# Nonurban Healthcare Coalition Radiation Annex

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# Nonurban Health Care Coalition

# Radiation Annex

## INTRODUCTION

A disaster or mass casualty event that significantly impacts the patient population, including pediatric patients, can occur at any time with or without notice. The size, number and scope of a radiation incident will vary considerably based upon geographical location, type, available resources and proximity to specialty care within the Nonurban Missouri Healthcare Coalition. Incidents that remain within the regional may be assisted and supported by the NU MO HCC. Events that impact 2 or more regions will serve to activate the NU MO HCC for incident support, information sharing and coordination. For statewide, FEMA Region 7 or national pediatric events DHSS ERC, MHA, MARC and STARRS will coordinate and deconflict response strategies, support communication and information sharing.

A statewide view of facilities and their current status is available on EMResource. An MCI Alert is available to identify Emergency Department capacity to manage patients by EMS partners. In addition, an Immediate Bed Availability query is available to facilitate Realtime information sharing, bed placement and surge capacity across the local region, state and FEMA Region as needed.

## SCOPE

To provide a framework for radiological response support within the NUMO HCC. Incident management and full response structure can be found in the NUMO HCC Response plan.

## Overview/Background of HCC and Situation

Missouri Nuclear Facilities:
All but one nuclear facility, which is being decommissioned, are located within the boundaries of the NUMO HCC. In addition, an incident at the Cooper Nuclear Facility in Nebraska could impact the NUMO HCC mainly in the NW Region.

Operating Nuclear Power Reactors – Callaway Plant

Fuel Cycle Facilities – None

Uranium Recovery Facilities – None

Operating Research and Test Reactors

- University of Missouri/Columbia – Columbia, MO
- University of Missouri/Rolla Pool – Rolla, MO

Facilities Outside of the NUMO HCC Regions

Operating Nuclear Power Reactors – Cooper Nuclear Station
Facilities Undergoing Decommissioning - Sigma-Aldrich

Missouri has 2 RITN facilities, neither of them are within the bounds of the NUMO HCC. However, both locations would be used should need arise. They are:

Barnes Jewish Hospital in Saint Louis, MO for adult patients
The Children's Mercy Hospital in Kansas City, MO for pediatric patients
Regional RITN facilities that are within the transfer pattern for NUMO HCC members are:
Nebraska Medicine in Omaha, NE for adults and pediatric patients
University of Iowa Hospitals and Clinics in Iowa City, IA for adult and pediatric patients

## ASSUMPTIONS

Radiation incidents may be accidental in nature (e.g., industrial or transportation accident) or purposeful, require prolonged response and extensive resource management challenges.

• Substantial differences in response protocols and priorities exist between power plant/ industrial, terrorist (e.g., RDD/dirty bomb) and nuclear bomb detonation. The plan should emphasize the scenario(s) most relevant to the community.
• The coalition annex does not replace the need for protocols at each hospital and EMS agency
• Different agencies may have authority over management of power plant, transportation, and terrorist incidents, including the authority to implement shelter-in-place and evacuation orders.
• The roles and responsibilities of agencies and organizations will change depending on the severity and scale of the incident and the respective level of activation by impacted jurisdictions and should be outlined ahead of an incident.
• Federal, state, and local emergency resources will all be needed during a large-scale event.
• Contamination assessments, proper PPE utilization, and decontamination efforts will be essential in protecting coalition partners, staff, and the public
• Staff at coalition facilities may be impacted by exposure, fear of exposure, or family obligations (e.g., child/family care if schools are closed, acute care facilities are affected).
• Fear from the incident will cause a worried well surge to the emergency departments and pharmacies. Consider how limited understanding of radiation and nuclear contamination will contribute to public anxiety and will require multi-modal solutions.
• Public safety (e.g., police, fire, EMS) and other first responder personnel are considered a high risk population; the implementation of protocols for monitoring control zones and effective contamination control measures will be essential for workforce protection.
• Federal resources (e.g., ambulance contracts, National Disaster Medical System [NDMS] teams) cannot be relied upon to mobilize and deploy for the first 72 hours.
• Management of contaminated waste from decontamination efforts should be managed in consultation with SMEs, EPA, and local water authorities.

Each facility or healthcare organization should understand expectations specific to them as part of the coalition. For example:

• Implementation of surge protocol specific to a radiation emergency will occur quickly- staff must be prepared to pivot operational procedures immediately.
• Initial trauma care should precede radiation injury management.
• Radiation contamination assessments will require rapid protocol and education implementation. Staff will need to evaluate real versus possible exposure, internal versus external contamination, and assess overall exposure levels for at-risk patients based on serial blood testing.
• Specialized expertise (such as clinical advisors) will be needed to manage the complexities of a major radiological incident (e.g., dose estimation, exposure type, treatment plans, site evaluations, decontamination protocol).
• Contaminated injury care and decontamination may require rapid expert consultation.
• Community screening sites will be required to assess low-risk patients.
Depending on the scale of the radiological event, it may be necessary to establish alternate care sites, especially for radiological exposure requiring higher levels of care.
• Emergency departments, outpatient care centers, and alternate care sites, must be prepared to rapidly screen large groups of potentially exposed individuals, triage, and transport as needed.
• Allocation of limited/scarce resources, and their distribution, should be based on agreed upon prioritization systems / methods.
• Large-scale radiological incidents may require the recruitment of volunteers (e.g., Medical Reserve Corp), retirees, and trainees to support and relieve screeners and healthcare workers.
• Some individual healthcare facilities may require large-scale fatality management support.
• Community-based interventions will require significant public health effort if an evacuation or shelter in place order is necessary. Critical infrastructures will be impacted (e.g., food distribution, isolation assistance, surveillance activities).
• Health concerns, prolonged response requirements, difficult work environments, and stress may present behavioral health challenges among staff of coalition members and the general public.
• Rural areas may be severely impacted by citizens fleeing an affected area and seeking care.

