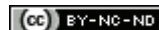


COVID-19: How the Radiology Department Should Combat this Global Pandemic

TANVI MODI¹, MITUSHA VERMA², GAURI AHUJA³, DEEPAK PATKAR⁴

ABSTRACT

The impact of the global pandemic due to novel Coronavirus Disease (nCOVID-19) has been braced by all medical subspecialties, including the radiology department. As Computerised Tomography (CT) of the chest as well as radiographs gain more and more importance in diagnosing, following up and prognosticating this respiratory infection, it becomes essential to have set protocols in place regarding imaging, disinfection and departmental workflow to ensure smooth functioning and protection of patients and health care workers. We have formulated the “AMMO” protocol as a guide to smooth functioning of the radiology department, which enumerates the steps to be taken for organisation of patient workload, organising equipment, disinfection protocols, maintaining the health and safety of radiology healthcare workers along with timely and accurate reporting. By combining the established guidelines and the knowledge gained from our experience at a dedicated COVID-19 hospital, this article aims to provide a reference in the management of radiology departments during this pandemic.

Keywords: “AMMO” workflow, Computerised tomography chest, Radiography

INTRODUCTION

COVID-19 has posed new challenges to healthcare worldwide. Every subset of the medical fraternity is involved in the prevention, diagnosis, treatment and management of this respiratory infection with a high fatality rate. With no past data to support the medical protocols against this new virus, the current guidelines and protocols are based on a trial and error method and as such vary in different countries and different institutions. These guidelines are not restricted to frontline medical and intensive care teams but are also being specified for the radiology department, which forms an integral part of emergency management and Novel COVID-19 Infected Pneumonia (NCIP) diagnosis. The perusal of various national and international articles can be cumbersome, confounding and time consuming [1].

Thus, this article is aimed to provide concise, cumulative information regarding radiology departmental workflow and standard operating protocols that are easy to emulate in the Indian scenario. As data and developing guidelines are changing dynamically, this article is based on current globally available information on this topic.

AMMO

Thus, the mnemonic “AMMO” i.e., Analyse, Minimise, Mobilise, Organise will be adopted to discuss the various subheadings of this article, to facilitate the battle of radiology departments against this pandemic.

I] Analyse

Status of patient- Receiving the patient and triage at departmental level

- Although stringent triage of patients is done at entry points of all medical care facilities, if a patient presents to the radiology department, few steps can be taken for screening of patients at the front desk.
- All patients must be asked to maintain adequate distance from the radiology front desk counter, and keep at least six feet distance from other patients and personnel in the waiting area.
- In case of an inpatient with respiratory symptoms, screening and testing for novel coronavirus should be done prior to imaging.

- An outpatient with respiratory symptoms should be referred to the relevant triage team immediately without proceeding with imaging.
- In case of asymptomatic patients presenting for routine imaging, appropriate rescheduling must be performed to avoid exposure of such patients to others who are possibly infected [2].
- Wherever possible, patients should be classified according to risk of being COVID-19 positive and be informed to radiology department as possible, suspected, confirmed [3].

Need for Imaging in COVID-19 Patients

- Multiple studies have been carried out to establish the role of CT chest and chest radiographs in the diagnosis and management of COVID-19. A study carried out in the disease epicenter in Wuhan claimed that CT chest has higher sensitivity as compared to initial RT-PCR for diagnosis [4]. Unless the disease prevalence is high and clustered, such as the situation experienced in Wuhan, the positive predictive value of CT in diagnosis is low [5].
- According to European Society of Radiology (ESR) guidelines [6], CT is the imaging modality of choice, if indicated. Chest radiograph is not sensitive for ground glass opacities and should be restricted to patients in intensive care who cannot be shifted for CT and where mobile CT scanners are not available.
- Ultrasound in positive patients should be performed at bedside. Indications for chest imaging include looking for pneumothorax or pleural effusion. If other organ systems are to be imaged, CT should be preferred over ultrasound wherever feasible.
- The Consensus Statement by the Fleischner Society [7] also states that imaging is not indicated in patients with suspected COVID-19 and mild clinical features, unless they are at risk for disease progression. Positive patients with worsening respiratory status or symptomatic patients with high clinical suspicion in resource-poor areas may undergo imaging. CT can be used to check for disease progression and rule out cardiogenic pulmonary edema or pulmonary thromboembolism.
- In case of imaging of other organ systems, CT should be preferred over ultrasound in situations where ultrasound is not found to be definitive [6].

