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Coronavirus disease (COVID-19): observations and lessons from primary medical care at a German community hospital

Martin Schiller[a], Juergen Fisahn[b], Ute Huebner[a], Patrick Hofmann[a], Joerg Walther[a], Susann Riess[a], Christiane Grimm[a], Hansjörg Schwab[a] and Wolfgang Kick[a]

[a]Department of Internal Medicine, Kliniken Hochfranken, Münchberg, Münchberg; [b]Department of Anesthesiology, Kliniken Hochfranken, Münchberg, Germany

ABSTRACT

The pandemic outbreak of COVID-19 challenges medical care systems all around the world. We here describe our experiences during the treatment of COVID-19 patients (n = 42) treated from 2 March 2020 to 16 April 2020 at a German district hospital. Forty-two COVID-19 patients were hospitalized and five patients developed a severe disease, requiring intensive care. Overall, 11 out of 42 hospitalized patients died.

COVID-19 caused lymphocytopenia, as well as increased d-dimer, c-reactive protein and creatine kinase, and lactate dehydrogenase levels. These changes were mostly pronounced in patients that developed a severe disease course. Radiologic findings included ground-glass opacity, bilateral/multilobular involvement, consolidation, and posterior involvement. We compared COVID-19 patients to an average population of 'non-COVID' patients. Interestingly, no laboratory or radiologic finding was specific for COVID-19 when standing alone, as comorbidities of 'non-COVID' patients certainly can mimic similar results.

In common praxis, the diagnosis of COVID-19 is based on a positive PCR result. However, a false-negative result causes problems for the workflow of an entire hospital. In our clinic, the consequences of a false assumption of SARS-CoV-2 negativity in four cases had dramatic consequences, as contact persons had to be quarantined. To avoid this, a comprehensive view of lab-results, radiology, clinical symptoms and comorbidities is necessary for the correct diagnosis or exclusion of COVID-19.

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1. Introduction

COVID-19 is a novel disease caused by the SARS-CoV-2 virus [1,2]. The disease mainly affects the respiratory tract causing hypoxemia, ARDS, and a fatal outcome in some affected individuals [3,4]. Complications include septic shock, secondary infections, acute kidney injury, myocardial damage, coagulopathies, and involvement of the central nervous system [2,4,5].

Since the pandemic outbreak of COVID-19, a variety of studies aimed to identify diagnostic or prognostic markers for this disease [6–9]. Patients` age, sofa score, and d-dimer levels are used as prognostic markers, and other laboratory findings such as lymphocytopenia, lactate dehydrogenase (LDH) or troponin levels seem to be relevant. Typical radiologic findings have been reported, namely ground-glass opacity, posterior involvement of the lung, or bilateral infiltration [10,11].

Now, primary and secondary health care is in the frontline of the COVID-19 pandemic. District and community hospitals are confronted with a large number of patients suffering from severe complications or developing ARDS.

Our clinic (together with other hospitals) provides medical care for a part of northern Bavaria, covering a population of about 100,000 residents. Up to now, there have been 300 COVID-19 positive patients registered in this area. Based on a cohort of 42 COVID-19 patients we report on our clinical observations and problems in the diagnosis and treatment of these patients (treated from 2 March 2020 to 16 April 2020).

2. Methods

This work was conducted at the Kliniken Hochfranken, a community hospital in Germany, north Bavaria. Laboratory and radiologic findings from hospitalized COVID-19 patients, as well as their respective comorbidities were analyzed. Patients' data were further compared to an average collective of 'non-COVID' patients. The diagnosis of COVID-19 was made either based upon a positive PCR-result or based on clinical and radiologic (mostly chest CT) findings (if PCR was negative). Samples for PCR were obtained from throat swabs or qualified sputum. Acute respiratory distress syndrome (ARDS) was diagnosed according to the 2018

CONTACT Martin Schiller martin.schiller@kliniken-hochfranken.de Kliniken Hochfranken, Münchberg, Hofer Straße 40 95213, Münchberg, Germany

Berlin definition. COVID-19 patients treated in our hospital from 2 March 2020 to 16 April 2020 were followed from the time of admission. Mean values and graphs were calculated using microsoft excel software.