## COALITION OPERATIONS

To facilitate appropriate pediatric response measures and create a common operating picture, an Incident Response Guide (IRG) has been created within the eICS platform to allow timely and simultaneous notification to all identified and appropriate healthcare partners. The incident will be initiated by the NU MO HCC or DHSS Emergency Response Center (ERC) when a mass pediatric event is identified. As well, each HCC involved in the response will create an eICS incident to capture their HCC's respective response components. At minimum, the HCC Region from which the event originates and the HCC Regions to which the patients are being transported will open and populate an eICS incident. If EMS Mutual Aid or strike team is activated, outside their HCC Region, they will also open and populate an eICS incident. All assigned positions with each eICS incident will be responsible to populate information into eICS relative to the incident. The DHSS ERC will monitor each HCC's eICS entries during the incident and duplicate the appropriate entries into the state-wide eICS incident or State Web EOC incident for state-wide situational awareness. Throughout the response, all state-level EMResource administrators to include DHSS ERC, MHA, MARC and STARRS should maintain visibility of all eICS incidents to facilitate communication and coordination, as necessary.

**Commented [KB1]:** In process….

## Healthcare Coalition (HCC)

- Coordinate local member resource needs.
- Assure engagement of regional 911/Public Safety Answering Point (PSAPs) in regional planning efforts.
- Provide updated information and training to healthcare facilities on routine basis.
- At the time of transport and referral to assessment hospital, assist with coordination and communication relative to the transport and referral processes.
- The healthcare coalition within whose jurisdiction the event originates and from which patients are being transported to appropriate facilities or tertiary care centers will assume responsibility for activating the incident in eICS, thus alerting all pertinent parties and beginning the incident documentation.
- The HCC will assist with patient reunification as requested by their partner entities and/or the DHSS ERC.

# Logistics

## Space

HCC Members not directly impacted by the radiation event may be able to support alternate care site spaces through established MOUs and agreements. The entity initiating the request retains full jurisdictional authority. Sheltering sites or other mass care venues should be coordinated with emergency management partners and at minimum be identified and status communicated with HCC membership as part of situational awareness. Support requests and opportunities should be communicated and filled within the priorities and capabilities of members.
Open PODS led by HCC members should be communicated within membership for situational awareness. These efforts can often be supported by coalition members and should receive priority within the capability of members to support.

## Staff

HCC members may be able to support the staffing needs of other member entities. This can occur through HCC agreements, mutual aid agreements or established MOUs.

## Supplies

Supplies and resource sharing will be supported through regional MCI caches, Regional PPE Chaches, hospital Mutual Aid Agreements, EMS Mutual Aid Agreement, Local Public Health Mutual Aid and NUMO HCC agreements. Each member organization of the NUMO HCC should utilize their established Point of Dispensing, or POD, plan for medical countermeasures from the Strategic national Stockpile. NUMO HCC Leadership will communicate timely updates and maintain situational awareness and coordination of medical countermeasures, and advocate for and support resource needs for NUMO HCC members.

## Operations and Medical Care

Medical operations and care is based upon the amount of exposure, contamination (both internal and external) and trauma related to the incident. Clinical Care Guidance is available in Appendix A.

### Exposure

Radiation exposure occurs when all or part of the body absorbs **penetrating** ionizing radiation from an external radiation source, as shown in the illustration above.
Exposure from an external source stops when a person leaves the area of the source, the source is shielded completely, or the process causing exposure ceases.
Radiation exposure also occurs after internal contamination, i.e., when a radionuclide is ingested, inhaled or absorbed into the blood stream.
This kind of exposure stops only if the radionuclide is totally eliminated from the body, with or without treatment.

- An individual exposed only to an **external source** of radiation, as shown above, is **NOT radioactive or contaminated** and may be approached without risk, just like after a chest x-ray or CT scan.
- Radiation from external exposure alone is either absorbed without the body becoming radioactive, or it can pass through the body completely.

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An individual exposed only to an **external source** of radiation, as shown above, is **NOT radioactive or contaminated** and may be approached without risk, just like after a chest x-ray or CT scan.

- Radiation from external exposure alone is either absorbed without the body becoming radioactive, or it can pass through the body completely.
- Therefore, if a person is scanned with a radiation survey monitor after external exposure alone, the device will not register radiation above the background level.
- Acute Radiation Syndrome (ARS) may result if the dose from whole or partial body exposure is high enough.

External contamination results when radioactive material is deposited on skin, hair, eyes, or other external structures, much like mud or dust. External contamination stops when the material is removed by shedding contaminated clothes and/or completely washing off the contamination.

Types of external contamination

- **Full body**: entire person is covered with radioactive material, not necessarily homogeneously
- **Partial body**: shielding blocks radioactive material from covering the entire person
- Wound contamination with radioactive shrapnel

- With explosion of a Radiological Dispersal Device (Dirty Bomb), radioactive shrapnel or fragments can be propelled through the air and become embedded under the skin or in tissues or organs.
- Radioactive material can enter the blood stream or the lymphatics (internal contamination).
- Internal Contamination
- Internal contamination results when radioactive material is taken into the body via inhalation or ingestion or open wounds.
- Internal deposition of radioisotopes in organs results in local exposure at that location.
- Internal contamination continues until the radioactive material decays, is flushed from the body by natural processes, or is removed by medical countermeasures.
- Types of internal contamination
- **Via respiratory tract:** When aerosol particles are inhaled, those measuring <5 micrometers can reach the alveoli, whereas larger particles will remain in proximal airways. Tiny particles can be absorbed by the lymphatic system or the blood stream, or continue to irradiate locally until exhaled, removed, or depleted of their radioactivity.
- **Via digestive tract:** If swallowed, soluble radionuclides may be absorbed in the upper tract, whereas insoluble radioactive particles may affect the lower gastrointestinal (GI) tract. Depending on the specific radioisotope, particles in the GI tract may be lavaged, expelled, and/or removed using drugs.
- **Via radioactive dust in open wounds:** Small radioactive particles in open wounds may be absorbed into the body via blood or lymphatic channels.