Need for Imaging other Patients

- Emergency imaging services must be provided as usual, after adhering to strict screening, hygiene and distancing protocols.
- Systematic evaluation of chronic diseases and screening procedures should be postponed. Imaging in emergency cases should be continued taking proper precautions. In case of cancer patients, imaging procedures including diagnostic, prognostic and image guided biopsies should be continued [6].
- The Centres for Disease Control and Prevention and the Society of Breast Imaging have permitted postponement of screening mammograms to reduce the spread of COVID-19 [8].
- The University of Washington [9] has implemented a three tiered approach to classify patients into Category 1- elective (can be postponed till further notice), Category 2- time sensitive (short delay within a definitive time frame) and Category 3- critical (need immediate care) in terms of invasive procedures. A similar approach can be adapted for diagnostic imaging.

Report Analysis

- Set protocols regarding swift reporting of suspicious findings on chest radiographs or CT scans and informing infectious diseases team, concerned clinician and epidemiology cell [3].
- Use of standard checklists for diagnosing and excluding imaging features suspicious for COVID-19 infection, based on standard guidelines [10] can prompt swift and standardised analysis of reports. This also makes it easier for clinicians to manage the patients.

II] Minimise

Staff

- Radiographers are particularly prone to come in contact with suspected or positive patients [1]. It is advisable to maintain at least three feet and ideally six feet distance from all the patients.
- Rotational shifts are advocated for radiologists and clerical staff.
- Technologists should have revised schedules including night and weekend shifts and fewer routine shifts [6].
- Radiology workstations must be separated by at least six feet [11].
- Minimal number of staff should be present in the radiology department at the time of imaging a suspected or positive patient.
- In CT department, 2 technicians (or 1 doctor and 1 technician) are desirable for imaging of a positive patient. After donning appropriate Personal Protective Equipment (PPE) inside the CT room, doctor/technician positions the patient, takes off the PPE within the CT room and exits from the scanner room
- The other technician should perform the scan. Patient should be removed from CT unit by accompanying doctor/first technician/radiologist by donning a new set of PPE [12].
- Any accessories such as finger rings worn by staff, or long nails should be avoided. Beards are noted to decrease efficacy of Filtering Facepiece (FFP2) masks [6].

Patients

- Physical copies of requisition forms from COVID-19 wards, physical copies of X-rays or previous imaging should not be brought to minimise contact. Verbal information or electronic communication must be followed.
- All patients coming for imaging must wear a mask and gown.
- Patients should be advised to minimise contact with surfaces in radiology department and to refrain from touching equipment, desks, table surfaces unless they are covered with disposable sheets.

- Multiple/daily radiographs for follow-up are not indicated in stable intubated patients [7].
- Similarly, repeat CT scans in recovering patients are not indicated [6].

Equipment

- Spatial organisation i.e., forming COVID-19 areas within the radiology department [6].
- Portable imaging of positive or suspected patients should be conducted as per availability.
- If possible, there must be dedicated CT and X-ray units for COVID-19 patients with adequate training of staff, so as to minimise contact and machine cleaning time post exposure.
- Similarly, dedicated ultrasound machines should be used for these patients to avoid cross contamination. Single use ultrasound jelly packets should be made available for these patients.
- Remove unnecessary equipment from the radiography/CT scanner room to simplify terminal cleaning.
- Some institutions are taking radiographs of positive patients kept in an isolation room through the glass of the isolation room door or at a greater than usual distance across a semi-isolated chamber into an isolation room [9].

