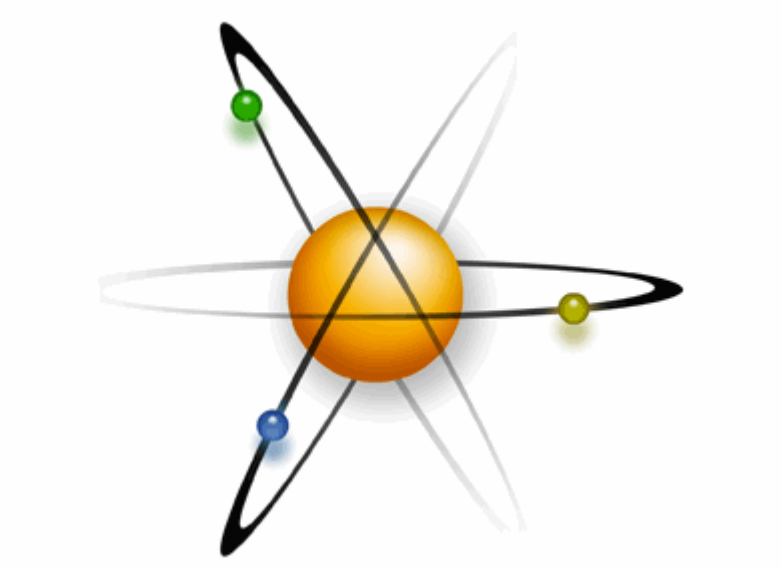
ADVISORY COMMITTEE ON THE MEDICAL USES OF ISOTOPES

SPRING 2025 MEETING
APRIL 7 - 8, 2025

Meeting Handout



MEETING AGENDA
ADVISORY COMMITTEE ON THE MEDICAL USES OF ISOTOPES
April 7 – 8 2025

One White Flint North Building, 11555 Rockville Pike, Commissioner's Hearing Room
North Bethesda, Maryland 20852

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, April 7, 2025 OPEN SESSION		
9:00 – 9:10	**1. Opening Remarks** Mr. Einberg will formally open the meeting, and Ms. Silberfeld will provide opening remarks.	**C. Einberg, NRC D. Silberfeld, NRC**
9:10 – 9:20	**2. Old Business** Dr. Tapp will review past ACMUI recommendations and provide NRC responses.	**K. Tapp, NRC**
9:20 – 9:40	**3. Open Forum** The ACMUI will identify medical topics of interest for further discussion.	**ACMUI**
9:30 – 10:15	**4. Medical Related Events** Mr. Dimarco will provide an update on recent medical events.	**D. Dimarco, NRC**
10:15 – 10:30	**BREAK**	
10:30 – 11:00	**5. Yttrium-90 (Y-90) Microsphere Gastrointestinal (GI) Deposition Medical Events Subcommittee Report** Dr. Harvey will discuss the subcommittee's evaluation of recent Y-90 microsphere medical events to identify potential cause of sudden increase in reported events involving unexpected GI deposition.	**R. Harvey, ACMUI**
11:00 – 11:45	**6. Training and Experience Requirements for All Modalities Subcommittee Report on Emerging Medical Technologies** Dr. Folkert will discuss the subcommittee's recommendations to the NRC on knowledge topics encompassing the safety related characteristics of emerging medical technologies.	**M. Folkert, ACMUI**
11:45 – 1:00	**LUNCH**	
1:00 – 1:30	**7. Generic Process Checklist Subcommittee Report** Mr. Green will discuss the subcommittee's recommendations regarding development of process checklists to minimize medical events.	**R. Green, ACMUI**
1:30 – 2:15	**8. NRC Medical Radiation Safety Team Updates** Dr. Tapp will provide an update on the Medical Radiation Safety Team's activities, including efforts to increase efficiency in licensing and oversight in response to the Advanced Act.	**K. Tapp, NRC**

2:15 – 2:30	**9. Special Recognition for Ms. Allen** Ms. Bloomer will make a special presentation to Ms. Allen	**T. Bloomer, NRC**
2:30 – 2:45	**10. Thoughts on Leaving the ACMUI** Ms. Allen will share her thoughts on leaving the ACMUI.	**R. Allen, ACMUI**
2:45 – 3:00	**BREAK**	
3:00 – 3:15	**11. ACMUI Reporting Structure** Ms. Marra will provide an overview of the current reporting structure. Members will discuss the reporting structure of the Committee and provide feedback to the NRC.	**A. Marra, NRC**
3:15 – 3:30	**12. Open Forum** The ACMUI will discuss medical topics of interest previously identified.	**ACMUI**
3:30– 3:45	**13. Administrative Closing** Ms. Marra will provide a meeting summary and propose dates for the fall 2025 meeting.	**A. Marra, NRC**
3:45 – 4:00	**BREAK**	
Closed Session		
4:00 – 4:30	**14. ACMUI Working Session: Biennial Evaluations**	**ACMUI**

Tuesday, April 8, 2025 **Open Session**		
10:00 – 12:00	**15. Commission Meeting with the ACMUI** The ACMUI will brief the Commission on various topics in a public meeting.	**ACMUI**
	16. Group Photo The ACMUI will take a group photo with and without the Commission.	**ACMUI**
12:00	**ADJOURN**	

2021 ACMUI Recommendations and Action Items

	ITEM	DATE	STATUS		Target Completion Date for NRC Action
10	The ACMUI endorsed the Radionuclide Generator Knowledge and Practice Requirements Subcommittee Report and the recommendations provided therein.	10/04/2021	*Accepted*	Open	March 2026

2022 ACMUI Recommendations and Action Items

	ITEM	DATE	STATUS		Target Completion Date for NRC Action
6	New subcommittee to create generic process checklists to be used during medical administrations was established.	12/5/2022	*Accepted*	Open	Spring 2025
8	The Subcommittee for Nursing Mother Guidelines was reestablished to update the guidelines last updated in 2019.	12/5/2022	*Accepted*	Open	Fall 2025

2023 ACMUI Recommendations and Action Items

	ITEM	DATE	STATUS		Target Completion Date for NRC Action
6	NRC staff will seek to obtain the number of annual Y-90 microsphere administrations from the manufacturers.	10/23/23	NRC Action	Open	Spring 2025

2024 ACMUI Recommendations and Action Items

	ITEM	DATE	STATUS		Target Completion Date for NRC Action
1	The ACMUI unanimously endorsed the report from the Subcommittee on Akesis Galaxy® RTi Draft Licensing Guidance, as presented.	4/8/24	NRC Action	Closed	Fall 2024
2	The ACMUI unanimously endorsed the report from the Subcommittee on Yttrium-90 Microsphere Brachytherapy Sources and Devices Eye90 Microspheres® Licensing Guidance, as presented.	4/8/24	NRC Action	Closed	Fall 2024
3	The ACMU provided a report with recommendations on LV Liberty Vision Corporation Yttrium-90 Disc and Iwand® Ophthalmic System Draft Licensing Guidance.	4/8/24	NRC Action	Open	Spring 2025
6	The ACMUI formed a subcommittee to reassess including an interventional radiologist in ACMUI membership	4/8/2024	ACMUI Action	Open	Fall 2025
8	The ACMUI recommended that the staff provide more information on root causes and corrective actions during their annual review of medical events and presentation to the Committee.	4/8/24	NRC Action	Closed	Fall 2024

	ITEM	DATE	STATUS		Target Completion Date for NRC Action
9	The ACMUI unanimously endorsed the Implementation of Part 35 T&E Subcommittee report with addendums.	6/5/24	NRC Action	Open	Spring 2025
11	The ACMUI unanimously endorsed the report of the Subcommittee on Financial Assurance Requirements for Disposition of Category 1–3 Byproduct Material Radioactive Sealed Sources.	8/29/24	NRC Action	Open	Spring 2025
12	The ACMUI unanimously endorsed the report from the Subcommittee on ACMUI bylaws regarding disclosures related to conflicts of interest.	11/4/24	NRC Action	Open	Spring 2025

OPEN FORUM

(No Handout)

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

Status of Medical Events FY 2024

Daniel DiMarco
Medical Radiation Safety Team
April 7, 2025

Purpose of Medical Event Reporting

- Medical event reporting helps to identify deficiencies in the safe use of radioactive material and ensures that corrective actions are taken to prevent recurrence.
- A medical event may indicate a potential problem in a medical facility's use of radioactive materials.
- It does not necessarily result in harm to the patient.
- Medical event reporting allows the NRC to determine if other licensees might be experiencing the same or similar challenges. The NRC assesses trends or patterns, identifies generic issues or concerns, and recognizes any inadequacy or unreliability of specific equipment or procedures.

Immediate Reporting Requirements

- A written report must be submitted within 15 days after discovery and must include
  - Licensee's name
  - Name of prescribing physician
  - Brief description of event
  - Why the event occurred
  - The effect, if any, on the individual(s) who received the administration
  - What actions, if any, have been taken or are planned to prevent recurrence
- Certification that the licensee notified the individual (or the individual's responsible relative or guardian), and if not, why not.
- Report should not include patient's name. Separate annotated copy of the report should be provided with patient name, identifying number, and copy of annotated report to referring physician.

Reporting Best Practices

- The NRC uses medical event reports to look for trends and generic issues.
- Provide enough detail that an uninvolved individual would have a full understanding of the event.
- Do not assume the reader knows all associated regulations or current standard protocols.
- Helpful details include:
  - Manufacturer, model, or specifications of supporting equipment associated with the event such as IV pump or gauge size.
  - Relevant information that preceded the event.
  - What staff was present.
  - How the event was identified.
  - Include short and long term corrective actions and how they are linked to the event.
  - Clearly highlight if the event or corrective actions involve a common industry-wide practice or procedure.

Medical Events FY 2019 - 2024

	FY19	FY20	FY21	FY22	FY23	FY24
35.200	1 (8*)	0	4	0	1	0
35.300	9	2	10	10	11	7
35.400	5	6	4	1	3	1
35.600	9 (10*)	13	5	11 (40*)	8	6
35.1000	32	27	41	34	36	34
Total	56	48	64	56	59	48

* The total number of patients involved if greater than the number of reports

Medical Events 2024

35.300 Medical events	**7**
Ra-223	2
Lutetium-177	3
I-131	2

35.300 Ra-223

- Patient Underdose [NMED #240289]
  - Prescribed 3.3 MBq (89.2 μCi), administered 1.68 MBQ (45.53 μCi)
  - Medical physicist deviated from written directive procedure to measure the activity in the dose calibrator and then deliver the dose
  - MP delivered the dose after adjusting using an outdated and incorrect formula
  - State initiated an investigation

35.300 Ra-223

- Patient Underdose [240289]
  - Prescribed 3.37 MBq (91.2 µCi), administered 2.68 MBq (72.46 µCi)
  - Medical physicist deviated from written directive procedure to measure the activity in the dose calibrator and then deliver the dose
  - MP delivered the dose after adjusting using an outdated and incorrect formula
  - State initiated an investigation
  - Same patient as previous event (2 doses with 2 separate WDs, one month apart)

35.300 Lu-177

- Patient Overdose [240075]
  - Patient prescribed 3.7 GBq (100 mCi), received 7.4 GBq (200mCi)
  - Original WD called for 7.4 GBq but oncologist had signed a dose alteration plan for 3.7 GBq
  - Alteration was not captured in the WD modification, and the full dose was delivered
  - Multiple root causes were identified, including changes in dose not being seen, not all employees having access to the patient electronic medical records, unavailability of reduced dosage ordering and a lack of dual sign off by Infusion Nurse and Nuclear Medicine staff
  - No adverse effects are expected
  - Corrective actions included WD completion closer to the actual therapy, creation of a reduced dose order in electronic records, inclusion of dual verification of dose, and discussion of reduced dose directly with the AU
  - This event occurred prior to issuance of Information Notice IN-2024-04 on Medical Events involving Administration of Therapeutic Radiopharmaceuticals

35.300 Lu-177

- Patient Overdose [230483]
  - Patient prescribed 5.55 GBq (150 mCi), received 7.4 GBq (200 mCi)
  - Patient was unintentionally administered the full dose, rather than the reduced dose
  - Root cause was determined to be lack of WD review and lack of timeout use before the procedure
  - No adverse effects are expected
  - Corrective actions included a review of the WD format and improvement of the two-technologist pre-treatment timeout procedure
  - Additional actions included reeducation stressing the importance of the pre-treatment timeout and attention to detail
  - This event occurred prior to issuance of Information Notice 2024-04 on Medical Events involving Administration of Therapeutic Radiopharmaceuticals

35.300 Lu-177

- Patient Underdose [240041]
  - Prescribed 7.4 GBq (200 mCi), administered 5.54 GBq (149.7 mCi)
  - Treatment went as planned; a survey meter positioned to monitor the vial determined that activity had been delivered to the patient
  - Post-treatment survey noted a residual activity of 1.62 GBq (43.7 mCi)
  - Investigation determined that due to changes in the licensee supply chain, a new IV set was being used
  - This new set did not have a clip to prevent backflow into the pump, which resulted in a visual constriction of the IV line
  - Technologist attempted to open up the tubing, which seemed successful after manipulation
  - Corrective actions included changing the procedure for infusion and repositioning the survey meter to more directly measure the activity in the vial

35.300 I-131

- Patient Overdose [230491]
  - Patient prescribed 3.7 GBq (100 mCi), received 5.92 GBq (160 mCi)
  - Root cause was determined to be human error
  - NMT misinterpreted AU handwriting on the WD and the AU failed to confirm the dose during the pre-treatment phase of the administration
  - Additionally, more minor discrepancies on the WD indicated a lack of oversight by the RSO
  - Adverse effects included an increased cancer risk due to an additional whole body dose of approx. 62 rem
  - Corrective actions included procedure updates for WD (including typing of prescribed dose), additional training for Aus on WDs, and more frequent RSO audits of WDs

35.300 I-131

- Patient Underdose [240143]
  - Prescribed 3.7 GBq (100 mCi), administered 0.148 GBq (4 mCi)
  - When performing routine radiation surveys at the end of the day the licensee found the 3.7 GBq capsule in its original packaging
  - Determined that the patient had only been given the diagnostic capsule
  - Root cause was determined to be a lack of dose confirmation on the written directive prior to administration
  - Corrective actions included education of NMTs on proper patient and activity processing
  - Additionally, procedures were revised to provide clarity on NMT responsibilities

Medical Events 2024

35.400 Medical events	**1**
Cs-131 (GammaTile)	1

35.400 GammaTile

- Patient Underdose [240198]
  - Prescribed 6,000 cGy (rad), received 3,600 cGy (rad)
  - 40 seeds successfully implanted in the brain for treatment
  - Patient returned due to medical complications and had the seeds removed over two procedures
  - Seven seeds were lost post-explantation, state conducted an on-site investigation