## Jurisdictional Specific Communication

Members receiving official communication, instructions or sharable situational awareness are encouraged to share these communications as permissible with HCC partners. A virtual Joint Information Center among HCC partners to support PIOs and coordinated communication efforts is encouraged. This could be attained through a separate eICS incident with scheduled touch points. Regions of the NUMO HCC may maintain google drives for sharable PIO resources.

**Commented [KB2]:** New Concept Alert!

## Triage and Screening

**Field Triage**

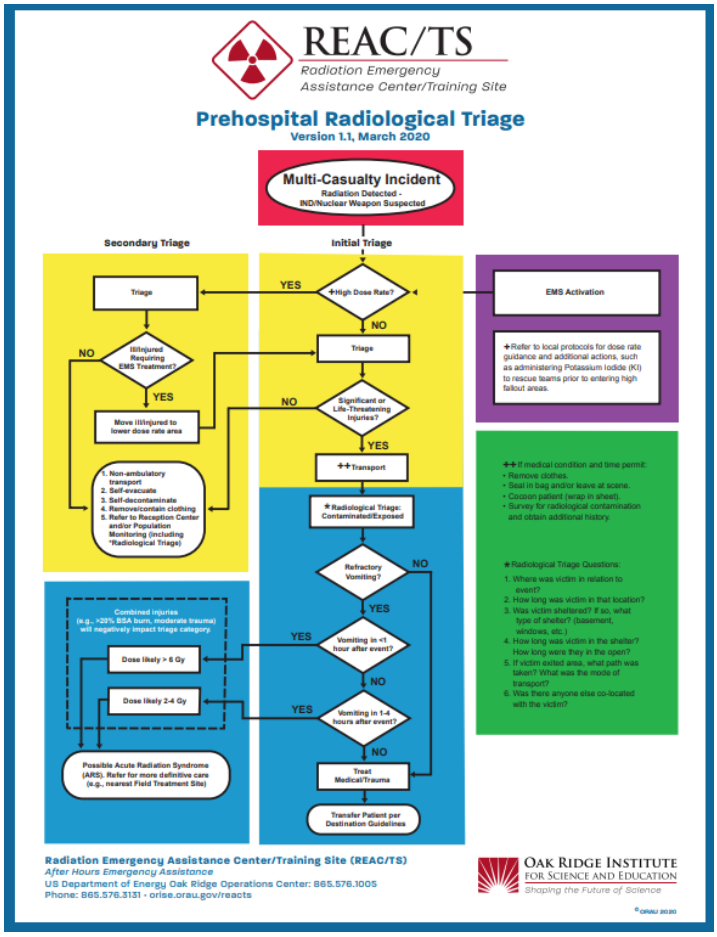
Radiological Triage is primarily performed in the pre-decontamination space either in the field or at the hospital casualty collection point. This triage is based on the patients risk of having significant radiological contamination and encompass three main priorities:

1. Identify High Radiation Sources (or Hot Particles) – if not identified early and shielded, these can place the patient surrounding people and staff at risk for acute radiation injury. This should be accomplished through a Rapid Radiological Survey and results relayed to the Command and shared with the NUMO HCC.

2. Triage patients with traditional MCI protocols – START, Jump Start, or SALT triage as per facility protocol. Red patients should be provided care without delay, or care delayed based on their radiological survey. Patients triaged yellow and green should receive a radiological survey consistent with patient numbers and resources available.
3. Identify persons with significant radioactive contamination (>10,000 cpm, or 5mrem/hr) that require rapid decontamination and assessment for internal contamination.
    a. When the amount of impacted individuals and responding resources permit, every patient should undergo a Full-body Radiological Survey, Patient Radiological Survey Sheet.
    b. When the number of patients exceeds the capacity to conduct a full-body survey, a rapid radiological survey should be performed and patients directed to either decontamination areas or an alternate survey area.

Throughout the initial response period, HCC regional duty officers should work to communicate with hospitals to identify facilities needing to update their Bed Availability. MHA staff and/or HCC designee should work with EMS and hospital transportation officers / Unit Leaders to identify facilities with capacity and support patient tracking initiatives.

**Prehospital Radiological TRIAGE GRAPHIC from REAC/TS Link**




***Hospital Triage for Arriving Victims of Contamination Radiological Incidents***

The following steps require a minimum of 3-5 survey meters and staff trained on their use. Additional staff will be required for casualty collection points, medical triage, decontamination and security or designees for patient traffic and flow management.

