COVID-19 and Health Workers: Radiation Protection

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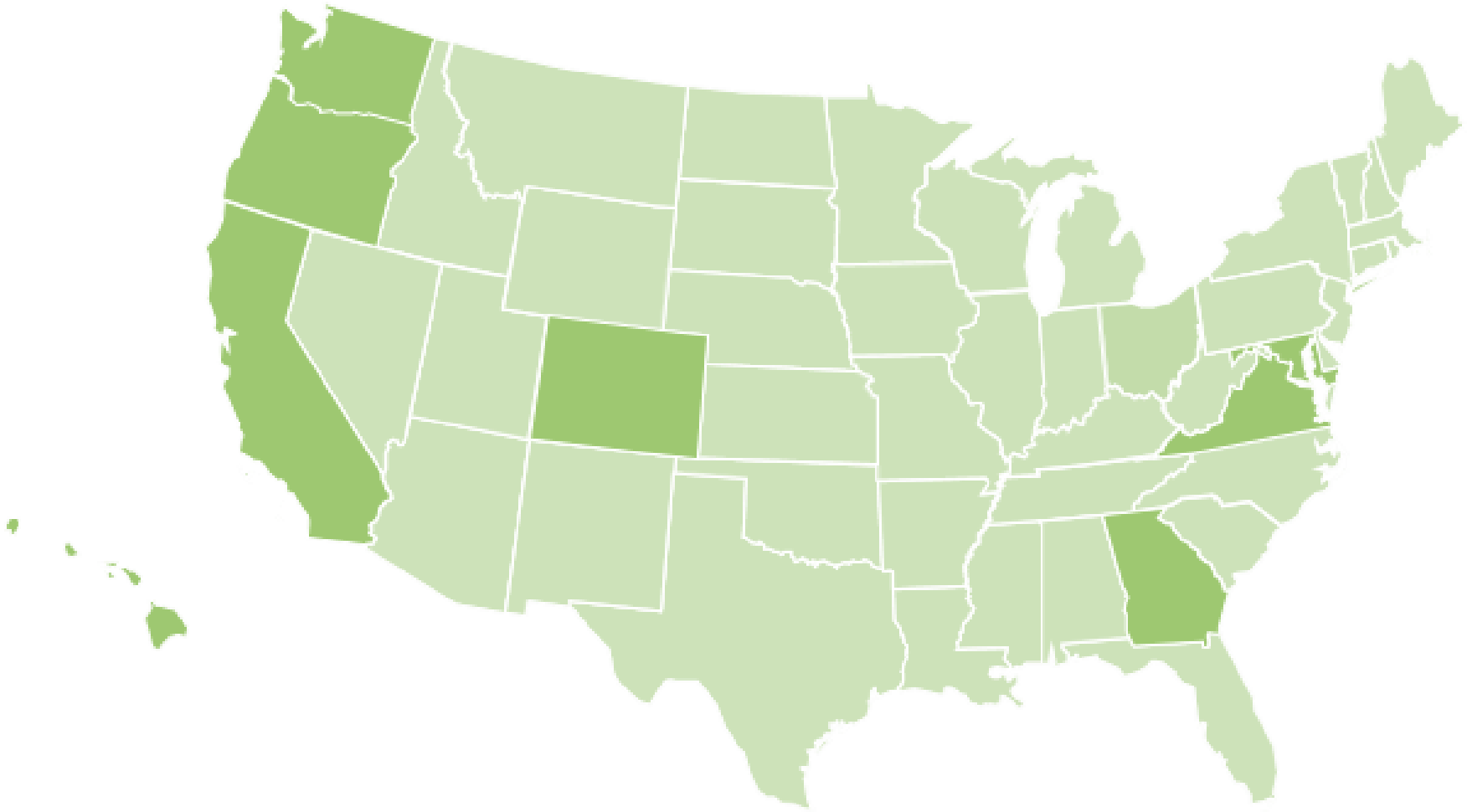
Outline

