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New Challenges for Radiology Professionals during the COVID-19 Pandemic

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Analyze the new challenges faced by radiology professionals in managing suspected or confirmed COVID-19 patients and understand their implications for the safety strategies of these professionals and patients.
Methodology: The method used was an integrative literature review, conducted by searching for publications in indexed journals in the databases PubMed, SciELO, Scopus, and ScienceDirect, covering the years from 2015 to 2020.
Results: In the data analysis, the articles were classified into 20 units of analysis, with information presented as sub-themes related to the publications of the selected studies, with a focus on the synthesis of the results.

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Conclusion: In conclusion, it is essential that not only all professionals involved in the process possess knowledge and preventive measures, but also that the entire radiology service is adequately prepared to receive patients, thereby ensuring greater stability in terms of environmental biosafety.

Keywords: Viral pneumonia; coronavirus infections; diagnosis; clinical protocols; X-ray computed tomography; hospital radiology service.

1. INTRODUCTION

The pandemic of patients infected with the coronavirus (COVID - 19) represents a threat and challenges for the whole world, specially for the health system and health professionals. Recent studies show a characteristic pattern in the indication of imaging tests, usually plain radiographs (X- ray) and computed tomography (CT) of the chest region [1,2].

Patients with clinical and laboratory suspicion of infection and worsening are referred to radiology departments (RD) for chest X - ray. CT is indicated in severe cases, for monitoring the infection and the evolution through time or even for symptomatic patients with normal X - ray or indeterminate findings [3,4,5].

Although the Brazilian College of Radiology (CBR) and the American College of Radiology do not recommend imaging tests for the diagnosis of Coronavirus - 2019 (COVID - 19), RD is often the first stop for these critically ill patients, which poses new challenges for radiology professionals [6].

For Myers et al. [6], the main challenges in the DR for the management of these patients are: transportation, decontamination of the room and equipment, proper use of personal protection and interpretation of imaging exams.

In this context, the study aims to analyze the new challenges for radiology professionals in the management of suspected or confirmed patients with COVID - 19 and its implications for safety strategies for these professionals and for the patient within the department.

2. METHODOLOGY

The present study is an update article, through a narrative review of articles found in the databases: Pubmed,Medline and Lilacs, with a research periodicity from January 2020 to April 2022, using the keywords “Viral pneumonia”; “Coronavirus infections”; “Diagnosis”; “Clinical protocols”; “X-ray computed tomography”; “Hospital Radiology Service” in Portuguese and English language “Viral Pneumonia”; “Coronavirus Infections”; “Diagnosis”; “Clinical Protocols”; “X- Ray Computed Tomography”; “Hospital Radiology Service”. The databases of the Brazilian College of Radiology, John Hopkins University and the World Health Organization (WHO) were also consulted.

The choices of basis considered the following criteria: Open Access databases to expand the possibility of online access to full texts and that were appropriate to capture publications dealing with the researched theme.

The Health Sciences Descriptors (DeCS) were used to systematize the search process and to define the keywords were used to systematize the search process and to define the keywords.

This definition was initially based on the publication “Coronavirus International Public Health Emergencies: Implications for Radiology Management”, Academic Radiology publication of 2020 [7].

The inclusion criteria considered studies published in the format of full scientific articles, containing the descriptors in the abstract and/or title, published in English and Portuguese language, whose general and-or specific objective explicitly refer to the object of study. Exclusion criteria were defined as the publications in form of letters, reviews, thesis, dissertations, editorials books, book chapters, government documents and newsletters, as well as studies that were not available online in full analysis and outside the period of interest or duplicated.

The selection of articles was made by the acceptance of two different researchers (T.V.C and O.B.F) and blinded using the online tool Rayyan QCRI. The results were presented in the form of sub - themes referring to the publications of the selected studies, with emphasis on the synthesis of results. The documents were analyzed and compared following the hybrid method proposed by Feredy and Muir -

Cochrane (2006), that is, the themes were selected from inductive and deductive analysis of the selected articles [8]. Thus, obtaining an analysis of the data about the new challenges for radiology professionals in the management of suspected or confirmed patients with Coronavirus - 2019 (COVID - 19) in the radiology department [9].

3. RESULTS

The database searches returned a total of 152 articles. After elimination of duplicate items, application of the criteria and detailed analysis of each manuscript, 27 articles were included in the research, constituting the final sample of the study, as described in Fig. 1.

To better visualize the results, the articles that formed the study were organized by year of publication, author, title and effect are presented in Table 1.

3.1 The Crisis and Challenges in Radiology Department

The two main resources of the DR are the image acquisition equipment, usually radiological (emitting ionizing radiation) and the radiology professionals. With the exception of ultrasound and magnetic resonance equipment, most of this equipment uses X-rays, but all of it is used to acquire medical images [6].