3. Results and discussion

When treating COVID-19 patients, a problem we encountered, was to establish a reliable diagnosis and -vice versa- a definitive exclusion of SARS-CoV -2 infection. At first sight, finding the diagnosis by a positive result in the SARS-CoV-2 PCR seems to be quite trivial. Especially, when positive PCR comes up in combination with characteristic symptoms, 'typical' lab findings or x-ray results. However, PCR results and clinical appearance can be misleading. Starting the treatment of COVID-19 patients, we falsely assumed a SARS-CoV-2 negativity in four cases. The consequences for the workflow in the entire hospital were dramatic, as a substantial amount of medical staff members had to be quarantined after having contact with these patients. Thus, we learnt that the correct exclusion of SARS-CoV-2 infection is a matter of topmost priority.

One of these patients (91 years, female) was admitted with fever, dyspnea, peripheral edema, nausea and vomiting. Laboratory results showed an elevated c-reactive protein (CRP), procalcitonin (PCT), and leukocytosis. The chest x-ray was suspicious for cardiac decompensation and beginning pneumonia (Figure 1). After a negative result from the SARS-CoV-2 PCR (throat swab) diuretics plus antibiotic treatment were started. The patient again developed fever and progressive dyspnea and a chest CT-scan showed ground-glass opacities and bilateral infiltrates, which are features of virus-pneumonia (Figure 1) [10,12,13]. Another case (55 years, male) presented with dyspnea, fever and cough. Again, SARS-CoV-2 PCR (throat swab) was negative and chest x-ray showed uncertain peripheral opacities (Figure 1). The patient received antibiotic treatment on a 'normal care unit' without isolation. Due to an impaired oxygen saturation and persistent fever, a CT-scan was performed, showing multilobular infiltrates (Figure 1). The SARS-CoV-2 PCR obtained from a qualified sputum sample came up with a positive result.

Up to now, we followed 42 hospitalized patients from the time of their admission. Twenty-eight (66.7%) patients developed a mild course of the disease and 19 (45.2%) patients have been discharged. Five (11.9%) patients were treated in our intensive care unit, out of which 4 developed an ARDS. Overall, 11 out of 42 hospitalized patients did not survive (26.2%). Table 1 shows the demographics and comorbidities of all patients. Laboratory results showed elevated CRP levels, an elevation of lactate dehydrogenase (LDH) and d-dimers. The most pronounced finding was

