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Letter to the Editor

COVID-19 Imaging in a Tertiary Care Setting – The Zurich Approach

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Abstract

The COVID-19 pandemic not only poses an existential threat to the entire society, but also poses a major challenge for hospitals, which cannot be met without interdisciplinary teamwork. For radiological institutions, trade-offs need to be made between radiological imaging capacity required for timely diagnosis of COVID-19, available resources for non-COVID-19-related diseases as well as the risk of infection to healthcare co-workers such as technicians and radiologists. In this study, we describe the scheme implemented at the University Hospital Zurich (Switzerland). The essence of the Zurich approach is early triaging of patients into four categories with either (i) proven COVID-19, (ii) high-risk of COVID-19, (iii) low risk of COVID-19, and (iv) no suspicion of COVID-19, with subsequent procedures including separation of patient pathways taking into account the availability of imaging modalities and protection measures for exposed healthcare workers. With the imposed measures, we were able to avoid any infections to healthcare workers at our hospital over a 3 months period at the height of the COVID-19 crisis in spring 2020. We hope to provide helpful insights for radiological institutions preparing for or coping with the COVID-19 pandemic with the following description.

Keywords: COVID-19, health care worker, management, protection, radiology department

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On March 11, 2020, the World Health Organization (WHO) declared the spread of coronavirus infections a global pandemic. Increasing SARS CoV-2 infection rates pose a major challenge to every single hospital and healthcare systems worldwide. As medical resources are scarce inthese exceptional circumstances, well-defined interdisciplinary guidelines regarding isolation, diagnostic and therapeutic approaches for this emerging patient cohort are of utmost importance.The American College of Radiology (ACR) recommends neither computed tomography (CT) nor chest X-ray (CXR) as a screening method, or as a first-line test to diagnose COVID-19 due to the low negative predictive value and the low specificity of imaging findings.[1, 2] The primary test for SARS CoV-2 diagnosis remains a laboratory testing using Reverse-Transcriptase Polymerase Chain Reaction (RT-PCR), however this is not always available with the required capacity and may require several hours or even days until the final result is obtained. CT should be used wisely and reserved for hospitalized symptomatic patients with specific clinical indications. Still, CT can be also a valuable method to assess the severity and evolution of infection. As Switzerland is among the countries with the highest number of COVID-19 cases per capita, we tried to define standard operating procedures (SOPs) for imaging examinations with optimal usage of the available resources.The University Hospital of Zurich (USZ)

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is a 900-bed academic level 1 trauma and maximum care center including 40 intensive care beds. The radiology institute carries-out approximately 35.000 CT scans every year. Three different cutting-edge CT scanners are available: one in the emergency department for primary care and two CT scanners in the rooms of the radiology department, one of which is used also for radiological interventions. In addition, there is a CT scanner installed at the department of radiation oncology for therapy planning.

Infrastructure

In all our discussions, representatives of the emergency department (ED) and the department of infectious diseases and hospital epidemiology were involved, and existing SOPs from the hospital's COVID-19 task force were included. All patients presenting to the ED are pre-triaged for COVID-19 infection in tents outside the ED. In case of a COVID-19 risk situation patients are strictly isolated before entering the hospital. Technologists played a major role in elaborating the imaging guidelines as they are in direct contact with patients and are at risk in this delicate situation. For infection control, we decided to separate paths as much as possible, thereby differentiating between the COVID-19 cohort and all other patients (Fig. 1).

It was decided that the CT scanner (hereafter referred to as CT1) next to the emergency room should be still accessible to all non-COVID-19 patients. Regarding the COVID-19 cohort, only low-risk patients needing an emergency CT should be scanned on this machine because of a less extensive cleanup process (see below). Using this CT machine to scan high-risk or confirmed positive COVID-19 patients would paralyze the scanner for very long time due to subsequent cleaning work.Patients with high-risk or confirmed infections are primarily scanned on the CT scanner located in the radiation oncology department (hereafter referred to as CT2), which is close proximity to the ED allowing short transport routes in the hospital. Unfortunately, the spatial access to this CT scanner is limited, meaning patients requiring bed transportation cannot be scanned on this CT scanner.

If patients need to be transported in bed, we have to perform these examinations at the CT scanner mainly used for interventional procedures (hereafter referred to as CT3) in the main rooms of the radiology department, which may coincide with the arrangement of emergency CT-guided interventions. Importantly, there is - no regular schedule on this scanner, except for rare emergency interventional procedures.

Our main diagnostic scanner (hereafter referred to as CT4), also located in the main radiology department, remains available to perform essential scans of non-COVID-19 patients, including outpatient radiological imaging (Fig. 1).