Radiology plays a very important role in the treatment of COVID - 19, as radiological exams are indispensable tools for diagnosing and monitoring patients to control the disease. And, in general, health systems have adapted to pandemic situations, as have DR professionals, who have had to build strategies to carry out their activities while resisting stress, emotional pressure, fighting on the front line with great professionalism, determination and commitment, adding a significant value to restoring a patient's health [32].

According to De Castro [33], COVID - 19 imaging tests are indicated for patients with clinical and laboratory picture of suspicion of the disease, especially those with a more severe clinical picture and for symptomatic hospitalized patients with normal radiographs or with indeterminate findings and evaluation of complications and search for alternatives diagnoses, as shown in Fig. 2.

The Brazilian College of Radiology (CBR) [34], recently suggested recommendations:

- Computed Tomography should NOT be used as screening or for the initial imaging diagnosis of COVID - 19; Its use should be reserved for hospitalized, symptomatic patients in specific clinical situations. Computed Tomography findings do not influences outcomes;
- When indicated, the protocol is high-resolution Computerized Tomography (HRCT), if possible with a low- dose protocol. The use of intravenous contrast is generally not indicated and is reserved for specific situations to be determined by the radiologist;
- After used by patients with a suspected or confirmed diagnosis of COVID -19 infection, the room and the equipment used must undergo a disinfection process;
- When chest X-rays are indicated in suspected/confirmed cases of hospitalized patients, we should favor the use of portable x- rays, as the surfaces of these machines can be more easily sanitized and the need to take patients to the imaging department is avoided.

COVID-19 pneumonia has a high mortality rate in some populations, including old people with diabetes,hypertension and other comorbidities [6]. The patient's breathing difficulty and clinical distress can be accompanied by imaging tests, usually plain X- rays, as shown in Fig. 3 or computed tomography (CT) scans of the chest region, as highlighted in Fig. 3.

Summarizing and analyzing the clinical and CT imaging characteristics of patients with new pneumonia caused by COVID - 19 has become a major challenge in RD radiology departments. It can trigger a cascade of events in patient management, including infection control measures and workers anxiety [7].

CT images usually show lesions with a mosaic paving pattern, i.e. a ground - glass pattern and consolidations in both lungs, as described in Table 4 [1,2,3,4,5].

Lei et al. [35], states a clinical case of a 33 - year - old woman, based on epidemiological characteristics, clinical manifestations, chest imaging and laboratory findings, a diagnosis of pneumonia was made by COVID-19. Chest CT showed multiple peripheral ground - glass opacities in both lungs (Fig. 5A) that did not spare the subpleural regions.

After receiving 3 days of treatment, combined with interferon- inhalation, the patient was clinically worse with the progressive lung opacities found on repeated chest CT (Fig. 5B).

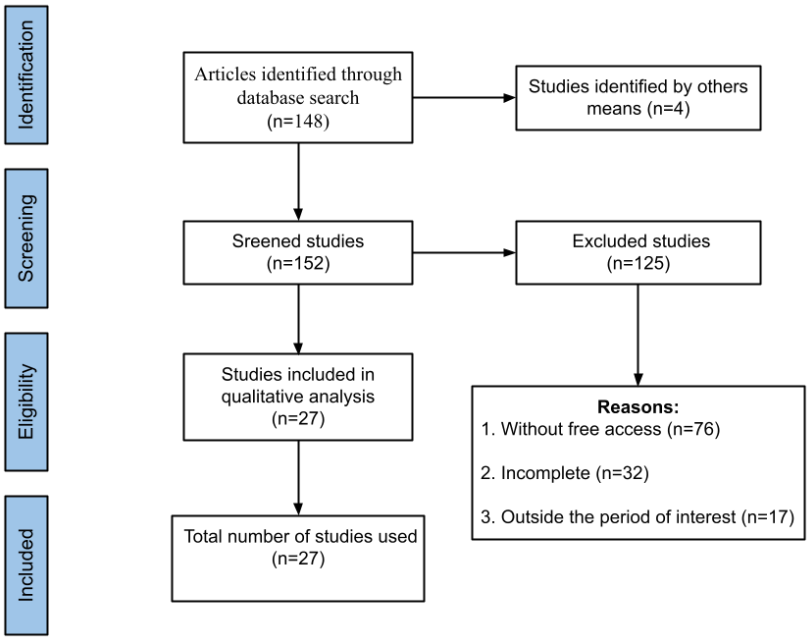

Fig. 1. Flowchart of the study selection strategy 1
Source: Adaptado de Page et al. [8]