- Brief summary of local experience, so far
- Protective measures against COVID-19
- Chest imaging in patient management
- Strategies and arrangements for portable imaging
  - Review of radiation safety goals and how to conduct a radiation protection assessment
  - Considerations for unshielded or temporary areas with an increased workload
  - Imaging through barriers
  - Practical tips for establishing workflows
- CRCPD Resources
- Self-Care Suggestions

Kaiser Permanente – a national view

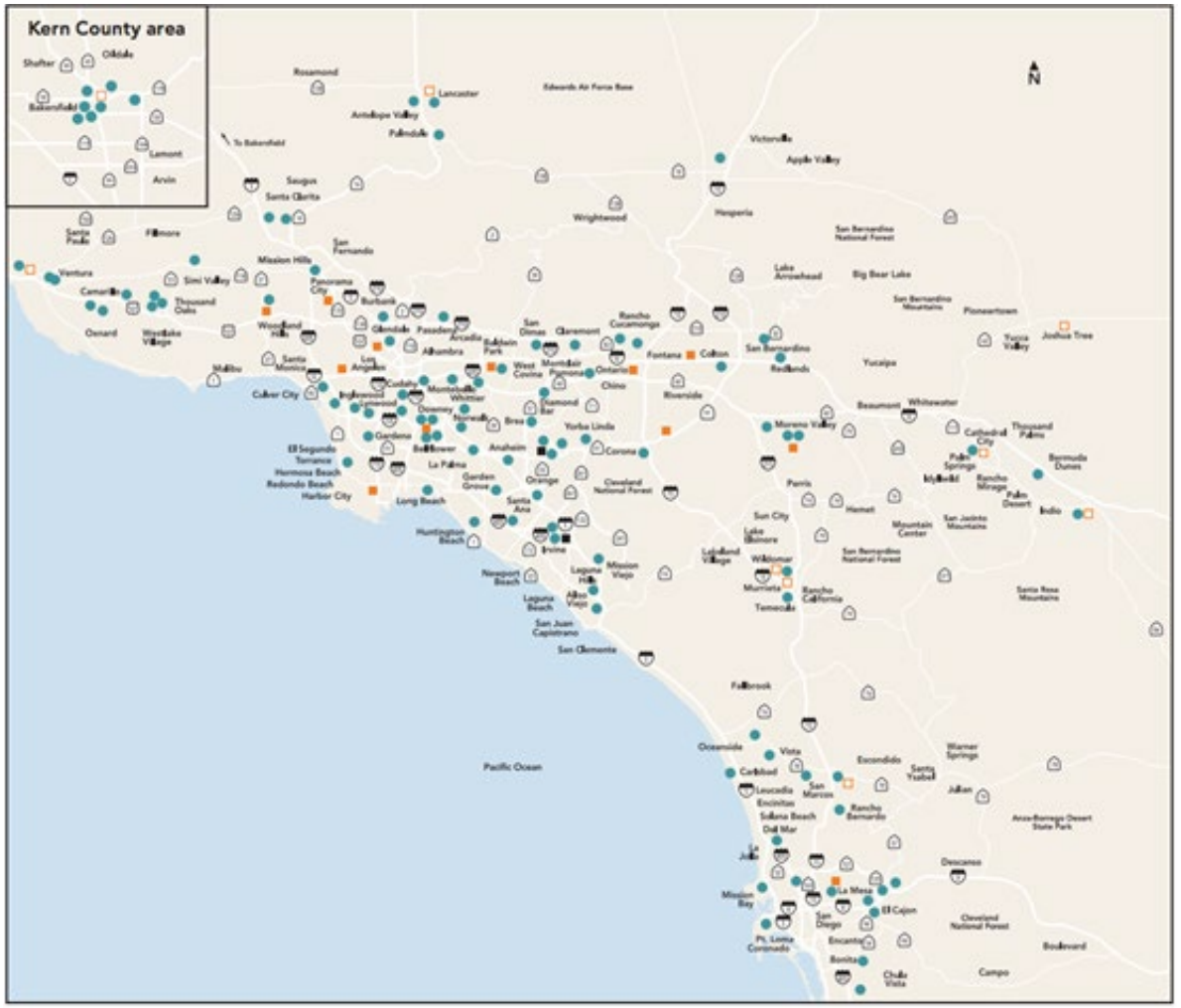


8 Regions:

- Hawaii
- Washington
- Northwest (Oregon/Washington)
- Northern California
- Southern California
- Colorado
- Mid-Atlantic
- Georgia