Medical Events 2024

35.600 Medical events	**6**
HDR	6

35.600 HDR

- Patient Overdose [230454]
  - 218.49 GBq (5.905 Ci) Ir-192 HDR unit
  - Prescribed 3,400 cGy (rad) over 10 fractions, received 4,420 cGy (rad)
  - Dwell times were not verified between planning and delivery systems for 8 fractions before being identified
  - Delivery system was on a Windows XP based personal computer that could not be on the licensee network due to security reasons
  - This configuration prevented communication between the planning and delivery systems, resulting in incorrect dwell times
  - No effects were noted to the patient, treatment was considered completed

35.600 HDR

- Patient Overdose [230436]
  - Expected dose to non-target organ was 200 cGy (rad), delivered 340 cGy (rad)
  - First fraction of treatment was delivered for management of cervical cancer when the error occurred
  - Follow-up determined that HDR channel assignments had been reassigned during setup mistakenly, followed by a failure to confirm proper channel assignment during the pre-procedure timeout

35.600 HDR

- Patient Overdose [230436] (cont.)
  - Patient proceeded with the rest of the treatment successfully, with no additional effects from the overdose
  - Corrective actions included retraining HDR staff on applicator configuration and verification of channel connection
  - Additionally, the licensee considered the use of different lengths of transfer tubes for different channels to physically distinguish it from other channels during automated length measurements

35.600 HDR

- Patient Overdose [230517]
  - Patient was prescribed 236.8 cGy (rad), received 362 cGy (rad)
  - Patient was scheduled to receive first fraction of treatment but was mistakenly administered a previous patient's treatment
  - Physicist set up the new patient in the HDR vault and confirmed that the patient was correct, without closing the previous treatment plan
  - Physicist closed the previous treatment plan after exiting the vault
  - Physicist then inadvertently re-opened the previous treatment plan and delivered the first fraction to the wrong patient

35.600 HDR

- Patient Overdose [230517] (cont.)
  - Physicist caught the error once they tried to upload the post-treatment summary and noticed there was one already completed
  - Dose evaluation was completed, and the remaining 9 fractions were changed to compensate for the overdose, resulting in a final dose only 2% below the original treatment plan
  - Corrective actions included modifications to the patient check in procedure, additional sign offs on the console treatment plans, and another verification to ensure the computer treatment plan and the prescribing computer plan match regarding the active patient

35.600 HDR

- Wrong Site [230461]
  - Patient prescribed three treatments of 550 cGy, total of 1,650 cGy (rad) to the uterus
  - During the third fraction, treatment was interrupted due to fluid in the transfer tubing
  - Replacement tubing was not the correct length, resulting in the source being outside of the patient for 10 seconds
  - Localized skin dose to the patient's thigh was estimated to be 300 cGy (rad) in a worst-case, direct contact scenario and 50 cGy (rad) for a more realistic, 8mm distance scenario
  - Physician noted that the dose was below the level likely to cause injury

35.600 HDR

- Wrong Site [230461] (cont.)
  - Delivered dose during this fraction was within 20% of the expected dose to the uterus
  - Corrective actions included leak testing tubing and revision of procedures to verify tubing length before starting treatment
  - Additionally, new procedures were developed for interruption of treatment to adjust patient setup

35.600 HDR

- Patient Underdose [240081]
  - 438.82 GBq (11.86 Ci) I-192 HDR Unit
  - Prescribed 600 cGy (rad) fractions, received 100 cGy (rad) for the third treatment
  - Dwell positions with two ovoid applicators was successful, but was obstructed with the tandem applicator
  - Repeated checks and attempts were unsuccessful, leading to the underdose
  - Investigation of the applicator found microfractures in the tandem
  - Licensee noted the matter seemed to be related to the autoclaving process for the applicators
  - Corrective actions included applicator replacement and development of additional precautionary safety procedures
  - Patient treatment was revised and successfully completed

35.600 HDR

- Patient Underdose [240044]
  - 236.06 GBq (6.38 Ci) Ir-192 HDR unit
  - Patient prescribed 550 cGy (rad) per fraction, received 60.5 cGy (rad)
  - Treatment time was determined to be six minutes and 15 seconds over nine dwell positions
  - After starting treatment and the timer counted down, timer froze at six minute and seven seconds
  - Physician stopped the treatment once the freeze was noticed, estimating the treatment time to be around 30-40 seconds
  - Investigation found that the device was functioning normally, and the timer freeze was unable to be replicated or verified
  - Licensee paused their HDR program until more troubleshooting could be performed

Medical Events 2024

35.1000 Medical events	**34**
GSR	1
Y-90 Microspheres	
– Unknown	3
– TheraSphere™	27
– SIR-Spheres®	3

35.1000 Gamma Stereotactic Radiosurgery

- Wrong Site [240018]
  - Patient was prescribed 80 Gy (8000 rad) to the left trigeminal nerve, delivered full dose to the right trigeminal nerve
  - MP misidentified the nerves during pre-treatment and the reviewing neurosurgeon and oncologist did not notice the error during the plan review
  - No adverse effects are expected
  - Corrective actions included implementation of new procedures for GSR procedures, additional peer reviews by a gamma knife trained oncologist, and a verbal timeout before all cases.

35.1000 Y-90 Microspheres

- Patient Overdose [240113]
  - Patient prescribed 2.6 GBq (70 mCi), delivered 3.13 GBq (84.5 mCi)
  - Technologist drew up 3.17 GBq (85.8 mCi)
  - Treatment was delivered within 30 minutes of the dose being drawn
  - Incident was discovered during a quarterly review a month later
  - Both AU and patient referring physician were satisfied with the activity delivered

35.1000 Y-90 Microspheres

- Patient Underdose [240351]
  - Prescribed 14,700 cGy (rad), received 5,880 cGy (rad)
  - Licensee suspected stasis but State is still inspecting

35.1000 Y-90 Microspheres

- Patient Underdose [240092]
  - Patient received 30% of prescribed dose
  - When inserting the catheter, vein contusions caused the underdose to occur
  - Licensee noted the incident did not cause stasis

35.1000 TheraSphere™

- Wrong Site [240352]
  - Patient prescribed 2.18 GBq (59 mCi), received 0.970 GBq (25 mCi)
  - During administration some of the dose as deposited in the stomach, resulting in a dose of 99 Gy (9,900 rad)
  - Root cause was determined to be a blockage and subsequent rupture of the catheter, noting that the administering physician felt resistance during administration
  - Licensee also noted that they were using a manufacturer recommended catheter and followed administration protocol

35.1000 TheraSphere™

- Wrong Site [240352] (cont.)
  - Corrective actions included advising IR AUs of this issue at conferences, notifying the vendor of the event, and notifying the licensee department of quality and safety
  - Treatment was paused to determine the extent of adverse effects
  - No symptoms were noted and the state confirmed that all recommendations were followed for the event

35.1000 TheraSphere™

- Wrong Site [240321]
  - Patient prescribed 1.31 GBq (45.92 mCi) for a dose of 250 Gy, mistakenly delivered 97 Gy (9,700 rad) to the stomach
  - Root cause was human error, the team used a pre-treatment mapping study from a previous administration
  - Severe adverse effects are expected
  - Corrective actions included education of all IRs, and a new, formal process for the treatment team to review correct MAA and angiography mapping techniques

35.1000 TheraSphere™

- Wrong Site [240272]
  - Patient prescribed 0.77 GBq (20.81 mCi), received 0 GBq (0 mCi)
  - All dose was deposited to stomach for a dose of 19,880 cGy (rad)
  - All recommended pre-treatment imaging was performed, including an angiogram the day of the treatment, showing no stomach filling
  - Post-treatment imaging revealed that the full dose had been deposited in the stomach

35.1000 TheraSphere™

- Wrong Site [240272] (cont.)
  - Root cause was not able to be definitively determined but the licensee believes that atypical flow was misinterpreted during pre-treatment planning
  - Additionally, 1 month before the treatment the patient was undergoing immunotherapy and angiogenesis treatment, which may have contributed to the event
  - Patient was treated for adverse effects to the GI system and appears to be recovering
  - Corrective actions included guidance for mapping studies with regards to abnormal arterial structure, use of cone beam CT to augment the pretreatment studies, and clear instructions to staff about reporting requirements

35.1000 TheraSphere™

- Wrong Site [240183]
  - Patient prescribed 0.613 GBq (16.57 mCi), received 0.582 GBq (15.73 mCi) to treatment site
  - Post-treatment analysis revealed and uptake to the stomach of 1,400 to 2,000 cGy (rad)
  - Follow-up with the patient showed no complications to the GI system
  - Root cause was suspected to be complex vascularity of the tumor not identified by two MAA mapping studies
  - The licensee stated that since the second MAA mapping was done the day of the treatment it was possible the MAA particles may have partially altered the flow dynamics of the tumor
  - No corrective actions were taken given that the administration had been given according to manufacturer's recommendation

35.1000 TheraSphere™

- Patient Underdose [240114]
  - Patient prescribed 1.79 GBq (48.38 mCi), delivered 0.67 GBq (18.11 mCi)
  - Root cause was determined to be the unintentional use of a smaller catheter than recommended by the manufacturer (0.019” inner diameter instead of 0.02”)
  - No adverse effects were expected and the dose delivered was determined to be clinically effective
  - Corrective actions included additional training on verification of catheter size for IR technologists and AUs, and revision of the SOP to include a step for catheter size verification

35.1000 TheraSphere™

- Patient Underdose [240305]
  - Patient prescribed 1.2 GBq (32.44 mCi), received 0.82 GBq (22.26 mCi)
  - Root cause was determined to be a kink in the catheter
  - Corrective actions included reminders to check flow through the microcatheter prior to administration and to keep watch on the overflow vial during the administration

35.1000 TheraSphere™

- Patient Underdose [240299]
  - Patient prescribed 2.072 GBq (56 mCi), received 1.369 GBq (36.95 mCi)
  - Treatment was intended to be two doses (A and B) for separate sections of the liver
  - Dose for segment B was mistakenly delivered to segment A
  - Incident was immediately discovered before delivering dose to segment B

35.1000 TheraSphere™

- Patient Underdose [240238]
  - Patient prescribed 4.29 GBq (116 mCi), received 0.1 GBq (2.62 mCi)
  - During treatment a tubing failure led to the suspension of treatment
  - Patient was rescheduled for treatment
  - Kit was held for decay to send to the manufacturer for analysis

35.1000 TheraSphere™

- Patient Underdose [240229]
  - Patient prescribed 3.712 GBq (100.32 mCi), received 0.3 GBq (8.1 mCi)
  - Attending physician noted no unusual signs during treatment
  - Inspection found that written procedures were not implemented to provide high confidence that the administration was performed in accordance with the written directive
  - A catheter smaller than recommended was used and individuals working under the supervision of the AU were not properly trained
  - Corrective actions included procedural changes to include catheter planning multiple times during the process

35.1000 TheraSphere™

- Patient Underdose [240208]
  - Patient prescribed 29,300 cGy (rad), 9,500 cGy (rad)
  - Patient was prescribed two administrations of microspheres, first vial was the underdose, second was uneventful
  - Event was discovered when surveying the waste post-treatment
  - Root cause was determined to be momentary stoppage of microsphere flow due to actuation of the relief valve, leading to microspheres dropping out of suspension
  - Patient was scheduled for additional treatment
  - No corrective actions were taken

35.1000 TheraSphere™

- Patient Underdose [240184]
  - Patient prescribed 1.304 GBq (35.24 mCi), received 0.931 GBq (25.16 mCi)
  - Root causes were determined to be clumping of microspheres in the V-vial, occlusion of the needle puncturing the vial, or kinking of the microcatheter
  - Corrective actions included updating procedures to lift the vial and shield out of the kit and striking it to loosen any microspheres if dosimeter readings are elevated
  - Additionally, flushing will continue until dosimeter readings are at background

35.1000 TheraSphere™

- Patient Underdose [240168]
  - Patient prescribed 1.77 GBq (47.9 mCi), received 0.248 GBq (6.7 mCi)
  - Patient prescribed 2 treatments with 2 WDs, underdose occurred on the second
  - Administering physician noted resistance due to a kinked catheter during treatment
  - Root cause was determined to be a kinked catheter due to tortuous anatomy
  - Flushing the catheter did not alleviate the resistance but did result in minor contamination of the IR suite
  - Surveys and decontamination of the room occurred without incident or overexposure

35.1000 TheraSphere™

- Patient Underdose [240159]
  - Patient prescribed 1.347 GBq (36.4 mCi), received 1.029 GBq (27.8 mCi).
  - Root cause was determined to be use of a smaller than recommended catheter (Catana 2.5F), tenuous patient branch anatomy, and not replacing the microcatheter after performing the bland embolization
  - No adverse effects were expected, and retreatment was not deemed to be necessary

35.1000 TheraSphere™

- Patient Underdose [240155]
  - Patient prescribed 560 MBq (15.135 mCi), received 49.99 MBq (1.351 mCi)
  - Root cause was determined to be clumping of microspheres due to overtightening of the Tuohy Leur lock
  - Dose information was obtained from post-treatment analysis of the waste
  - No negative health effects were expected, and the treatment was rescheduled

35.1000 TheraSphere™

- Patient Underdose [240135]
  - Patient prescribed 2.11 GBq (57.03 mCi), received 0.477 MBq (12.9 mCi)
  - No adverse effects are expected
  - State performed an on-site inspection
  - Root cause was determined to be blockage of the administration line because of a faulty needle in the plunger of the administration kit

35.1000 TheraSphere™

- Patient Underdose [240053]
  - Patient prescribed 1.29 GBq (34.99 mCi), received 0.853 GBq (23.05 mCi)
  - The administering physician noted significant resistance during treatment and on saline flushes
  - Root cause was determined to be clumping of the microspheres with the reason being unclear
  - No adverse effects are expected and the physician determined that the patient did not need to be retreated

35.1000 TheraSphere™

- Patient Underdose [240048]
  - Patient prescribed 380 MBq (10.27 mCi), received 160 MBq (4.32 mCi)
  - Root cause was determined to be an obstruction in the microcatheter
  - No adverse effects were expected, and retreatment plans are being evaluated
  - No shunting was noted during the treatment
  - Waste was delivered to the manufacturer for further investigation

35.1000 TheraSphere™

- Patient Underdose [240032]
  - Patient prescribed 489.6 Gy (rad), received 113.9 Gy (rad)
  - Root cause was determined to be blockage of the catheter due to unadministered microspheres
  - Retreatment was planned
  - Corrective actions included procedure changes

35.1000 TheraSphere™

- Patient Underdose [240013]
  - Patient prescribed 3.5 GBq (94.59 mCi), received nearly 0 GBq
  - During the second of two administrations post-treatment surveys indicated nearly all of the dose remained in the delivery tubing
  - Patient was planned to be retreated in the future
  - State performed a reactive inspection
  - Investigation determined the root cause to be clumping of the microspheres with time between dose preparation and delivery being a possible complicating factor