Exposure Time

- A dedicated waiting area must be assigned for COVID-19 positive patients.
- Radiology department should be cleared of all other patients, particularly vulnerable patients at the time of imaging COVID-19 positive or suspected patients.
- At the time of ultrasound, patient's face should be turned away from the sonologist to prevent risk of droplet transmission if patients coughs or sneezes.
- Focused minimal ultrasound techniques to be followed such as obtaining video recordings or selected images from 8 areas (2 anterior, 2 lateral, 2 posterior) for interpretation outside the ultrasound room, so as to reduce scan time to 2-3 minutes [13].
- Reporting rooms should not be accessible to patients. There should be minimal interaction with patients which can be facilitated by telephonic explanation of reports and doubts.

III] Mobilise

Equipment

- Portable X-ray unit with a dedicated Computed Radiography (CR) cassette should be used for bedside radiographs.
- A dedicated reader should be used and if it is not possible, few CR cassettes devoted to COVID-19 patient imaging should be immediately disinfected after exposure using 1% sodium hypochlorite solution before taking to a reader.
- Cassettes are also to be covered in disposable sheets.
- Anteroposterior projections reduce contact of cassette with patients.
- Disposable sheets must be placed on equipment such as CT gantry, X-ray table, ultrasound bed.

PPE

- The purpose of PPE is to prevent blood and body fluids from reaching skin, airways, mucosal membranes, clothes of healthcare workers.
- Selection of PPE depends on the type of interaction. However, all technicians, doctors, nurses and helpers who are involved in organising or caring of the patients must have appropriate PPE.
- Minimal PPE includes face masks, goggles, a face shield, gloves, a long-sleeved gown, laboratory coats, shoe covers, head covers.

- The procedure for dressing and undressing has a specific order. According to ESR and CDC guidelines, [6,14] the steps involved in donning PPE are:
 1. Identify and gather proper PPE to wear
 2. Hand wash- with soap and water or hand sanitiser
 3. Don the long-sleeved gown
 4. Fix the gown at the back
 5. Put on and fix the face mask- N95 respirator, FFP2 or triple layer face mask, as per availability. Respirator or mask should cover both mouth and nose and should be extended under the chin. The nose piece should be fitted on the nose with both hands. Mask should not be removed and dangled under the chin or kept in scrub pockets between patients.
 6. Put on the goggles or face shield
 7. Perform hand hygiene and then put on gloves.
 - The removal of the PPE is done in reverse order as follows (as per CDC guidelines) [14]:
 1. Remove gloves
 2. Remove gown
 3. Remove face shield or goggles by touching straps, without touching the front of the face shield or goggles
 4. Remove facemask or respirator using the straps, without touching the front part
 5. Perform hand hygiene.
 - After removing the used pair of gloves during doffing, a new pair of gloves is recommended to avoid contamination during disrobing [6].
 - The use of PPE in consecutive encounters with more than one patient should be carried out as per the availability and institutional protocols.
 - PPE should not be worn outside of the designated areas and must be worn just prior to entering designated areas and should be removed by staff before exiting such areas.
 - Staff should be trained regarding appropriate use; steps involved in donning and doffing, and adherence to hand hygiene in spite of wearing PPE.
- Simultaneously, security department should ensure an empty "COVID corridor" along the route to and from the radiology department, to minimise unnecessary contact with other patients or healthcare workers.
- Strict disinfection of floor, walls or surfaces should be performed along the corridor in case of spillage of any body fluids of the patient.

Work from Home

- Provision to be made for radiologists to work from home, keeping minimum staff in the department.
- Access to patient information, imaging studies to be provided on personal laptops or computers.
- Picture Archiving and Communication System (PACS) servers should be upgraded to support the increased volume of radiologists reporting from their homes.
- Constant Information Technology (IT) support should be made available.
- Rotational one week on and one week off duty can be implemented, with the off-duty staff providing remote support whenever needed [9].

IV] Organise

Training of Staff

- Radiology department staff must be trained in hygiene, disinfection, safe distancing and patient handling by hospital infectious diseases team representative [2].
- Training regarding correct donning and doffing of protective gear for all healthcare workers by institutional infectious diseases team.
- Departmental protocols to be enforced in collaboration with hospital management.