The Southern California Region of Kaiser Permanente

- 15 Hospitals
- Hundreds of Medical Office Buildings
- Thousands of Physicians
- Medical School
- Insuring approximately 4.6M in SCal
- Regional radiation safety program overseeing personnel monitoring for 6500 participants
- Medical Physics is part of the Medical Imaging Technology and Informatics Department



Surge preparation

- Surge areas allow the management of patients requiring unusual or specialized evaluation and care and are also used when patient problems require special intervention to protect medical providers, other patients and the integrity of the health care organization.
- Each medical center prepared one or more surge care areas starting towards the end of February
  - Combination of tents, designated isolation areas in the ED, repurposing of other parts of facilities
  - Requests for the setup and use of portable radiographic imaging in these areas was essentially immediate.

Photo courtesy Devin Grissom, Kaiser Permanente Downey Medical Center

Surge preparation

- The Los Angeles County Radiologic Health Branch requires a shielding plan check.
- My first call was to local regulators. We formulated a protocol for assessing temporary, unshielded areas.
- Our facilities are located across multiple counties so we requested that the entire state consider the protocol in all areas. Completed 3/11/2020.

COUNTY OF LOS ANGELES ◆ DEPARTMENT OF PUBLIC HEALTH
ENVIRONMENTAL HEALTH
ENVIRONMENTAL PROTECTION ◆ RADIATION MANAGEMENT

Guidance for X-ray Use in a Temporary Location (non-shielded)

Operator

1. Personal monitoring badge must be used.
2. The operator must stand 6 feet from the primary beam and use an apron or mobile shield during exposure.

X-ray performance on gurney patients

The beam is directed toward the image receptor which is placed behind the patient (AP). No additional shielding should be required posterior to the receptor if the beam is appropriately collimated to minimize scatter radiation and ALARA technique is used.

All gurney patients

Should be placed 6 feet apart or incorporate the use a mobile shield to decrease the likelihood of receiving scatter radiation from other patients (receiving X-rays).

X-ray performance on the standing patient

The beam is directed toward an image receptor placed in front of the patient (PA). To reduce the need for additional posterior shielding, the image receptor must be placed adjacent to a location with low occupancy or with a wall having high natural shielding such as brick or concrete.

All Patients

The image receptor/X-ray beam must be located at least 6 feet away side walls unless the walls are constructed of natural shielding such as brick or concrete.

Waiting patients

All patients should be located away from the X-ray area with boundaries placed to ensure the public dose limit.

Signage

Place the appropriate warning signs as required by CCR Title 17.

Surge Preparation in the community

- State-funded Los Angeles Surge Hospital (LASH) opened on April 13
  - Facility is located near downtown Los Angeles and was the shuttered St. Vincent Medical campus before it reopened
  - Only accepting individuals diagnosed with COVID-19
  - Partnership with the State of California, County of Los Angeles, Dignity Health, and Kaiser Permanente
- Los Angeles Convention Center is now being turned over for use as a field medical facility
- The meeting facility for the annual RSNA conference, McCormick Place, has also been converted to a field hospital

Photo from fox32chicago.com

Imaging COVID-19 patients

- The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society pubs.rsna.org/doi/10.1148/radiol.2020201365, published April 7

Essentials

- ☐ Imaging is not indicated in patients with suspected COVID-19 and mild clinical features unless they are at risk for disease progression.
- ☐ Imaging is indicated in a patient with COVID-19 and worsening respiratory status.
- ☐ In a resource-constrained environment, imaging is indicated for medical triage of patients with suspected COVID-19 who present with moderate-severe clinical features and a high pre-test probability of disease.