35.1000 TheraSphere™

- Patient Underdose [240009]
  - Patient prescribed 10,500 cGy (rad), received 5,050 cGy (rad)
  - Tubing failure resulted in microspheres being contained in the device tubing
  - No spill occurred and the manufacturer representative observed the event
  - Remainder of the prescribed dose was scheduled to be delivered at a later date
  - Corrective actions included procedural changes for a more thorough inspection of device tubing and to agitate the vial prior to administration

35.1000 TheraSphere™

- Patient Underdose [230509]
  - Patient prescribed 1.86 GBq (50.27 mCi), received 1.019 GBq (27.54 mCi)
  - All pre-treatment procedures were completed but MAA showed possible reflux to the bowel
  - Physician cautiously delivered the dose, and when removing the catheter, the survey equipment showed a higher than usual level of background radiation
  - Post-treatment survey showed activity in the delivery system
  - Root cause was determined to be reflux issues causing activity to remain in the kit, and the physician not risking bowel reflux with additional flushes
  - Corrective actions included patient monitoring for reflux and anatomical issues, and ensuring that all additional flushes will be completed

35.1000 TheraSphere™

- Patient Underdose [230480]
  - Patient prescribed 1.51 GBq (40.89 mCi), received 0.84 GBq (22.59 mCi)
  - Treatment was administered with no complications and three saline flushes were completed
  - Post-treatment surveys indicated residual activity in waste
  - Investigation showed a rupture in the microcatheter passing through the Y-fitting, allowing microspheres to collect in the fitting
  - No adverse effects to the patient were expected
  - Corrective actions included manufacturer communication and refresher training to the staff on set-up of administration lines

35.1000 TheraSphere™

- Patient Underdose [230471]
  - Patient prescribed 976 MBq (26.38 mCi), received 96 MBq (2.59 mCi)
  - Pre-treatment flush of the catheter with saline and contrast solution was uneventful but attempts to deliver the microspheres were unsuccessful
  - Root cause was determined to be a kink in the catheter due to tortuous anatomy, possibly because of the difference in pressure between the flushes (200 psi) and the microspheres (30 psi)
  - No adverse effects were expected
  - Corrective actions included education about this issue for other AUs

35.1000 TheraSphere™

- Patient Underdose [230469]
  - Patient prescribed 11,800 cGy (rad), received 6,431 cGy (rad)
  - Treatment involved three vials, 1 occurred without incident but the physician noted increased resistance delivering 2 and 3
  - Root cause was determined to be user error
  - Mandrel was not removed before attempting to remove the microcatheter from the packaging, causing internal damage affecting the yield in vial 1 and 3
  - No adverse effects were expected but the patient was followed for possible retreatment
  - Corrective actions included sharing awareness of proper unpackaging technique, additional monitoring by the AU, and generic discussion on IR tasks was held among the operational leadership

35.1000 TheraSphere™

- Patient Underdose [230464]
  - Patient prescribed 12,000 cGy (rad), received 4,170 cGy (rad)
  - During line check while attempting to administer the microspheres, the administering physician experienced some difficulties, stopped the procedure, and noticed a higher than usual background reading
  - Imaging of the patient revealed very little of the dose was delivered
  - No adverse effects were expected but the patient was monitored for the next two weeks
  - The licensee planned to hold the kit for decay and send it to the manufacturer for analysis
  - Corrective actions included procedure revision

35.1000 TheraSphere™

- Patient Underdose [230434]
  - Patient prescribed 562.4 MBq (15.2 mCi), received 399.97 MBq (10.81 mCi)
  - AU noticed high back pressure during the treatment
  - Possible root causes were stated to be issues with the administration set or coring of the septum but no definitive cause was identified
  - No adverse effects were expected and the dose was determined to be clinically effective
  - No corrective actions were taken since there was no clear root cause and no violations were identified during the investigation

35.1000 TheraSphere™

- Patient Underdose [230432]
  - Patient prescribed 266.4 MBq (7.2 mCi), received 207.72 MBq (5.614 mCi)
  - Root cause was determined to be microspheres held up in the hub due to inadequate flush volume
  - No adverse effects are expected, and no additional treatment was needed
  - Corrective actions included education with a follow-up safety committee meeting, and flushing of microspheres with 30 cc of fluid, barring stasis

35.1000 SIR-Spheres®

- Patient Overdose [240333]
  - Patient prescribed 199.8 MBq (5.4 mCi), received 253.08 MBq (6.84 mCi)
  - Incident discovered during a quarterly records review
  - Root cause was determined to be the small activity of the dose, personnel had difficulty drawing microspheres into the syringe without under or overdosing the vial
    - The licensee noted that treatments under 370 MBq (10 mCi) generally have a 15% residual activity
  - No adverse effects to the patient were expected and the dose delivered was considered clinically acceptable

35.1000 SIR-Spheres®

- Patient Underdose [230155]
  - Patient prescribed 499.5 MBq (13.5 mCi), received 295.63 MBq (7.99 mCi)
  - Treatment was suspended due to tubing failure
  - Patient was rescheduled for follow-up treatment
  - Investigation could not find the cause of the clogged tubing and both the manufacturer and the licensee noted that the tubing size was acceptable for the procedure

35.1000 SIR-Spheres®

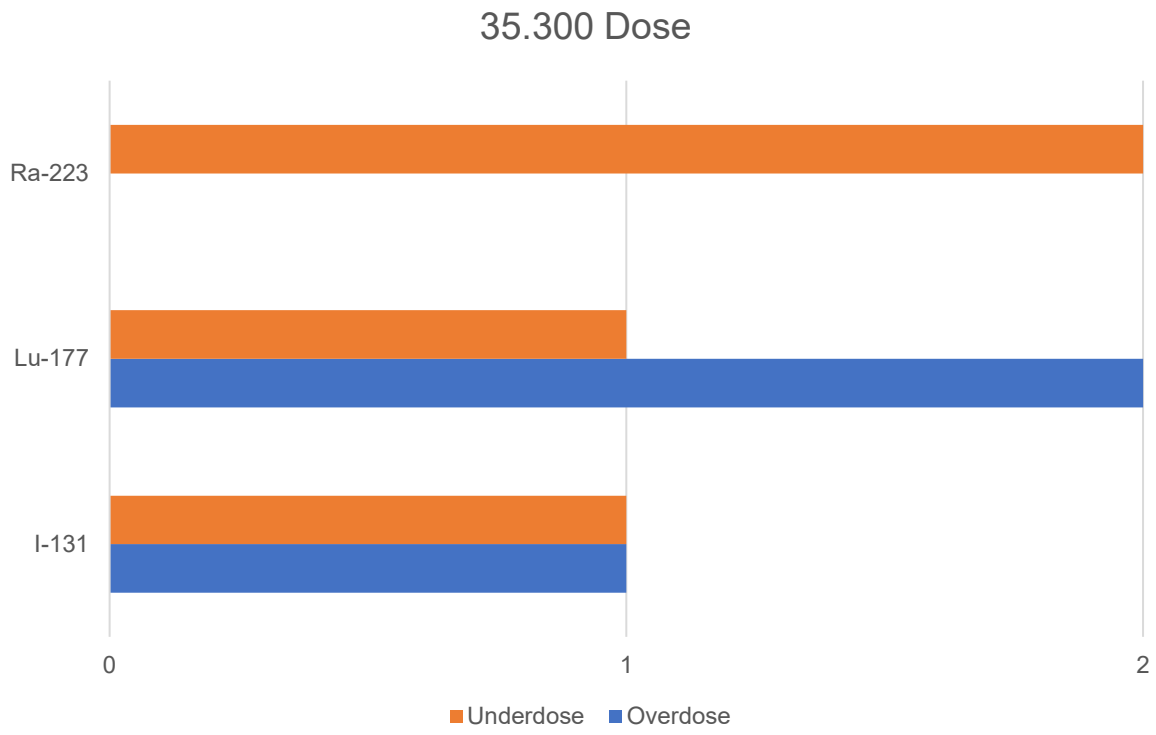
- Patient Underdose [240274]
  - Patient prescribed 708.18 MBq (19.14 mCi), received 285.64 MBq (7.72 mCi)
  - During the treatment a leak was discovered in the system tubing and treatment was stopped
  - Connection was reestablished and treatment continued, after which all contamination was remediated
  - Root cause was determined to be the treating physician's error to properly connect the tubing to the microcatheter
  - No adverse effects were expected and the dose delivered was considered therapeutically adequate
  - Corrective actions included double checks of all tubing and injecting contrast to check for leaks before administration

Summary

- 35.300
  - Ra-223 underdoses both resulted from the use of a dose administration equation from an outdated manufacturer document
  - Shows importance of using current manufacturer recommendations and regularly updating procedures based on these recommendations
  - Lu-177 overdoses resulted from administration of full doses instead of reduced doses
  - Lu-177 underdose resulted from supply chain issues and loss of expected equipment

Summary

- 35.300 (cont.)
  - Iodine underdose due to human error, no confirmation of dose delivery
  - Many of these issues are explored in IN-2024-04

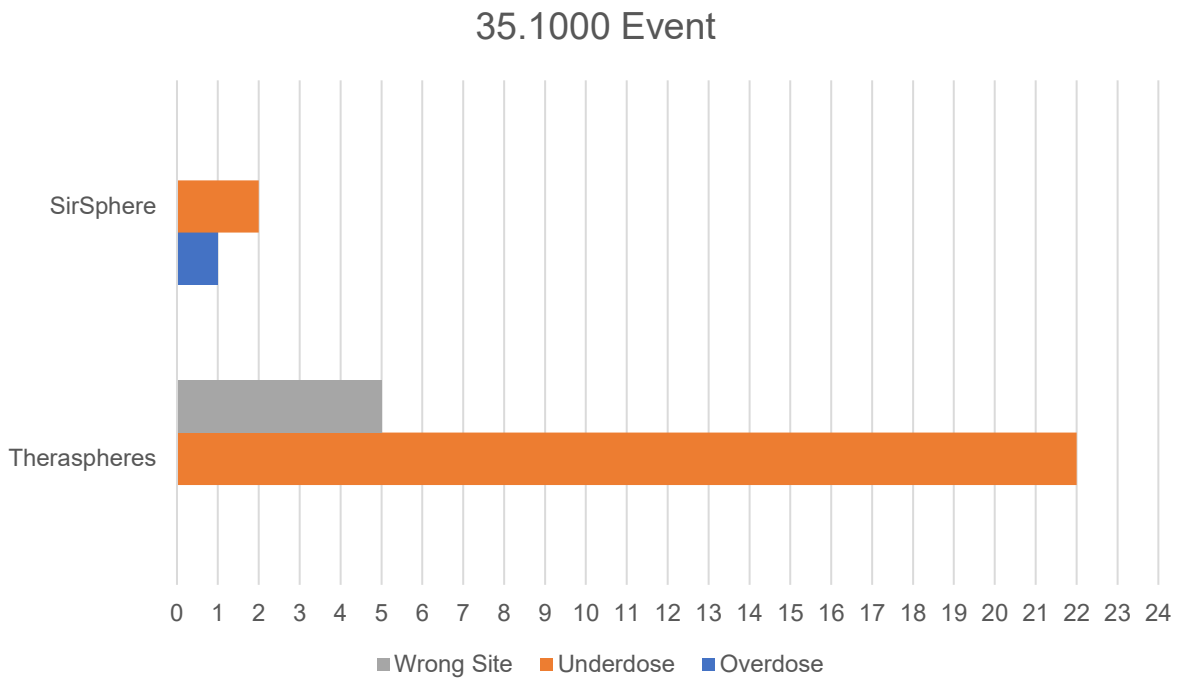


Summary

- 35.600
  - No identifiable trend or connecting thread for events this year
  - Human error dominates the root causes, mostly through improper use of equipment or use of improper equipment
  - Verification of proper and intact equipment
  - Verification of treatment parameters and patient treatment plan

Summary

- 35.1000
  - GI deposition events
  - Issues with correct equipment usage (catheters and tubing)
  - Clumping of microspheres due to a variety of issues including time between administration and dose prep, low pressure during administration, and use of improper equipment.



Acronyms

- AMP – authorized medical physicist
- AU – Authorized User
- Cs-131 – Cesium-131
- FY – Fiscal Year
- HDR – High Dose Rate Remote Afterloader
- I-192 –Iridium-192
- IVB – Intravascular Brachytherapy
- IR – Interventional Radiology
- Lu-177 – Lutetium-177

Acronyms

- NMT – Nuclear medicine technician
- RSO – radiation safety officer
- WD - Written Directive
- Y-90 – Yttrium-90

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

QUESTIONS?

Review of Yttrium-90 (Y-90) Microsphere Gastrointestinal (GI) Deposition Subcommittee

Presented by Richard P. Harvey, Subcommittee Chair

Advisory Committee on the Medical Use of Isotopes

April 7, 2025

Subcommittee Members

- John Angle, MD (Consultant)
- Joanna Fair, MD
- Michael Folkert, MD
- Richard Harvey, DrPH (Chair)
- Michael O'Hara, PhD
- Zoubir Ouhib, MS

- NRC Staff Resource: Sarah Spence, CHP

Subcommittee Charge

- Evaluate changes in Y-90 microsphere brachytherapy practice and recent Y-90 microsphere medical events to identify potential cause of sudden increase in reported events involving unexpected GI deposition.

Background

- Y-90 microsphere brachytherapy has been performed for approximately 20 years using Sir-Spheres® (resin) or Theraspheres® (glass). Sirtex and Boston Scientific are the current respective manufacturers.
- Five events have been reported to NRC's Medical Event Database (NMED) since May 2024 indicating significant deposition of Y-90 microspheres to the gastrointestinal (GI) system with one event being retracted.

Background

- GI deposition is a known undesirable outcome associated with microsphere brachytherapy but the NRC typically receives very few reported medical events with GI deposition.
- The aforementioned 5 events involved Theraspheres® but similar events have occurred with Sir-Spheres® historically.