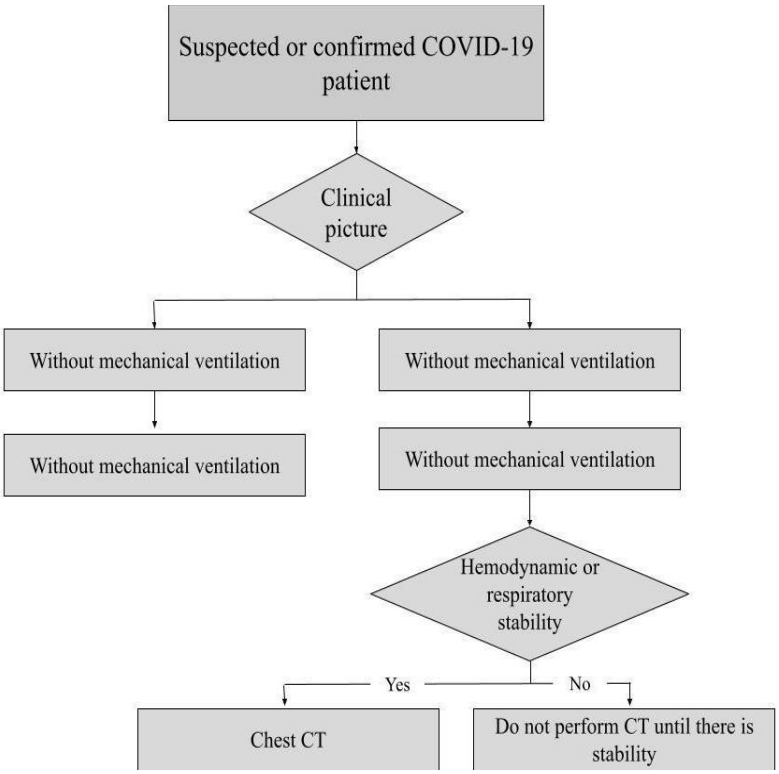

Fig. 2. Flowchart for requesting imaging tests (for suspected or COVID - 19 patients)
Source: De Castro [33]

Table 1. Presentation of the selected articles according to the identification stipulated for each article as well the title, author(s), year and conclusions

ID	Title, Author (S) and Year	Conclusions
A1	Analysis of clinical characteristics and laboratory findings of 95 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a retrospective analysis [5]	Several factors were related to severe coronavirus pneumonia in 2019 and the composite outcome and more related studies are needed in the future.
A2	Radiation Therapy Care During a Major Outbreak of COVID-19 in Wuhan [10]	More than 100 radiotherapy patients were treated, with no incidence of on-site transmission of COVID - 19 between patients and healthcare workers during the period.
A3	Association of radiologic findings with mortality of patients infected with 2019 novel coronavirus in Wuhan, China [3]	The tomographic findings of NCIP were characterized by predominant ground - glass opacities mixed with consolidations, mainly peripheral and central peripheral or combined distributions, with the bilateral and inferior zones of the lung being most involved. A simple CT scoring method was able to predict mortality.
A4	Post-discharge surveillance and positive virus detection in two medical staff recovered from coronavirus disease 2019 (COVID-19), China, January to February 2020 [11]	A small proportion of recovered patients may show a positive outcome after discharge and post - discharge surveillance and isolation needs to be strengthened.
A5	Head and neck cancer radiotherapy amid COVID-19 pandemic: Report from Milan, Italy [12]	Proper and timely organization has allowed for the optimization of patients, better balancing the possibilities of patient care and staff safety.
A6	Head and neck radiotherapy amid the COVID-19 pandemic: practice recommendations of the Italian Association of Radiotherapy and Clinical Oncology (AIRO) [13]	Practical recommendations on logistical issues, treatment delivery and protection of health personnel at a time of limited resources.
A7	CoronaVirus International Public Health Emergencies: Implications for Radiology Management [7]	In an epidemic of acute infectious diseases, the radiology department plays an essential role in diagnosing infected patients. However,the management of these potentially infected patients require protection of both the doctor, workers and uninfected patients.
A8	Guide for Nuclear Medicine Applications During the COVID-19 Outbreak [14]	The workers should wear appropriate personal protective equipment and patients should be assessed as an elective case according to their COVID - 19 clinical status. In cases of cancer requiring urgent treatment, radionuclide treatment (RNT) should be planned according to the result of the COVID - 19 test
A9	Chest Radiographic and CT Findings of the 2019 Novel Coronavirus Disease (COVID-19): Analysis of Nine Patients Treated in Korea [4]	COVID-19 pneumonia in Korea was mainly manifested as pure to mixed ground - glass opacities with an irregular to confluent or nodular shape in the bilateral peripheral posterior lungs. A considerable proportion of patients with COVID-19 pneumonia had normal chest X- rays.
A10	When nuclear medicine radiological protection meets	The implementation of a robust plan in nuclear medicine departments is necessary