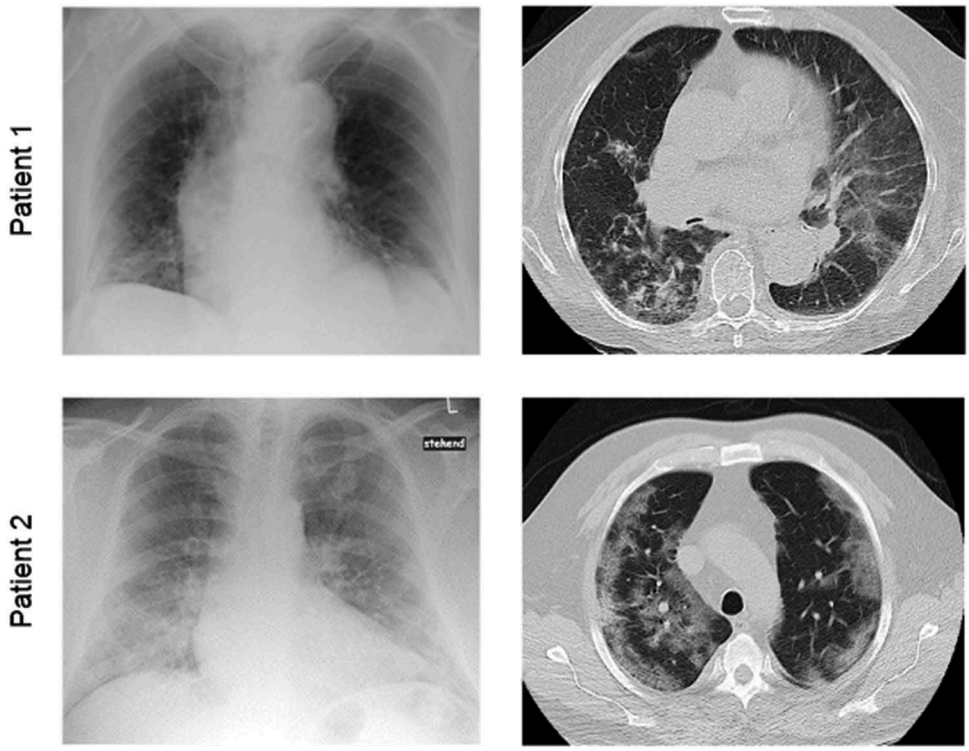

Figure 1. Radiologic findings from two COVID-19 patients that were – by mistake – assumed to be SRAS-CoV-2 negative.

Upper row (Patient 1, 91 years, female): The chest x-ray (shown on the left) was suspicious for cardiac decompensation plus beginning pneumonic infiltrate (basal right). The CT-scan (right side), performed 3 days later on, shows ground-glass opacities, beginning consolidation, and bilateral infiltrates. Patient 2 (55 years, male): Chest x-ray is suspicious for peripheral and basal opacity. The CT-scan revealed multilobular ground-glass opacities with crazy paving.

Table 1. Demographics and clinical characteristics of COVID-19 patients.

	Total	Survivor	Non-survivors
	n = 42	n = 31	n = 11
Demographics:			
Age, years	71.3 (35–94)	67.4 (35–94)	82.3 (61–91)
Sex			
- female	21	17	4
- male	21	14	7
Comorbidities:			
- Hypertension	27 (64.3%)	19 (60.1%)	8 (72.7%)
- Diabetes	16 (38.1%)	11 (35.5%)	5 (45.5%)
- Atrial fibrillation	12 (28.6%)	6 (19.4%)	6 (54.5%)
- Congestive heart failure	10 (23.8%)	5 (16.1%)	5 (45.5%)
- Chronic obstructive lung disease	10 (23.8%)	7 (22.6%)	3 (27.3%)
- Obesity	10 (23.8%)	8 (25.8%)	2 (18.2%)
- Chronic kidney disease	9 (21.4%)	5 (16.1%)	4 (36.4%)
- Dementia	8 (19%)	3 (9.7%)	5 (45.5%)
- Cerebrovascular disease	8 (19%)	3 (9.7%)	5 (45.5%)
- Coronary heart disease	7 (16.7%)	3 (9.7%)	4 (36.4%)
- Malignancy	7 (16.7%)	3(9.7%))	4 (36.4%)
Laboratory findings:			
- C-reactive protein [mg/L]	77	63.4	115.1
- Creatine kinase [U/L]	201.8	172.8	283.7
- Lactate dehydrogenase [U/L]	357.9	278.9	580.7
- Troponin [pg/mL]	26.4	20.5	51.4
- D-dimer [ng/mL]	663	609.8	804.8
- Procalcitonin [ng/mL]	0.54	0.13	0.88
- White blood cell counts [/nL]	6.7	6.5	7.1
- Platelet counts [/nL]	237.2	257.4	180.1
- Lymphocytes [%]	16.3	18.0	11.5
- Lymphocyte count [/nL]	0.92	1.0	0.75
- Neutrophiles [%]	74.3	72.1	80.1
SARS-COV-2 verification:			
PCR-positive (all samples)	37 (88.1%)		
- PCR from throat swab positive	35		
– First throat swab	– 33		
– Second throat swab (if first negative)	– 2		
- Qualified sputum positive (and throat swab negative)	2		
PCR-negative, but suspicious radiologic finding	5 (11.9%)		

a reduction of lymphocyte counts. Interestingly, non-survivors and patients who developed a severe disease course showed a pronounced lymphocytopenia as well as high LDH and d-dimer levels already at the time of their admission (Figure 2(a), Table 1). Radiologic findings were in line with previously described observations, namely ground-glass opacity, bilateral and multilobular involvement, crazy paving, consolidation, and posterior involvement. Chest CT images from three representative cases are shown in Figure 2(b).

