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Cover Story

New Care Delivery

Moscow Radiology: COVID-19 Preparedness and Action

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A systematic approach (CT as modality of choice, contactless workflow, staff restructuring, intensive learning, information and methodological support, a concept of clinically confirmed COVID-19 cases with classification according to severity, network of outpatient CT centres with the head reference centre, quality assurance) allowed maximum availability, safety, quality, and standardisation of radiological diagnosis of COVID-19 in the Moscow megalopolis.

Key Points

- Moscow has implemented a systematic approach for treatment and management of COVID-19.
- A network of outpatient CT centres (functioning 24/7, workload 94 studies per 1 scanner) allows to control 'stay-at-home' patients, to provide timely detection of deterioration signs, and indications for hospitalisation.
- Clinically confirmed case of COVID-19 (regardless of the result of a single laboratory test for the presence of SARS-CoV-2 RNA by PCR and the epidemiological history) based on clinical manifestations of the acute respiratory symptoms and typical features for COVID-19 on the chest CT scan.
- Municipal radiology reference center assumed the tasks related to the interpretation of radiologic exams conducted in municipal outpatient facilities: uninterrupted remote radiology reporting, mandatory double review of all cases of viral pneumonia, quality control (peer-review).
- Strategy for applying diagnostic imaging services during the COVID-19 pandemic: 1) no radiology exam in case of absent of symptoms and clinical signs; 2) the primary diagnostic method for coronavirus disease is high-resolution chest computed tomography; 3) portable X-ray or ultrasound is used to assess the dynamics of clinical symptoms in patients in ICU.

The COVID-19 pandemic has forced all countries of the world to take extraordinary measures to overcome the disease, curb its spread, as well as confront the growing economic crisis. The challenges to national healthcare systems are enormous, requiring mobilisation of all resources, intensive involvement of the new opportunities, special protection of medical personnel, real-time solutions, practical actions in a rapidly changing environment and under high stress (Guan et al. 2020; Liang and Zhejiang 2020). It should be noted, that radiology is at the forefront of COVID-19 struggle. In Moscow, the first case of COVID-19 was detected on March 2, 2020. At the time of writing, 62,658 confirmed cases are reported in Moscow, of which 6,374 patients recovered, and 695 died. Only 15% of patients were over 65 years old. The Government of the Russian Federation and the Moscow Mayor's Office have taken unprecedented measures to provide support and curb the spread of coronavirus infection. In this article, we share information on activities of the diagnostic radiology services in the capital of our country, and our experience of managerial, logistical, educational, and methodological measures, as well as application of digital technologies.

In total, Moscow has more than 150 state medical facilities, national

medical research centres (funded by the federal budget), and a well-developed private sector. The number of hospital beds per 10,000 population is 62.1. Primary care medical facilities (city clinics) can provide about 309 appointments per shift per 10,000 population. There are a number of medical personnel per 10,000 population: doctors - 58.3, nurses - 82.8. As of January 1, 2020, the population of Moscow was 12,692,500 people.

The municipal radiology diagnostic services integrate diagnostic departments of city outpatient and inpatient facilities (CT, MRI, x-ray, mammography, nuclear medicine). Medical facilities are well-equipped for the provision of interventional radiology and radiation therapy. All diagnostic equipment is connected to the Unified Radiological Information Service (URIS). URIS provides:

- operational management through the dashboard to monitor the usage, workload, and operability of equipment (pilot studies on dose control monitoring are in progress);
- standardisation of study protocols and reports;
- citywide quality control system (peer-review);
- centralisation of radiology report writing and telemedicine consultations;
- training and research (including artificial intelligence).

During the COVID-19 pandemic, the main tasks of the Moscow diagnostic radiology services became the following:

1) ensuring readiness for high-intensity work under conditions of increasing workload on top of losses among medical staff;
2) reducing mortality and improving outcomes through the high-quality, timely and uninterrupted diagnostics and follow-up;
3) the early diagnosis of pneumonia caused by COVID-19 before the development of conditions requiring mechanical ventilation.

Preventing the Spread of Infection

Multiple managerial, methodological, and administrative measures have been taken to implement these tasks. Moscow Healthcare Department provided regulations and methodological recommendations, the Chief Officer of Regional Radiology and Instrumental Diagnostics issued informational letters. Moscow Research and Practical Clinical Center of Diagnostics and Telemedicine Technologies (also known as 'Moscow Radiology') is the main organisation which provides strategy, methodology, management, quality control, digital technologies introduction, teleradiology and learning for the municipal radiology diagnostic services.

