Perception and practice regarding infection control measures in Radiology department during pre-COVID and COVID times—A survey among radiologists and a review of current concepts and literature

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Abstract

Aim: In this study, we aim to evaluate the perception and practice of IPC measures by Radiologists during pre-COVID and present COVID times, while conducting a thorough review of current concepts and literature, to provide a standard operating procedure (SOP) for radiology operations. Methods: This study was conducted by Department of Radiodiagnosis and Imaging, Kasturba Medical College, MAHE, Mangalore. After obtaining approval from the institutional ethics committee, and other required permissions, the Google form questionnaire was sent to 350 Radiologists via email and text during the period of May 2020. Data was collected by time-based sampling in the period of fifteen days during the end of the total lockdown time. Results: 54% (n = 152) reported never attending a training session on (Infection Prevention & Control) IPC prior to the COVID-19 outbreak. The perception regarding IPC were found to be good among radiologists as majority of the respondents were correctly able to answer questions regarding IPC. 86% (n = 152) of the respondents believed that their knowledge on IPC has improved during the COVID-19 pandemic. However, it was revealed that majority of the respondents only started to practice appropriate contact and droplet / procedural precautions only after the COVID-19 outbreak. Conclusion: The present COVID-19 scenario coupled with the lack of knowledge and training regarding IPC amongst radiologists evident from the results of our survey, highlights the need for proper training and establishing standard operating procedures and best practices in IPC pertinent to modern radiology practice

Key words: COVID-19; empirical precautions; infection prevention and control; procedural precautions; radiology; source control; standard operating procedure; standard precautions; triage

Introduction

Knowledge and training regarding infection prevention and control (IPC) is lacking among radiologists, and as
modern Radiology practice evolves into its more clinical role, the implementation of standardized IPC measures becomes increasingly relevant. This was evident in a study conducted by Reddy et al., wherein, an online infection control survey for the members of Society of Interventional Radiologists (SIR) was conducted which revealed that only a small percentage of interventional radiologists practised proper infection control measures in their practice. The recent COVID-19 pandemic has taken the world by storm, being the third severe coronavirus outbreak over the past 20 years. Due to its high transmissibility (R0) and a relatively lower mortality rate (2%), over 6 million people have been infected, with over 370,000 deaths at the time of writing this article. COVID-19 may be transmitted via droplets, contact, and possibly airborne transmission. The potential risks of such disease transmission exist in the radiology department as the diagnosis of COVID-19 often relies heavily upon imaging and should be prevented with the implementation of proper IPC measures. Strategies to reduce the risk of acquiring and transmitting COVID-19 due to close patient contact and invasive patient care in the Radiology department is essential. In a report of 44,672 COVID-19 cases in China, 1,716 (3.8%) were health care workers (HCWs), wherein, 14.8% of confirmed cases among HCWs were classified as critical, observing a total of five deaths. Similarly, there are reports of several radiology staff who were infected as a result of improper isolation protocols for patients suspected or confirmed of COVID-19.

In this study, we aim to evaluate the perception and practice of IPC measures by radiologists during pre-COVID and present COVID times, while conducting a thorough review of current concepts and literature, to provide a standard operating procedure (SOP) for radiology operations in the present context.

**Methodology**

This descriptive cross-sectional study was conducted by the Department of Radiodiagnosis and Imaging, Kasturba Medical College, MAHE, Mangalore. A structured proforma (questionnaire) was built on “Google Forms” for this purpose based on literature review and inputs from experts in medical radiology, infection control, epidemiology, and medical education. The Google forms questionnaire was pilot tested and modified accordingly, as needed. After obtaining the approval from the institutional ethics committee and also the other required permissions, the Google form questionnaire was sent to the study participants via social media, specialty groups, personal contacts, or email. The study participants comprised of consultant radiologists, residents, and postgraduates working in clinics, diagnostic centers, and hospitals involved in performing ultrasound, reporting cross-sectional imaging, and performing procedures in interventional radiology (IR) suites who consented to participate. Data was collected by time-based sampling in a period of 15 days during the end of the total lockdown time.