Protecting during imaging – US Centers for Disease Control and Prevention

- According to the CDC, current data suggest that close-range aerosol transmission by droplet and inhalation, and contact followed by self-delivery to the eyes, nose or mouth are likely routes of transmission
- Recommendations:
  - All patients should be masked
  - Machines must be cleaned and disinfected after each patient encounter per droplet precautions
  - Radiology staff should wear a mask, goggles or a face shield, gloves, and an isolation gown
  - https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html

Cleaning and disinfection

- Surfaces must be cleaned first – removal of dirt and/or organic matter from a device or surface
- Disinfection removes pathogens or significantly reduces their numbers
- Common disinfectants:
  - Sodium hypochlorite (bleach)
  - Alcohol
  - Phenolic compounds
  - Peroxygen compounds
- Follow manufacturer's recommendations for disinfectants
- Damp cleaning should be used over dusting, change cloths frequently
- Manufacturers of imaging equipment should specify products safe for use on equipment

Protective Measures

Limit exposure opportunities and preserve PPE by

- Prevent or minimize transmission from individuals by controlling the source. Monitor everyone entering a healthcare facility for symptoms and intercept before there is excessive contamination or transmission.
- Use engineering controls such as barriers and altering work practices to minimize patient contact

- Reschedule non-urgent care such as screening, non-emergent, or elective exams
- Developing PPE contingency strategies
  - Reprocessing
  - Possible use beyond a single patient contact

Radiation Safety Goals

- Do not exceed regulatory limits for exposure of occupational workers or the general public
- Optimize the use setup to ensure that exposures are As Low As Reasonably Achievable
  - Control of the radiation source
  - Protective garments
  - Occupational exposure monitoring
  - Minimize risks
    - Inadvertent exposure to patients or staff
    - Imaging wrong patient or pregnant patients
    - Reduce repeats

Radiation Protection Survey Assessment

- Determine the expected likelihood and magnitude of exposures in normal operation and, to the extent reasonable and practicable, to make an assessment of potential exposures. Including:
  - Operational limits and conditions for the operation of the facility;
  - The ways in which structures, systems and components, including software, and procedures relating to protection and safety might fail, singly or in combination, or might otherwise give rise to exposures, and the consequences of such events;

Radiation Protection Survey Assessment

Start with a diagram of the area if available. Walk the area to confirm diagram is accurate. You may need to draw your own diagram.

Identify occupancy around the use location

Identify primary and secondary barriers

Estimate the workload

Use an appropriate phantom material to simulate an actual patient, including scatter

Use an appropriate radiation detector

Take advantage of any barriers that may provide shielding, such as brick or concrete walls adjacent to outdoor tents