ID	Title, Author (S) and Year	Conclusions
	biological COVID-19 protection [15]	to prevent further nosocomial spread of the virus.
A11	The practice of oral and maxillofacial radiology during COVID-19 outbreak [16]	Some strategies have been described, including indications for procedures, infection control and correct use of personal protective equipment, as well as evoking the appropriate practice environment during and after the rise of COVID - 19.
A12	Emerging 2019 Novel Coronavirus (2019-nCoV) Pneumonia [17]	Patients with fever and/or cough and conspicuous ground- glass opacity lesions in the peripheral and posterior lungs on CT images. Combined with normal or reduced white blood cells and a history of epidemic exposure, they are highly suspected of having 2019 novel coronavirus (2019-nCoV) pneumonia.
A13	CT Imaging Features of 2019 Novel Coronavirus (2019-nCoV). [18]	The complement image in a subset of patients during the study's time window often showed mild or moderate progression of the disease, manifested by an increase in the extent and density of lung opacities.
A14	A new coronavirus associated with human respiratory disease in China [10]	This outbreak highlights the continued ability of viral spillover from animals to cause serious illness in humans.
A15	Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China [19]	The 2019-nCoV infection caused a group of severe respiratory illness similar to the severe acute respiratory syndrome coronavirus and was associated with ICU admission and high mortality. A major space in our knowledge of the origin, epidemiology, duration of human transmission and clinical spectrum of the disease need to be filled by future studies.
A16	A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster [20]	Our findings are consistent with the person - to - person transmission of the new coronavirus in hospital and family settings and reports of infected travelers in other geographical regions.
A17	Differences of viral panel positive versus negative by real-time PCR in COPD exacerbated patients [21]	Viral respiratory tract infections should be considered in hospitalized COPD exacerbation patients with a history of frequent exacerbations, normal PCT values and absence of consolidation on chest CT scans. The use of broad - spectrum antibiotic therapy should be avoided in patients with these characteristics.
A18	Provision of a consistent national approach to radiation therapy workforce protection measures in Australia during the COVID-19 pandemic [22]	Strong leadership, quality communication and clear direction are needed during this crisis to ensure that radiation therapists receive all the support and resources they need to maintain safety and well - being during the COVID - 19 pandemic.
A19	Dynamic changes of chest CT imaging in patients with coronavirus disease-19 (COVID-19) [23]	Chest CT images of COVID - 19 patients have certain characteristics with dynamic changes, which are important for monitoring the progress of the disease and clinical treatment.
A20	Imaging Profile of the COVID-19 Infection: Radiologic Findings and Literature Review. Radiology: Cardio Thoracic	The pulmonary manifestation of COVID-19 infection is predominantly characterized by ground- glass opacification with occasional consolidation on CT.

ID	Title, Author (S) and Year	Conclusions
	Imaging [24]	
A21	Management of infection control and radiological protection in diagnostic radiology examination of COVID-19 cases [25]	It describes disinfection measures and protective materials prone to confusion in diagnostic imaging amid the COVID-19 epidemic, providing frontline radiologists with guidance and suggestions on how to use them in clinical practice.
A22	Clinical Management of Lung Cancer Patients during the Outbreak of 2019 Novel Coronavirus Disease (COVID-19). [26]	Protective provisions and control measures aimed at protecting lung cancer patients from COVID - 19 have been of increasing concern.
A23	Chest CT practice and protocols for COVID-19 from radiation dose management perspective. [27]	When indicated, a chest CT should be performed with a low-dose monophasic protocol using fast scanning techniques to minimize motion artifacts.
A24	Radiotherapy workflow and protection procedures during the Coronavirus Disease 2019 (COVID-19) outbreak: Experience of the Hubei Cancer Hospital in Wuhan, China [28]	During more than a moth and a half of uninterrupted radiation oncology clinical operation during the worst outbreak in Wuhan, no known COVID-19 infections occurred in our radiotherapy center for our patients or workers.
A25	Preparedness and Best Practice in Radiology Department for COVID-19 and Other Future Pandemics of Severe Acute Respiratory Infection [29]	It describes measures to increase the preparedness of the Radiology Department, such as careful screening of workers and patients, thorough disinfection of equipment and rooms, proper use of personal protective equipment.
A26	Radiology department strategies to protect radiologic technologists against COVID19: Experience from Wuhan [30]	Describes strategies to combat COVID-19 in the radiology department, including personal arrangements, environmental modification, protection level,settings and disinfection methods.
A27	COVID-19 outbreak and cancer radiotherapy disruption in Italy: Survey endorsed by the Italian Association of Radiotherapy and Clinical Oncology (AIRO) [31]	Information technology, treatment prioritization and the implementation of hypofraction and protection procedures have enabled a balance between cancer patients and patient/health workers safety.