Organisational Decisions

Management. In the radiology department, we have created an operational management group under the department head leadership. The group's responsibilities include coordinating measures within the framework of infection control, interacting with a medical facility administration, collecting and disseminating current information on infection control among employees (including messaging services), preparing the emergency strategy, planning, and implementing measures to ensure seamless operation. We developed a checklist for self-assessment of the department readiness to operate during the COVID-19 pandemic (telemed.ai/biblioteka-dokumentov/chek-list-po-gotovnosti-k-covid-19).

Separation. Mandatory measures: separation of patient flows, separation of personnel shifts, and zoning of radiology departments, creating contactless workflows. A radiology department should be divided into the following zones:

- "red"
- conditionally clean (in hospital settings),
- buffer
- "green."

Staff restructuring. The following actions were performed in municipal hospitals:

- nurses from other departments were transferred to radiology departments to assist x-ray technicians;
- screening programmes were discontinued, and x-ray technicians from those programmes were transferred to CT-scan rooms;
- with additional staff, operation in CT-scan rooms is organised in a new way. Three employees work there: a doctor – remotely, an x-ray technician – in the control room, an assistant (a nurse or released x-ray technician from another modality) – in the treatment room. The assistant also positions a patient on the table and communicates with patients directly.

Active visits management. A number of planned radiology exams are reduced. At the same time, the availability and timeliness of radiological studies in emergencies are rigorously kept. Diagnostics in oncology and life-threatening conditions, interventional radiology, radiation therapy, and others are fully operational.

Infection control. Disinfection, sanitation, and infection control measures are carried out under the current legislation of the Russian Federation. Additionally, international best practices are considered.

Outpatient CT Centers (OCTC). In Moscow, patients with mild COVID-19 are treated at home. Medical observation is carried out remotely by the staff of a specialised telemedicine centre. Medications are provided to municipal clinics' patients free of charge. A network of outpatient CT centers (OCTC) has been developed in Moscow to improve monitoring of these patient cohorts, provide timely detection of signs of deterioration, and indications for hospitalisation. Centres were opened on the base of municipal city clinics. OCTC is examining patients with COVID-19 who are assigned to this clinic. Studies are free of charge for patients and funded by the Federal Funds for Mandatory Medical Insurance.

The operation of the OCTC is regulated and standardised by a special decree. In particular, the following rules are established:
• working hours, time periods of patient examinations and disinfection (studies are carried out 24 hours daily, seven days a week);
• dividing departments into zones;
• structure and number of healthcare teams;
• rules for routing and ensuring continuity of medical care;
• infection control measures, personnel protection measures, disinfection.

At the stage of the OCTC creation, specialised training for doctors and x-ray technicians was conducted, methodological support was provided to heads of departments and leaders of medical facilities. General practitioners who work in municipal outpatient facilities joined the team of OCTCs. They refer patients with severe respiratory symptoms (t° >38,5°C, cough, shortness of breath or difficulty breathing) to the CT scan. If negative dynamics are detected on CT images, the patient goes back to the physician who determines the necessity of hospitalisation. It is how the concept of "clinically confirmed case of COVID-19" is implemented.

All OCTCs have special support from Moscow Radiology Reference Center. At the time of writing, 48 OCTCs are functioning in Moscow 24/7, about 5,000 chest CT scans are performed daily for patients with COVID-19 before transferring them to a hospital or to home care. The average load is 94 studies per a CT scanner (workload is 108%). The highest record was 163 studies in a day. It is absolutely incredible work of Moscow doctors and technicians. During the first two weeks of operating, OCTCs performed 45,444 chest CT scans, radiologists identified 23,021 patients with CT-signs of COVID-19. We cannot fail to mention the numerous volunteers from small and medium-sized businesses (restaurants, cafes) who provide hot meals to the personnel of OCTCs.

Guidelines

Under the auspices of 'Moscow Radiology,' a working group of experts was formed (representatives of 10 clinics in Russia). International and domestic experience has been systematised, and the group developed the guidelines "Radiology and Coronavirus Disease (COVID-19): Organisation, Methodology, Interpretation" (medradiology.moscow/f/ luchevaya_diagnostika_koronavirusnoj_infekcii_covid-19_v2_17042020-4.pdf).