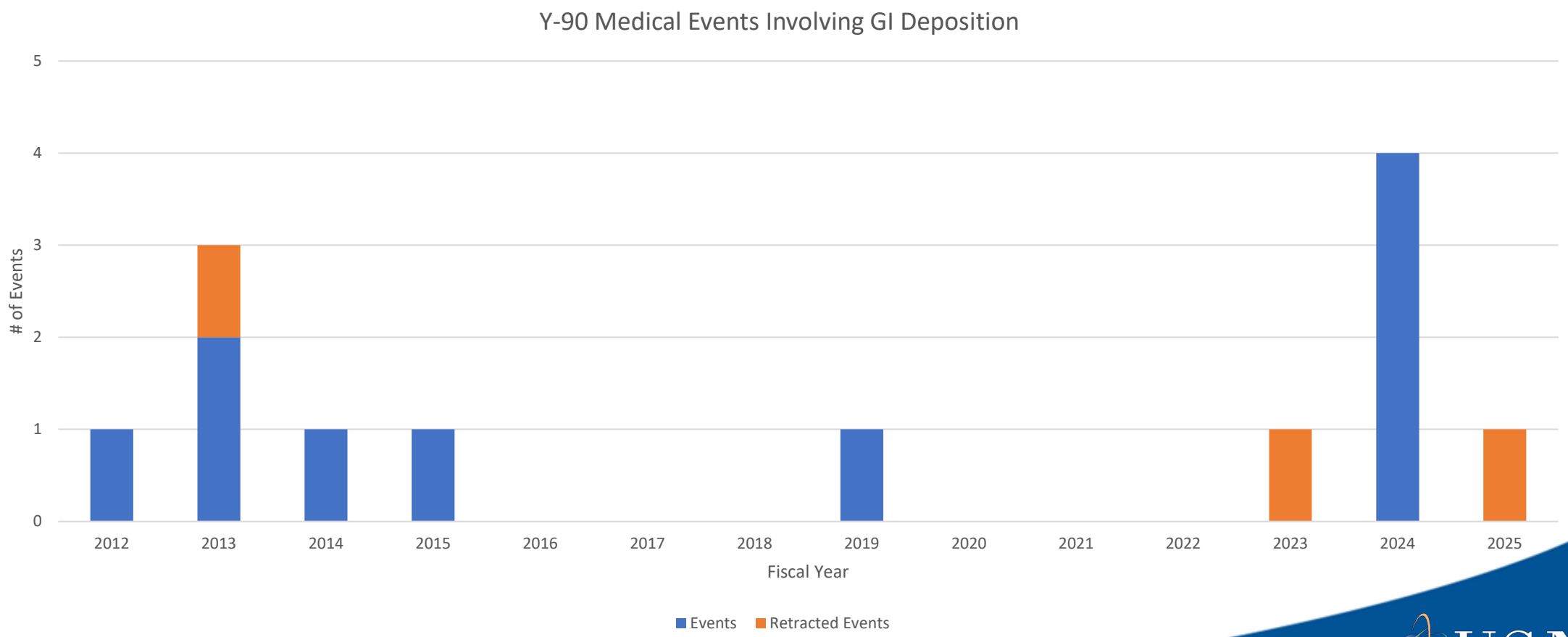
Background

- Prior to Y-90 microsphere treatment, a mapping procedure with Tc-99m macroaggregated albumin (MAA) is performed to predict microsphere flow dynamics and deposition in the liver
- Mapping may be performed same day or ahead of time
- Timing and site of MAA injection are not standardized
- Acceptable duration of time between mapping and treatment is variable based on AU experience and judgement

Findings

- Incidence rate of <0.5% for Y-90 microsphere brachytherapy medical events as reported to NMED
- Incidence rate has remained unchanged with a minor increase in events with GI deposition in 2024 (unclear if this represents a trend)
- Volume of treatments is increasing (manufacturer data to NRC)

Findings



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

Findings

- Improved imaging technology may have resulted in more events identified – increased use of Single Photon Emission Computed Tomography (SPECT) vs. planar imaging or lack of post-therapy imaging
- Treatments are challenging due to the difficulty of placing catheters in small vessels with tortuous paths
- Difficult to standardize process because of patient-specific anatomy, normal variants and clinical judgement/expertise

Licensee Explanations for GI Deposition

- Difference in microsphere (treatment) size vs. Tc-99m MAA (mapping) size – unlikely to be clinically relevant
- Mapping & treatment same day or not – licenses perform via both methods with success
- Pharmaceuticals such as Avastin may affect the flow dynamics of MAA or Y-90 microspheres – these agents are or should not be taken for several weeks prior to treatment

Subcommittee Recommendations to NRC

- NRC should determine the number of procedures being performed by leveraging relationships with manufacturers to provide a better understanding of medical events as it relates to Y-90 procedure volume
- No apparent consistent cause for these events has been identified but continued monitoring is recommended
- NRC should consider methods to inform licensees of these events

Recommendations for Industry Consideration

- Licensees should perform post-therapy imaging to determine the extent and impact of GI deposition
- Tc-99m MAA, particularly SPECT/CT imaging, in combination with careful pre-procedure angiography, are useful in screening for potential GI deposition

Recommendations for Industry Consideration

- Manufacturers should provide additional education and training for Authorized Users
  - Pitfalls
  - Recommendations
  - Concerns regarding using catheters other than recommended by manufacturer
- Maintain documentation of additional provided education
- Manufacturers should make every effort to inform in writing their users about any unexpected medical events with recommendations as a preventive measure to avoid a possible trend

Acronyms

- ACMUI – Advisory Committee on the Medical Use of Isotopes
- AU – Authorized User
- CHP – Certified Health Physicist
- GI – Gastrointestinal Deposition
- MAA – Macroaggregated Albumin
- NMED – NRC Medical Event Database
- NRC – United States Nuclear Regulatory Commission
- SPECT – Single Photon Emission Computed Tomography
- Tc-99m – Technetium-99m
- Y-90 – Yttrium-90

U.S. Nuclear Regulatory Commission
Advisory Committee on the Medical Uses of Isotopes

Subcommittee on the Review of Yttrium-90 (Y-90) Microsphere Gastrointestinal (GI) Deposition

Draft Report
Submitted on March 7, 2025

Subcommittee Members:
John Angle, MD (Interventional Radiology Consultant)
Joanna Fair, MD (Radiology Physician)
Michael Folkert, MD (Brachytherapy Physician)
Richard Harvey, DrPH (Radiation Safety Officer; Chair)
Michael O'Hara, PhD (FDA Representative)
Zoubir Ouhib, MS (Brachytherapy Physicist)

NRC Staff Resource: Sarah Spence, CHP

Subcommittee Charge: The subcommittee on the Review of Yttrium-90 (Y-90) Microsphere Gastrointestinal (GI) Deposition was established by Dr. Hossein Jadvar, MD, PhD on January 15, 2025. The subcommittee was charged to review Y-90 microsphere gastrointestinal deposition on medical events involving significant GI deposition of microspheres.

Background: Y-90 microsphere brachytherapy has been performed for approximately 20 years using Sir-Spheres® and Theraspheres®. Five events have been reported to the NRC's Medical Event Database (NMED) system since May 2024, with one event being retracted, indicating significant deposition of Y-90 microspheres to the gastrointestinal (GI) system. GI deposition is a known possible complication of microsphere brachytherapy but the NRC receives very few reported events with GI deposition. The previously mentioned five medical events occurred with Theraspheres® but similar events have occurred with Sir-Spheres.

Discussion: Prior to Y-90 microsphere treatment, a mapping procedure with Tc-99m MAA is performed to predict microsphere flow dynamics and liver deposition. Mapping may be performed the same day or prior to day of treatment with no clinical relevance to treatment success or flow dynamics. Additionally, mapping is not performed prior to every treatment if time between prior mapping and treatment does not require it. Differences between Tc-99m MAA and Y-90 microspheres particle size are not significant. Any pharmaceuticals that may affect flow dynamics should be temporarily arrested prior to treatment.

Incidence rates of Y-90 medical events reported to the NRC via NMED are less than 0.5% relative to the number of vials sold (internal data) and their rate has remained consistent even as the number of treatments is increasing. But there was an increase in the crude number of NMED events that resulted in GI deposition. Improved technology and imaging techniques may have resulted in more events being identified. These treatments remain complicated and challenging with no standardization of the procedure.

No clear root cause has been identified for these medical events due to the modest number that have occurred and inconsistent nature of the events. Continued monitoring of these events and evaluation by this committee and Medical Events subcommittee may prove valuable in assessment of Y-90 medical events with significant GI deposition.

The ACMUI subcommittee on the Review of Yttrium-90 (Y-90) microsphere gastrointestinal (GI) deposition recommends the following.

Subcommittee Recommendations to NRC:

1. NRC should determine the number of Y-90 procedures being performed on an ongoing basis
2. Continued surveillance of Y-90 medical events with emphasis on GI deposition by NRC and this subcommittee
3. NRC should consider methods to inform licensees of these events.

Subcommittee Recommendations for Industry Consideration:

1. Licensees may consider performing post-therapy imaging (i.e. SPECT, PET or planar imaging) to assess extent of GI deposition
2. Manufacturers should inform users and provide additional training to prevent similar medical events
3. Training should be documented by the licensee

References:

1. NRC Medical Events Involving Y-90 Microsphere Gastrointestinal Deposition Summary

2. NMED Medical Events

Respectfully submitted, March 7, 2025
Subcommittee on the Review of Yttrium-90 (Y-90) microsphere gastrointestinal (GI) deposition
Advisory Committee on the Medical Uses of Isotopes (ACMUI)
U.S. Nuclear Regulatory Commission (NRC)

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

Subcommittee on Training and Experience for All Modalities

Michael R. Folkert, M.D. Ph.D.

Advisory Committee on the Medical Uses of Isotopes

April 7th, 2025

Subcommittee Membership

- Michael R. Folkert, MD PhD (Chair)
- Richard Harvey, DrPH (Radiation Safety Officer)
- Hossein Jadvar, M.D. Ph.D. (Nuclear Medicine Physician)
- Zoubir Ouhib, MS (Therapy Medical Physicist)
- Megan L. Shober, MS (Agreement State Representative)

- NRC Staff Resource: Maryann Ayoade, MS

Charge

- The current charge of the subcommittee is to review and evaluate the training and experience requirements for all modalities in 10 CFR Part 35.

- On August 20, 2024, the subcommittee received the expanded charge to provide recommendations to the NRC on knowledge topics encompassing the safety related characteristics of emerging medical technologies required for Authorized Users to fulfill their radiation safety-related duties and supervision roles; the methods on how knowledge topics should be acquired; and consideration for continuing education, vendor training for new medical uses, and training on the NRC regulatory requirements.

Introduction

- Continuing innovation in the uses of radioactive byproduct material has led to new applications and indications in areas such as gamma knife technology, ophthalmic treatments, diffusing radioactive particle implants, and an increasingly diverse array of diagnostic and therapeutic radiopharmaceuticals.

Introduction

- **EMTs** are generally classified under 10 CFR 35.1000, but development of new radiopharmaceuticals, brachytherapy applications, and other devices utilizing radioactive byproduct material normally regulated under 10 CFR 35.200, 35.300, 35.400, and 35.600, may incorporate novel ligand/radioisotope combinations and/or administration methods that may pose additional patient and radiation safety risks and require additional training.
  - This is not limited only to therapeutic applications, but also potentially diagnostic applications as well, as an increasing array of diagnostic radioligands are integrated into the clinic.

Introduction

- For each medical use modality, 10 CFR 35 regulations prescribe the minimum hours of classroom and laboratory training as well as supervised experience for proposed authorized users. **Core knowledge areas** include:

Classroom and laboratory training in:

- radiation physics and instrumentation
- radiation protection
- calculations pertaining to the use and measurement of radioactivity
- chemistry of byproduct material for medical use
- radiation biology

Work experience in:

- managing and assaying radioactive materials
- performing surveys
- calibrating and maintaining assay and survey equipment
- assaying and preparing doses
- managing spills, waste, and contamination
- developing safe protocols for radioactive material management
- safely and appropriately delivering radioactive doses to patients

Introduction

- In addition to these core knowledge areas, there has been increasing complexity around aspects of patient selection, patient and caregiver education, interactions of radioactive material applications with other therapies and interventions, pre- and post-procedure dosimetry, patient monitoring and release, and reporting of adverse reactions and medical events.

- The subcommittee also recognizes that the AU may not be physically present in some applications (for example, the administration of radiopharmaceuticals by CNMTs) but may be monitoring the dose administration virtually.
  - As such, the independent educational needs of the entire healthcare team are also a consideration that must also be met to ensure the safe utilization of EMTs using radioactive byproduct material.

Background

- For each medical use modality, 10 CFR 35 regulations detail the minimum hours of classroom and laboratory training as well as supervised experience for proposed AUs.
- T&E requirements for EMTs are described in 10 CFR 35.1000 licensing guidance.

- The current regulatory framework for authorized user training and experience was established in 2002 following a comprehensive overhaul of 10 CFR 35.
- Over the past two decades, the ACMUI has revisited AU T&E requirements regarding board certification pathways (2002, 2009, 2023), 10 CFR 35.300 radiopharmaceuticals (2013, 2016, 2019) and EMTs (2022).

Background

- With the rapid increase in development of novel radiopharmaceuticals in the late 2010s, stakeholders expressed concerns with the perceived burden of T&E requirements for AUs.
- NRC staff engaged stakeholders, the ACMUI, and Agreement States and explored options to reduce the regulatory burden for physicians seeking to become AUs while preserving training critical to radiation safety.
- This led NRC staff to submit a rulemaking proposal in 2020 (SECY-20-0005) to modify T&E requirements in 10 CFR 35, Subparts D and E for unsealed byproduct material.

Background

- 2020 Rulemaking proposal (SECY-20-0005):
  - Goals were to establish high-level radiation safety training criteria in advance of expected new EMTs/novel radiopharmaceutical therapies and eliminate the case-by-case approval of AUs on radioactive byproduct materials licenses.
  - The rulemaking would have eliminated the alternate pathway for unsealed byproduct material use and required AUs to be certified by a recognized specialty board.
  - Medical specialty boards seeking NRC recognition would have needed to demonstrate that their training programs meet NRC training requirements for T&E.

- In 2022, the Commission voted against this rulemaking plan and approved maintaining the status quo.
  - The Commission did recommend evaluation of current specialty board recognition criteria, and to evaluate knowledge topics required for AUs to fulfill their radiation safety-related duties and supervision roles; the methods on how knowledge topics should be acquired; consideration for continuing education, vendor training for new medical uses, and training on the NRC regulatory requirements.

Background

- In 2022 , the Commission approved initiation of an EMT rulemaking (SECY-21-0013), which would move many EMTs from 10 CFR 35.1000 to other sections of Part 35.
  - This rulemaking would codify T&E requirements for AU physicians for these technologies.
  - In 2023, NRC staff published a draft regulatory basis for this rulemaking.
  - The EMT rulemaking remains in the proposed rule phase.

- As a result, NRC staff are assessing ways to make the existing EMT T&E requirements more generalizable instead of having a customized set of T&E requirements for each 10 CFR 35.1000 licensing guidance document.
  - The Subcommittee's current charge to review knowledge topics for EMTs is connected to the EMT rulemaking in an effort to identify consistent T&E elements for AUs.