Importantly, we compared COVID-19 patients to a population of 'non-COVID' patients that were treated in our hospital. These patients reflect a population with comorbidities, that have an impact on various laboratory findings. The characteristics of these patients are shown in Tables 2 and 3. From this control group, we learnt that some surrogate markers used for COVID-19 diagnosis, are also present in an average patient population. The laboratory results obtained from these control patients (in comparison with COVID-19 patients) are shown in Figure 3 (scatter graphs) and in Table 2 (mean values).

Compared to control patients, the reduction of absolute lymphocyte counts, as well as CRP, creatinine kinase (CK), LDH, and d-dimer elevation were highly frequent in COVID-19 patients and mostly pronounced in patients developing a severe course of the disease.

Five patients developed a severe disease course and had to be treated in our intensive care unit (ICU). Among these, four patients developed an ARDS and were treated according to the respective German and international recommendations [14–17]. Two of the ICU-patients had a fatal outcome. In one case, mechanical ventilation was not initiated due to the patient's will, the other patient died after asystolic heart arrest (d11 from hospitalization). We observed a considerable increase in d-dimer levels in all critically ill patients and these patients developed a peak in CRP, pCO2 and PCT levels during ICU treatment. Eighty percent (4/5) of the critically ill patients needed mechanical ventilation and prone positioning. Sixty percent (3/5) developed an anuric kidney failure and required hemofiltration. Figure 4(a) shows the time course of laboratory values (three patients, which are currently treated at our ICU are shown). Figure 4(b) shows the development of chest-CT-findings (two

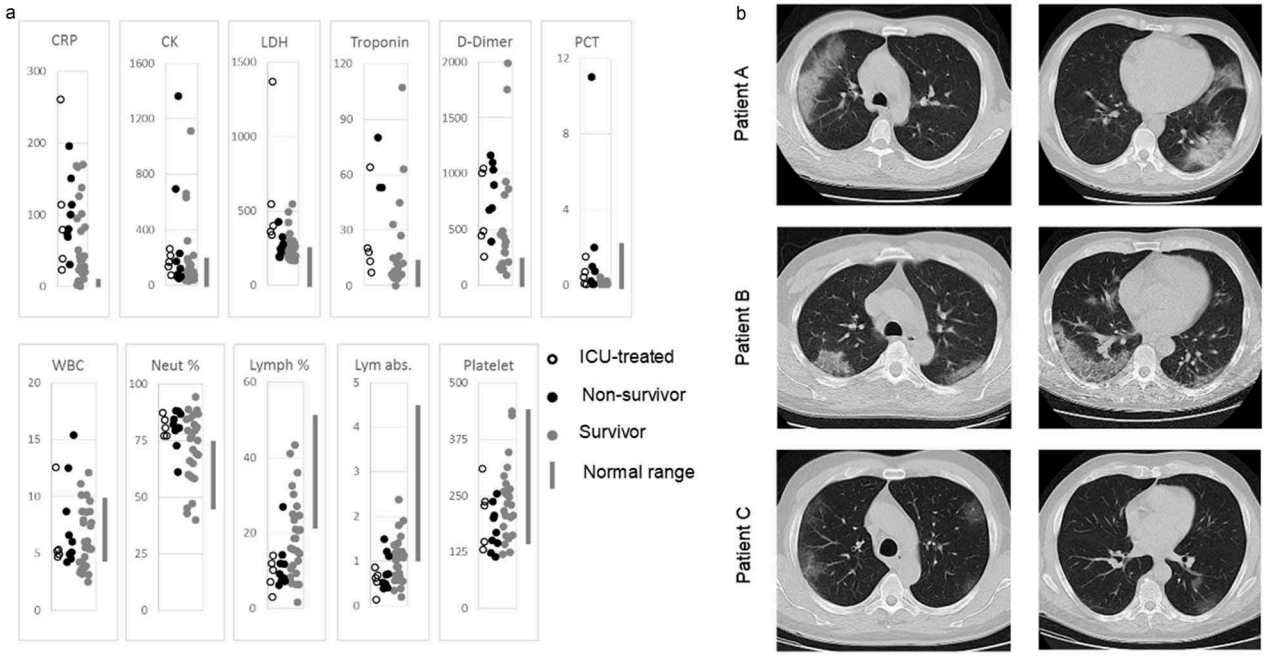

Figure 2. Laboratory results and CT-scans obtained from COVID-19 patients.

