

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 constitutes 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, resources available for non-COVID-19 associated diseases as well as the risk of infection to healthcare co-workers such as technicians and radiologists. In this work, we describe the scheme imposed at the University Hospital Zurich (Switzerland). The core 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 a 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 during 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 the 11th March, 2020 the World Healthcare 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 to the health care systems worldwide. As medical resources are scarce during these 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) does not recommend neither computed tomography (CT) nor chest X-ray (CXR) as a screening method or as a first-line test to diag-

nose COVID-19 due to the low negative predictive value and the low specificity of imaging findings.^[1,2] The primary test for the diagnosis of SARS CoV-2 remains laboratory testing using Reverse-Transcriptase Polymerase Chain Reaction (RT-PCR), which, however, is not always available with the required capacity and which may require several hours or even days until the final result is available. CT should be used wisely and should be 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 ranks among the countries with the highest number of COVID-19 cases per capita, we tried to define standard operating pro-

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cedures (SOPs) for imaging examinations with optimal usage of the available resources.

The University Hospital Zurich (USZ) is a 900 bed academic level 1 trauma and maximum care center including 40 intensive care beds. The radiological institute carries-out approximately 35.000 CT scans every year. Three different state-of-the-art CT scanners are available: one in the emergency department for primary care and two CT scanners in the rooms of the radiology department, from which one is being 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 of the ED. In case of a COVID-19 risk situation patients are strictly isolated before entering the hospital. Technologists played a major role in the elaboration of imaging guidelines as they are in direct contact with the patients and are at risk in this delicate situation. For infection control, we decided to separate paths as much as possible, hereby differentiating between the COVID-19 cohort and all other patients (Fig. 1).

It was decided that the CT scanner (hereafter called CT1) next to the emergency room should be still available to all non-COVID-19 patients. Regarding the COVID-19 cohort, only low-risk patients who need an emergency CT should be scanned on this machine because of a less extensive cleaning process (see below). Using this CT machine to scan high-risk or confirmed positive COVID-19 patients would paralyze the scanner for too long time due to subsequent cleaning work.

Patients with high-risk or confirmed infection are primarily scanned on the CT scanner located in the radiation oncology department (hereafter called CT2), which is in close proximity to the ED allowing short transport routes through the hospital. Unfortunately, the spatial access to this CT scanner is limited meaning that patients for whom bed transport is mandatory cannot be scanned on this CT scanner.

If patients have to be transported in bed, we are forced to perform these examinations at the CT scanner mainly used for interventional procedures (hereafter called CT3) in the main rooms of the radiological department, which may collide with the planning of emergency CT-guided interventions. Importantly, there is - except from the rare emer-

gency interventional procedures - no regular program on this scanner.

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

Procedures

At our hospital, we usually conduct CT scans in COVID-19 suspicious or confirmed patients to rule-out other, life-threatening differential diagnosis such as a pulmonary embolism (PE). We also perform CT scans in some COVID-19 positive patients in order to obtain a baseline image before randomizing subjects into different prospective therapeutic trials. The scanning protocol is chosen depending on the main indication. In order to rule-out PE, we use a standard CT pulmonary angiography protocol. In cases where lung involvement or evolution of infection should be assessed, we perform an unenhanced chest CT at a standard dose.

The following workflow has been established: If a patient with COVID-19 suspicious symptoms is admitted to our hospital, he will be primarily adjudicated as being at high risk along with highest protection measures (see below). After patient history was taken, after physical examination and SARS CoV-2-test sampling, further diagnostics are performed depending on the clinical situation. If the indication for CT is given, the clinicians have to inform the responsible radiologist by telephone. In a first step, the indication is critically questioned by the radiologist, and a shared, interdisciplinary decision is made about the indication for the exam. 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

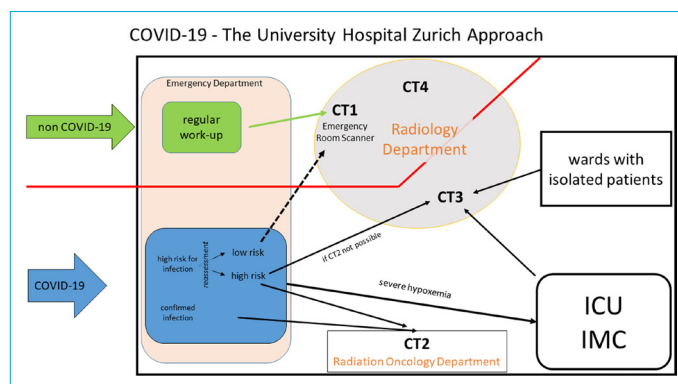


Figure 1. Schematic representation of the current patient pathways from the emergency department to the imaging sites. Our aim was to isolate as much as possible patients with proven or high risk of COVID-19 infection from non COVID-19 patients (red line).

into one of the four following groups depending on their infection status:

- i. Confirmed COVID-19 by a positive test result.
- ii. High-risk of COVID-19: Fulfilling the following criteria: 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 health care workers wear a surgical face mask and re-usable foil-glasses. For terminal disinfection alcohol-based antiseptics are used (i.e. Meliseptol®).