Scheduling of COVID-19 Patients

- Restricting imaging of COVID-19 positive patients to particular time slots during the day (except emergencies) may help prevent unnecessary exposure of other patients and entire staff team [12].
- Radiology can play a role in detecting community transmission by maintaining a census of patients who attended the department with contact number at the same time as a positive patient to follow-up.

Process of Disinfection

- Deep cleaning must be performed after every patient, with a down time of approximately one hour.
- Similar precautions to be taken for all imaging rooms, including interventional radiology suite.
- Air exchange rates must be increased in various sections of radiology department. Ventilation in MRI suites must be improved [9].
- Supervision of cleaning process to be done by designated departmental or management staff.

Employee Testing

- In general, a short duration of unprotected interaction (a few minutes or less) within a diagnostic radiology department with a positive patient or a prolonged close contact with a masked infected patient by a healthcare worker donning adequate PPE are categorised as low-risk exposures [7].
- The strategy for COVID-19 testing according to the latest update dated 9/4/2020 by the Indian Council of Medical Research states that testing should be extended to symptomatic healthcare workers. Also, asymptomatic direct and high-risk contacts of confirmed cases should be tested once between day 5 and day 14 of coming in contact with the confirmed case [16].

Disinfectants

- Alcohol based hand rubs or facilities to wash hands with soap and water must be made available at strategic locations in the hospital and in the department, particularly at entry points.
- Ethyl alcohol, isopropyl alcohol, iodophor germicidal detergent solution or other disinfectants must be mobilised to disinfect CT and MR machine gantries, non-invasive ultrasound probes, blood pressure cuffs, and image viewing station mouse and keyboards after every contact with suspected patients. Safest disinfectant for particular equipment must be mobilised after contacting equipment vendors [1].
- Decontamination of metal, plastic, glass surfaces can be done by using a solution which consist of 62 to 72% ethanol, 0.5% hydrogen peroxide, or 0.1% sodium hypochlorite within one minute of possible contamination [15].
- CT scanner, Magnetic Resonance Imaging (MRI) scanner and console rooms are sanitised with 1% sodium hypochlorite solution.
- The high-frequency contact surfaces such as handles, door knobs, operating consoles, switches, should be wiped with a cloth soaked with alcohol-based disinfectants.
- The CT and MRI suites should be tightly closed for 1 hour to thoroughly ventilate and exchange the room air [12].

COVID Corridor

- When a patient is to be taken to radiology department for imaging, it is advisable to pre- inform the department for the necessary preparatory steps to be taken.

- According to the National Task force for COVID-19 constituted by the Indian Council of Medical Research, prophylactic use of hydroxychloroquine by asymptomatic healthcare workers involved in care of suspected or confirmed cases of COVID-19 has been advised [17]. However, the Department of Radiology must initiate this after appropriate guidance from relevant physicians of the institution, depending upon the level of exposure.
- All employees exposed to COVID-19 who are asymptomatic are required to return to work, to attest to their health daily and to self-monitor for symptoms twice per day.
- Symptomatic employees who test positive must undergo isolation and appropriate medical care. Symptomatic employees who test negative may return to work when symptom-free for 24 hours [9].
- All employees must stay in self isolation from the time of swabbing till their test results are obtained.