Knowledge Acquisition and Maintenance

- While the **final** review and approval of authorized users is primarily the responsibility of the NRC and Agreement States, the subcommittee strongly feels that the acquisition of general safety content and continuing education should primarily be the responsibility of:
  - **Medical boards** such as:
    - The American Board of Radiology
    - The American Board of Nuclear Medicine
  - **Accreditation councils** such as
    - The Accreditation Council for Graduate Medical Education
    - The Commission on Accreditation of Medical Physics Education Programs;

  and
  - **Professional societies** that are actively engaged in the training and certification of AUs, RSOs, ARSOs, ANPs, AMPs, and OPs

Knowledge Acquisition and Maintenance

- Professional societies actively engaged in providing educational content relevant to initial certification and maintenance of certification include but are not limited to:
  - Society of Nuclear Medicine and Medical Imaging (**SNMMI**)
  - American Society for Radiation Oncology (**ASTRO**)
  - American Association for Physicists in Medicine (**AAPM**)
  - American College of Nuclear Medicine (**ACNM**)
  - American College of Medical Physics (**ACMP**)
  - American Society for Medical Dosimetry (**ASMD**)
  - American College of Radiation Oncology (**ACRO**)
  - American Pharmacists Association (**APhA**) APhA-APPM Nuclear Pharmacy Practice Special Interest Group (**SIG**)
  - Health Physics Society (**HPS**)
  - American College of Radiology (**ACR**)
  - Radiological Society of North America (**RSNA**)
  - American Society of Nuclear Cardiology (**ASNC**)
  - American Brachytherapy Society (**ABS**)
  - American Radium Society (**ARS**)

Engagement In Radiation Safety Education

- **There is demonstrated interest and engagement in radiation safety educational development by the professional societies.** For example:
  - The SNMMI and ACNM are circulating a joint practice guideline for the use of radiopharmaceuticals.
  - ASTRO has been developing a radiopharmaceutical "safety white paper."
  - The ABS is developing training objectives for radiopharmaceutical practice.
  - The ACR has partnered with multiple societies to develop practice parameter guidelines for a range of diagnostic and therapeutic applications involving radioisotopes, which are regularly updated in collaboration with multiple societies including SNMMI, ACNM, ASTRO, ABS, and ARS.

NRC Evaluation of Content

- While the NRC cannot “endorse” or preferentially favor a training pathway, it is recommended that the NRC evaluate whether educational materials or a program “meets requirements” for initial certification with a technology or application.
- It will likely be necessary that the NRC will have to develop a range of training scenarios for initial certification that will depend on the time that has elapsed since professional training was completed by the prospective AU, as well as which training pathway the prospective AU initially completed.
  - This is in keeping with the request for “case scenarios” in the recent T&E report (https://www.nrc.gov/docs/ML2418/ML24185A268.pdf).

Continuing Medical Education

- The subcommittee recognizes the role for ongoing CME in supporting quality of care and radiation safety.
- In terms of CME, the subcommittee recognizes that professional societies are actively developing and providing CME for practitioners administering existing and emerging technologies through **recorded**, **virtual**, and **in-person** offerings.
- The AU will need to maintain records of their CME.
- We recommend that professional societies develop guidelines for CME minimum contact hours; we would also recommend that the NRC explore the need to define minimum CME requirements for AUs.

Continuing Medical Education

- Verification of ongoing training/experience and CME must follow applicable state, local, and certification board requirements, as well as the authority of the hospital or practice clinical credentialing program.
  - Credentialing is a process where medical facilities grant healthcare professionals (such as physicians, non-physician mid-level providers, medical physicists, nurses, medical dosimetrists, and medical technologists) the ability to practice medicine and supportive services in their clinical sites.
  - **Credentialing and maintenance of associated privileges is not regulated by the NRC.**

Application-Specific Knowledge Base

- In addition to the core knowledge areas, the practical knowledge base for EMTs must include application-specific content and documentation of training on:
  - patient assessment and eligibility
  - patient and caregiver education on the procedure and radiation safety (verbally and in writing)
  - how to develop site-specific protocols for administration and use of the medical technology
  - radiation safety and quality control for all aspects of the procedure including ordering, preparation, administration, and disposal of contamination/waste (if present)
  - components of the written directive for therapeutic administrations
  - pre-procedure assay/dosimetry
  - role of post-procedure dosimetry
  - patient monitoring, discharge instructions, and release, including management of procedural events such as extravasations
  - follow-up protocols for therapeutic interventions
  - reporting of adverse reactions and medical events
  - aspects of supervision of the healthcare team, including relevant NRC regulatory requirements

Supervision

- The administration/use of EMTs may require the direct involvement of a range of other specialties including CNMTs, RNs, RSOs, and Medical Physicists, under remote supervision.
- Understanding of NRC regulatory requirements for these roles must also be required for the AU.
  - The educational needs of the entire healthcare team, including the licensee/administrator, CNMT, RN, RSO, and MP (if available/applicable), must also be met to ensure the safe utilization of EMTs using radioactive byproduct material.
  - The AU must have a clear understanding of the roles and limitations of each member of their team, and a documented plan for how they would interact with these members when physically present and when monitoring remotely.

Role of Vendors

- For EMTs and new radiopharmaceutical applications, the application vendor has a significant role in recommending and providing the appropriate knowledge and technical training for the safe and effective use of their technology.
  - Vendor training should cover all aspects of how to correctly use the new device/drug.
  - Training should also include contraindications to use and remind trainees not to modify/substitute aspects of the device or procedure without the approval of the manufacturer.

Hands-On, In-Person

- It is the recommendation of this subcommittee that **hands-on** training should be expected for any new therapeutic device/drug, or for any therapeutic application that has a unique delivery platform.
  - This means that the prospective user would have to conduct mock use or supervised patient use of the device/drug using **the actual device/drug** or a **model device** that incorporates all practice aspects of the new technology.
  - Any training must include opportunities for the prospective AU to ask questions about the training material and process and receive answers in real time.
  - The trainer (vendor and/or current AU) must be able to directly assess prospective AU learning in the context of the training prior to unsupervised clinical implementation.

Hands-On, In-Person

- It is the recommendation of this subcommittee that the trainer (either a vendor representative or an AU for the new technology) must be physically present (**“in-person”)** for the training of the prospective user and their team, even in situations where the standard-of-care administration or use of the technology may be performed with the AU supervising remotely.

Medical Events

- The NRC should encourage licensees to include information in annual refresher training for appropriate individuals (AUs, CNMTs, etc) regarding medical events involving radiopharmaceuticals or devices used by the licensee.

- We recommend that information on known medical events should also be included in initial training for a new device/drug application.

Recommendations

1. Core knowledge base topics should be supplemented with application-specific content for existing and future EMTs incorporating radioactive byproduct materials.
2. The NRC should enable the relevant professional societies to develop curricula for initial training and should explore how best to evaluate these curricula on an ongoing basis and how these curricula may be incorporated into an efficient licensing process.
3. The NRC should explore the need to define minimum CME requirements for AUs.
4. Training for new therapeutic devices/drug or any therapeutic application that has a unique delivery platform should be both hands-on and in-person with a vendor representative and/or an AU for the new technology prior to unsupervised clinical implementation.
5. The NRC should encourage inclusion of information on known medical events in annual refresher training for drugs/devices used by the licensee, and in initial training for a new drug/device application.

Abbreviations

- 10 CFR: Title 10 of the *Code of Federal Regulations*
- AMP: Authorized Medical Physicist
- ANP: Authorized Nuclear Pharmacist
- ARSO: Associate RSO
- AU: Authorized User
- CME: Continuing Medical Education
- CNMT: Certified Nuclear Medicine Technician
- EMT: Emerging Medical Technology
- OP: Ophthalmic Physicist
- RN: Registered Nurse
- RSO: Radiation Safety Officer
- T&E: Training and Experience

Questions or Comments?

U.S. Nuclear Regulatory Commission
Advisory Committee on the Medical Uses of Isotopes

Subcommittee on Training and Experience for All Modalities

Draft Report
Submitted: March 10, 2025

Subcommittee Membership:
Michael R. Folkert, M.D., Ph.D. (Brachytherapy Radiation Oncologist, Chairman)
Richard Harvey, DrPH (Radiation Safety Officer)
Hossein Jadvar, M.D., Ph.D. (Nuclear Medicine Physician)
Zoubir Ouhib, MS (Therapy Medical Physicist)
Megan L. Shober, MS (Agreement State Representative)

NRC Staff Resource: Maryann Ayoade, MS

CHARGE

The current charge of the subcommittee is to review and evaluate the training and experience requirements for all modalities in 10 CFR Part 35.

On August 20, 2024, the subcommittee received the expanded charge to provide recommendations to the NRC on knowledge topics encompassing the safety related characteristics of emerging medical technologies required for Authorized Users to fulfill their radiation safety-related duties and supervision roles; the methods on how knowledge topics should be acquired; and consideration for continuing education, vendor training for new medical uses, and training on the NRC regulatory requirements.

The subcommittee met several times through September and October of 2024, and then again in February and March of 2025, to discuss the expanded charge and propose recommendations. A pause in the subcommittee discussion was made after the October meeting to review potential conflict of interest (COI) within the subcommittee membership. Following the COI review by the U.S. Nuclear Regulatory Commission (NRC), it was confirmed that the participation of the subcommittee membership in ACMUI activities outweighed any reasonable concern of an appearance of a lack of integrity or impartiality, and the subcommittee membership was authorized to participate in the matters relevant to this charge prior to reconvening in February 2025.

INTRODUCTION

Continuing innovation in the uses of radioisotopes has led to new applications and indications in areas such as gamma knife technology, ophthalmic treatments, diffusing radioactive particle implants, and an increasingly diverse array of diagnostic and therapeutic radiopharmaceuticals. Emerging medical technologies (EMTs) are generally classified under title 10 of the *Code of Federal Regulations* (10 CFR) 35.1000, but development of new radiopharmaceuticals, brachytherapy applications, and other devices utilizing radioactive byproduct material normally regulated under 10 CFR 35.300, 35.400, and 35.600, may also incorporate novel ligand/radioisotope combinations and/or administration methods that may pose additional patient and radiation safety risks and require additional training. This is not limited only to therapeutic applications but also potentially diagnostic applications as well (regulated under 10 CFR 35.100 and 35.200), as an increasing array of diagnostic radioligands are integrated into the clinic.

Training for all medical applications of isotopes requires appropriate classroom and laboratory training in radiation physics and instrumentation, radiation protection, calculations pertaining to the use and measurement of radioactivity, chemistry of byproduct material for medical use, and radiation biology, as well as work experience to provide training in managing and assaying radioactive materials, performing surveys, calibrating and maintaining assay and survey equipment, assaying and preparing doses, managing spills, waste, and contamination, developing safe protocols for radioactive material management, and safely and appropriately delivering radioactive doses to patients.

In addition to these core knowledge areas, there has been increasing complexity around aspects of patient selection, patient and caregiver education, interactions of radioactive material applications with other therapies and interventions, pre- and post-procedure dosimetry, patient monitoring and release, and reporting of adverse reactions and medical events. The subcommittee also recognizes that the authorized user (AU) may not be physically present in some applications (for example, the administration of radiopharmaceuticals) but may be monitoring the dose administration virtually. As such, the independent educational needs of the entire healthcare team are also a consideration that must also be met to ensure the safe utilization of EMTs using radioisotopes.

In this report, we will review the background the current training and experience (T&E) landscape, discuss our recommendations on the acquisition and maintenance of general knowledge base for Authorized Users (AUs) on safety aspects of medical technologies using radioisotopes, expectations for application-specific training for EMTs (including the role of the vendor and implications for “hands-on” and “in-person” training), and considerations for forward planning to address authorization for new technologies.

BACKGROUND

For each medical use modality, 10 CFR Part 35 regulations prescribe the minimum number of hours of classroom and laboratory training, as well as supervised experience for proposed AUs. T&E requirements for EMTs are described in 10 CFR 35.1000 licensing guidance documents. The current regulatory framework for AU training and experience was established in 2002 (67 FR 20249), following a comprehensive overhaul of 10 CFR 35. In the past two decades, the ACMUI has revisited AU T&E requirements a number of times regarding board certification pathways (in years 2002, 2009, and 2023), 10 CFR 35.300 radiopharmaceuticals (in years 2013, 2016, and 2019) and EMTs (in year 2022).

With the rapid development of novel radiopharmaceuticals in the late 2010s, stakeholders expressed concerns with the perceived burden of T&E requirements for AUs. NRC staff engaged stakeholders, the ACMUI, and Agreement States, and explored options to reduce the regulatory burden for physicians seeking to become AUs while preserving training critical to radiation safety. This led NRC staff to submit a rulemaking proposal in 2020 (SECY-20-0005) to modify the T&E requirements in 10 CFR 35, Subparts D and E for unsealed byproduct material. A primary driver for this proposal was to establish high-level radiation safety training criteria in advance of the expected arrivals of new, complex radiopharmaceutical therapies and eliminate the case-by-case approval of individual physicians as AUs on radioactive byproduct materials licenses. The rulemaking would have eliminated the alternate pathway for unsealed byproduct material and required physician AUs to be certified by an NRC-recognized specialty board. Medical specialty boards seeking NRC recognition would have needed to demonstrate that their certification processes meet NRC requirements for T&E. However, in 2022, the Commission voted against this rulemaking plan and approved maintaining the status quo.

In 2022, the Commission approved initiation of a medical rulemaking (SECY-21-0013, “Rulemaking Plan to Establish Requirements for Rubidium-82 Generators and Emerging Medical Technologies (Rb-EMT”) that would move many EMTs from being regulated via licensing guidance under 10 CFR 35.1000 to other sections of Part 35. This rulemaking would, in part, codify T&E requirements (that are currently in licensing guidance) for AU physicians for these technologies. In 2023, the NRC staff published a draft regulatory basis for this rulemaking. The emerging medical technologies rulemaking remains in the proposed rule phase.

One effect of moving T&E requirements from licensing guidance into the regulations in 10 CFR 35 is that these requirements will necessarily become less flexible. As a result, the NRC staff are assessing ways to make the existing EMT T&E requirements more generic, in order to apply them to a broader range of technologies (including future technologies), instead of having a customized set of T&E requirements for each 10 CFR 35.1000 licensing guidance document. The subcommittee’s current charge to review knowledge topics for EMTs is connected to the Rb-EMT rulemaking in an effort to identify consistent T&E elements for AUs.