**Results**

During the period of May 2020, a total of 350 radiologists were requested via email and text to participate in our 66-item questionnaire, of which 152 completed the full survey. The survey comprised of three sections – A) Demography, B) Perception of Infection Prevention and Control (IPC) measures among radiologists, and C) Impact of COVID-19 on the practice of IPC measures among radiologists. The questions were aimed at assessing the perception, knowledge, attitude, and practices in infection control measures within the Radiology department.

**A. Demography**

Of all the respondents, performing ultrasound (70%) and reporting cross-sectional imaging (76%) were the most frequently reported predominant areas of radiology practice. A majority of the respondents (54%) reported never receiving any form of training on IPC prior to the COVID-19 pandemic.

**Table 1: Demography**

| Characteristics | Number of respondents | Percentage |
|-----------------|-----------------------|------------|
| **Sex (n=152)** |                       |            |
| Male            | 94                    | 62%        |
| Female          | 58                    | 38%        |
| **Age (n=152)** |                       |            |
| 20-29           | 44                    | 29%        |
| 30-39           | 48                    | 32%        |
| 40-49           | 39                    | 26%        |
| 50-59           | 15                    | 10%        |
| ≥60             | 6                     | 4%         |
| **Class level/designation (n=152)** | | |
| Postgraduate    | 35                    | 23%        |
| Senior Resident | 16                    | 11%        |
| Consultant      | 75                    | 49%        |
| Private Consultant | 26               | 17%        |
| **Predominant area of radiology practice (n=152)** | | |
| Ultrasound      | 106                   | 70%        |
| Cross-sectional imaging reporting | 115 | 76% |
| Interventional procedures in the cath lab | 21 | 14% |
| Nonvascular interventions | 55 | 36.18% |
| Intensive care and related areas | 27 | 17.76% |
| **Have you ever attended a training session on ipc prior to the covid-19 pandemic? (n=152)** | | |
| Yes             | 70                    | 46.05%     |
| No              | 82                    | 53.95%     |
| **If yes, what form of training did you receive? (n=119)** | | |
| Seminar         | 11                    | 9.24%      |
| Lecture         | 32                    | 26.89%     |
| Workshop        | 3                     | 2.52%      |
| CME/Web-based training | 21 | 17.65% |
| N/A             | 52                    | 43.70%     |
attending a training session on infection prevention and control (IPC) prior to the COVID-19 pandemic. For further details on demographic characteristics, refer to “Table 1”

B. Perception of infection prevention and control (IPC) measures

The general knowledge and perception regarding IPC were found to be good among the respondents. Majority of the respondents were able to correctly answer the questions regarding disease transmission, standard precautions, and personal protective equipment (PPE). However, majority of the respondents (57.2% (n = 152)) perceived “Use of leak-proof plastic containers” as a part of standard precautions by CDC. Although, considered as an important specimen-handling precaution[1] in IPC, the use of leak-proof plastic containers, is not a part of the “Standard Precautions by CDC”. On average, approximately 31% (n = 152) of the respondents incorrectly identified the sequence of donning and doffing of PPE. Additionally, 86% of all respondents (n = 152) believed that their knowledge of IPC has improved during the phase of COVID-19 pandemic.

The questions and percentile answers aimed at the knowledge of the principles of IPC and PPE are listed in Tables 2 and 3. Awareness of standard precautions and the Spaulding classification system are listed in Tables 4 and 5, respectively.

(C) Assessing the practice of IPC measures and the impact of COVID-19 on the practice of IPC measures among radiologists

This section was broadly divided into the following subsections – “Triage, Early recognition & source control,” “Standard Precautions (CDC),” “Contact and Droplet Precautions,” “Procedure Precautions,” and “Future Plans.” Various practices of IPC were mentioned under each subsection and the participants were asked to indicate whether those practices were practiced since before the COVID-19 outbreak, started practicing after the COVID-19 outbreak or if NOT practiced at all, by checking “Before”, “After,” OR “Neither,” respectively.