(a) The quantitative laboratory values are shown on the respective x-axes. C-reactive protein (CRP, mg/L), creatine kinase (CK, U/L), lactate dehydrogenase (LDH, U/L), troponin (pg/mL), d-dimer (ng/mL), procalcitonin (PCT, ng/mL), white blood cell counts (WBS, count/nL), percentage of neutrophils (Neut %), percentage of lymphocytes (Lymph %), absolute lymphocyte counts (Lymph abs., count/nL), and platelet counts (Platelet, counts/nL) are depicted. Grey dots represent survivors and black dots represent deceased patients. Blank dots represent patients who had to receive intensive care treatment. Grey bars, shown on the right of each diagram, indicate the respective normal ranges. (b) Patient A and patient B show bilateral/multilobular ground glass opacity, beginning consolidation and crazy paving. Posterior and peripheral involvement is found in both patients. Patient C shows discrete ground-glass opacities in the lung-periphery, again bilateral involvement is seen.

Table 2. Demographics and clinical characteristics of control patients.

	Total
	n = 50
Demographics:	
Age, years	69.4 (33–87)
Sex	
- female	25
- male	25
Deceased	6 (12%)
Comorbidities:	
- Hypertension	28 (56%)
- Diabetes	15 (30%)
- Atrial fibrillation	10 (20%)
- Congestive heart failure	14 (28%)
- Chronic obstructive lung disease	10 (20%)
- Obesity	11 (22%)
- Chronic kidney disease	10 (20%)
- Dementia	9 (18%)
- Cerebrovascular disease	8 (16%)
- Coronary heart disease	7 (14%)
- Malignancy	8 (16%)
Relevant acutal diagnoses:	
- Myocardial infarction	1 (Troponin: 85 pg/mL)
- Leg vein thrombosis	1 (D-dimer: 1450 hg/mL)
- Septic shock	2 (C-reactive protein: 262.3 mg/L; 256 mg/L)

Table 3. Comparison of laboratory results between controls and COVID-19 patients.

	'Non-COVID' patients	COVID-19 patients
	n = 50	n = 42
Laboratory results:		
- C-reactive protein [mg/L]	30.7	77
- Creatine Kinase [U/L]	117.7	201.8
- Lactate Dehydrogenase [U/L]	268.3	357.9
- Troponin [pg/mL]	25.8	26.4
- D-dimer [ng/mL]	409.6	663
- Procalcitonin [ng/mL]	0.64	0.54
- White blood cell counts [/nL]	9.0	6.76.7
- Platelet counts [/nL]	268.9	237.2
- Lymphocytes [%]	21.9	16.3
- Lymphocyte count [/nL]	1.9	0.92
- Neutrophils [%]	65.6	74.3

patients with ARDS on day 1 and day 15 from admission are shown).

From these cases, we learnt that the diagnosis or the exclusion of COVID-19 cannot be made on the basis of a single laboratory or x-ray result. According to some authors, the sensitivity of PCR from throat samples is below 90%, and somewhat higher in samples obtained from lower respiratory tract. Chest CT has a good sensitivity, if specific radiologic findings are present [3,7,12,18]. Laboratory results are helpful and especially lymphopenia, CRP, d-dimer, CK and LDH elevations are found in COVID-19 patients [7,19]. However, many comorbidities can mimic these laboratory changes and the relevance of other