To protect our medical staff and to assure a presence of doctors during the whole pandemic, we do not only apply all the recommended hygienic standards at our institute but go one step further. We split 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 has to supervise the examinations. The two other groups work decentralized at 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 in the main radiology department building.

Discussion

Imaging highly infectious patients during exceptional circumstances requires a well-defined workflow. Recently

published studies emphasized the need of precise management strategies to adequately deal with this swarm of highly infectious patients.^[3, 4] Our concept is mainly based upon a precise triaging of patients and on the use of only one scanner which is not located in 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 triaging into low and high risk for infection is very challenging if not impossible when a high number of patients arrive at the ED. Therefore, initially all patients with fever and/or cough visiting the ED are considered high risk for COVID-19 infection, necessitating maximum protection measures from the beginning. This impacts on the locations to perform imaging with the aim to affect the non-COVID-19 routine as less as possible.

According to our approach we try to avoid performing magnetic resonance imaging (MRI) and ultrasonography (US) in proven or highly suspicious COVID-19 patients. We believe that ultrasonography in SARS CoV-2 positive or highly suspicious patients should be performed as rare as possible, since this modality requires close physical contact being associated with an increased infection risk. We are also very restrained concerning MRI in this patient cohort as CT is the modality providing most relevant information 24/7 and in a fast way, particularly in patients in critical conditions. In most cases MRI can be postponed until proof of recovery.

CT is performed not as a screening nor as a diagnostic tool. CT is performed in these patients only if we believe that the result could lead to a change of patient and therapeutic management (Fig. 2). To avoid unnecessary scans, we insist that radiologists need be informed personally and in detail

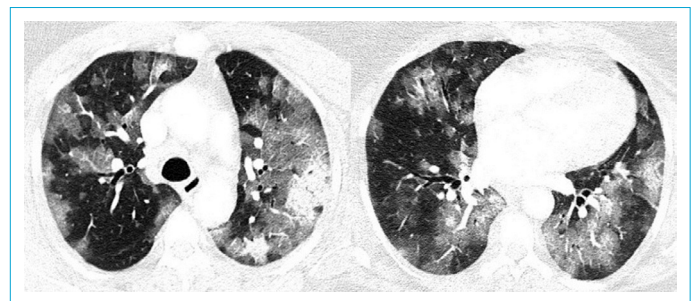


Figure 2. 57-year-old female patient presenting with cough and fever (up to 39°C) for three days. The patient had diabetes type II and arterial hypertension. The patient presented with tachypnoea and an SpO₂ of 68%. As respiratory failure was evolving (Horovitz quotient 65 mmHg), the decision was made 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]

before scheduling the scan. A constant and continuing discussion is the indication for contrast-enhanced chest CT 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 are of utmost importance these days. The Lancet reported that in Italy 20% of responding health care workers were infected and some even died.^[5] Radiology technicians and less so radiologists are among the first-line health care worker being confronted to COVID-19 patients. As correct personal protection and thorough disinfection subsequent to the examinations are time consuming, we reinforced all our involved teams to make sure that all instructions are obeyed. Furthermore, besides the physical exhaustion, potential psychological issues during these difficult times must be considered. To prevent psychological exhaustion or burn-out, our hospital set up a specialized hotline.

It must be emphasized that such discussions and internal guidelines are ever evolving as the optimal strategy is a moving target and needs to adapt always to actual circumstances. At the moment of writing this article, the USZ has not run-out of capacity for both, intensive care unit beds and referred imaging examinations. At later stages of the COVID-19 pandemic, other trade-offs and choices are likely.

Compared with other regions in Europe, the greater Zurich area was relatively little hit by COVID-19 most likely due to the restrictions and social distancing recommendations imposed already early in the course of the 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 at 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 worker was infected by SARS CoV-2 during this 3 months period.

Radiology departments have to be accurately prepared to the COVID-19 pandemic. Procedures regarding strict separation of patient pathways, the availability of imaging modalities and protection measures for exposed healthcare workers have to be clearly defined and decisions need be based on the available resources. Radiologists should consider working partially decentralized to assure the presence of doctors during the entire pandemic. At our hospital, we are confident that with these measures taken we are ready to handle the rush of patients offering them 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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