DISCUSSION

Acquisition and Maintenance of General Knowledge Base for Safety Aspects of Medical Technologies Using Radioisotopes

Prior to becoming an AU, the core requirements of 10 CFR Part 35 must be met for the class of applications (10 CFR 35.59 and 35.190, 35.290, 35.390, 35.392, 35.394, 35.396, 35.490, 35.590, or 35.690)

While the final review and approval of AUs are primarily the responsibility of the NRC and Agreement States, the subcommittee strongly feels that the acquisition of general safety content and continuing education should primarily be the responsibility of the medical boards such as the American Board of Radiology and the American Board of Nuclear Medicine; accreditation councils such as the Accreditation Council for Graduate Medical Education and the Commission on Accreditation of Medical Physics Education Programs; and professional societies that are actively engaged in the training and certification of AUs, Radiation Safety Officers (RSOs), Associate RSOs (ARSOs), Authorized Nuclear Pharmacists (ANPs), Authorized Medical Physicists (AMPs), and Ophthalmic Physicists (OPs). Professional societies that are engaged in radiation safety educational development may include but are not limited to:

- Society of Nuclear Medicine and Medical Imaging (SNMMI)
- American Society for Radiation Oncology (ASTRO)
- American Association for Physicists in Medicine (AAPM)
- American College of Nuclear Medicine (ACNM)
- American College of Medical Physics (ACMP)
- American Society for Medical Dosimetry (ASMD)
- American College of Radiation Oncology (ACRO)
- American Pharmacists Association (APhA) APhA-APPM Nuclear Pharmacy Practice Special Interest Group (SIG)
- Health Physics Society (HPS)
- American College of Radiology (ACR)
- Radiological Society of North America (RSNA)
- American Society of Nuclear Cardiology (ASNC)
- American Brachytherapy Society (ABS)
- American Radium Society (ARS)

Safety educational development is an area of active engagement by the professional societies. For example: SNMMI and ACNM are circulating a joint practice guideline for the use of radiopharmaceuticals, ASTRO has been developing their “safety white paper”, and ABS is developing training objectives for radiopharmaceutical practice. The ACR has partnered with multiple societies to develop practice parameter guidelines for a range of diagnostic and therapeutic applications involving radioisotopes, which are regularly updated in collaboration with multiple societies including SNMMI, ACNM, ASTRO, ABS, and ARS.

In our discussions with the NRC staff, it was noted that the NRC cannot “endorse” or preferentially favor a training pathway, but we would recommend that the NRC evaluate whether educational materials or a program “meets requirements” for initial certification with a technology or application. As the NRC itself is not in the position to develop and disseminate initial and ongoing educational content, a mechanism must be in place for the NRC staff to validate whether an existing training program meets minimum specifications. It will likely be necessary that the NRC will have to develop a range of training scenarios for initial certification

that will depend on the time that has elapsed since professional training was completed by the prospective AU, as well as, which training pathway the prospective AU initially completed. This is in keeping with the request for “case scenarios” in the recent ACMUI T&E for All Modalities subcommittee report (https://www.nrc.gov/docs/ML2418/ML24185A268.pdf).

The subcommittee recognizes the role for ongoing continuing medical education (CME) in supporting quality of care and radiation safety. In terms of CME, the subcommittee recognizes that professional societies are actively developing and providing CME for practitioners administering existing and EMTs through recorded, virtual, and in-person offerings. The AU will need to maintain records of their CME. We recommend that professional societies develop guidelines for CME minimum contact hours; we would also recommend that the NRC explore the need to define minimum CME requirements for AUs.

Verification of ongoing T&E and CME must follow applicable state, local, and certification board requirements, as well as the authority of the hospital or practice clinical credentialing program. Credentialing is a process where medical facilities grant healthcare professionals (such as physicians, non-physician mid-level providers, medical physicists, nurses, medical dosimetrists, and medical technologists) the ability to practice medicine and supportive services in their clinical sites. Credentialing and maintenance of associated privileges is not regulated by the NRC. These credentialing programs may add additional requirements or increased training/CME contact hours over those recommended by the NRC and/or professional societies. AUs should receive information on medical events related to the domains of radioactive byproduct material with which they practice via vendors and professional societies, and review of these materials should be documented; additionally, if a licensee has a violation associated with a medical event related to the use of radioactive byproduct material, this should trigger the need for additional remediation/corrective action and CME and/or additional training for that AU.

Application-Specific Knowledge Base Training for Emerging Medical Technologies and the Role of Vendor Training

In addition to the core knowledge areas covered above, the practical knowledge base for EMTs must include application-specific content and documentation of training on:

- Patient assessment and eligibility
- Patient and caregiver education on the procedure and radiation safety (verbally and in writing)
- How to develop site-specific protocols for administration and use of the medical technology
- Radiation safety and quality control for all aspects of the procedure including ordering, preparation, administration, and disposal of contamination/waste (if present)
- Components of the written directive for therapeutic administrations
- Pre-procedure assay/dosimetry
- Role of post-procedure dosimetry
- Patient monitoring, discharge instructions, and release, including management of procedural events such as extravasations
- Follow-up protocols for therapeutic interventions
- Reporting of adverse reactions and medical events
- Aspects of supervision of the healthcare team, including relevant NRC regulatory requirements

New 10 CFR 35.1000 as well as 10 CFR 35.200, 35.300, 35.400, and 35.600 applications may have very complex indications and patient selection criteria that will require additional training, as well as ongoing assessment needs due to changes in patient clinical condition. Therapeutic radiopharmaceuticals can have very different radiation protection needs due to different radioisotopes or pathways for excretion. Radiation safety protocols may vary widely due to state, local, and hospital/practice requirements, and AUs need to be able to address these effectively. Follow-up protocols and reporting of adverse reactions/medical events are critical for EMTs as there will generally be limited or no long-term data on toxicities or unexpected radiation safety issues, and AUs must stay up to date on information as it becomes available.

As noted above, simply understanding the role of the AU in a new application may be insufficient, as the administration/use of the technology may require the direct involvement of a range of other specialties including— Certified Nuclear Medicine Technologists (CNMT), Registered Nurses (RN), RSOs, and Authorized Medical Physicists (AMP). Understanding of NRC regulatory requirements for these roles must also be required for the AU. As such—

- The educational needs of the entire healthcare team, including the licensee/administrator, CNMT, RN, RSO, and AMP (if available/applicable), must also be met to ensure the safe utilization of EMTs using radioisotopes.

- The AU must have a clear understanding of the roles and limitations of each member of the healthcare team, and a documented plan for how they would interact with these members when physically present and when monitoring remotely.

Pre-procedure assays and dose calibration methodology are generally well established, and application-specific training should be provided. However, post-procedure dosimetry protocols are not well established for many radiopharmaceutical applications and may not be clear for

EMTs. This topic is an area of ongoing research and discussion, and the subcommittee recommends that post-treatment dosimetry should be performed, when possible (and applicable), following professional society recommendations.

- Proper equipment for assaying and dosimetry must be in place for pre-procedure and post-procedure (where applicable) assessments, and the AU (and CNMT, AMP, RN, etc. as applicable) should be trained in their use.

For EMTs and new radiopharmaceutical applications, the application vendor has a significant role in recommending and providing the appropriate knowledge and technical training for the safe and effective use of their technology. Vendor training should cover all aspects of how to correctly use the new device/drug. Training should also include contraindications to use and remind trainees not to modify/substitute aspects of the device or procedure without the approval of the manufacturer.

It is the recommendation of this subcommittee that hands-on training should be expected for any new therapeutic device/drug, or for any therapeutic application that has a unique delivery platform. This means that the prospective user would have to conduct mock use or supervised patient use of the device/drug using the actual device/drug or a model device that incorporates all practice aspects of the new technology. Any training must include opportunities for the prospective AU to ask questions about the training material and process and receive answers in real time. The trainer (vendor and/or current AU) must be able to directly assess prospective AU learning in the context of the training prior to unsupervised clinical implementation.

Additionally, it is the recommendation of this subcommittee that the trainer (either a vendor representative or an AU for the new technology) must be physically present ("in-person") for the training of the prospective user and their team, even in situations where the standard-of-care administration or use of the technology may be performed with the AU supervising remotely.

The NRC should encourage licensees to include information in annual refresher training for appropriate individuals (AUs, CNMTs, etc.) regarding medical events involving radiopharmaceuticals or devices used by the licensee. We recommend that information on known medical events should also be included in initial training for a new device/drug application.

Forward Planning to Address New Technologies

For any new therapeutic device/drug (such as we have seen in the licensing guidance for new versions of Y-90 microspheres or novel ocular therapy applicators), training requirements will generally be addressed under 10 CFR 35.1000 with licensing guidance and ACMUI commentary/review. A new application that would normally fall under 10 CFR 35.300 or 35.400 that has unique considerations from other applications in that class (for example, the diffusing radioactive particle applicator Alpha DaRT (https://www.nrc.gov/docs/ML2202/ML22021B298.pdf) can be licensed instead under 10 CFR 35.1000. For a new parenteral/oral radiopharmaceutical application that would normally be under 10 CFR 35.300, regulation via 10 CFR 35.1000 licensure can be considered if, for example, a novel form of administration or co-administration is involved or if a novel targeting ligand with unique biological properties is used.

SUBCOMMITTEE RECOMMENDATIONS

1. Core knowledge base topics should be supplemented with application-specific content for existing and future EMTs incorporating radioactive byproduct materials.

2. The NRC should enable the relevant professional societies to develop curricula for initial training and should explore how best to evaluate these curricula on an ongoing basis and how these curricula may be incorporated into an efficient licensing process.

3. The NRC should explore the need to define minimum CME requirements for AUs.

4. Training for new therapeutic devices/drug or any therapeutic application that has a unique delivery platform should be both hands-on and in-person with a vendor representative and/or an AU for the new technology prior to unsupervised clinical implementation.

5. The NRC should encourage inclusion of information on known medical events in annual refresher training for drugs/devices used by the licensee, and in initial training for a new drug/device application.

Respectfully submitted, March 10, 2025
Subcommittee on Training and Experience for all Modalities
Advisory Committee on the Medical Uses of Isotopes
U.S. Nuclear Regulatory Commission

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

Subcommittee on Development of a Generic Process Checklist to Help Reduce Medical Events - Report

Richard L. Green

Advisory Committee on the Medical Uses of Isotopes

April 8, 2025

Subcommittee Members

Rebecca Allen, MS

Richard Green, BS Pharm (chair)

Richard Harvey, DrPH

Hossein Jadvar, MD, PhD

Melissa Martin, MS

Zoubir Ouhib, MS

NRC Staff Resource: Daniel Dimarco

Charge

On Dec 6, 2022, Dr Darlene Metter, the ACMUI Chair created a subcommittee on the development of a generic process checklist to help reduce medical events

Background

Due to the increased number of medical events in 2021, a suggestion was made for the ACMUI to develop generic process checklists for all user procedures. It was noted that it may be appropriate to have the professional licensing boards take the lead on developing, communicating, and standardizing the checklists.

Development Process

On 6 January 2025 the subcommittee met and discussed what items should be on a generic process checklist utilized to help avoid medical events in the clinical use of radioactive materials / radiation. It is understood that this generic process checklist would be focused on radiopharmaceuticals but could be easily adapted by users to focus on other modalities of the use of radiation in medical care such as brachytherapy or external beam radiation therapy.

Generic Process Checklist Elements

(using radiopharmaceuticals as an example)

- Establish patient identity (2 methods utilized)
  - Determine pregnancy status if applicable
- Verify elements of the prescription
  - Is it the correct radiopharmaceutical?
  - Is it the correct dose?
- Do laboratory results support the dose?
- Do imaging results support therapy, if being performed?
  - Is it the correct route of administration?
- Are all professionals working within their scope of practice?

Generic Process Checklist Elements

- Conduct patient / family support education prior to administration (consultation) and is understood
- Verify that the dose matches the written directive if applicable
  - If written directive, comply with requirements of 10 CFR 35.41
- Is the route of administration patent?
- Measure or calculate the radiopharmaceutical activity
- Administer the dosage
- Check for possible extravasation of injection
- Record keeping is conducted (residual activity?)
- Patient release – dose to the public (Reg guide 8.39) – verbal, with interpreter if required and in writing, documentation
- Contact information of Nuclear Medicine (or other applicable) department

Local Customization is Required

Each licensee / department shall develop a process (checklist) that is specific to their practice and processes. This development should often start by reviewing approved procedure documents and accrediting organization requirements and any national patient safety goals that have been established. All process checklists / processes should work together to assure the "Five Rights of Medication Administration"

- the right patient
- the right drug
- the right route
- the right dose
- at the right time

A “Checklist” does not mean it must be paper based

While a paper checklist could be utilized, it is understood that modern means utilizing software platforms and barcodes could be extremely beneficial in preventing medication errors / medical events. These could include the following.

- CPOE - computerized prescription order entry
- IVWMS- IV Workflow Management Systems
- eMAR - electronic medication administration records
- BCMA - barcode medication administration

Effectiveness of Modern Tools

E-prescribing "has been shown to reduce medication errors in the ambulatory setting by as much as sevenfold."[1]

It was found that after implementation of BCMA, "nontiming errors had a relative risk reduction (RRR) of 41.4%, …wrong medication errors had a RRR of 57.4%, … wrong dose errors had a RRR of 41.9%, … wrong route of administration errors had a RRR of 68%, … and administration documentation errors had a RRR of 80.3%."[2]

1. Porterfield, A., Engelbert, K., & Coustasse, A. (2014). Electronic prescribing: Improving the efficiency and accuracy of prescribing in the ambulatory care setting. Perspectives in Health Information Management, 11(Spring), 1-13.

2. Shah, K., et al (2016), Bar Code Medication Administration Technology: A Systematic Review of Impact on Patient Safety When Used with Computerized Prescriber Order Entry and Automated Dispensing Devices. Canadian Journal of Hospital Pharmacy, 69 (No 5), 394-402.

Summary

The subcommittee developed a generic process checklist that could be adapted by licensees to help avoid medical events in the clinical use of radioactive materials / radiation. Each licensee / department should develop a process (checklist) that is specific to their practice and processes. Checklists to help prevent medical events would be most effective if they incorporated software platforms and barcoding.

Recommendations

The subcommittee recommends the following.

- Each licensee / department should develop a process (checklist) that is specific to their practice and processes.
- NRC staff should consider the best means to communicate this process (checklist) recommendation to licensees, either by information notice or guidance document.

Acronyms

- ACMUI – Advisory Committee on the Medical Uses of Isotopes
- BCMA – barcode medication administration
- CPOE – computerized prescription order entry
- eMAR – electronic medication administration record
- IVWMS – IV workflow management system
- NRC – U.S. Nuclear Regulatory Commission

U.S. Nuclear Regulatory Commission (NRC)

Advisory Committee on the Medical Uses of Isotopes (ACMUI)

Subcommittee on Development of a Generic Process Checklist to Help Reduce Medical Events

Draft Report

Submitted: Feb 12, 2025

Subcommittee Members
Richard Green, BS Pharm (chair)
Rebecca Allen, MS
Richard Harvey, DrPH
Hossein Jadvar, MD, PhD
Melissa Martin, MS
Zoubir Ouhib, MS
NRC Staff Resource: Daniel Dimarco

Charge

On Dec 6, 2022, Dr. Darlene Metter, the ACMUI Chair, created a subcommittee on the development of a generic process checklist to help reduce medical events.