Source: author's own construction (2023)

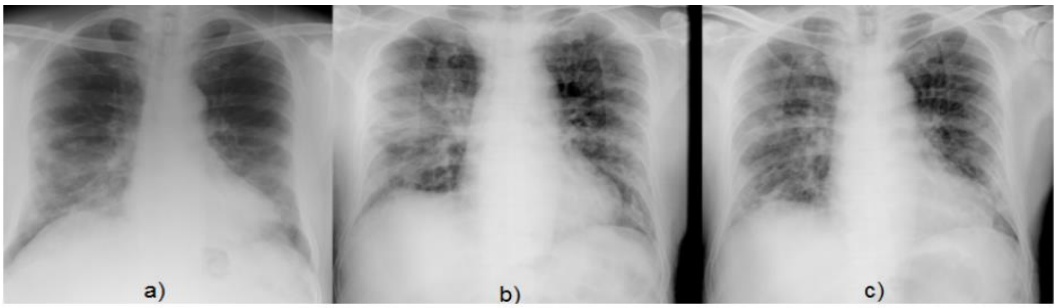

Fig. 3. It shows the supervision of the infection by chest X - rays of a confirmed COVID -19 patient

a) Shows a consolidation in the lower right zone on day 0; in b) Addition of new consolidated changes in the periphery of the right zone and the perihilar region. This mid- zone change improves on day 7 radiographically c). Source: NG et al. [24]

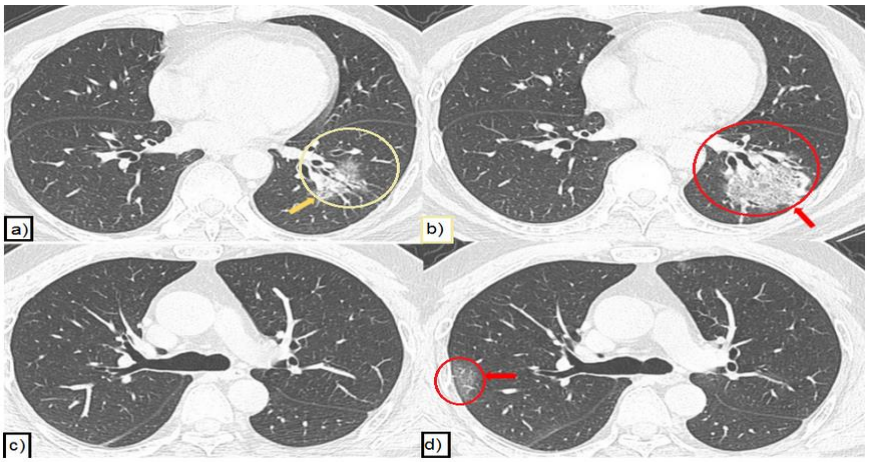

Fig. 4. It shows the supervision of the infection by CT with axial sections of the chest region of a confirmed COVID - 19 patient

Day 0 of presentation to hospital showed ground - glass opacities in the left lower lobe (image a,arrow), but not in the right upper lobe (image c). Subsequently, 3 days later, the management of CT showed an increased ground - glass changes with some peripheral consolidation (inverted halo, image b) (arrow) and a new ground - glass opacities in the right upper lobe periphery (image d) (arrow). Source: NG et al. [24]

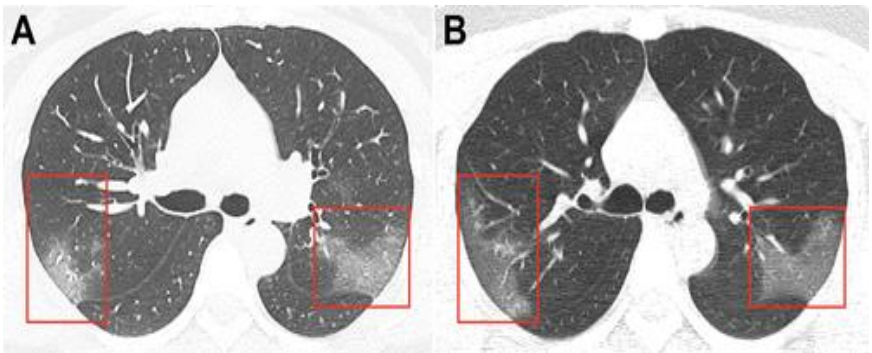

Fig. 5. Bilateral peripheral pulmonary opacities, without subpleural sparing, are common CT findings of new coronavirus pneumonia in 2019

Figure 5A shows several ground- glass opacities in the bilateral lungs. The ground- glass opacities are seen in the posterior segment of the right upper lobe and the posterior apical segment of the left upper lobe. Fig. 5B, the image taken three days after days of observation shows a progressive ground - glass opacities in the posterior segment of the right upper lobe and the posterior apical segment of the right upper lobe and the posterior apical segment of the left upper lobe. Source: Lei et al. [35]

For Myers et al. [6], creating a plan for DR in the specific circumstances inherent in the viral criticality of COVID-19 involves at least three distinct steps and departments to structure a standard DR plan for patient care during the viral wave, as described in Table 2.