Majority of the respondents reported establishing a triage station and practicing source control after the COVID-19 outbreak [Figure 1]. Almost all the respondents reported the practice of “Standard Precautions (CDC)” either since before or after the COVID-19 outbreak. Majority (51%) of the participants reported the practice of “strict hand hygiene” before and after contact with each patient and/or with potentially infectious material. “Prevention of needle stick or sharp injuries” was reported by 92% of the respondents since before the COVID-19 outbreak. However, upon inquiring on “proper handling, cleaning, and disinfection of patient care equipment,” “providing patient education on respiratory hygiene,” and “use of appropriate PPE,” majority of the respondents reported the practice of these standard precautions only after the COVID-19 outbreak (72%, 53%, and 77% respectively) [Figure 2]. On inquiring upon practice of “Contact and Droplet precautions,” it was revealed that majority of the respondents started to practice these precautions only after the COVID-19 outbreak, whereas, some respondents even reported not practicing these precautions at all. A much greater portion of respondents (n = 152) reported practicing contact and droplet preventive protocols related to isolation only after the COVID-19 outbreak such as “placement of patients in properly ventilated single room(s)” (64%), “assigning a designated team of HWCs to provide care for those under isolation” (90%), “appropriate donning and doffing of PPE” (84%), and “using a new set of PPE for a different patient” (59%). Similarly, preventive protocols related to transportation of patients were also reported to be practiced majorly after the COVID-19 outbreak. Only 25% (n = 152) of the respondents reported regular cleaning and disinfection of all surfaces the patients may be in contact with, since before the COVID-19 outbreak. However, the “use of disposable/dedicated equipment,” including the “use of dedicated portable X-ray/diagnostic equipment” were the only preventive measures listed under “contact

Table 2: Perception of Radiologists regarding disease transmission in Radiology Departments

| Questions and responses                                      | Number of respondents | Percentage |
|--------------------------------------------------------------|-----------------------|------------|
| Which areas of the radiology department are most likely for pathogen exposure? (n = 152) |                       |            |
| Common waiting area                                          | 107                   | 70.39%     |
| Procedure holding area                                       | 100                   | 65.79%     |
| Examination rooms                                            | 103                   | 67.76%     |
| On procedure units (e.g.: Radiography table/CT scanner)      | 129                   | 84.87%     |
| Storage room                                                 | 19                    | 12.50%     |
| What are the primary modes of transmission in a Radiology department? (n = 152) |                       |            |
| Direct/Indirect contact route                                | 132                   | 86.84%     |
| Droplet route                                                | 143                   | 94.08%     |
| Airborne route                                               | 101                   | 66.45%     |
| Bloodborne route                                             | 25                    | 16.45%     |
| Vector-borne                                                 | 3                     | 2%         |

Figure 1: Triage, Early Detection & Source Control (n=152)
Table 3: True or false statements

| True | False |
|------|-------|
| “COVID-19 transmits mainly via Droplet route and Contact route, and possibly Airborne transmission” (n = 152) | 136 89% 16 11% |
| ASEPSIS, DISINFECTION & STERILIZATION |
| “ASEPSIS is the state of being free from all disease-causing organisms” (n = 152) | 131 86% 21 14% |
| “DISINFECTION is the reduction of microorganism burden without elimination of all microorganisms” (n = 152) | 130 86% 22 14% |
| “STERILIZATION is the elimination of all microorganisms from a surface but NOT spores” (n = 152) | 28 18% 124 82% |
| “DISINFECTION does NOT eliminate spores” (n = 150) | 127 85% 23 15% |