Example surge area with temporary, fixed use of a portable

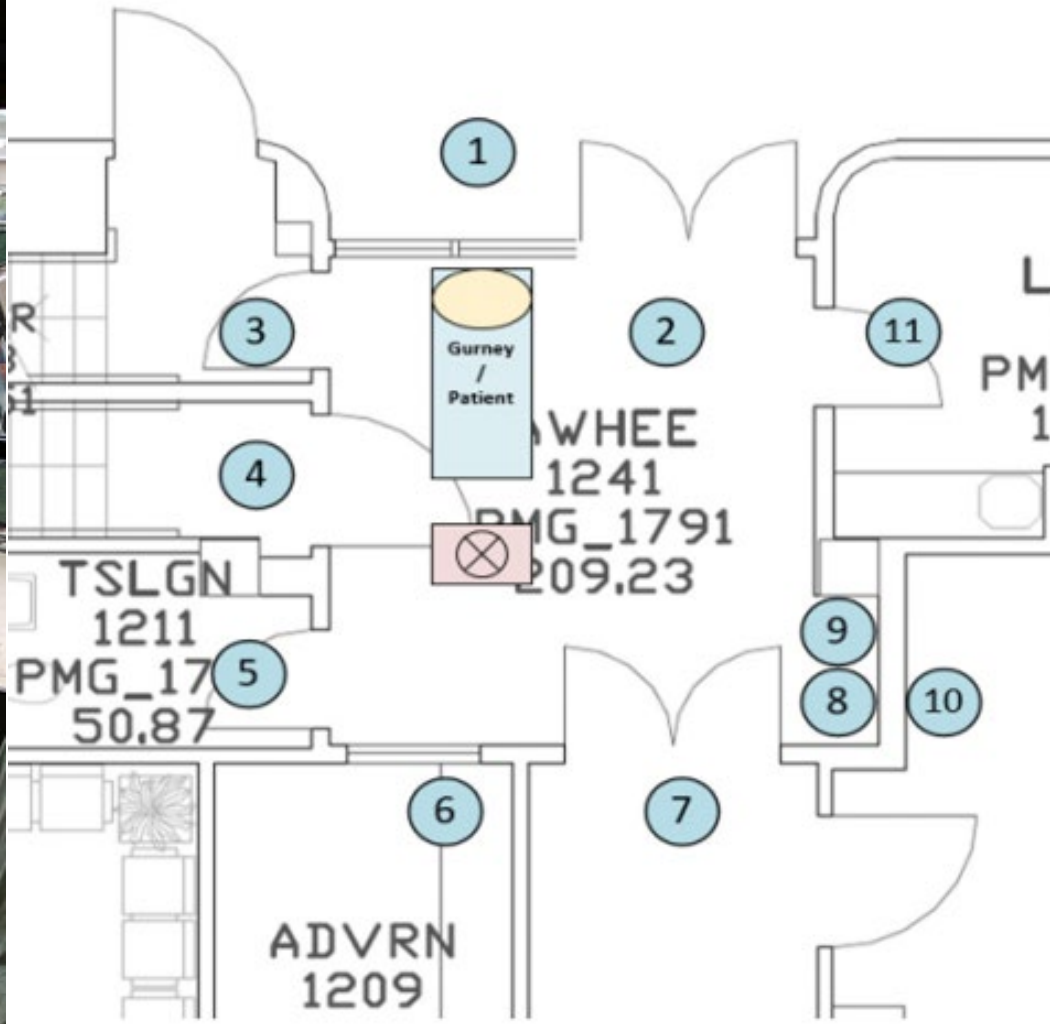


Photo and diagram courtesy of Matt Wait, Medical Radiation Physicist, SCPMG

X-Ray Source:	Sys. No. 8822					Phantom Material:	Anthropomorphic chest phantom
System Make:	Canon	Insert Make:	Toshiba	kV:	100	Workload:	125.0 mA-min/wk
System Model:	RadPRO Mobile3	Insert Model:	E7886	mAs:	2	Orientation:	Towards upright gurney
System SN:	G71743	Insert SN:	5H755	SID (cm):	180	Collimation:	18" x 24"

Location	Description	Use Factor *U*	Occupancy Factor *T*	Measured (uR)	**mR/wk**	Controlled Area	Limit (mR/wk)
1	6' behind upright gurney	1	1/40	3.6	0.34	No	2
2	6' right of gurney	1	1/20	4.8	0.90	No	2
3	6' left of gurney (north stairwell)	1	1/40	2.3	0.22	No	2
4	South stairwell	1	1/40	11.6	1.09	Yes	100
5	Bathroom	1	1/20	0.1	0.02	No	2
6	Break Room	1	1/5	0.3	0.23	No	2
7	Corridor	1	1/5	1.4	1.05	No	2
8	Operator position (Corner)*	1	1	4.2	15.75	Yes	100
9	Corner with shield*	1	1	0.3	1.13	Yes	100
10	ER Room	1	1/5	0.2	0.15	No	2
11	Storage Room	1	1/20	3.1	0.58	No	2

Measurements with a Ludlum 9DP calibrated within the last year

Imaging through barriers – a protocol at the University of Washington:

Portable Radiography

Radiology teams from our institution have minimized staff and equipment exposure by performing single-view portable radiographs through the windows on doors to isolation rooms.