Pathologies that exclusively affect the lung parenchyma and particularly the interstitium, are best demonstrated in lung studies using high-resolution computed tomography, a technique known by the acronym HRCT.

3.2 The Crisis and Challenges for the Radiology Professionals

Radiology professionals include radiologists, physicists, nurses, radiology technologists and technicians, nursing technicians, administrative and hygiene workers. The DR has a multidisciplinary team that carries out multiple tasks, as shown in Table 4.

4. DISCUSSION

4.1 Treatment of Patients in the RD DR - Findings with and without Incidence of the Virus after Chest CT

The contribution of the research by Yoon et al.[4] point out the radiographic and tomographic findings of the chest of the new coronavirus disease. CT scans were administered to nine patients who had already tested positive for COVID-19. Authors understand that pulmonary manifestation infected or not by COVID-19 is characterized by the appearance of ground - glass opacity after the CT scan [24,4]. Authors conduct CT scans on infected and non - positive patients in order to show the incidence of the virus in the patient.

Table 2. It lists common imaging findings for COVID -19 and challenges during the

Exam	Common COVID-19 findings	Challenges
Chest X-Ray	Multifocal airspace opacities similar to other coronavirus infections.	Chest X-ray findings are late compared to HRCT.
TC Chest of high Resolution	Peripheral, focal or multifocal ground - glass opacities and bilateral in 50-75% of cases.	In children, the finding of consolidation surrounded by ground - glass attenuation seems to be more common than in adults

Source: author himself (2023)

Table 3. It lists the most suitable tests, basic protocol and challenges for COVID - 19 patients

Exam	Basic positioning protocol for for performing the examination	Issues
High resolution computed tomography (HRCT)	EV constrast: No Plane: Axial Start: Apex of thorax End: Posterior costophrenic sinus Thickness: 1 mm Increment: 10 mm Algorithm: BONE	Computed tomography of the chest has proven to be an excellent method of diagnostic imaging and support, since there are various imaging findings that can be detected in COVID - 19, especially in pneumonia caused by the virus, which has a frosted glass appearance when viewed on the scan.
Simple Chest X- Ray	Patient in an orthostatic or sitting position, hands on hips, palms open; perpendicular X- ray beam centered on the mid - sagittal plane at the level of the seventh thoracic vertebra source - receiver distance 1.80m.	Radiographic examination is a rapid diagnostic method that is used as an adjunct to COVID - 19 and is highly recommended for initial patient assessment.
Simple chest X- ray in bed	Patient in bed, supine position and image detector under the chest area. Mobile X- ray equipment properly positioned at the bedside light beam centered 10 cm below the jugular notch.	Conducted on patients in the intensive care unit (ICU) for daily control and patient evolution, thus minimizing contamination in other sectors.

Source: Bertolazzi et al. [36]

Table 4. It relates radiology professionals, their multi tasks and new challenges

Professional	Multitasks	New Challenges
Medical Radiologist	It is the responsibility of the radiologist to interpret the images generated by the technicians and/or technologists and to advise the doctor of the findings.	The role of the radiologist has proven to be fundamental in the face of the Covid -19 pandemic and the protection of this professional must start from screening, with questions of possible symptoms of respiratory infection to the patient, so that preventive actions can be adopted even before the examination is conducted.
Medical Physicist	Coordinate the radiology team, conduct the equipment quality, control assurance program to optimize techniques for images and propose a low dose to the patient.	Training to reduce medical and occupational exposures in the acquisition of chest X - ray in the intensive care unit (ICU) bed. Preparing CT dose optimization protocols.
Radiology technologists and technicians	Perform procedures for acquiring images by operating specific equipment, being responsible for the proper positioning of the patient for exams on the respective equipment.	Preventive measures to avoid personal contamination and care in sanitizing equipment after use. Using the PPE necessary for patient care.
Nurses	Managing patient appointments, responsible for administration of venous contrast medium.	Training the multidisciplinary team in the use of PPE, managing the flow of patients with suspected or positive Covid - 19, disposal of materials and instruments used.
Nurse Technician	Monitor the patient's vital signs, puncture peripheral access and help with positioning during the examination.	Preventive measures for person - to - person transmission during procedures in hospital environments.

Source: author himself (2023)

In addition, the characteristics that CT brings with it are the location, extent and distribution of each abnormality present in the patient. They show different characteristics in recovered patients and in cases of mortality due to the virus, with a greater risk of infection in the elderly due to their lower immune functions [3].

In the results of Song et al. [16] we look at a study with imaging contributions to emergent pneumonia in humans with COVID -19 [17]. This study was based on 51 patients, in which post - test CT images showed pure ground- glass opacity (GGO) in 39 out of 51 (77%) patients and GGO with reticular and/or interlobular septal thickening in 38 out of 51 (75%) patients. Along the same lines, Chung et al. [18] researched 21 patients who underwent chest CT scans to check the incidence of pneumonia. It is worth noting that they all tested positive for COVID - 19 [18].