Strategy for Applying Diagnostic Imaging Services During the COVID-19 Pandemic.

The purpose of diagnostic radiology is primary diagnostics, differential diagnostics, patient routing, follow-up, determination of indications for transferring patients to the intensive care unit, or for discharging from the hospital for outpatient treatment. Considering the resources and capabilities, our own and international medical experience, we proposed the following principles of choosing a modality of diagnostic imaging services:
1. If symptoms and clinical signs of acute respiratory infection (ARI) are absent (regardless of the epidemiological history), the use of radiology studies is not recommended.
2. The primary method for the diagnostics, confirmation, and follow-up of COVID-19 (taking into account clinical and laboratory data) is high-resolution computed tomography of the chest (in outpatient and inpatient settings).
3. For critically ill patients (including those who are in intensive care and resuscitation units (ICU), if they cannot be transported, or if computed tomography is not available), x-ray (a portable x-ray machine) or ultrasound is used to assess the dynamics.

As per regulations of the Russian Federation and international recommendations, polymerase chain reaction (PCR) is used for the final diagnosis (verification) of COVID-19. However, our own experience in fighting the pandemic in Moscow and international publications indicate several PCR problems (Ai et al. 2020; Dai et al. 2020; Pan et al. 2020):
• low sensitivity;
• long waiting time for results (at least one day), leading to the delay in beginning a specific therapy;
• high proportion of false-negative results.

This situation has forced us to review approaches for classifying the cases of coronavirus infection. As a result, the Moscow healthcare system has adopted the concept of clinically confirmed case of COVID-19.

Clinically Confirmed Case of COVID-19

Clinical manifestations of the acute respiratory infection (in the absence of other known causes explaining clinical symptoms, regardless of the epidemiological history):
1. Body temperature above 37.5 °C
2. One or more of the following symptoms:
• cough – dry or with scanty sputum
• shortness of breath, feeling of congestion in the chest
• blood oxygen saturation according to pulse oximetry (SpO_2) ≤ 95%
• sore throat, runny nose, and other catarrhal symptoms
• weakness, headache
• anosmia
• diarrhoea.

Typical chest CT features of COVID-19:
• ground-glass opacities
• consolidation zones
• thickening of interlobular septa interstitium ("crazy paving")
• hydrothorax
• bilateral, mainly lower lobar, peripheral, perivascular distribution.

This approach allowed to route patients more efficiently and begin a specific therapy earlier. PCR continues to be performed according to the standard protocol, but the negative result of the method are almost entirely levelled. In the pandemic, the main method for diagnosis of COVID-19 in Moscow has been computed

tomography because of the limitations of PCR test. In municipal outpatient facilities, a CT scan is used for sorting patients with signs of ARI and follow-up patients with a mild form of COVID-19. In hospitals, a CT scan is used for follow-up, disease progression prediction, determining criteria for a patient's discharge from the hospital for outpatient treatment (Ai et al. 2020; Dai et al. 2020; Pan et al. 2020).

We realise, that CT scan can identify a difference between viral and bacterial pneumonia in patients with ARI symptoms starting from the third-fifth of illness. Unfortunately, signs of COVID-19 are not recognised on CT images during the first 3-4 days of illness and in mild cases. Computed tomography is included in all clinical protocols and guidelines for the city medical facilities. Methodological support has been provided:

- standardised operating procedures have been developed (primarily for x-ray technicians on how to perform studies and disinfect equipment)
- doctor's training, informational support for department heads at the regular remote seminars (meetups)
- remote quality control (peer-review), individual quality improvement measures (educational, organisational, technical, others) based on the results
- telemedicine consulting by experts for city doctors.

To standardise the doctor's performance, we developed a unique classification and a short format of the CT-scan report. We recommended solutions for patient routing, criteria for hospitalisation in the intensive care unit, or a patient's discharge from the hospital based on the clinical manifestation and the degree of pulmonary tissue involvement (Table 1). Classification allows to standardise patient routing and treatment.

The implementation of these approaches ensured a systematisation of operation of Moscow diagnostic radiology services, its effective interaction with clinical divisions, outpatient and inpatient medical facilities. Proposed classifications and criteria allowed to speed up doctors' productivity, make it standardised, transparent, easily manageable and adaptable to rapidly changing environment. By introducing the concept of "clinically confirmed case of COVID-19," we could reduce the time from the disease onset to the beginning of the specific therapy.