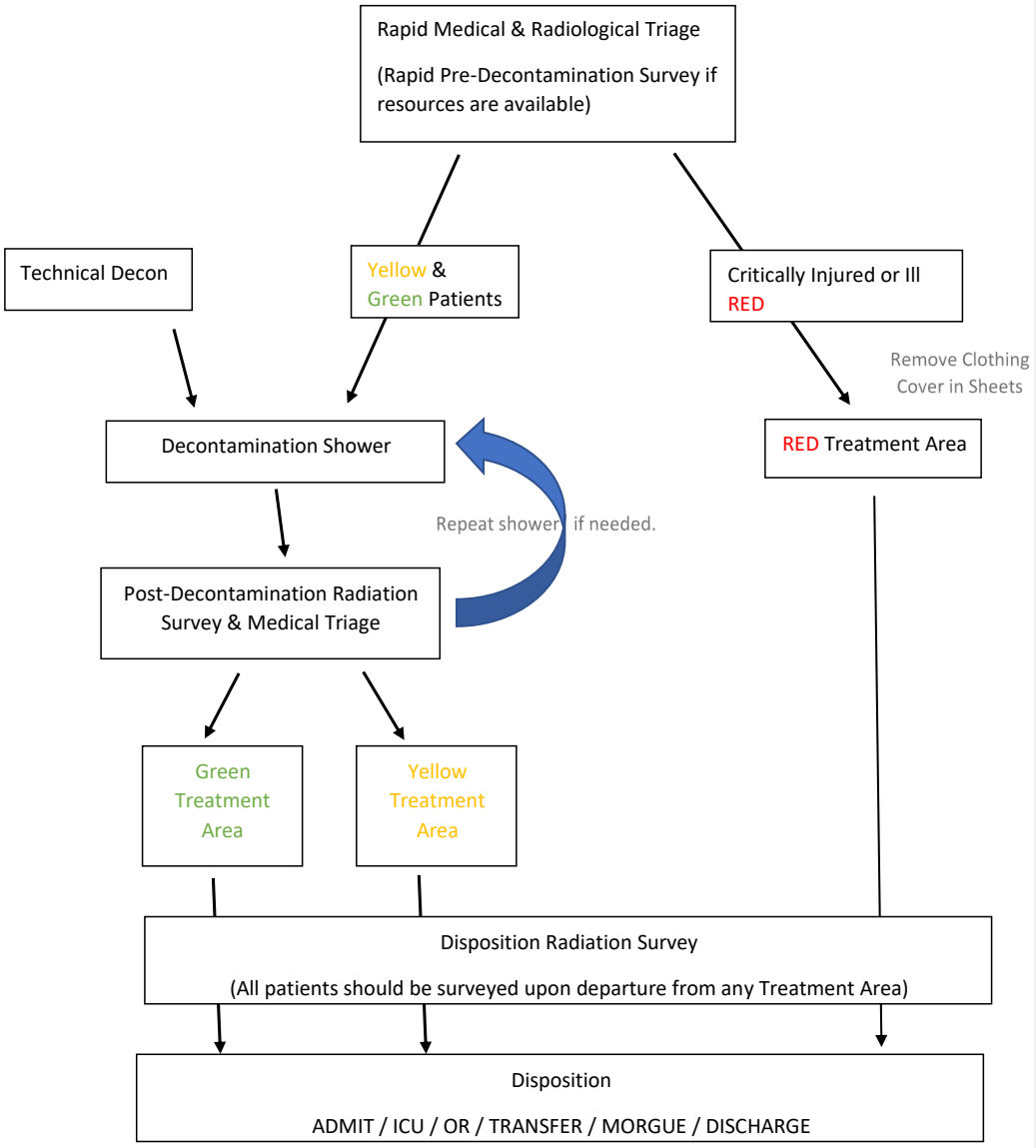
1. Patients arrive via ambulance, on-foot, or other method of transportation.
2. Initial rapid medical triage conducted by staff in full decontamination PPE. This triage is based upon triage screening procedures at the facility and use standardized tools such as START, Jump START or SALT triage methods.

   a. RED Significantly injured or ill, with life threatening injuries, bypass conventional triage and are sent to RED CONTROL TREATMENT AREA. Prior to entry, clothing should be removed, and patient should be transferred to a clean stretcher. The Red Treatment Area Surveyor should conduct a radiation survey simultaneous with stabilizing medical treatment.
   b. All others are sent to Pre-Decontamination Casualty Collection Points.
3. Pre-decontamination surveyor, also in full decon PPE, will assess arriving victims for high activity sources, and if time permits, conduct rapid radiological screening surveys. The following individuals should receive priority for decontamination showers:
   a. Moderately injured/ill victims should go to head of the decontamination line (if possible, all wounds should be covered with water proof dressing, and decontaminated in treatment areas)
   b. Visual or measured facial or upper body contamination (especially if >10,000 cpm or 5 mrem/hr) without injury should also receive priority for decontamination.
   c. Children and pregnant females
4. Post-decontamination survey should be conducted by the PostDecontamination Surveyor. These surveys should be documented. (See Post-Decontamination Survey Sheet).
   a. If contamination is still present and > 200 cpm = 0.1 mrem/hr (this may be raised to 1000 cpm if the arriving group is large) then patient should be redirected to shower again if their medical condition will permit.
   b. Continue process until 1) survey indicates level below 200 cpm or 2) unable to decrease contamination or 3) at least 3 showers have been conducted.
   c. c. If < 200 cpm, then patient to be medically triaged by a clinician to YELLOW or GREEN TREATMENT AREAS.
5. In each treatment area, patients should be frequently medically reassessed and up-triaged if their condition deteriorates.
6. In each treatment area, prior to discharge or disposition, all patients should have a repeat and documented Disposition Radiological Survey (See Post Decontamination Survey Sheet) as well as necessary follow up instructions, necessary treatment, and counseling.