In the same approach as Song et al. [17], Chung et al. [18], analyzes the images in relation to the following characteristics (a) presence of ground - glass opacities, (b) presence of consolidation, (c) number of lobes affected by ground - glass opacities or consolidated, (d) degree of lobe involvement, in addition to the overall pulmonary "total severity score", (e) presence of nodules, (f) presence of pleural effusion, (g) presence of thoracic lymphadenopathy (defined as lymph node size ≥ 10 mm in the short axis dimension) and (h) presence of underlying lung disease, such as emphysema or fibrosis. Eighteen patients had some kind of abnormality after infection with the virus, presenting with pulmonary and respiratory problems [17,18].

In conclusion, the article with their research and literature reviews highlight the radiographic and tomographic findings of the chest of patients infected with COVID - 19. For Chung et al. [18], the CT findings showed the presence of ground glass (57%) and peripheral distribution (33%). "Pulmonary cavitation, discrete pulmonary nodules, pleural effusions and enlarged lymph nodes were absent" [18]. All of them conducted research with patients and in the patients and in

the same vein, Song et al. 2020 also reported that their tests found signs of the virus in 77% of patients and that 14% of patients did not show opacities on CT scans[17]. In contrast, the presence of pulmonary opacities was reported in all the studies, in which “ground - glass opacities and consolidation in the pulmonary periphery have been the hallmark of images in patients with COVID -19 infection” [24].

4.2 Strategies to Fight COVID-19 in the Radiology Department

The RD main considerations in planning for a viral crisis is to increase the transfer rate of patients who need imaging exams and to protect patients and workers from transmission of the virus. The DR could acquire expertise in subterfuge to avoid cross - contamination of the pathogen, such as installing negative pressure equipment in examination rooms, and training workers together by limiting contact with the contaminated patient.

Wan et al. [29], discusses preventive measures for the radiology sector during the COVID - 19 pandemic and future proposals for the department to be prepared for a new pandemic crisis[29]. Among the measures suggested are screening by patients and workers, the use of personal protective equipment, as well as the isolation of patients whose CT scan findings are suspicious for COVID - 19. Some ways of being prepared for the pandemic have been suggested to the DR: everyone who attends the department should perform hand hygiene, and everyone should have and use surgical masks [29].

In the same way, guidelines are also provided, in which all employees, patients and general workers of the DR, with any symptoms,should be quarantined and seek appropriate testing sites for SARS - CoV-2 infection based on local and institutional guidelines. In addition, in this pandemic scenario, it has been suggested that DRs screen for essential and non - essential exams, in which the imaging exams of patients who were not emergency cases could be postponed. Most suspected or confirmed COVID - 19 cases should have a chest X- ray, but the recommendation would not be to send them to the radiology department in the emergency room due to the high risk of contamination, and the department would be advised to set up and isolated screening station with a portable CXR outside the emergency department.

In the same way, Zhao et al. [30] presented strategies to protect radiologic technicians against COVID -19 [29]. According to the authors, “radiologic technologists who perform CT scans for infected patients become high - risk medical care professionals”. The DR has an obligation to guarantee a minimum of safety for professionals, since technicians are responsible for performing CT scans on patients suspected of having or already infected with the SARS -COV-2 virus, running the direct or indirect risk of pathogens [30].

At the moment of the high risk of infection and the advance of the pandemic, strategies and measures adopted were essential. The authors highlighted the importance of knowledge about the infection in the DR, so training the entire team is a strategy pointed out, as well as the organization of the sector, organizing care groups with a more experienced and knowledgeable head responsible for the care group. With regard to the training of the RD team and knowledge about the pandemic, Niu et al. [25], also highlighted important reflections and knowledge that the technologist should know, such as “being familiar with the infection control and prevention level requirements in different posts, the types of related protective articles and their uses, and the requirements and methods for disinfecting personnel, equipment and premises”.

In the same way that Wan et al. [29] pointed out the use of personal protective equipment, so did Zhao et al. [30], because the imaging methods of the infected patient include performing CT and digital radiography of the chest, in which technologists are responsible for conduct these operations, in turn various protective equipment for the professional is required: “Cap”, “Surgical mask”, “Respirator”, “Protective Glass”, “Isolation gowns”, “Gloves”, “Shoe Covers”. In addition, the DR should be concerned about disinfecting the rooms and the air in the environment, where they recommend keeping the air conditioners switched off, and they recommend leaving an air purifier on in the CT room at all times. In the contamination room where the patients are being imaged, the room should be equipped with UV lamps, as these disinfect the air for around 60 minutes twice or three times a day.