Digital Infrastructure

Moscow Radiology Diagnostic Services is a shared digital space. It is based on the Unified Radiological Information Service (URIS). URIS is an information system with its own data centre, to which all digital diagnostic equipment of municipal outpatient facilities and partially city hospitals are connected (complete connection of hospitals is planned from 2019 to 2021). The main functions of URIS include:

- centralised archive of radiology studies' results;
- monitoring of equipment operation, accessibility to radiological services for patients;
- supporting managerial decision making;
- providing remote communication for writing radiology reports and expert consulting;
- remote quality control;
- providing medical data for training, research, development of artificial intelligence.

To expand the functionality of the radiological information system, we supplemented it with a dashboard, speech recognition, and intellectual (AI-based) report templates (as part of a scientific experiment). URIS is also integrated with the Uniform Medical Information and Analytical System of Moscow (UMIAS), that ensures continuity of city medical facilities' work and minimises study duplication. Also, thanks to this integration, the studies' results are available to city residents in their account on the portal "Moscow State Services." Taking into account the pandemic experience, we can already say that URIS, as the basis of the unified digital space, requires the prompt integration of hospitals, modules for monitoring radiation dose, and rapid increase in computing resources.

Teleradiology

The COVID-19 pandemic has led to a real telemedicine boom. On one hand, the demand for direct-to-consumer telemedicine and telehealth has dramatically increased. On the other hand, telemedicine and digital technologies have become non-alternative basis for organising healthcare in the "doctor-to-doctor" segment. The potential of telemedicine as the tool for healthcare management in a pandemic are enormous:

1) fast arrangement of consultations, decision making support, including patient logistics;
2) effective reallocation of human resources, including covering the increasing losses among medical personnel;
3) uninterrupted use of expertise of self-isolated doctors;
4) decrease of face-to-face social and professional contacts among healthcare workers.

In diagnostic radiology, telemedicine allows remote reporting, expert consulting on complicated cases, remote quality control (peer-review).

The Moscow healthcare system has adopted the concept of clinically confirmed case of COVID-19

Severity	CT	Clinical Data	Decision
Zero	CT-0 Not consistent with pneumonia (including COVID-19).	–	Inform a primary care physician. Refer to a specialist.
Mild	CT-1 Ground glass opacities. Pulmonary parenchymal involvement =<25% OR absence. CT sigs on top of typical clinical manifestations and relevant epidemiological history.	A. t° <38.00°C B. RR <20/min C. SpO_2 >95%	Follow-up at home using telemedicine technologies (mandatory telemonitoring).
Moderate	CT-2 Ground glass opacities. Pulmonary parenchymal involvement 25-50%.	A. t° >38.50°C B. RR 20-30/min C. SpO_2 95%	Follow-up at home by a primary care physician
Severe	CT-3 Ground glass opacities. Pulmonary consolidation. Pulmonary parenchymal involvement 50-75%. Lung involvement increased in 24–48 hours by 50% of respiratory impairment per follow-up studies.	One or more signs on top of fever: A. t° >38,50°C B. RR ≥30/min C. SpO_2 ≤95% D. Partial pressure of oxygen (PaO_2)/ Fraction of inspired oxygen (FiO_2) ≤300 mmHg (1 mmHg=0,133 kPa)	Immediate admission to a COVID-specialised hospital. In a hospital setting: immediate transfer to ICU. Emergency computed tomography (if it is not done before).
Critical	CT-4 Diffuse ground glass opacities with consolidations and reticular changes. Hydrothorax (bilateral, more on the left). Pulmonary parenchymal involvement >=75%.	Signs of shock, multiple organ failure, respiratory failure.	Emergency medical care. Immediate admission to a specialised hospital for patients diagnosed with COVID-19. In a hospital setting: immediate transfer to ICU. Emergency computed tomography (if it is not done before and a patient's condition allows for it).
Recovery	Criteria for regression of pathological changes: – reduction of ground glass opacities, appearance of new ground glass opacity zones is permissible no more than 25% of the transverse size of one side of the thorax; – reduction of previously visible consolidation zones; – residual opacities in pulmonary parenchyma of various lengths and distribution; – absence of pleural effusion associated with COVID-19.	A. Normal body temperature (less than 37.0°C) B. No signs of increased respiratory failure with oxygen saturation exceeds 96% C. C-reactive protein level decreased to less than double of normal range, white blood cells count is above 3.0x109/L	Discharge from the hospital for outpatient treatment, dynamic monitoring at home using telemedicine technologies if required (telemonitoring).