SCARCE RESOURCE TRIAGE

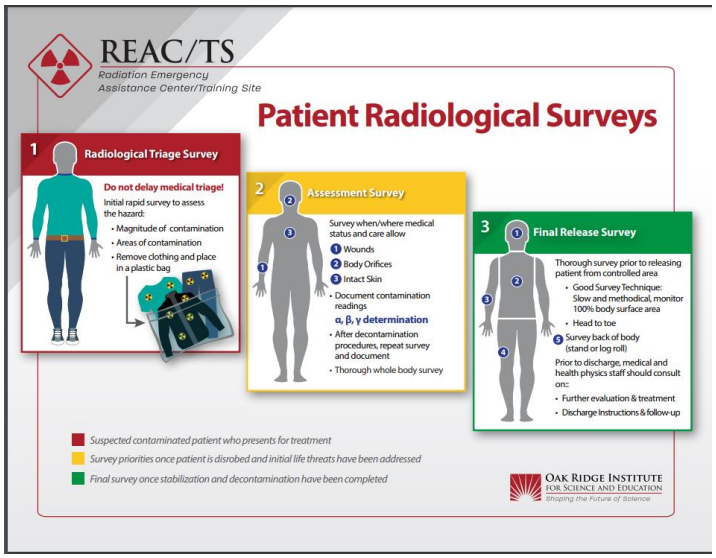
Available online at REMM or the REMM APP. Triage Tool Cards are available.

# Hospital Triage Flow Chart for a Contaminating Radiation Incident



2.5.2 Patient Care/Management

Patient Radiological Surveys




Patient Radiological Survey Sheet

## Treatment

Medical Aspects of Radiation Incidents

CDC Acute Radiation Syndrome: A Fact Sheet for Physicians

CDC Cutaneous Radiation Injury: A Fact Sheet for Physicians

CDC Radiation and Pregnancy: A Fact Sheet for Clinicians

CDC Radiation Emergencies Pocket Guide for Clinicians

## Safety and Control Measures

PPE and personal dosimeters (if available) should be worn. Additional PPE may be requested through regional PPE caches, Hospital Mutual Aid, HCC agreements and the DHSS warehouse.

Radiation Donning and Doffing posters are available from REAC/TS.

## Fatality Management

- In a radiological/nuclear event, radioactive materials may contaminate the deceased.

- Evaluating the deceased with appropriate radiation survey meters can confirm or rule out contamination. Advice from a health physicist would be useful.
- Type of event may dictate timing of handling the deceased
    - If cause of death secondary to nuclear weapon detonation: consider delaying recovery of remains for 1-2 days to allow decay of fission products.
    - If cause of death secondary to explosive radiological dispersal device (RDD) (aka "Dirty Bomb"): no benefit to delaying recovery of remains.
- If the deceased is known or suspected to be contaminated, personnel engaged in handling of the body should be issued personal protective equipment (PPE) and a personal dosimeter.
- All persons coming into contact with the deceased should be aware that other, more acutely hazardous agents, may be present.
    - Non-radiological contaminant hazards (e.g., chemical agents) may pose more significant risks to health and safety of persons handling the body.
    - Non-radiological contaminant hazards (e.g., chemical agents) may necessitate use of higher levels of PPE.
- Disaster Mortuary Operations Response Teams (DMORTs) from HHS/NDMS may be available to assist. Missouri DMORT

## Transport

Remember that if patient/victim transport is needed before decontamination can be completed, ensure that transport personnel wear proper PPE, including personal dosimeters.

1. Wrap contaminated areas or whole patient/victim in two layers of full-body sheets.
2. Preserve ability to observe and monitor patient fully during transport even though patient is wrapped.
3. Pay attention to the patient's body temperature
    a. Avoid patient hyperthermia from 2 blankets on a hot day.
    b. Avoid hypothermia on a cold day, especially if patient's clothes have been removed.
4. Following transport of contaminated patient/victim:

a. Ensure complete survey and decontamination of transport vehicle and equipment.

b. Ensure proper disposal of all contaminated equipment.

c. Arrange for survey and decontamination of responders, as needed.

## Surveillance, Tracking, and Situational Awareness

HICS forms 254 and 255 should be used for all patients contacts and reported through designated channels to jurisdictional authorities.

## Rehabilitation, Outpatient Follow-Up Services

**Instructions for short-term monitoring of individuals released from the scene of a possible radiological/nuclear incident** (PDF - 53 KB)

Contact your personal physician as soon as possible to report:

- Any information you received from those who helped you during the incident.
- What happened to you during the incident
- Where you were at the time of the incident
- How long you were at the scene
- Whether you may have been shielded from radiation by buildings, vehicles, or other solid objects.
- Anything else you know or were told at the scene about your circumstances at the time.
- The results of any tests (like blood tests) you may have received at the incident scene or at another medical facility.
- Whether authorities at the scene recorded your information into the log of people involved in the event
- Your physician should consider performing a blood test called a CBC (complete blood count with differential).
    - If there is genuine concern that you could have been exposed to radiation, this should be done immediately.
    - The results of this test can help your doctor determine if radiation has affected your body's ability to make new blood cells.
- If your blood counts appear to be abnormal, your physician should consider repeating the test daily until the problem is clarified.
    - Abnormally low blood counts, especially the lymphocyte count, may be a sign that you were exposed to high levels of radiation.
    - Abnormal blood counts may not necessarily be due to exposure to radiation, however.
    - Exposure to high levels of radiation can cause a condition known as Acute Radiation Syndrome (ARS).

- If your CBC is abnormal and the results cannot be explained by other medical problems, your doctor should immediately contact a medical official responsible for helping people connected with the incident.