Table 4: Are the following part of ‘Standard Precautions’ by CDC (Yes/No/Not Sure) (n = 152)

| Yes | No | Not sure |
|-----|----|--------|
| Hand hygiene | 152 (100%) | 0 (0.00%) | 0 (0.00%) |
| Avoid patient transportation | 34 (22.4%) | 85 (56.0%) | 33 (21.7%) |
| Use of appropriate PPE | 149 (96.8%) | 1 (0.6%) | 2 (1.32%) |
| Respiratory hygiene and cough etiquette | 134 (88.2%) | 5 (3.3%) | 15 (9.87%) |
| Use of leak-proof plastic containers over glass containers | 87 (57.2%) | 23 (19.1%) | 36 (23.7%) |
| Safe injection practices | 131 (86.2%) | 8 (5.26%) | 13 (8.55%) |

Table 5: “Spaulding Classification” for Disinfection of reusable medical items

| Questions and responses | Percentage |
|-------------------------|------------|
| Are you aware of the Spaulding classification system? (n = 152) | |
| Yes | 30% |
| No | 70% |
| If Yes, how does it classify reusable medical items? (n = 66) | |
| Correct (Critical, Semi-critical, and Non-critical items) | 66% |
| Incorrect | 34% |

“double-bagging of US unit and transducer & C-arm” was reported not practiced by majority of the respondents (39%, 64%, and 58%, respectively). Although, reported to be practiced, a major bulk of the procedural precautions related to disinfection were reported to be practiced only after the COVID-19 outbreak, including, disinfection of all workstations and procedural rooms after each use (71%), mandatory cleaning undertaken at least four times per day (70%), etc. (For further details on the practice of procedural precautions among radiologists, please refer to Figure 4).

Discussion

Based on the questionnaire on perception and practice, a quick review of the current concepts is presented below.

Broad Guidelines

1. Establishment of efficient central coordination between hospital infection prevention and control and the radiology department
2. Screening, Early Detection, and Source Control –
From the results of our quick survey, it was revealed that establishment of triage stations and the practice of source control was majorly only done after the outbreak of COVID-19 occurred [Figure 1].

Screening of all patients for COVID-19 should be done prior to all examinations by establishing a triage station with a standardized questionnaire at all the hospital entrances. This provides a systemic approach towards assessment of all patients at the time of admission and early detection of any active or subclinical cases of COVID-19[10].

The standardized questionnaire should be able to clarify any history of fever and/or signs/symptoms of respiratory illness such as cough, sore throat, breathlessness etc.

Apart from clinical history, it is also essential to inquire with the patient about any form of contact or travel history.[11]

Temperature screening should be implemented at all hospital entrances to identify anyone with symptoms that may be related to COVID-19[11].

**Source Control is the early detection of any suspected/confirmed COVID-19 cases followed by rapid isolation** of such patients in an area distinctly separate from all other patients.

3. Implementation of Standard Precautions (CDC)[12] for all patients.

- Standard precautions advocated by The Center for Disease Control and Prevention (CDC) include –
  1. Strict hand hygiene (by either using an alcohol-based hand rub or by washing hands with soap and water for at least 20 seconds).[11,12]
  2. Use appropriate personal protective equipment (PPE) whenever there is an expectation of possible exposure to infectious material.

Refer to Table 6 for a brief summary of appropriate PPE requirements according to the level of protection required based on the evidence-based measures in radiology department to limit transmission by Lahoti et al.[11]

- Follow respiratory hygiene/cough etiquette principles,
- Proper handling, cleaning, and disinfection of patient care equipment/devices and the environment,
- Follow safe injection practices, and
- Ensure healthcare worker safety including proper handling of needles and other sharps.

- The results of our survey clearly indicated that most of the standard precautions mentioned above, except for strict hand hygiene and prevention of needle/sharps injury were practiced by radiologists only
after the COVID-19 outbreak. This gives an insight into why implementation of standard precautions for all patient care is essential in radiology departments.

- Standard precautions should be strictly implemented for ALL patients including suspected/confirmed cases\(^{[12]}\) of COVID-19.

4. Implementation of Additional Empirical Precautions for select patients [Table 7]

- Contact and Droplet Precautions: From the results of our survey, it was revealed that among the radiologists who completed our survey, majority of them only reported implementing these precautions after the COVID-19 outbreak, whereas some respondents even reported not practicing these precautions at all.