- The patient is positioned standing or sitting in front of the door inside the isolation room with a nurse/staff wearing a lead shield, holding the plate to the patient's chest.
- The portable machine camera is brought close to the glass, and adjustments are made to the machine to optimize the film.
- The film is passed by the gowned nurse outside the room with removal of the plastic sheet while passing to the X-ray staff outside the room, keeping the plate clean.
- While artifact from the window is sometimes present on the film, our radiologists have been able to read from these for multi-focal pneumonia and tube placement.

See images below:

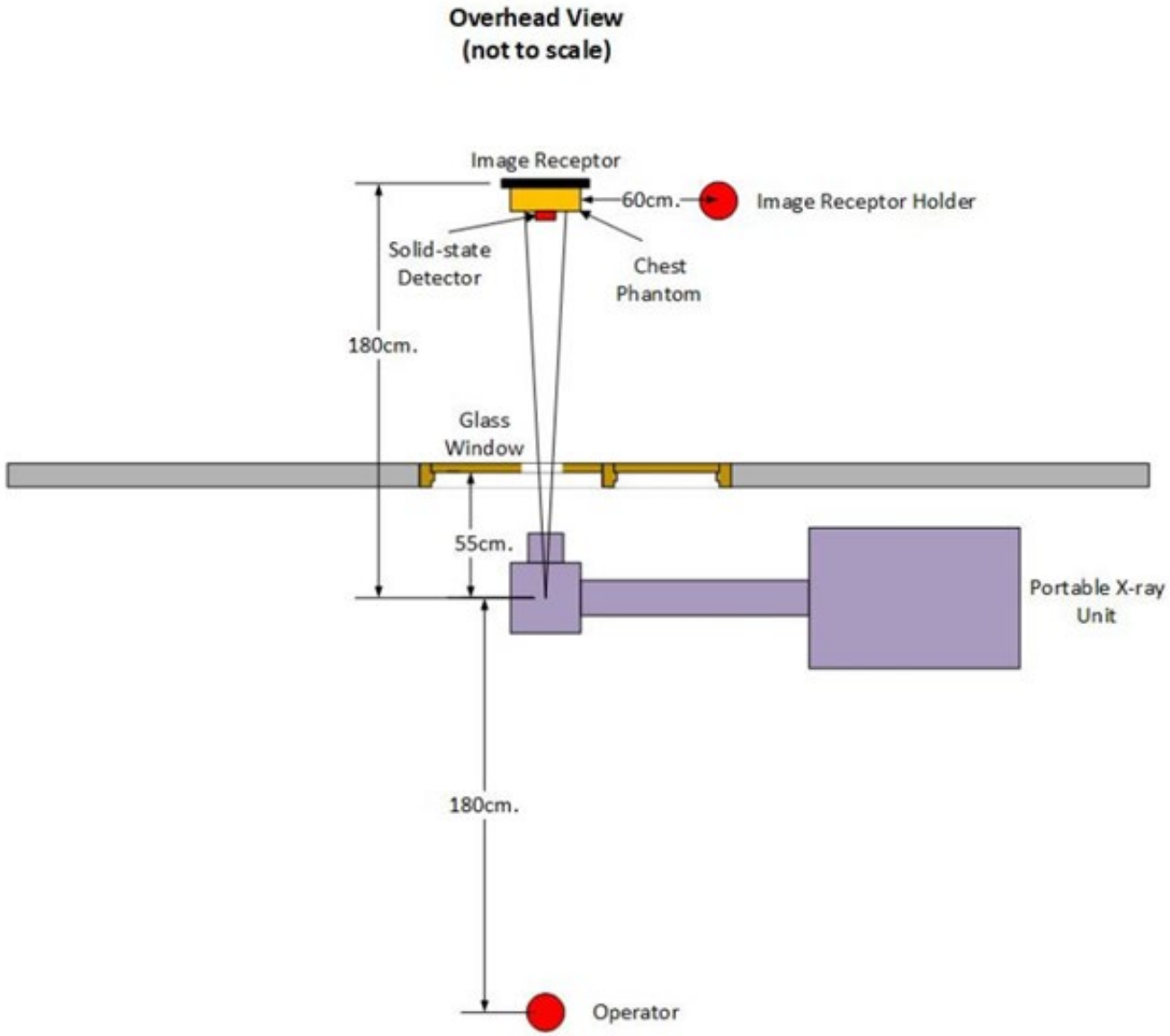


Figure 1 – Diagram of the test setup

Figure courtesy Patrick Brunick, Resident Physicist, SCPMG

Recommendations from our measurements

- If imaging through a physical barrier to minimize contamination of the portable equipment:
  - Ensure that the barrier is plastic or glass without intentional lead equivalence
  - Be aware of barriers with structural components such as wire mesh
  - Continue to shield operators
  - If possible, personnel should not hold the image receptor, try to use a stand or place the image receptor behind the patient on a gurney
  - Try to create a primary barrier behind the image receptor such as a rolling lead shield
  - Determine what, if any, imaging parameters should be modified to optimize imaging

Other Practical Tips

- Engage end users in the assessment so the workflow can be optimized
- Try to use DR instead of CR, check to make sure that light field is visible in the proposed area
- If wired access is not available in the surge area, evaluate wireless capabilities
- The unit will need to be charged, try to find an area with electrical power access
- If non-standard terrain is to be used (inside a tent in the parking lot), work with your engineer to ensure safe transport
- Consider protection from the elements and ways to secure the source from tampering or theft

CRCPD Resources

- www.crcpd.org/covid-19
- Training Resources
- Guidance for regulators
  - Radiation Machine Compliance and COVID-19
  - Temporary Use of X-Ray Machines and COVID-19
- Links to public information

Registration and Use of X-Ray Machines and COVID-19

Registration of units:

1. Device used in an extension of an existing registered facility