**Instructions for all persons involved in a radiological/nuclear incident (victims, persons concerned they may have been victims, and all responders)** (PDF - 49 KB)

**Commented [KB3]:** Source REMM - https://remm.hhs.gov/followup.htm

- Register with an official government agency (federal, state, tribal, or local) charged with collecting the names of all persons involved in the incident, so that appropriate monitoring can be arranged later.
- Monitoring is appropriate for all persons connected with the incident, including:
- Persons who had any radiation-related health effects identified at the time of the incident.
- Persons who may not have had radiation-related health effects at the time but who were near the scene.
- Persons who participated in incident/emergency response: e.g., health care providers, EMS personnel, hospital personnel, security personnel, etc.
- Listen for follow-up instructions from authorities managing the incident.
- Since every incident is different, you should try to find out what recommendations are made by authorities after more is known about the whole incident.
- Listen for how to contact officials who may be able to provide you with additional information or answer any questions you may have.
- It is normal to feel psychologically affected by the incident (fear, anxiety, depression, hopelessness, etc.) and you should speak with your doctor about these feelings.

## Deactivation and Recovery

The NUMO HCC will enter recovery phase after acute care and load balancing has occurred. This will be monitored through regular touch points and a daily status type in EMResource. It is anticipated that the larger the event the more delayed and drawn out the recovery to deactivation period will be. Best practice would be to initiate an eICS Recovery incident for coordination through deactivation. The initial incident can remain open until each facility enters that phase of operations. It is recognized that with multiple locations and jurisdictions and facility types in the NUMO HCC entities will not make a simultaneous transition to the recovery phase. Recovery will be self-identified by each facility but broadly speaking would be when all service lines are reopened or determined to require long term abatement or repairs prior to coming back online.

# Special Considerations

## Behavioral Health

Behavioral Health facilities will first address their existing patient population and staffing needs, including possible exposures and contamination. Unless there is significant exposure and gross contamination, patient decontamination should be through their internal established process and medical clinical consult through their physician with SME telehealth support if needed. Pt can be transferred as a last result. No behavioral health patient should be denied access to care or delayed care due to being in a behavioral health facility.

Behavior health facilities can play an active role in response to radiation events by supporting local facilities and communities by temporarily surging outpatient and emergency services if available.

Contributing to and vetting social media messages.

Providing press release statements that support mental health and positive coping strategies.

Examining what type of inpatient surge capacity may be a possibility, considering an 1135 waiver to expand capacity.

For facilities, staff and providers it is encouraged to provide the Disaster Distress Helpline 1-800-985-5990. Psychological First Aid in Radiation Disasters is also available.

## Pediatric and At-Risk Populations

Pediatric patients have higher risk from radiation and nuclear incidents than adults because of their smaller size and developing bodies, which make them more susceptible to radiation poisoning and more likely to develop short- and long-term medical issues including mental health problems and certain cancers. Some of the medical implications for pediatric patients in radiation and nuclear incidents include acute radiation syndrome, psychological effects, cancer risks, and other late tissue reactions.

The American Academy of Pediatrics provides the following recommendations for pediatricians:

- Download information on how and when to use KI (potassium Iodine), and ensure the information is accessible in an emergency.

  The CDC Internal Contamination Clinical Reference (ICCR) Application for IOS and Android users.

- When the risk of exposure to radioactive iodine is temporary, mothers can continue to breastfeed their infants if appropriate doses of KI are given to them within four hours of contamination; if not, they should be prioritized to receive other protective measures like evacuation.

- Monitoring children for contamination and decontamination should be done at a center equipped to perform these functions. Pediatric providers should ask local and state health departments about the location of community facilities that may be designated in real time (see http://bit.ly/2Rhnpfl).
- Pediatric medical centers should ensure their facilities are equipped to receive and manage contaminated children (and accompanying adults). Inpatient centers should download the Internal Contamination Clinical Reference Application at https://emergency.cdc.gov/radiation/iccr.asp.
- Pediatricians should provide ongoing assessment, treatment and specialist referrals for the mental health needs of patients/parents affected by radiation emergencies.
- Training of health professionals in managing mental health issues related to emergency events should be expanded. Accrediting agencies should include requirements for office training and preparedness, including KI administration to exposed children.

Clinical Effects in Relation to Whole-body Radiation Dose:

| **Clinical Effect** | **Whole-body Dose, Gy** |
|---|---|
| Threshold for developing clinically apparent ARS | 1 (children may have a lower threshold than adults) |
| $LD_{50/60}$ without significant medical therapy[59,–63] (http://www.remm.nlm.gov/LD50-60.htm) | ~4.5 |
| $LD_{100}$ | 8 |
| Hematopoietic syndrome | 2–6 |
| Gastrointestinal syndrome | 6–10 |
| Cerebrovascular syndrome | >20 |
| Cutaneous syndrome | >2 (to the skin) |

$LD_{50/60}$, lethal dose that will kill 50% of the exposed population within 60 days; $LD_{100}$, lethal dose, 100%.

The American Academy of Pediatrics has published After Pediatric Considerations Before, During, and After Radiological and Nuclear Emergencies and identifies medical countermeasures for pediatric patients that are available and include:

| Medical Countermeasure | Indication | Comment |
|---|---|---|
| Prussian blue | Enhances the fecal elimination of radioactive cesium or thallium by interrupting their enterohepatic circulation | Considered safe in children because it is not absorbed into the body. Not approved for ages <2 y. Use preemergency use authorization for ages 6 mo–2 y.<br>Causes constipation and blue feces. |
| Pentetate calcium trisodium | Enhances the renal elimination of plutonium, americium, and curium | Approved in children. If >1 dose is needed, the zinc form is preferred. |
| Pentetate zinc trisodium | Enhances the renal elimination of plutonium, americium, and curium | Approved in children. |
| KI | Saturates the thyroid with stable iodine, which prevents the uptake of radioiodine. | See below |