Role of Radiology in Management of the Pandemic

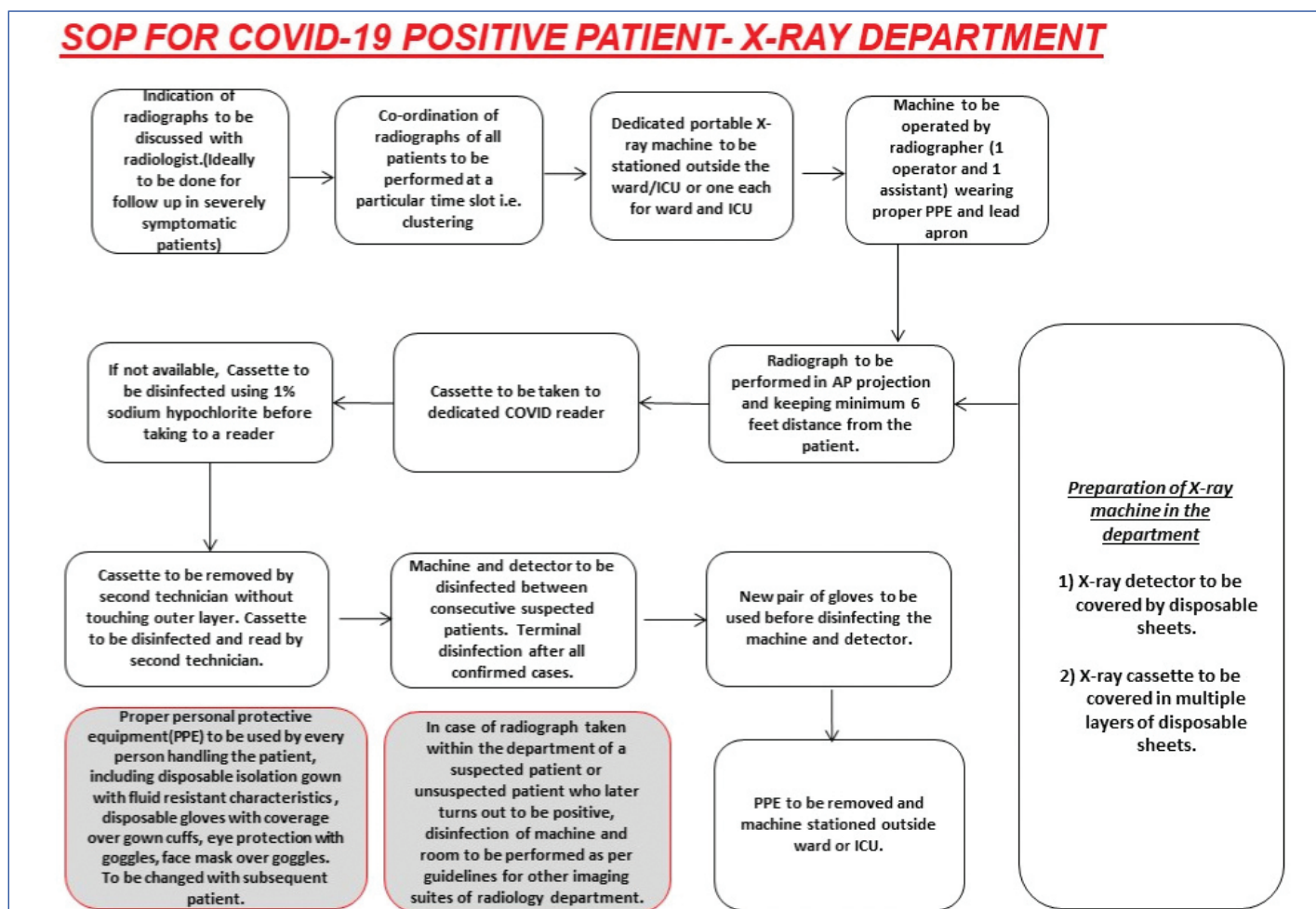
- In order to prepare for a surge in the number of cases, avoidable intervention procedures must be put on hold to keep more hospital beds and resources available for COVID-19 patients.
- Postponement of elective procedures can also reduce the patient population exposures to hospital environment.
- Clinical redeployment: Radiologists can get pushed to frontline during a pandemic of this proportion (as experienced during SARS outbreak). Hence there must be preparation for future outbreaks with proper training [18].
- According to the Ministry of Health and Family Welfare, radiology residents fall in Category E in terms of clinical management during this pandemic and hence may be mobilised to any level of health facility, primarily for co-ordination activities [19]. They should be trained for the same.

- Hybrid work teams can be developed with shift work and assignment of routine, emergency and COVID-19 related duties to each team.
- Radiology department should comply with daily audits of infection control procedures.
- A radiology task force team should be set up to manage operations, update department members, educate members regarding disinfection policies.
- As transit isolation and COVID-19 treatment centres are being installed all over the country, the Radiology department can co-ordinate with health authorities regarding provision of portable radiography services and designated CT or ultrasound services for these non-hospital centres and institutions.