Table 1: Classification of the severity of lung tissue abnormalities in patients with COVID-19 and routing rules

Thanks to teleradiology, a face-to-face contact of radiologists and radiation oncologists with patients can be minimised. Almost all doctors can be removed from the "red" zone. The exception is doctors who are involved in conducting studies with contrast enhancement (according to the current regulation, a radiologist must be present at the procedure room).

Methodological Assistance

Recommendations for radiology departments:

- move doctor's offices to the "green" zone, isolate them as much as possible, and provide the necessary number of workstations and auxiliary computer equipment;
- issue radiology reports using hospital (radiological) information system (in Moscow - URIS);
- switch most radiologists to remote operation mode;
- distribute workstations to doctors (at least professional monitors), provide remote connection to hospital (radiological) information system (in Moscow - URIS);
- implement time-limits for x-ray technicians in the conditions of the remote doctor's work, as well as for remote radiology reporting and study consultation.

Moscow Radiology Reference Center

In April 2020, Moscow Radiology Reference Center (MRRC) was launched. MRRC is designed for the most effective use of the primary healthcare personnel, simplifying management of medical staff and ensuring its interchangeability (including prevention of workflow interruptions in radiology departments due to the staff shortage). MRRC operates 24/7/365 providing radiology reports and quality control (peer-review) of diagnostic studies.

The planned number of doctors in MRRC is 500. All radiologists of outpatient radiology services are concentrated in the reference centre. Of course, in the pandemic, we are talking about operating remotely or at the facilities divided into zones. In any case, most of radiologists are removed from the healthcare settings, which reduces the risk of infection and their absence at work. MRRC assumed the tasks related to the interpretation of radiologic exams conducted in municipal outpatient facilities:

- uninterrupted remote reporting of radiologic exams
- mandatory double review of all cases of viral pneumonia
- quality control (peer-review).

Additionally, at the level of the Russian Federation, MRRC provides:

- organisational and methodological support of the diagnostic radiology services of the country
- expert remote consulting
- support of educational events
- participation in scientific research.

Moscow Radiology Reference Center provides constant support of OCTCs (see above). Doctors on-call conduct round-the-clock remote quality control (peer-review) of studies and provide expert telemedicine consulting, if necessary (approximately 20-25% of cases). During the first two weeks of OCTC operating, Moscow Radiology Reference Center made 10,391 peer-reviews and consultations.

Expert Telemedicine Consulting

Earlier, remote discussions of complicated clinical cases were carried out by consultants of the 'Moscow Radiology' centre regularly. Consultants of the centre conducted decision-making support for doctors of Moscow municipal outpatient facilities for particularly complicated, atypical, rare cases. Note, that such consultations were provided in different modalities. Annually 'Moscow Radiology' carried out around 3,000-3,500 expert teleconsultations.

With the pandemic progression, a demand for expert telemedicine consultations on the differential diagnosis of viral pneumonia has increased, and not only from Moscow municipal clinics but also from medical facilities of other regions of the Russian Federation. It required to design special mechanisms for handling such requests. 'Moscow Radiology' has developed a radiological information system (RIS). It allows doctors from different regions of the Russian Federation to upload anonymised studies in the DICOM standard, and for consultants to conduct remote interpretations. A two-stage approach was methodically applied:

- stage I – upload an anonymised video to 'Moscow Radiology' chat for triage, a consultant on duty determines the need for a complete consultation;
- stage II – if the need is confirmed, a full study is downloaded in the DICOM standard into a special RIS, and the consultant doctor provides a complete teleconsultation.

At the triage stage, cases which were not consistent with viral pneumonia were eliminated, for example, bacterial pneumonia, oncology. Such a process reduced the burden on the consultant radiologists of 'Moscow Radiology,' allowing them to work only with targeted cases. Moreover, this accelerated process of making diagnostic decisions at the local medical facilities, reduced, among other things, medical staff concerns and patients' anxiety.