KI or Potassium Iodine

| Age Group | Predicted Thyroid Gland Exposure, mGy | KI Dose, mg | # or Fraction of 130-mg Tablets | # or Fraction of 65-mg Tablets | Milliliters of Oral Solution, 65 mg/mL |
|---|---|---|---|---|---|
| >40 y | ≥5000 | 130 | 1 | 2 | 2 |
| 18–40 y | ≥100 | 130 | 1 | 2 | 2 |
| Pregnant or lactating women | ≥50 | 130 | 1 | 2 | 2 |
| 12–18 y[a] | ≥50 | 65 | 0.5 | 1 | 1 |
| 3–12 y | ≥50 | 65 | 0.5 | 1 | 1 |
| 1 mo–3 y | ≥50 | 32 | Use KI oral solution[b] | 0.5 | 0.5 |
| 0–1 mo | ≥50 | 16 | Use KI oral solution[b] | Use KI oral solution[b] | |

Medical Countermeasures for Treating the Hematopoietic Subsyndrome of ARS

| **Medical Countermeasure** | **Indication** | **Comment** |
|---|---|---|
| Granulocyte colony-stimulating factor (filgrastim and pegfilgrastim) | Neutropenia | Approved for use in adults and children. |
| Granulocyte-macrophage colony-stimulating factor (sargramostim) | Neutropenia | The liquid formulations containing benzyl alcohol or lyophilized formulations reconstituted with bacteriostatic water for injection, USP (0.9% benzyl alcohol), should not be administered to neonates and young infants. |
| Antibacterials | Neutropenia | Follow guidelines provided by professional societies (eg, Infectious Diseases Society of America and the American Society of Clinical Oncology[65,66]). |
| Antivirals | Neutropenia | Follow guidelines provided by professional societies (eg, Infectious Diseases Society of America and the American Society of Clinical Oncology[65,66]). |
| Antifungals | Neutropenia | Follow guidelines provided by professional societies (eg, Infectious Diseases Society of America and the American Society of Clinical Oncology[65,66]). |
| Platelets | Thrombocytopenia | Irradiated and leukocyte reduced. |
| Packed red blood cells | Anemia | Irradiated and leukocyte reduced. |
| Stem cell transplant | Failure to respond to other therapies<br>Absence of significant combined injuries or comorbid conditions | Contact the Radiation Injury Treatment Network (https://ritn.net/default.aspx) |

## Obstetrical and Perinatal Patients in Radiological Incidents

Obstetrical patients in radiological incidents will have many questions and require follow up support from their obstetrician and other care providers in the coming days, weeks, months and years. The following is provided from the CDC as a general information guide and general knowledge. NUMO HCC members are encouraged to provide referral for follow up care to the patients established or intended establishment with their OB provider of choice. In addition, Telemedicine SME consult may be advisable when possible for the mental health of the mother.

Mothers who have been contaminated and are now in labor, every effort should be made to ensure a decontamination process prior to delivery if possible.

CDC Potential Health Effects (other than cancer) of Prenatal Radiation Exposure:

| Acute Radiation Dose* to the Embryo/Fetus | Time Post Conception (up to 2 weeks) | Time Post Conception (3rd to 5th weeks) | Time Post Conception (6th to 13th weeks) | Time Post Conception (14th to 23rd weeks) | Time Post Conception (24th week to term) |
|---|---|---|---|---|---|
| **<0.10 Gy (10 rads)** | Noncancer health effects NOT detectable | | | | |
| **0.10–0.50 Gy (10–50 rads)** | Failure to implant may increase slightly, but surviving embryos will probably have no significant (non-cancer) health effects. | Growth restriction possible | Growth restriction possible | Noncancer health effects unlikely | |
| **> 0.50 Gy (50 rads) The expectant mother may be experiencing acute radiation syndrome in this range, depending on her whole-body dose.** | Failure to implant will likely be high, depending on dose, but surviving embryos will probably have no significant (non-cancer) health effects. | Probability of miscarriage may increase, depending on dose.<br>Probability of major malformations, such as neurological and motor deficiencies, increases.<br>Growth restriction is likely | Probability of miscarriage may increase, depending on dose.<br>Growth restriction is likely. | Probability of miscarriage may increase, depending on dose.<br>Growth restriction is possible, depending on dose. (Less likely than during the 6th to 13th weeks post conception) | Miscarriage and neonatal death may occur, depending on dose. § |

| Acute Radiation Dose* to the Embryo/Fetus | Time Post Conception (up to 2 weeks) | Time Post Conception (3rd to 5th weeks) | Time Post Conception (6th to 13th weeks) | Time Post Conception (14th to 23rd weeks) | Time Post Conception (24th week to term) |
|---|---|---|---|---|---|
| | | | | Probability of major malformations may increase | |

8th to 25th Weeks Post Conception:
The most vulnerable period for intellectual disability is 8th to 15th weeks post conception
Severe intellectual disability is possible during this period at doses > 0.5 Gy
Prevalence of intellectual disability (IQ<70) is 40% after an exposure of 1 Gy from 8th to 15th week
Prevalence of intellectual disability (IQ<70) is 15% after an exposure of 1 Gy from 16th to 25th week

***Note: This table is intended only as a guide. The indicated doses and times post conception are approximations.***

Table adapted from Table 1.1. of the National Council on Radiation Protection and Measurements' Report No. 174, "Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance" [NCRP2013].