Web Training/Conferences/Resident Teaching Meets

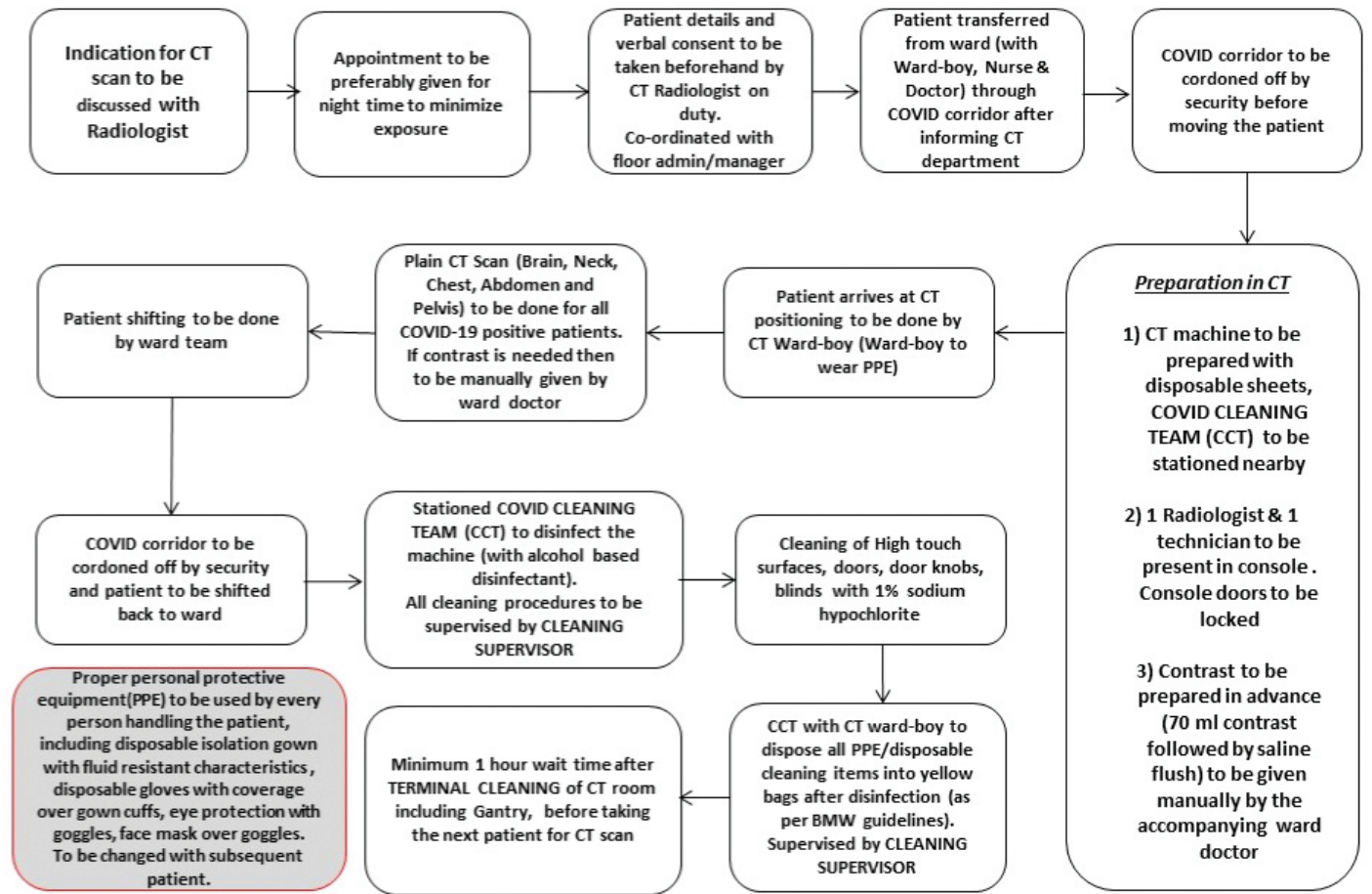
- Specific training in image interpretation of COVID-19 on chest CT and chest radiograph as well as the use of standardised report templates should be included in radiology curricula in training programs [11].
- All faculty meets or trainings with more than six people in attendance (or as per individual departmental space constraints) must be conducted online by video conferencing [9].
- As in person training is not possible, teleconferences, webinars, video case discussion sessions must be promoted to continue trainee education.
- During off time, emphasis must be placed on research activities.
- Daily or weekly updates regarding departmental policies in imaging of patients and management of pandemic must be provided by senior faculty members.