Background

Due to the increased number of medical events in 2021, a suggestion was made for the ACMUI to develop generic process checklists for all user procedures. It was noted that it may be appropriate to have the professional licensing boards take the lead on developing, communicating, and standardizing the checklists.

Development Process:

On 6 January 2025 the subcommittee met and discussed what items should be on a generic process checklist utilized to help avoid medical events in the clinical use of radioactive materials / radiation. It is understood that this generic process checklist would be focused on radiopharmaceutical but could be easily adapted by users to focus on other modalities of the use of radiation in medical care such as brachytherapy or external beam radiation therapy.

Generic Process Checklist Elements (using radiopharmaceuticals as an example)

- Establish patient identity (2 methods utilized)
    - Determine pregnancy status if applicable
- Verify elements of the prescription
    - Is it the correct radiopharmaceutical?
    - Is it the correct dose?
        - Do laboratory results support the dose?
        - Do imaging results support therapy, if being performed?
    - Is it the correct route of administration?
- Are all professionals working within their scope of practice?
- Conduct patient / family support education prior to administration (consultation) and is understood
- Verify that the dose matches the written directive if applicable
    - If written directive, comply with requirements of 10 CFR 35.41
- Is the route of administration patent?
- Measure or calculate the radiopharmaceutical activity
- Administer the dosage
- Check for possible extravasation of injection
- Record keeping is conducted (residual activity?)
- Patient release – dose to the public (Reg guide 8.39) – verbal, with interpreter if required and in writing, documentation
- Contact information of Nuclear Medicine (or other applicable) department

Local Customization is Required

Each licensee / department shall develop a process (checklist) that is specific to their practice and processes. This development should often start by reviewing approved procedure documents and accrediting organization requirements and any national patient safety goals that have been established. All process checklists / processes should work together to assure the "Five Rights of Medication Administration"

- the right patient
- the right drug
- the right route
- the right dose
- at the right time

A "Checklist" does not mean it must be paper based

While a paper checklist could be utilized, it is understood that modern means utilizing software platforms and barcodes could be extremely beneficial in preventing medication errors / medical events. These could include the following.

- CPOE - computerized prescription order entry
- IVWMS- IV Workflow Management Systems
- eMAR - electronic medication administration records
- BCMA - barcode medication administration

E-prescribing "has been shown to reduce medication errors in the ambulatory setting by as much as sevenfold."[1]

It was found that after implementation of BCMA, "nontiming errors had a relative risk reduction (RRR) of 41.4%, ...wrong medication errors had a RRR of 57.4%, ... wrong dose errors had a RRR of 41.9%, ... wrong route of administration errors had a RRR of 68%, ... and administration documentation errors had a RRR of 80.3%."[2]

1. Porterfield, A., Engelbert, K., & Coustasse, A. (2014). Electronic prescribing: Improving the efficiency and accuracy of prescribing in the ambulatory care setting. Perspectives in Health Information Management, 11(Spring), 1-13.
2. Shah, K., et al (2016), Bar Code Medication Administration Technology: A Systematic Review of Impact on Patient Safety When Used with Computerized Prescriber Order Entry and Automated Dispensing Devices. Canadian Journal of Hospital Pharmacy, 69 (No 5), 394-402.

Summary

The subcommittee developed a generic process checklist that could be adapted by licensees to help avoid medical events in the clinical use of radioactive materials / radiation. Each licensee / department should develop a process (checklist) that is specific to their practice and processes. Checklists to help prevent medical events would be most effective if they incorporated software platforms and barcoding.

Recommendations

The subcommittee recommends the following.
Each licensee / department should develop a process (checklist) that is specific to their practice and processes.

NRC staff should consider the best means to communicate this process (checklist) recommendation to licensees, either by information notice or guidance document.

Respectfully submitted on February 12, 2025,
Subcommittee on Development of a Generic Process Checklist to Help Reduce Medical Events
Advisory Committee on the Medical Uses of Isotopes (ACMUI)
U.S. Nuclear Regulatory Commission (NRC)

NRC MEDICAL TEAM UPDATES

Katie Tapp, PhD
Medical Radiation Safety Team
April 7, 2025

Outline

01

Advanced Act

02

Rulemaking and Guidance Updates

Advanced Act Updates

Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act of 2024 (ADVANCE Act)

ADVANCE Act was signed into law in July 2024.

Builds on prior initiatives to modernize and streamline the regulatory environment for advanced nuclear technologies, including

- facilitate American nuclear energy leadership
- support development and deployment of new nuclear energy technologies
- preserve existing nuclear energy
- strengthen America's nuclear energy fuel cycle and supply chain infrastructure
- improve the Commission's resources and efficiency

The Act increases emphasis on ***efficiency***

Scope of Update

Updated Mission Statement

ADVANCE Act Section 507

ADVANCE Act Section 505 and M-LEAP (materials licensing efficiencies and processes)

#ADVANCENRC

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

ADVANCE-ing the Mission

NRC Mission Statement

The NRC protects public health and safety and advances the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment.

ADVANCE Act Section 507 Improving Oversight and Inspection Programs

- Section 507 requires the Commission to submit a report to Congress that identifies specific improvements to the nuclear reactor and materials oversight and inspection programs that the Commission may implement to maximize the efficiency of such programs through, where appropriate:
  - The use of risk-informed, performance-based procedures;
  - Expanded incorporation of information technologies; and
  - Staff training.

- *NRC held a public meeting on December 12, 2024 to obtain feedback from Stakeholders on this section.*

ADVANCE Act Section 507 Ideas under Consideration

Improvements to the inspection planning, implementation, and technology to increase efficiency

- Several material inspection procedures were previously revised to incorporate a risk-informed performance-based program by introducing risk modules. Additional inspection procedures will be revised to incorporate the use of risk modules and ensure the Be *risk*SMART decision making tool are incorporated into the procedures.
- Assess NRC medical events follow-up process and update applying risk informed principles.
- Evaluate the inspection and enforcement program to identify efficiencies and flexibility.

ADVANCE Act Section 505 Nuclear Licensing Efficiency

- Materials Licensing Efficiencies and Processes (M-LEAP)
- M-LEAP empowers licensing process optimization to enable the efficiency, timeliness, and predictability (ETP) of regulatory decision-making
- M-LEAP initiative is a core component of the NRC's Strategic Direction Initiative (SDI) to streamline licensing reviews for operating reactors, new reactors, and materials licensing activities across licensing organizations in the agency, consistent with the mission statement
- M-LEAP partners and coordinates with Reactor(R)-LEAP in support of ADVANCE act 505 on Nuclear Licensing Efficiency

M-LEAP Medical Licensing Ideas Under Consideration

- Streamline Licensing Approvals Regarding Training and Experience of Medical Authorized Individuals

- Landing Page for Emerging Medical Technologies Guidance to enhance the review process of emerging medical technology by leveraging stakeholder engagement to gain licensing efficiency while ensuring safety reviews are not jeopardized.

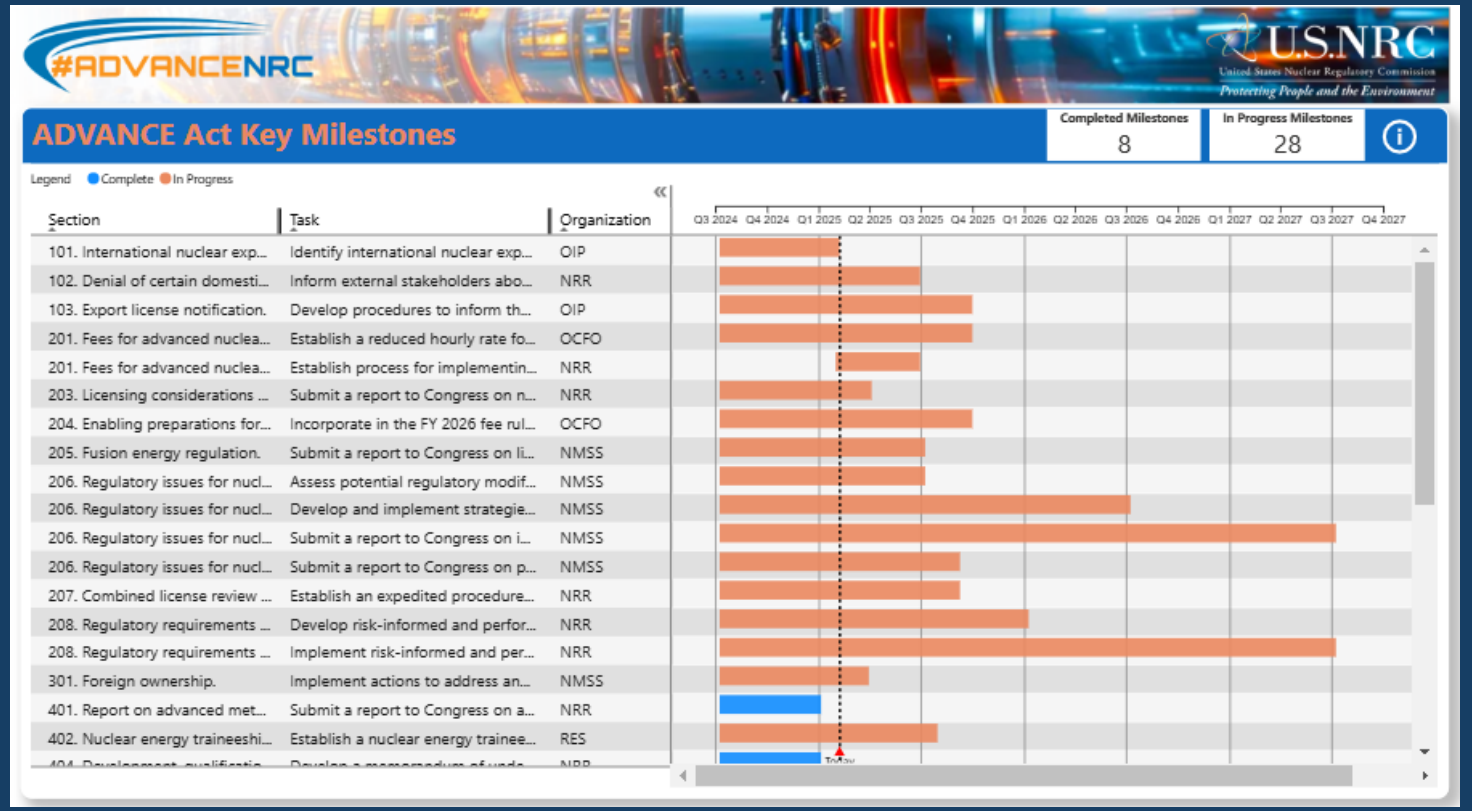
Feedback on Medical Ideas from ACMUI

- What do you think of these ideas for M-LEAP?

- What other ideas should the NRC staff consider to increase licensing efficiency regarding the medical use of byproduct material?