Procedures

At our hospital, we usually perform CT scans on patients with suspected or confirmed COVID-19 to rule-out other life-threatening differential diagnoses such as a pulmonary embolism (PE). We also perform CT scans on some COVID-19 positive patients to obtain a baseline image before randomizing subjects to different prospective therapeutic trials. The scanning protocol is chosen depending on the main indicator. We use a standard CT pulmonary angiography protocol to exclude PE. In cases where lung involvement or infection evolution needs to be assessed, we perform an unenhanced chest CT at a standard dose. The following workflow has been established: If a patient with suspected symptoms of COVID-19 is admitted to our hospital, he will be first judged to be at high risk along with the highest protection measures (see below). After the patient's history is taken, and following a physical examination and SARS CoV-2-test sampling, further diagnosis is made depending on the clinical situation. If the indication for CT is given, the clinicians have to inform the responsible radiologist by phone. In the first step, the indication is critically questioned by the radiologist, and a shared, interdisciplinary decision is made on the indication for the examination. If all agree on the indication, the clinician is required to carefully check and provide a written communication of the patient's infection status, including detailed information concerning symptoms, pre-test probability and laboratory findings. The referring physician triages the patient based on the infection status into one of the four following groups:

i. Confirmed COVID-19 by a positive test result.

ii. High-risk of COVID-19: Fulfilling the following criteria:

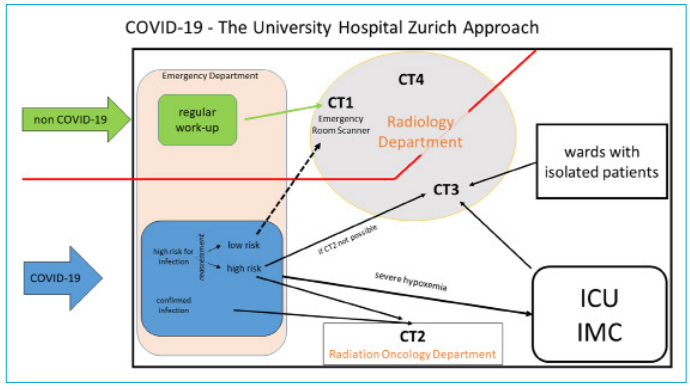

Figure 1. Schematic representation of the current patient pathways from the emergency department to the imaging sites. Our aim was to isolate as much as possible patients with proven or high risk of COVID-19 infection from non CODIV-19 patients (red line).

symptoms of an acute respiratory tract infection with or without fever plus contact to a proven positive COVID-19 patient.

iii. Low-risk of COVID-19: The above-mentioned criteria are not fulfilled, however, a SARS-CoV-2 infection is deemed possible.

iv. No suspicion of COVID-19.

Hereupon, imaging is performed using the various CT scanners as outlined above (Fig. 1):

1. Patients with confirmed SARS CoV-2 infection are examined on scanner CT2.
2. Patients with high risk for SARS CoV-2 infection are examined in CT2 (or in CT3).
3. Patients with low risk for SARS CoV-2 infection are examined in CT1.

According to our hospital epidemiology department, we distinguish between two different protection measures:

A. Extensive protection measures are required when dealing with high risk or proven COVID-19 patients. In this case, health care workers have to wear a surgical face mask, protection glasses, gloves as well as a single-use gown. Terminal disinfection of surfaces in contact with the patient is performed using aldehyde-based antiseptics. (i.e. Kohrsolin FF ® 1%).

B. Standard protection measures are adopted when dealing with low-risk COVID-19 patients. This means healthcare professionals wear a surgical face mask and reusable foil goggles. For terminal disinfection, alcohol-based antiseptics are used (i.e. Meliseptol ®).

To protect our medical staff and ensure that doctors are available during the enite pandemic, we do not only implementing all the recommended hygienic standards at our institute but we go one step further. We divided our team of radiologists into three different groups. One group has to be present at any time at the main site of the University Hospital campus and supervise the examinations. The other two groups work decentralized at the two other sites of the campus. Our concept foresees that if one group fails due to illness or has to be isolated under quarantine, another group can take over work at the main radiology department building.

Discussion

Imaging highly infectious patients during exceptional circumstances requires a well-defined workflow. Recently published studies highlighted the need for precise management strategies to adequately deal with this crowd of highly infectious patients.[3, 4] Our concept is mainly based upon a precise triaging of patients and the use of a single scanner not located at the center of the radiology department. Moreover, patient transport routes should be chosen as short as possible to prevent virus spread. However, we experienced that detailed triage towards a low and high risk of infection was very challenging, if not impossible when a large number of patients came to the ED. Therefore, initially all patients with fever and/or cough visiting the ED are considered high risk for COVID-19 infection and require maximum protection measures from the outset. This has an impact on the locations where the imaging will be carried out in order to affect the non-COVID-19 routine as little as possible.