The following Standard Operating Procedures (SOPs) can be used in various sections of Radiology Department [Table/Fig-1-4]:



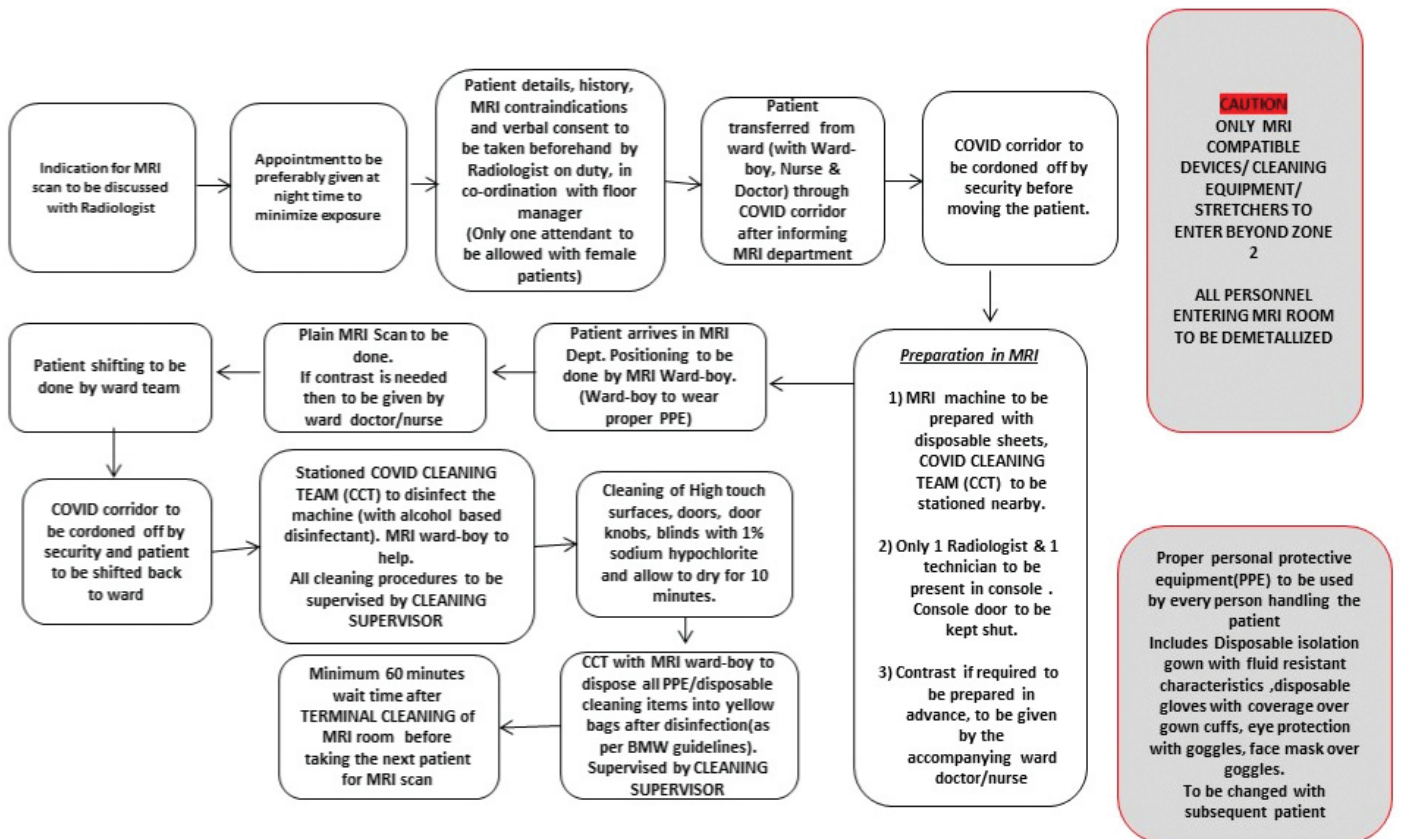
[Table/Fig-1]: Standard Operating Procedure (SOPs) for imaging of COVID-19 positive patients: X-ray department.