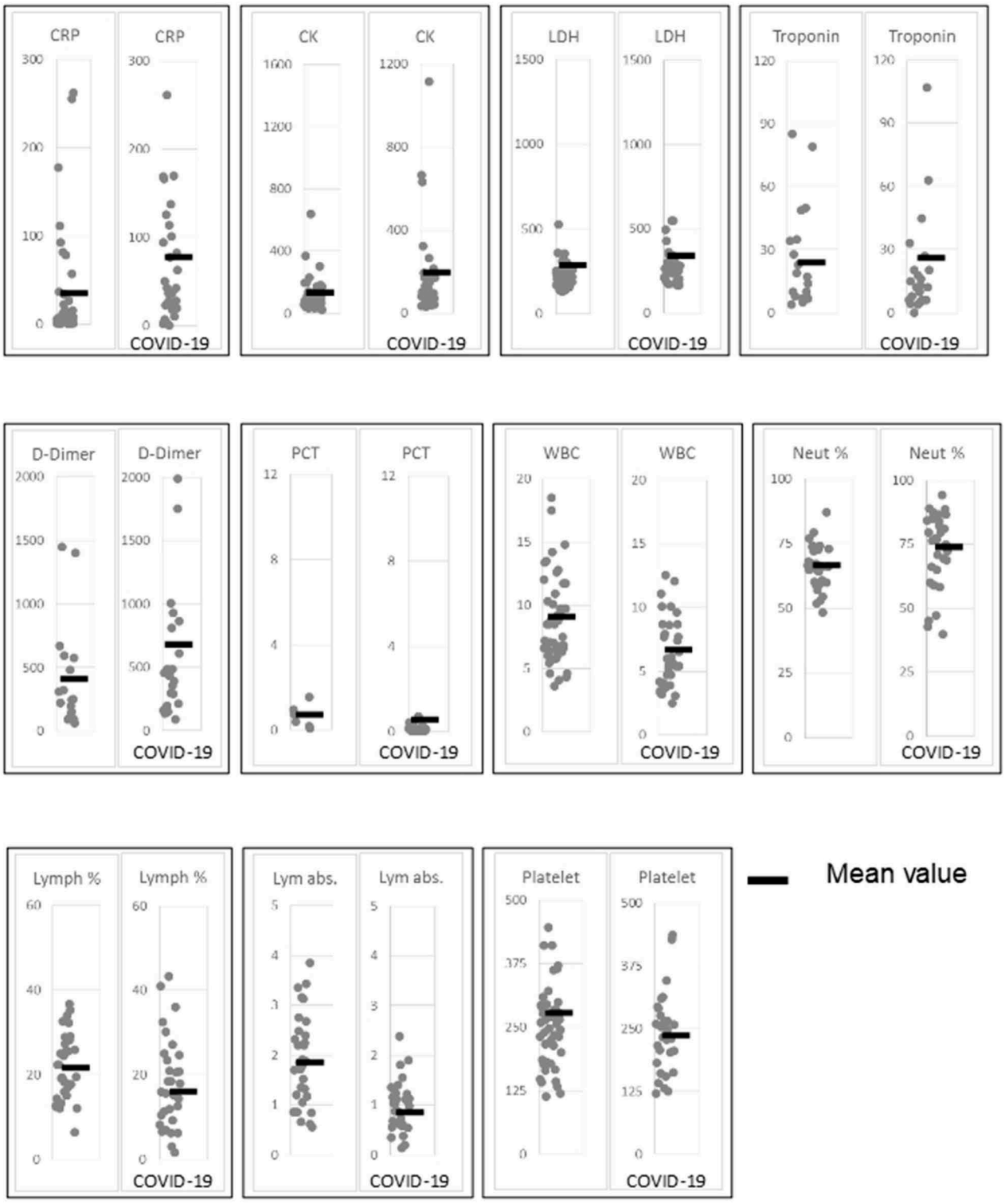

Figure 3. Comparison of laboratory results obtained from hospitalized 'non-COVID' patients and COVID-19 patients treated in our hospital.

