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

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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
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 reverse 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](image.png)

**Figure 1.** Radiologic findings from two COVID-19 patients that were – by mistake – assumed to be SARS-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.
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

| 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 [×10⁹/L] | 6.7 | 6.5 | 7.1 |
| - Platelet counts [×10⁹/L] | 237.2 | 257.4 | 180.1 |
| - Lymphocytes [%] | 16.3 | 18.0 | 11.5 |
| - Lymphocyte count [×10⁹/L] | 0.92 | 1.0 | 0.75 |
| - Neutrophiles [%] | 74.3 | 72.1 | 80.1 |
| SARS-COV-2 verification: | | |
| PCR-positive (all samples) | 37 (88.1%) | 35 | |
| - PCR from throat swab positive | 35 | 33 | |
| - First throat swab | 35 | 33 | |
| - Second throat swab (if first negative) | 2 | 2 | |
| - Qualified sputum positive (and throat swab negative) | 2 | 2 | |
| PCR-negative, but suspicious radiologic finding | 5 (11.9%) | 5 | 5 |
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
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,
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.

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