Niu et al. [25], points out levels of care for radiologists in different scenarios and levels, pointing out the necessary virus prevention equipment that professionals should use. The authors cited the importance of mobile and/or

fixed dedicated DR/CT equipment and diagnostic examination rooms also being well disinfected, given that patients who are suspected of being positive will not be if they are not already. Disinfection methods include: disinfecting the surface of the material with 75% ethanol or a disinfectant containing 500 mg/l chlorine;ultraviolet light, which is used to disinfect the air indoors, The ultraviolet lamps installed should not be less than 1.5 W/m 3 in quantity and less than Niu et al. [25], points out levels of care for radiologists in different scenarios and levels, pointing out the necessary virus prevention equipment that professionals should use. The authors cited the importance of mobile and/or fixed dedicated DR/CT equipment and diagnostic examination rooms also being well disinfected, given that patients who are suspected of being positive will not be if they are not already. Disinfection methods include: disinfecting the surface of the material with 75% ethanol or a disinfectant containing 500 mg/l chlorine; ultraviolet light, which is used to disinfect the air indoors. The ultraviolet light lamps installed should not be less than 1.5 W/m 3 in quantity and not less than 70 μW/cm 2 in intensity, and others. It is very important to disinfect the X-ray examination room by cleaning the doors, floor, handles and all the equipment.

Li et al. [37], pointed out that the best way to protect radiology department staff, so that they are not infected by the virus. However, Myers et al. [6] cited that patient-to-patient, patient-to-staff and staff-to-patient transmission may be included as risks in the healthcare setting if strict precautions are not followed. Clear and frequent communication between healthcare professionals, including radiologists, is essential to improve patient care during the pandemic ZHANG et al.[7]; SIMPSON et al.[1].

In turn, all the authors point to the importance of the safety of radiologists, where departments have somehow prepared and taken safety measures for professionals and patients in the most critical scenario of the pandemic.

The research results discussed in this article highlight the radiographic and tomographic findings of patients with COVID - 19. Computed Tomography (CT) scans were conducted on infected and uninfected individuals, revealing characteristic manifestations of lung involvement, such as the presence of ground - glass opacities. These findings help to identify and monitor the presence of the virus in patients. In addition, the location, extent and distribution of abnormalities detected on CT scans provide valuable information on the severity of the disease, especially in older individuals who are more vulnerable due to lower immune function.

Several studies have demonstrated the presence of pulmonary abnormalities in COVID - 19 patients using computed tomography images. These abnormalities include ground- glass opacities, consolidations and multiple lobe involvement. The severity of lung involvement can be assessed using a total lung severity score. In addition, other findings such as nodules, pleural effusion and thoracic lymphadenopathy may be present. These abnormalities indicate the impact of the virus on the respiratory system, leading to lung and respiratory problems.

Considering the importance of imaging findings in the diagnosis and monitoring of COVID -19 patients, radiology departments must implement strategies to combat the spread of the virus and protect patients and healthcare professionals. Measures such as increasing service capacity, preventing cross - contamination and installing negative pressure equipment in examination rooms should be implemented. Proper training and adherence to infection control protocols are crucial for the safety of radiology professionals.

Preventive measures, including screening of patients and staff, the use of personal protective equipment and the isolation of patients suspected of having COVID-19, should be followed. Essential and non-urgent imaging tests should be triaged to effectively manage patient flow. Suspected or confirmed COVID-19 cases should undergo chest radiography at designated isolated screening stations outside the radiology department. The protection of radiology technicians, who are at high risk due to their involvement in computed tomography and digital chest radiography procedures, is of utmost importance. Adequate knowledge, training and the proper use of personal protective equipment are essential for their safety.

Efforts should be made to maintain a clean and disinfected environment in radiology departments. This includes regular disinfection of surfaces, adequate air ventilation and the use of UV lamps for air disinfection. Radiologists and healthcare professionals must communicate effectively to ensure the best care for patients during the pandemic.

5. CONCLUSIONS

After selecting the articles and reading the full texts, it was possible to conclude that the studies report the importance of imaging exams in RD to assist and monitor the treatment of pneumonia caused by COVID - 19.

There is also agreement on the importance of training, continuing education and patient care, making it clear that the professionals involved in RD must continue to receive incentives in order to overcome the challenges posed by a pandemic. It should be noted that during the entire period of the pandemic it was not possible to carry out home office activities, with the exception of those with a personal history of risk factors, because the work was almost daily with a lot of professionalism and determination.

Their commitment to their health, even when exposed to infectious risks, has kept them persevering in the face of so many uncertainties. The pandemic has reaffirmed the importance of an imaging service where professionals such as radiology assistants, technicians and technologists, doctors and residents, physicists, nursing staff, biomedical professionals, physiotherapists and other health workers can carry out their activities with the utmost dedication. As an opportunity for future work, we suggest looking for new studies in other databases and also constantly carrying out research that includes radiology departments and COVID-19, making it possible to cover these topics and contribute to professional development.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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