Social Media and Web

E-mail, internet messengers, telephone, social networks, video conferencing are actively used for communication on organisational, logistical, and methodological issues. In particular, the number of Moscow Radiology' Telegram® channel (t.me/MoscowRadiology) users has increased by five times in three weeks. There are 2,738 participants now (radiologists, x-ray technicians, department heads). It became the platform for a rapid exchange of information about the current situation and problems, discussion of organisational issues, sharing experience, informing about a release of guidelines, regulatory documents, educational events, as well as for triage consultations. Also, 'Moscow Radiology' set up chats for:

- heads of radiology departments
- x-ray technicians
- consultant doctors involved in methodological work
- AI integration and accuracy evaluation.

Such channels and chats existed before, voluntarily uniting specialists. During the pandemic and quarantine measures, they have become a critical tool for real-time communication. The number of users in each chat increased by several times. 95-100% of each target audience is united in thematic groups. Health workers are promptly and effectively informed based on their target profiles.

During the first days of the pandemic, 'Moscow Radiology' set up a website Radiologists vs COVID-19 (sdo.npcmr.ru/basic-kt-module-2). to accumulate the most relevant information, guidelines, regulations, webinars, etc. The website allows to quickly and conveniently inform medical community.

Artificial Intelligence

In the conditions of staff shortage (including personnel absence due to sickness) and sharp increase in workload, the use of computer vision technologies and artificial intelligence for automated analysis of diagnostic images has become especially relevant. The main potential scenarios for such tools are the following:

- triage (sorting) of CT scans performed in the primary care settings
- assessment of chest-CT abnormalities in patients with COVID-19 in dynamics.

In this case, AI can help save doctors' time and reallocate their attention to challenging cases. Since January 2020, a large-scale scientific experiment has been launched in Moscow to assess the capabilities of computer vision technologies in radiology. The project is being implemented by the Moscow Government and provides grants to companies that develop services based on artificial intelligence (mosmed.ai). Currently, 12 companies have already participated in the experiment, and the selection of new participants continues. The uniqueness of the project is that companies can integrate their software into URIS, and prospectively analyse tens and hundreds of thousands of studies. We intend to assess diagnostic accuracy, commitment, and satisfaction of doctors, as well as level of technological defects. Initially, the experiment was conducted on three types of studies: chest CT for detecting lung cancer, mammography for detecting breast cancer, chest x-ray for detecting several pathologies (tuberculosis, cancer, pneumonia). However, the pandemic has made adjustments – now services can participate in the experiment for detecting signs of viral pneumonia (including COVID-19) on CT scans and chest x-rays.

At the time of this writing, the first developer of such an algorithm has successfully integrated into URIS. Calibration and a preliminary assessment of the algorithm accuracy are underway.

Training

Due to the rapid evolution of the pandemic, we have faced an acute need to inform and train our medical staff:
1) Information vacuum: most medical professionals lack evidence-based information about the diagnosis, treatment, prevention of COVID-19, as well as the management of radiology services during a pandemic;
2) Rapid changes in the medical and tactical situation, the accumulation of knowledge in real-time, need to provide up-to-date but verified information to many medical professionals almost daily;
3) At the same time, minimisation of personal social contacts and excessive workload, the highest stress level made traditional forms of information exchange (conferences, masterclasses, classroom training courses) completely ineffective.

To solve these problems, 'Moscow Radiology' has developed and implemented "Training and Informing System for Radiologists in the COVID-19 Pandemic."
Target audience:

- heads of radiology and ultrasound departments,
- radiologists and specialists in ultrasound diagnostics,
- x-ray technicians.

The system includes a combination of modern pedagogical and information technologies.
1. Pedagogical technologies:

- interactive training
- training in small groups (cooperation technologies)
- mutual learning
- problem-based learning.

2. Information technologies:

- full transition to the remote operation mode (webinar platforms)
- expanding the arsenal of software products and web applications, increasing the interactivity of e-learning (spaces for group work, online voting, joint 'whiteboard', etc.)
- expanding the number of applied mobile applications
- emphasis on chats in social networks and internet messengers (for informing, analysing clinical cases, training).

As a result, we conducted a combination of asynchronous distance learning courses and interactive online training in the group work format.

Learning Strategies

a) Standard advanced training courses on general topics.
Goal: fully maintain the processes of routine postgraduate education.
Mechanism: full transition to e-learning mode, measures to ensure access to educational materials from workplaces.
b) Targeted doctors and x-ray technicians training on COVID-19 issues.
Goal: prepare medical personnel for the pandemic.
Mechanism:
i) training – short-term online courses;
ii) constant information on current issues – webinars (with access to the recordings), special channels in social networks.
As an example, the 18-hours distance course on ultrasound and imaging diagnostics of COVID-19 (sdo.npcmr.ru/basic-kt-module-2).
c) Courses for radiologists who have not been trained before on chest computed tomography (CT).
Goal: provide a reserve of specialists for timely CT reporting.