SOP FOR COVID-19 POSITIVE PATIENT- CT SCAN DEPARTMENT

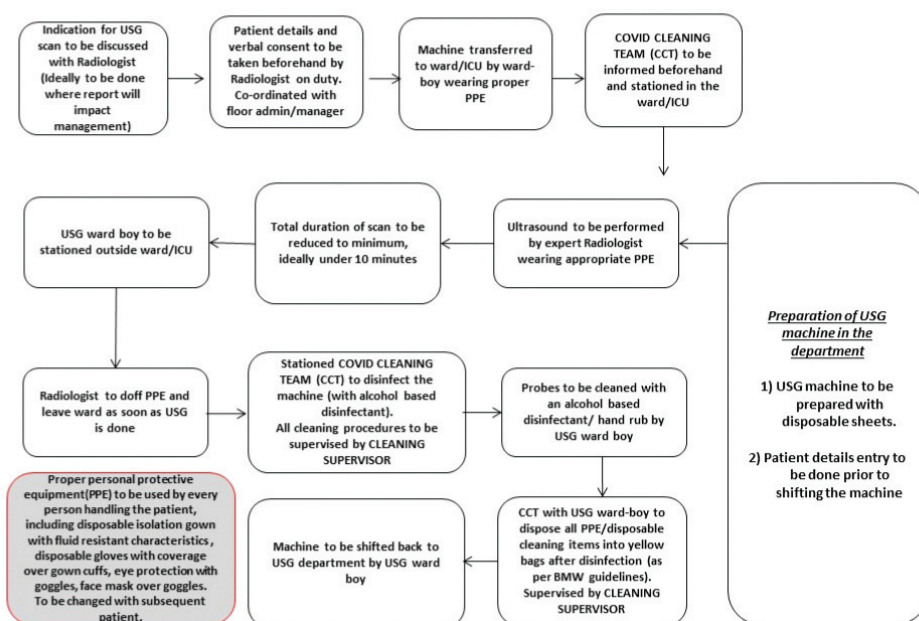


[Table/Fig-2]: Standard Operating Procedure (SOPs) for imaging of COVID-19 positive patients: CT scan department. BMW-Biomedical waste management guidelines

SOP FOR COVID-19 POSITIVE PATIENT- MRI DEPARTMENT



[Table/Fig-3]: Standard Operating Procedure (SOPs) for imaging of COVID-19 positive patients: MRI department.

SOP FOR COVID-19 POSITIVE PATIENT- ULTRASOUND DEPARTMENT**[Table/Fig-4]:** Standard Operating Procedure (SOPs) for imaging of COVID-19 positive patients: Ultrasound department.**CONCLUSION(S)**

The Department of Radiology has an important role in the prevention, diagnosis and management of this novel COVID-19 pandemic. Access to updated resources, proper knowledge, co-ordination, disinfection and systematic protocols can ensure a meaningful contribution of our speciality at the time of a global crisis.

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AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. NA

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Jun 02, 2020
- Manual Googling: Jul 01, 2020
- iThenticate Software: Aug 27, 2020 (10%)

ETYMOLOGY: Author OriginDate of Submission: **Jun 01, 2020**Date of Peer Review: **Jun 20, 2020**Date of Acceptance: **Jul 01, 2020**Date of Publishing: **Sep 01, 2020**