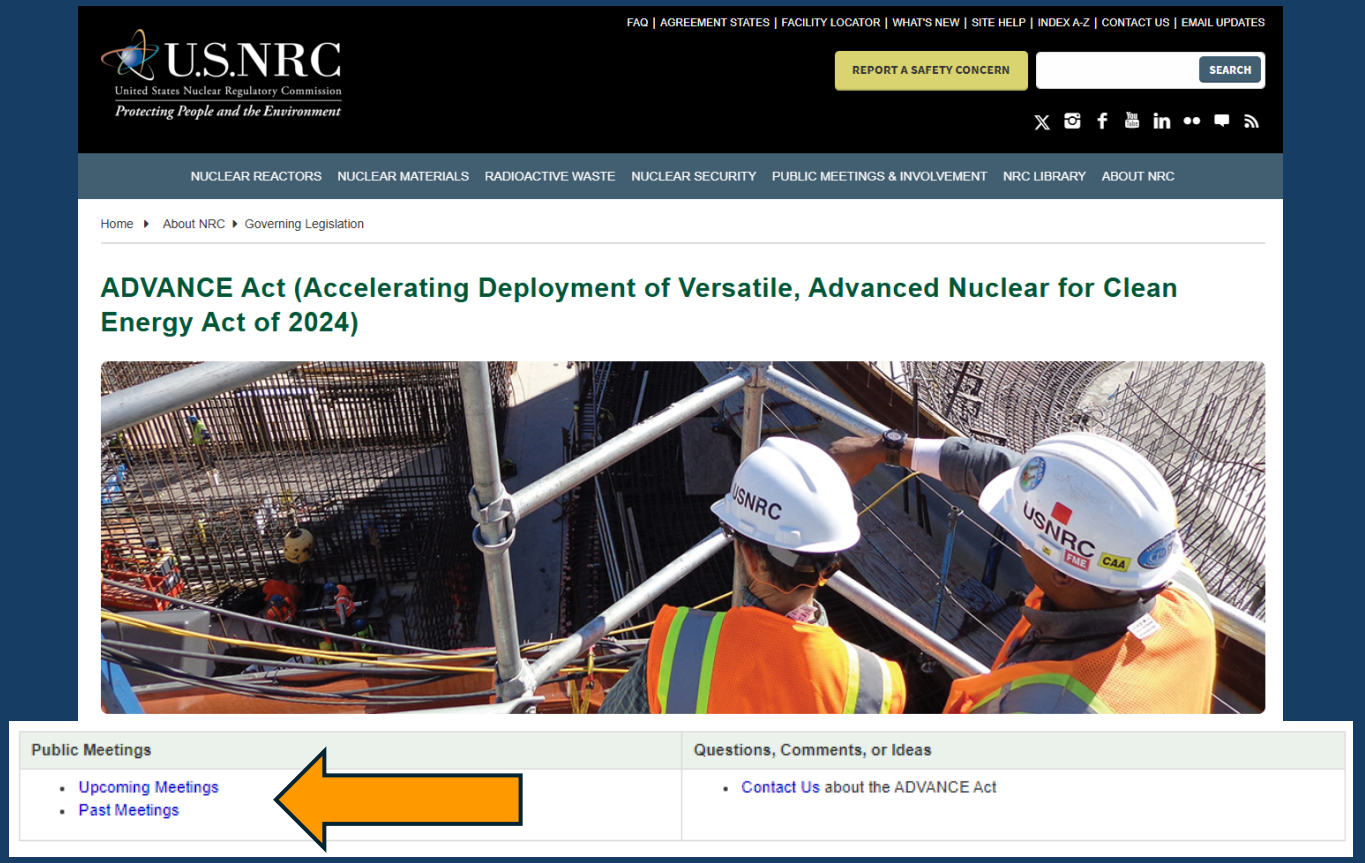
How to Follow Our Progress

Follow NRC's ADVANCE Act implementation with this Dashboard

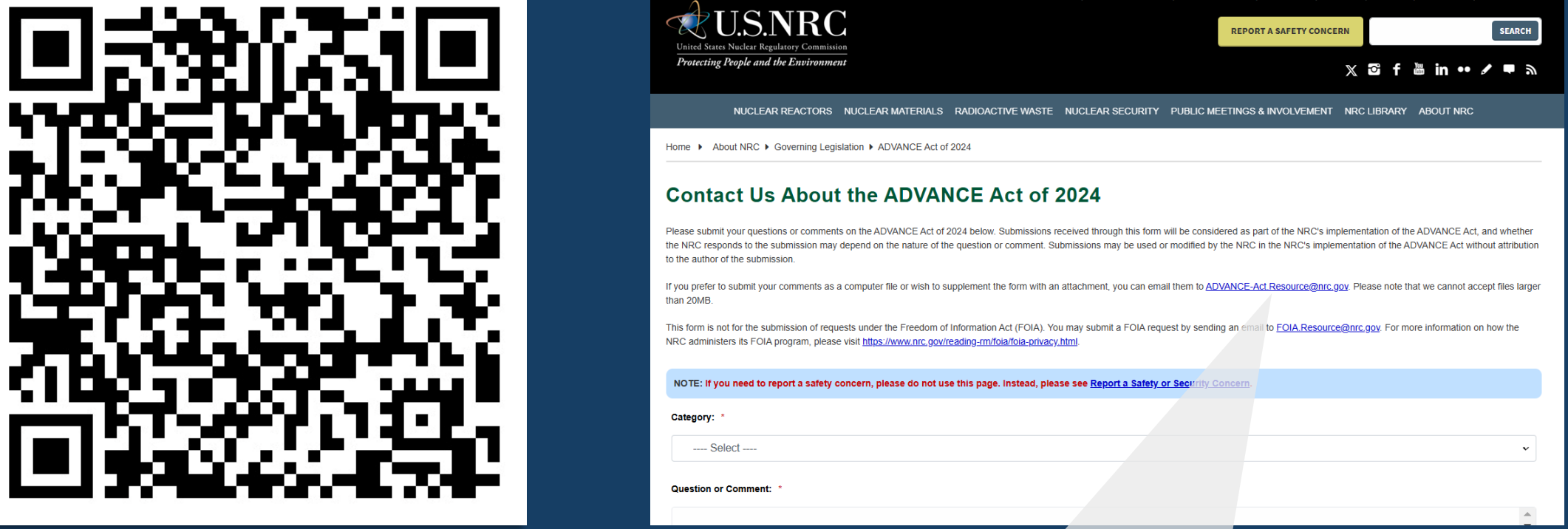


For Upcoming and Past Meetings

For NRC's public meeting information on ADVANCE Act



How to Ask Questions and Submit Ideas



Contact us with ADVANCE Act questions, comments, and ideas

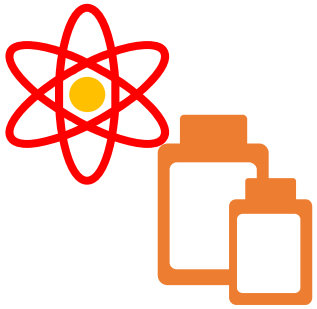
ADVANCE-Act.Resource@nrc.gov

MEDICAL RULEMAKING AND GUIDANCE ACTIVITIES

Medical Rulemakings

EXTRAVASATIONS

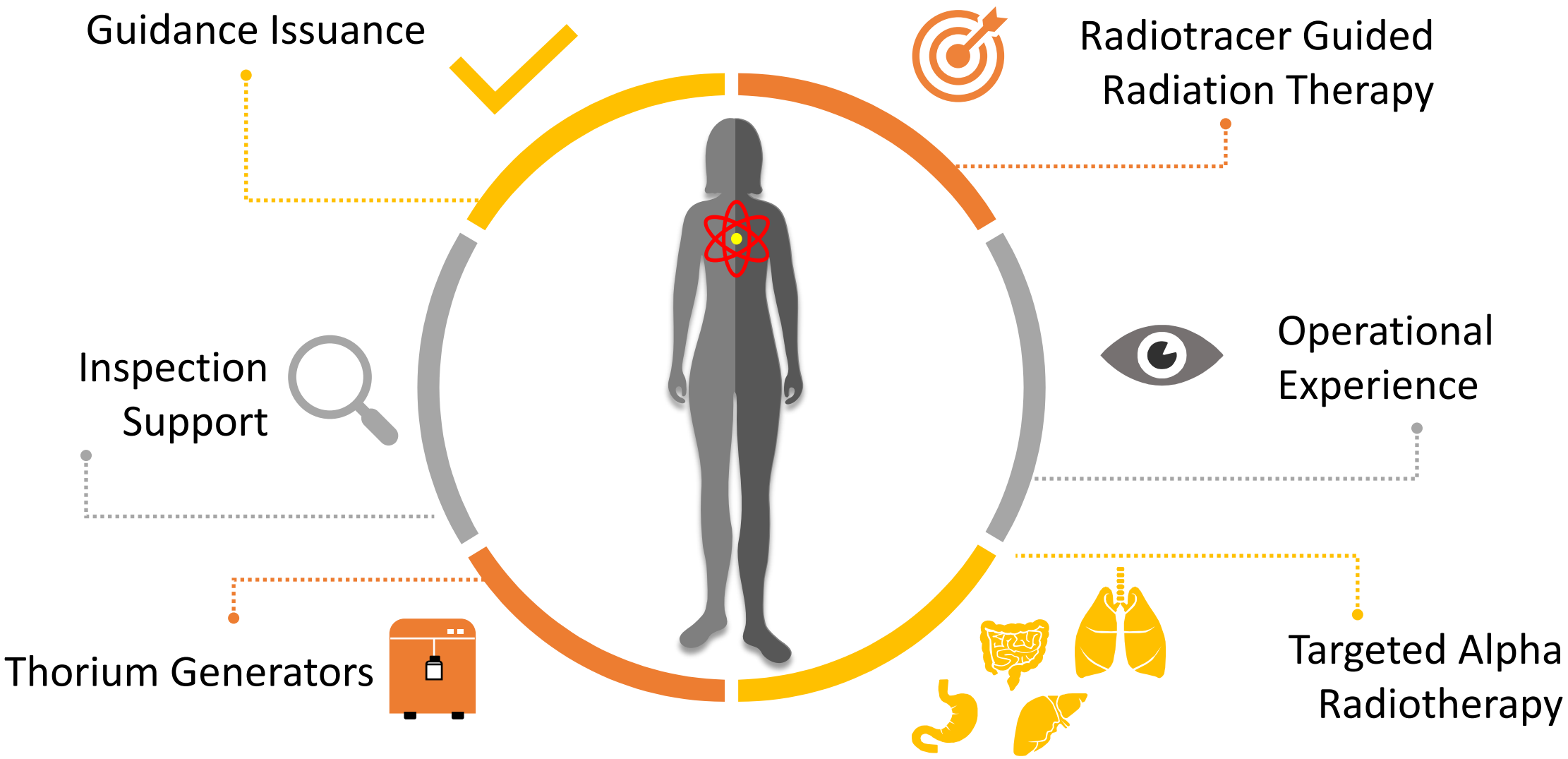
Ongoing rulemaking to amend 10 CFR Part 35 to require reporting of certain nuclear medicine extravasations.



EMT/RB-82 GENERATORS

Ongoing rulemaking to establish requirements for Rb-82 generators and well-established EMTs currently regulated under 10 CFR 35.1000 and establish flexibility for future EMTs.

EMERGING MEDICAL TECHNOLOGIES



NRC Medical Toolkit | EMTs: https://www.nrc.gov/materials/miau/med-use-toolkit/emerg-licensed-med-tech.html

Training and Experience Guidance

- Interim Staff Guidance consolidates current guidance.
- Evaluating licensing practices for efficiency.
  - Modernizing Forms.
  - Enabling Training Curriculum.
  - Authorized User Database.

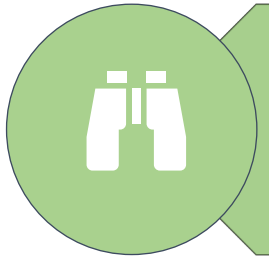
NRC Follow-up to a Medical Event

- Assess the NRC's response to medical events using the Risk Triplet.
  - What can go wrong?
  - How likely is it?
  - What are the consequences?
- Area of Focus
  - Timing
  - Scope

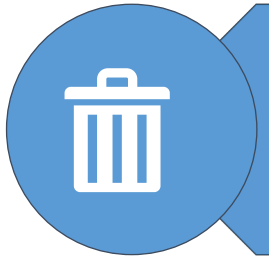
Inspection Procedure Update

- Brachytherapy
- Gamma Stereotactic Radiosurgery Units
- Medical Broadscope
- Radiopharmacies

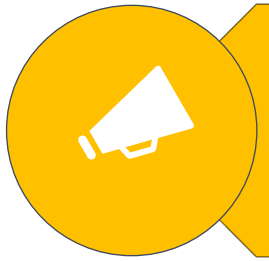
Additional Activities



Patient Release Guidance



Waste Guidance



Continued Operational Experience Communications

ACMUI Procedures Update

- Enhanced Policy and Procedure
- Bylaws Revision
- New Member Guidance Update
- Additional Ethics Training
- Updated Hiring Practices

Acronyms

- ACMUI – Advisory Committee on the Medical Uses of Isotopes
- ETP - Efficiency, Timeliness, and Predictability
- EMT – Emerging medical technology(ies)
- GSR – Gamma stereotactic radiosurgery
- IN – Information Notice
- M-Leap – Material Licensing Efficiency and Processes
- NRC – Nuclear Regulatory Commission
- SDI - Strategic Direction Initiative
- RSO – Radiation Safety Officer
- Rb – Rubidium

Contact Us!

Katherine.Tapp@nrc.gov

medicalquestions.resource@nrc.gov

Medical Uses Licensee Toolkit | NRC Public Website

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

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

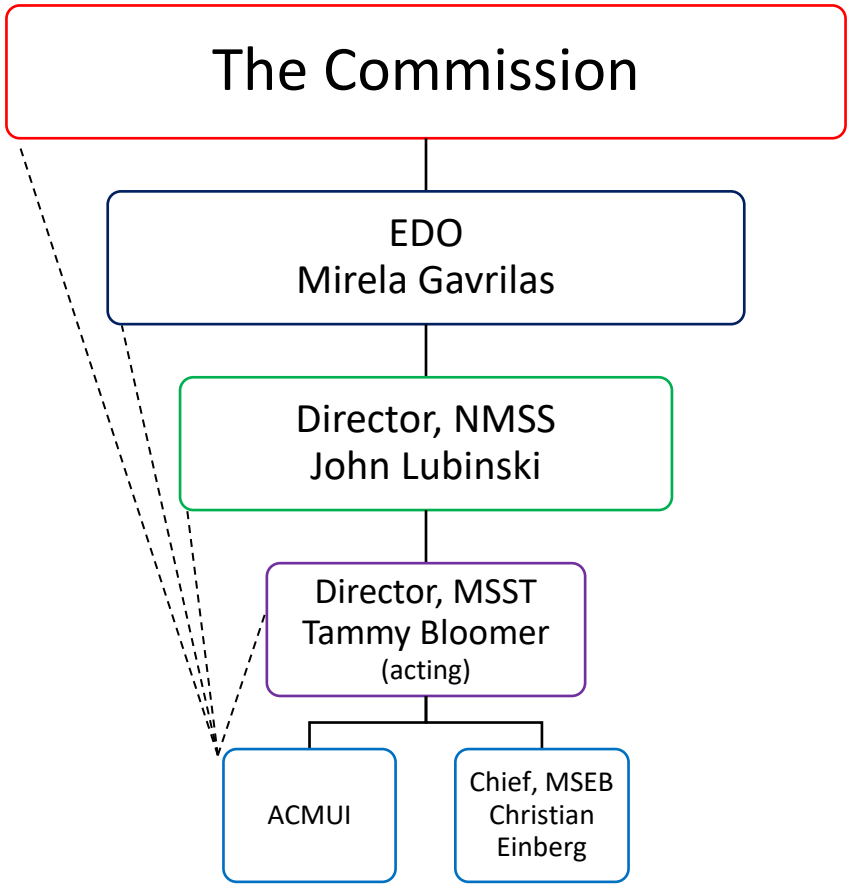
ACMUI Reporting Structure

Ally Marra
Medical Radiation Safety Team
April 7, 2025

Outline

- Current Reporting Structure
- Annual Review
- Meetings
- Discussion

Current Reporting Structure



Annual Review

- In September 2012, the ACMUI recommended to have an annual review of reporting structure.

Meetings

- Two meetings each year
- April/May
- October/November

- Approximately 2-3 teleconferences (as needed)

ACMUI Discussion

Points of Contact

- Tammy Bloomer- MSST Director, acting
- Tammy.Bloomer@nrc.gov

- Dafna Silberfeld– Deputy MSST Director
- Dafna.Silberfeld@nrc.gov

- Christian Einberg – Designated Federal Officer (DFO), Chief, MSEB
- Christian.Einberg@nrc.gov

- Ally Marra– ACMUI Coordinator
- Alessandra.Marra@nrc.gov

Acronyms

- ACMUI – Advisory Committee on the Medical Uses of Isotopes
- DFO – Designated Federal Officer
- EDO – Executive Director for Operations
- MSST – Division of Materials Safety, Security, States, and Tribal Programs
- MSEB – Medical Safety and Events Assessment Branch
- NMSS – Office of Nuclear Material Safety and Safeguards

OPEN FORUM

(No Handout)

SEPT2025

SUN	MON	TUE	WED	THU	FRI	SAT
	01 Labor Day	02	03	04 ASNC Meeting	05 ASNC Meeting	06 ASNC Meeting
07 ASNC Meeting	08	09	10	11	12	13
14	15 **ACMUI TENTATIVE DATE**	16 **ACMUI TENTATIVE DATE**	17	18	19	20
21	22 Rosh Hashanah	23 Rosh Hashanah	24 Rosh Hashanah	25	26	27 ASTRO Meeting
28 ASTRO Meeting	29 ASTRO Meeting	30 ASTRO Meeting				

OCT2025

SUN	MON	TUE	WED	THU	FRI	SAT
			01 Yom Kippur ASTRO Meeting	02 Yom Kippur	03	04
05	06 Sukkot	07 Sukkot	08 Sukkot	09 Sukkot	10 Sukkot	11 Sukkot
12 Sukkot	13 Columbus Day Sukkot Shemini Atzeret & Simchat Torah	14 Shemini Atzeret & Simchat Torah	15 Shemini Atzeret & Simchat Torah	16	17	18
19	20	21	22	23	24	25
26	27 **ACMUI TENTATIVE DATE**	28 **ACMUI TENTATIVE DATE**	29	30	31	

ADMINISTRATIVE CLOSING Script

Here are some potential dates for the Fall 2025 ACMUI meeting.

September 15th and 16th

And October 27th and 28th

The dates you select will be provided to the staff in the office of the secretary and hopefully they will align with one of your proposed dates for the meeting.