Mechanism: short-term distance courses on conducting chest CT scan and reporting.
d) Training heads of diagnostic departments on COVID-19 issues.
Goal: to provide strategic professional development training for leadership of medical facilities on issues of organisation and management, infection control, changes in regulations. Mechanism:
i) training – regular (weekly) meetups with presentations of relevant materials, practical experience from various medical institutions and territories, discussions;
ii) constant information on current issues – webinars (with access to their recordings), special channels in social networks (tele-med.ai/obrazovanie/vebinary/)
e) Training physicians on specific issues of diagnostic radiology of COVID-19.
Goal: reduce the time from patient admission to diagnosis and beginning a specific therapy.
Mechanism: short-term distance courses and webinars for physicians, anesthesiologists on the basics of chest CT scan and x-ray with emphasis on the diagnosis of viral pneumonia.

Recommendation Based on Results of the System Performance

1) Maximise the use of digital technologies and social media for continuous education and information of healthcare workers about COVID-19 issues;
2) Increase the social responsibility of business structures – to provide free access for educational institutions and medical professionals to software and web services for implementing distance learning during a pandemic;
3) Training courses for X-ray technicians, radiologists, physicians, healthcare administrators (leadership of medical facilities and heads of radiology and ultrasound departments) should be separated and have a specific approach;
4) Combine different training formats – short-term distance courses, constant information through enclosed channels in social networks, expert telemedicine consultations for the analysis of clinical cases.

Conclusion

Moscow has implemented a systematic approach – "imaging modality of choice – regulatory requirements – methodological support – quality assurance." It allowed maximum availability, safety, quality, and standardisation of radiology diagnostics of COVID-19 in a few days in the Moscow megalopolis.

Our main goal is to save people's lives. The role of diagnostic radiology during the COVID-19 pandemic has become crucial. Radiologists' significance and their level of responsibility have been fundamentally transformed. Previously, we were talking about the qualitative interpretation of diagnostic images and effective communication with clinicians. Now the situation has changed. During the COVID-19 pandemic, radiologists provide triage "en masse" and routing of patients between outpatient and inpatient medical facilities.

Moscow Healthcare Department has identified a pandemic response strategy. Within its framework, the parent organisation ('Moscow Radiology') established the goal setting for the radiology diagnostic services, provided a set of methodological, educational, scientific, organisational support, and implemented a quality control system. The role of the professional community is immeasurable! The dedicated work of medical staff, at the same time, active communication, feedback, selfless and friendly sharing of their experience and knowledge with colleagues, mutual support, giving advice are crucial in a pandemic. In truth: Aliis inserviendo consumor!

Conflicts of Interest:

None. ■

REFERENCES

Ai T, Yang Z, Hou H et al. (2020) Correlation of Chest CT and RT-PCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases [published online ahead of print] Radiology, 200642. doi:10.1148/radiol.2020200642.

Dai WC, Zhang HW, Yu J et al. (2020) CT Imaging and Differential Diagnosis of COVID-19. Can Assoc Radiol J, 71(2):195-200. doi:10.1177/0846537120913033

Guan WJ, Ni ZY, Hu Y et al. (2020) Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med, 382(18):1708-1720. doi:10.1056/NEJMoa2002032.

Handbook of COVID-19 Prevention and Treatment. Ed. by T. Liang. (2020) Zhejiang University School of Medicine.

Huang Z, Zhao S, Li Z et al. (2020) The Battle Against Coronavirus Disease 2019 (COVID-19): Emergency Management and Infection Control in a Radiology Department [published online ahead of print] J Am Coll Radiol, S1546-1440(20)30285-4. doi:10.1016/j.jacr.2020.03.011.

Kooraki S, Hosseiny M, Myers L, Gholamrezanezhad A (2020) Coronavirus (COVID-19) Outbreak: What the Department of Radiology Should Know. J Am Coll Radiol, 17(4):447- 451. doi:10.1016/j.jacr.2020.02.008.

For full references, please email editor@healthmanagement.org or visit https://iii.hm/14ys