In our approach, we try to avoid performing magnetic resonance imaging (MRI) and ultrasonography (US) on proven or highly suspected COVID-19 patients. We believe that ultrasonography in SARS CoV-2 positive or highly suspected patients should be performed as rarely as possible, since this modality requires close physical contact associated with an increased risk of infection. We are also very constrained concerning MRI in this patient cohort as CT is the modality providing most relevant information quickly and 24/7, particularly in patients under critical conditions. In most cases, MRI can be postponed until recovery is proven. CT cannot be used as a screening or as a diagnostic tool. In these patients, CT is carried out only if we believe that the result could lead to a change of patient and therapeutic management (Fig. 2). To avoid unnecessary scanning, we insist that radiologists should be informed personally and in detail before scheduling the scan. It is a controversial issue that the indication for contrast-enhanced chest CT whether to exclude or diagnose pulmonary embolism, since most of these patients have dyspnea and elevated serum D-dimer levels.Sparing medical resources and protecting medical staff is of paramount importance these days. The Lancet

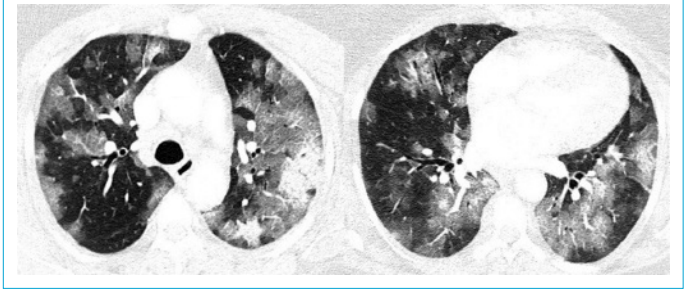

Figure 2. 57-year-old female patient presenting with cough and fever (up to 39°C) for three days. The patient had diabetes type II and arterial hypertension. The patient presented with tachypnoea and an SpO_2 of 68%. As respiratory failure was evolving (Horovitz quotient 65 mmHg), the decision was made to intubate the patient and to start ventilation. Chest CT was performed to rule-out pulmonary embolism and showed extensive bilateral ground-glass opacities and consolidations similar to previous reports.[6, 7]

reported that in Italy 20% of healthcare workers responding to Covid-19 were infected, and some even died.[5] Radiology technicians, and to a lesser extent, radiologists are among the first-line healthcare professionals to exposed to COVID-19 patients. As the correct personal protection and thorough disinfection subsequent to the examinations are time-consuming, we have reinforced all our relevant teams to ensure that all instructions are followed. Furthermore, in addition to the physical exhaustion, possible psychological problems that may arise during these difficult times should also be considered. To prevent psychological fatigue or burn-out, our hospital set up a special helpline.

It should be emphasized that such discussions and internal guidelines are ever-evolving, as the optimal strategy is a moving target and needs to be adapted always to actual circumstances. At the time of writing this article, the USZ has not run-out of its capacity for both intensive care unit beds and referred imaging examinations. In the later stages of the COVID-19 pandemic, other trade-offs and options are possible .Compared with other regions in Europe, the larger Zurich region was relatively less hit by COVID-19, most likely due to the restrictions and social distancing recommendations imposed early in the course of pandemic. The height of the pandemic was in the second half of March 2020. Meanwhile (June 2020), 9770 patients have been tested for COVID-19 in our hospital with 253 positive cases and 12 deaths. Imaging was performed in 108 of these patients, of which 66 had at least one CT examination. Importantly, no healthcare professional was infected with SARS CoV-2 during this 3 month period.

Radiology departments have to be properly prepared against the COVID-19 pandemic. Procedures for strict separation of patient pathways, the availability of imaging modalities and protection measures for exposed healthcare workers should be clearly defined and decisions should be based on available resources. Radiologists should consider working in a partially decentralized way to ensure the presence of doctors during the entire pandemic. At our hospital, we are confident that with these exemplary measures, we are ready to handle the influx of patients by providing them with the best possible imaging diagnostics.[6, 7]

Main messages:

- Strict separation of patient pathways
- Ideally use of only one computed tomography (CT) scanner to examine COVID-19 patients, preferentially at a satellite location enabling short transport routes
- Precise and strict CT imaging indications, no CT for screening or diagnosis
- Providing sufficient protection material to health care workers while sparing resources
- Assuring adequate staffing at all times to prevent physical and/or psychological exhaustion
- Organization of decentralized working
- Continuous interdisciplinary discussions with emergency medicine, infectiology and hospital epidemiology to adapt fast to changing scenarios

Disclosures

Ethics Committee Approval: Ethics committee approval was not requested for this study.

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