Each diagram shows results obtained from 'non-COVID' patients on the left side. COVID-19 patients are shown on the right. C-reactive protein (CRP, mg/L), creatine kinase (CK, U/L), lactate dehydrogenase (LDH, U/L), troponin (pg/mL), d-dimer (ng/mL), procalcitonin (PCT, ng/mL), white blood cell counts (WBS, count/nL), percentage of neutrophils (Neut %), percentage of lymphocytes (Lymph %), absolute lymphocyte counts (Lymph abs., count/nL), and platelet counts (Platelet, counts/nL) are depicted. Black bars show mean values.

diagnoses must not be underestimated. Thus, a comprehensive view of lab-results, radiology, and clinical symptoms has to be made for the diagnosis or exclusion of COVID-19. In order to ensure the workflow and function of our primary and secondary medical care systems, a reliable identification of SARS-CoV-2 positive patients is necessary. If there is any (only the slightest) doubt about SARS-CoV-2 negativity the respective patient should be quarantined on an isolation ward. In current praxis,

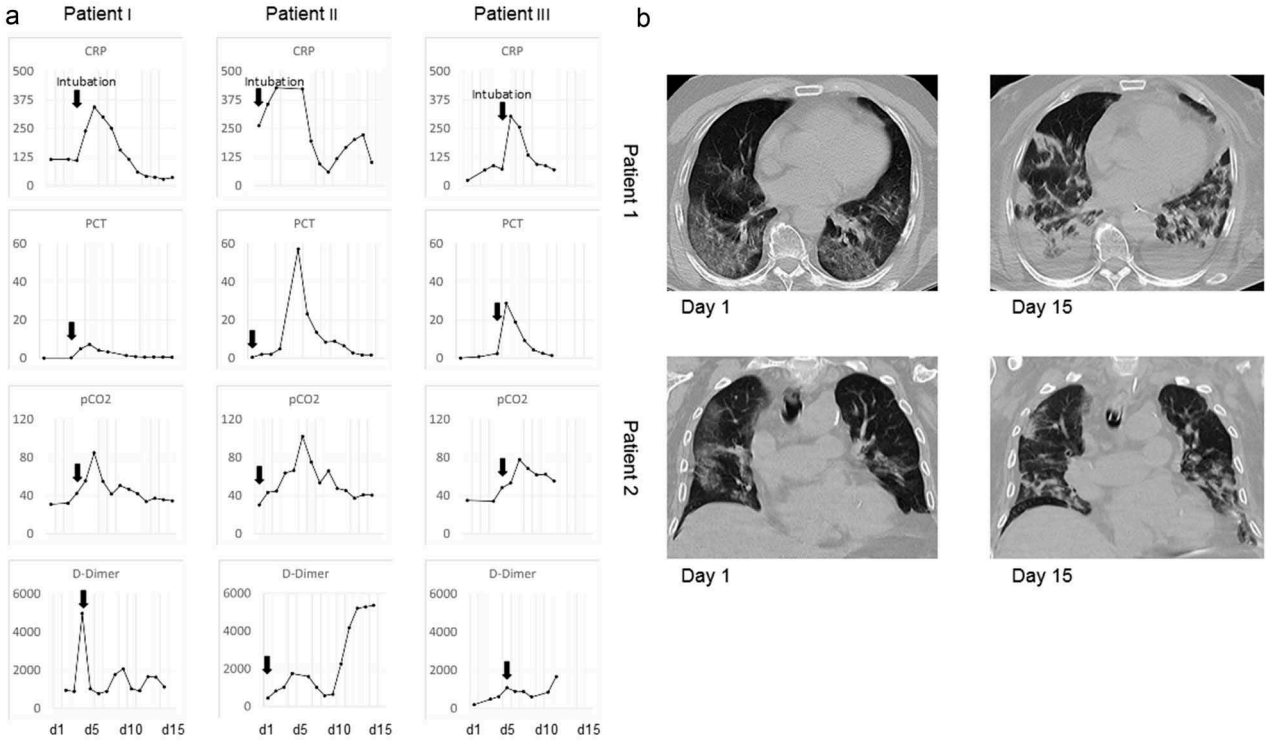

Figure 4. Time course of laboratory results and CT-findings obtained from ARDS patients.

(a) The time course of quantitative laboratory results is shown. C-reactive protein (CRP, mg/L), procalcitonin (PCT, ng/mL), pCO2 (mmHg), and d-dimer (ng/mL) levels are depicted. The time of endotracheal intubation is indicated by a black arrow. (b) CT-scans obtained from two respective patients on day 1 and day 15 from admission are shown. Over time, a worsening of CT-findings is observed and a consolidation and spreading of pneumonic infiltrations is found.

a notification to the health department is to be made, if COVID-19 diagnosis is confirmed by PCR. However, clinicians have to be aware that negative PCR results cannot completely rule out a SARS-CoV -2 infection.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

[1] Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020 Feb 24. DOI:10.1001/jama.2020.2648.