   It is considered the same facility when existing units are used in tents or other buildings in the vicinity of the registered facility. New units need to be registered according to the state requirements within 90 days of the first use. Existing units (portable) could be used in these areas without any additional notification.

2. Device used in a new location by an existing registrant

   A portable unit already registered to the facility could be moved and used at the new facility as long as the ownership is the same. For any units that would be installed for use in a single room/location, the facility would need to notify and register such unit with the state within 90 days of the first use.

3. Device used in a previously closed facility (ex. Closed hospital)

   A portable unit already registered at an existing facility, could be moved and used at the previously closed facility as long as the ownership is the same. For any units that would be installed for use in a single room/location, the facility would need to notify and register such unit with the state within 90 days. If the unit is installed in a room that previously had shielding approved, no new shielding review would need to be completed. If the facility is in use longer than 90 days, the shielding should be verified. If the facility is opened and run by the federal government (ex. FEMA), state registration would not be required.

4. Device used in a non-traditional medical setting (ex. Convention Center)

   If the non-traditional setting is being run by an existing facility, a portable unit already registered to the facility could be moved and used. For any units that would be installed for use in a single room/location, the facility would need to notify and register such unit/facility with the state within 90 days of the first use.

   If the non-traditional setting is run by a state government entity or private entity not previously registered with the state, all units would need to be registered within 90 days of the first use.

   If the non-traditional setting is run by the federal government (ex. FEMA), state registration would not be required.

Registration and Use of X-Ray Machines and COVID-19

Shielding requirements:

1. Portable x-ray equipment

   Portable x-ray equipment is designed to move from one location to another and does not require a shielding evaluation to be completed. No one should be within six feet of the patient and the radiation source when exposures are made.