- Procedural Precautions (including airborne precautions): The results of our survey indicated that the knowledge and practice of procedural precautions is lacking among radiologists. This implicates the importance of a proper and relevant set of instructions for implementation of appropriate empirical precautions in the setting of a radiology department.

- Table 7 represents a summary of the essential contact & droplet and airborne precautions pertaining to radiology departments based on the results of our survey along with a review of current concepts and literature\(^{[1,14-18]}\).

5. Development and implementation of Standard Operating Procedures (SOPs) for various imaging modalities and interventional procedures for suspected or confirmed cases of COVID-19.

- Refer to Figure 5 for a Standard Operating Procedure (SOP) for performing portable chest X-ray for suspected/confirmed patients of COVID-19. Figure 5A – Procedure before entering a patients room, Figure 5B – Procedure in the patient’s room, Figure 5C – Procedure after acquiring patient’s X-ray\(^{[19,20]}\).

- Refer to Figure 6 for a Standard Operating Procedure (SOP) for performing CT scan for a suspected/confirmed patient of COVID-19\(^{[19-21]}\).

6. Imaging should only be performed for a COVID-19 patient when imaging will impact the management and outcome of the patient\(^{[19]}\).

7. Decontamination of reusable medical items according to the Spaulding Classification System\(^{[21]}\).
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Critical items (contacting normal sterile body surfaces)
Example – Endovascular/endovaginal US probe, reusable surgical instruments
Decontamination – Heat-resistant items disinfected by steam sterilization and heat-sensitive items disinfected by ethylene oxide gas/hydrogen peroxide gas/plasma/ozone or a liquid chemical sterilant.

Semi-critical items (contacting mucus membranes or broken skin)
Example – Endoscopes, cystoscopes etc.
Decontamination – High-level decontamination with chemical sterilant after each use.

Non-critical items (contacting intact skin)
Example – CT/MRI gantry, noninvasive US probes, viewing station keyboard/mouse/surfaces
Decontamination – by low-intermediate level disinfectant after each use.

8. STAFF RELATED –
(i) Staff should be restricted from travelling to any domestic or international destinations for work-related activities.
(ii) Adapting to video-conferences for staff meeting.
(iii) Adapting to remote interpretations in situations where staff may need to go into isolation.

From our quick survey, it was revealed that majority (54%) of the respondents reported not receiving any form of training on IPC prior to this COVID-19 pandemic, and 86% of the respondents believed that their knowledge of IPC has improved during this COVID-19 pandemic. 97% of the respondents believed that best practices in IPC should be continued with same vigilance even after the COVID-19 pandemic, and that IPC should be made a permanent part of the postgraduate curriculum. 93.3% of the respondents believed that a “paperless system” involving wireless transfer and reporting of images can contribute significantly in IPC in radiology departments. Other suggestions provided by the respondents included mandatory training sessions on IPC for everyone, assigning an IPC officer similar to radiation safety officer (who performs checks on regular intervals, making required adjustments and improvements), and automatic doors that limit contact transmission. A limitation of the study was a relatively lower number of responses (n = 152), and varied responses from different states/areas.

Conclusion

In conclusion, although the COVID-19 crisis continues to persist, it presents us with an opportunity to continue with improved vigilance and refine standard operational procedures to achieve optimum IPC. Although, following all the guidelines may not be possible in every setting, the present COVID-19 scenario coupled with the lack of knowledge and training regarding IPC among radiologists evident from the results of our survey, highlights the need for proper training and establishing standard operating procedures and best practices in IPC pertinent to modern radiology practice. Radiology departments should be well prepared to continue their operations, especially urgent procedures, and essential elective imaging/procedures, during this period of COVID-19 pandemic. The disease burden can also be better handled and staff and patients can be better protected by adopting to the current concepts and
Declaration of patient consent
The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their participation in our online Google forms questionnaire. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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