[2] Wu F, Zhao S, Yu B, et al. A new coronavirus associated with human respiratory disease in China. Nature. 2020 Mar;579(7798):265–269..

[3] Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet Lond Engl. 2020 Feb 15;395 (10223):497–506.

[4] Young BE, Ong SWX, Kalimuddin S, et al. Epidemiologic features and clinical course of patients infected with SARS-CoV-2 in Singapore. JAMA. 2020 Mar 3. DOI:10.1001/jama.2020.3204.

[5] Baig AM, Khaleeq A, Ali U, et al. Evidence of the COVID-19 virus targeting the CNS: tissue distribution, host-virus interaction, and proposed neurotropic mechanisms. ACS Chem Neurosci. 2020 Apr 1;11 (7):995–998.

[6] Vuorio A, Watts GF, Kovanen PT. Familial hypercholesterolemia and COVID-19: triggering of increased sustained cardiovascular risk. J Intern Med. 2020 Apr 3. DOI:10.1111/joim.13070.

[7] Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet Lond Engl. 2020 Mar 28;395 (10229):1054–1062.

[8] Wang L, He W, Yu X, et al. Coronavirus disease 2019 in elderly patients: characteristics and prognostic factors based on 4-week follow-up. J Infect. 2020 Mar 30. DOI:10.1016/j.jinf.2020.03.019.

[9] Guo T, Fan Y, Chen M, et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). JAMA Cardiol. 2020 Mar 27. DOI:10.1001/jamacardio.2020.1017.

[10] Ye Z, Zhang Y, Wang Y, et al. Chest CT manifestations of new coronavirus disease 2019 (COVID-19): a pictorial review. Eur Radiol. 2020 Mar 19. DOI:10.1007/s00330-020-06801-0.

[11] Lei J, Li J, Li X, et al. CT imaging of the 2019 novel coronavirus (2019-nCoV) pneumonia. Radiology. 2020 Apr;295(1):18.

[12] Li Y, Xia L. Coronavirus disease 2019 (COVID-19): role of chest CT in diagnosis and management. AJR Am J Roentgenol. 2020 Mar 4:1–7. DOI:10.2214/AJR.20.22954.

[13] Dai H, Zhang X, Xia J, et al. High-resolution chest CT features and clinical characteristics of patients infected with COVID-19 in Jiangsu, China. 2020 Apr 6. Int J Infect Dis. 2020 Jun; 95: 106–112. doi: 10.1016/j.ijid.2020.04.003.

[14] Alhazzani W, Moller MH, Arabi YM, et al. Surviving sepsis campaign: guidelines on the management of critically Ill adults with coronavirus disease 2019 (COVID-19). Crit Care Med. 2020 Mar 27. DOI:10.1097/CCM.0000000000004363.

[15] Jin Y-H, Cai L, Cheng Z-S, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). Mil Med Res. 2020 Feb 6;7(1):4.

[16] Kluge S, Janssens U, Welte T, et al. [Recommendations for critically ill patients with COVID-19]. Med Klin Intensivmed Notfallmedizin. 2020 Apr 14:1–4. DOI:10.1007/s00063-020-00689-w. [Epub ahead of print].

[17] Thomas-Ruddel D, Winning J, Dickmann P, et al. [Coronavirus disease 2019 (COVID-19): update for anesthesiologists and intensivists March 2020]. Anaesthesist. 2020 Apr;69(4):225–235.

[18] Feng H, Liu Y, Lv M, et al. A case report of COVID-19 with false negative RT-PCR test: necessity of chest CT. Jpn J Radiol. 2020 May;38(5):409-410. DOI:10.1007/s11604-020-00967-9. Epub 2020 Apr 7.

[19] Wu C, Chen X, Cai Y, et al. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA Intern Med. 2020 Mar 13. DOI:10.1001/jamainternmed.2020.0994.