2. Fixed radiography unit

   For a unit installed for use in a single room/location, the registrant should provide an initial radiation protection survey with at least four points indicated, one on side of the location (with appropriate scatter readings) including a general layout of the location with primary barrier and boundaries indicated. The boundaries should not exceed the public exposure limit. No one should be within six feet of the patient or radiation source when exposures are made unless a portable shield is used. For any unit in use for more than 90 days, a complete shielding review would need to be completed.

3. CT unit on a coach brought to the facility

   The coach should be parked in an area with low occupancy and boundary controls should be used. The registrant should provide a radiation protection survey with at least four points indicated, one on each side of the location (with appropriate scatter readings) including a general layout of location with boundaries indicated. The boundaries should not exceed the public exposure limit.

4. CT unit installed in a "permanent" room at a temporary facility

   For a unit installed for use in a single room/location, the registrant should provide an initial four radiation protection survey with at least four points indicated, one on each side of the room/locations (with appropriate scatter readings) including a general layout of the locations with primary barrier and boundaries indicated. The boundaries should not exceed the public exposure limit. For any unit in use for more than 90 days, a complete shielding review would need to be completed.

Registration and Use of X-Ray Machines and COVID-19

X-ray use in a temporary location

Operator:

1. Personal monitoring badge should be used.
2. The operator must stand 6 feet from the primary beam and use an apron or mobile shield during exposure. The operator must also be able to control access to the controlled area during exposure.

X-ray performance on gurney patients;

When the beam is directed toward the image receptor placed behind the patient (AP) no additional shielding should be required posterior to the receptor if the beam is appropriately collimated to minimize scatter radiation and ALARA technique is used.

All gurney patients;

Should be placed 6 feet apart or incorporate the use of a mobile shield to decrease the likelihood of receiving scatter radiation from other patients (receiving X-rays).

Registration and Use of X-Ray Machines and COVID-19

X-ray performance on the standing patient

To reduce the need for additional posterior shielding when the beam is directed toward an image receptor placed in front of the patient (PA), the image receptor must be placed adjacent to a location with low occupancy or with a wall having high natural shielding such as brick or concrete.

Ideally, the image receptor should not be held by a person. If possible, a cassette holder should be used. If this is not an option, the patient should be imaged on a gurney. In the event that neither of these is possible, no one individual should be designated to hold the image receptor.

All Patients

The image receptor/X-ray beam must be located at least 6 feet away from side walls unless the walls are constructed of natural shielding such as brick or concrete.

Waiting patients

All patients should be located away from the X-ray area with boundaries placed to ensure compliance with the public dose limit.

Signage

Place the appropriate warning signs as required by (insert state regulations).

Registration and Use of X-Ray Machines and COVID-19

Imaging through a physical barrier

To minimize contamination of the portable equipment various barriers could be used such as plastic or glass. If imaging is done though a glass, the glass should not have additional lead equivalent added. If there is a structural component to the glass which could interfere with the image, the radiologist should evaluate prior to imaging.

Maintaining Control of the Radiation Source

When not in use, the unit should be secured from unauthorized use.

Personal Shielding

Adequate lead aprons, gloves, and thyroid shields should be available.

Self-Care to Promote Well-Being

From MED+ED web solutions

- Take breaks, eat nutritious food, get plenty of sleep and exercise
- Stay connected with others through electronic means and phone calls
- Maintain your normal routine whenever possible
- Use healthy personal distractions such as music, exercise, cooking and hobbies
- Get outdoors for fresh air while following social distance guidelines
- Above all else, be gentle and kind with yourself and loved ones

www.mededwebs.com/blog/taking-care-of-yourself-during-covid-19-uncertainty

AAPM Liaisons to CRCPD – Annual training at the CRCPD Meeting

2019 CRCPD annual meeting in Anchorage, Alaska. Left to right: Kyle Jones, Jessica Clements, Melissa Martin, Mary Fox, Kate Hintenlang, Richard Martin, and Bette Blankenship

Hands-On Training during a CRCPD Meeting