 x	x			