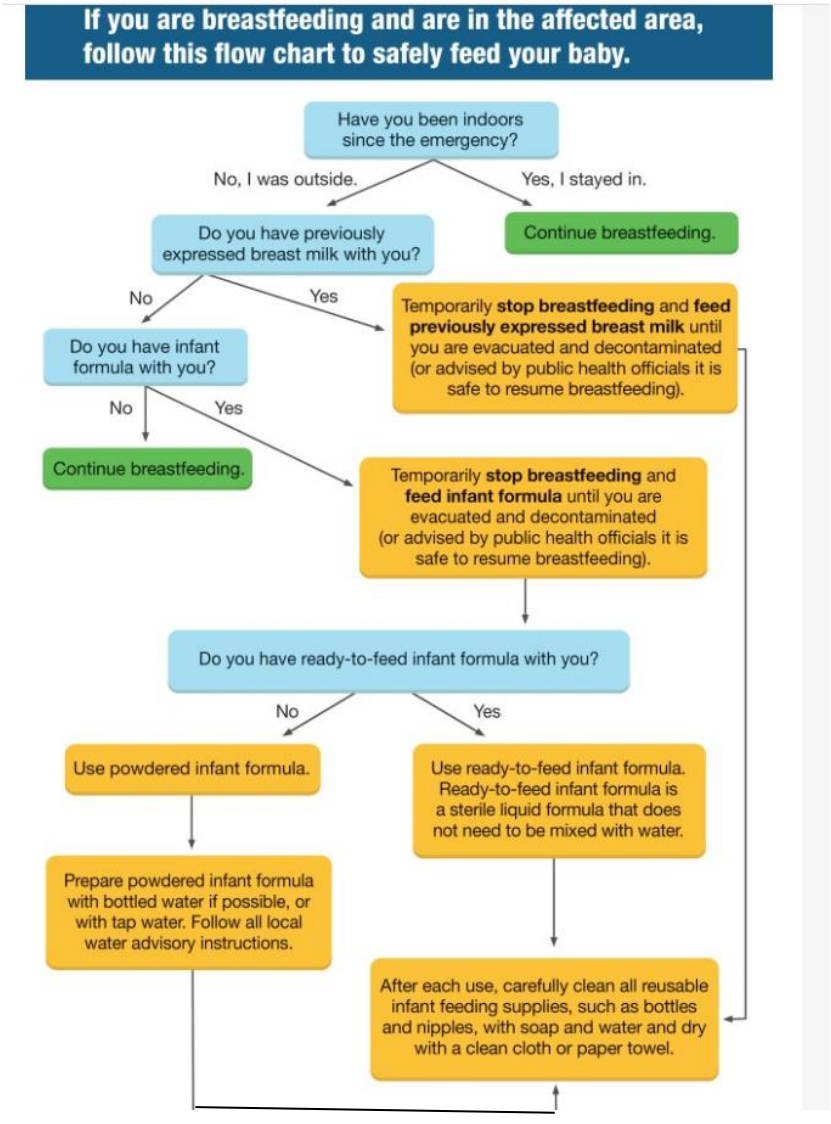
| | |
|---|---|
| * | Acute dose: dose delivered in a short time (usually minutes). Fractionated or chronic doses: doses delivered over time. For fractionated or chronic doses, the health effects to the fetus may differ from what is depicted here. |
| † | Both the gray (Gy) and the rad are units of absorbed dose and reflect the amount of energy deposited into a mass of tissue (1 Gy = 100 rads). In this document, the absorbed dose is that dose received by the entire fetus (whole-body fetal dose). The referenced absorbed dose levels in this document are assumed to be from beta, gamma, or x-radiation. |
| § | For adults, the LD50/60 (the dose necessary to kill 50% of the exposed population in 60 days) is about 3-5 Gy (300-500 rads) and the LD100 (the dose necessary to kill 100% of the exposed population) is around 10 Gy (1000 rads). |

Table adapted from Table 1.1. of the National Council on Radiation Protection and Measurements' Report No. 174, "Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance" [NCRP2013].

## Infant Feeding

This issue is timely and relevant to the healthcare community and guidance will vary based on the type of incident and level of exposure and contamination of both the caregivers and the environment. The CDC provides an Infant feeding in radiological Emergencies landing page that is very helpful in addressing many of the questions in the initial period. Generally speaking, for formula fed babies preprepared formula or formula mixed with bottled water is preferable until local officials declare the

tap water safe for drinking. Boiling water does not remove radiological contamination. If tap water is all that is available, infants should still be fed formula with that water unless told otherwise by local officials. It is safer then going out to look for bottled water or premixed formula. For breast fed babies, the CDC provides the algorithm below. For all infants hydration and nutrition is extremely important. If infant feeding supplies are not able to be washed safely, or are not available infant cup feeding is a viable option. Use disposable cups and throw them away after each feeding.



# Appendices:

## Training and Exercises

Just in Time and on demand training is available from multiple resources. It is encouraged that all HCC entities incorporate radiological training into their routine preparedness work and at a minimum have updated printed resources and Apps downloaded on workplace devices for decision support tools.

CDC Just in Time Training for Hospital Clinicians

CDC Medical Countermeasures for Radiation and Contamination

Radiation Surge Annex Pediatric Workshop WRAP-EM

REAC/TS Hospital Checklist for Radiation Emergencies

REAC/TS Just in Time Training for Ground and Air EMS Transports

Handbook for Radiological Dispersion Devices First Responders Guide – The First 12 hours

Helpful Apps for HCC members:

REMM – Radiation Emergency Medical Management
Guidance on Diagnosis and Treatment for Healthcare Providers

ICCR – Internal Contamination Clinical Reference


REAC/TS Radiation Emergency Assistance / Training Center Includes eGuide for The Medical Aspects of Radiation Incidents, 5th edition, Just in Time Training videos and radiation counter measures

## Legal Authorities

The NUMO HCC has no legal or jurisdictional authority but serves to support all ESF 8 partners in healthcare planning, preparedness, response and recovery.

Additional Resources/References

REAC/TS – Radiation Emergency Assistance Center / Training Site

RITN – Radiation Injury Treatment Network

REMM – Radiation Emergency Medical Management

CDC Radiological Disasters Landing Page