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Letter to the Editor

Emerging key laboratory tests for patients with COVID-19

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Listed below are six key laboratory tests/areas that have an important role in monitoring patients with COVID-19 with specific tests/scores highlighted in Table 1. Additional resources for laboratory related testing may be found at the International Federation of Clinical Chemistry and Laboratory Medicine website (IFCC Information Guide on COVID-19: https://www.ifcc.org/ifcc-news/2020–03-26-ifcc-information-guide-on-covid-19/).

1. **Complete blood count (CBC) with differential**
   The three CBC findings of poor prognosis are: leukocytosis, thrombocytopenia, and lymphocytopenia [1–3]. Lymphocytopenia occurs across populations regardless of co-infection. Whether poor prognosis is associated with lymphocytopenia below the reference interval or absolute count is unclear.
2. **Acute phase response and inflammatory biomarkers**
   COVID-19 patients have high concentrations of the acute phase response proteins (i.e., c-reactive protein [CRP] and ferritin) and inflammatory biomarkers (i.e., cytokines such as Interleukin-6; IL-6) at admission [1,2]. CRP is more widely available, and is a sensitive biomarker of inflammation and tissue damage that is increased at admission and during hospitalization [2,4].
3. **Kidney, liver and cardiac injury**
   Kidney injury prevalence (via creatinine measurement) at admission is unknown but 11–15% of hospitalized COVID-19 patients may have acute kidney injury [1,2]. Alanine aminotransferase (ALT) elevations at admission range from 22% to 32% and cardiac injury (via cardiac troponin measurement) has been reported to range from 15% to 44% [1–3]. Other liver biomarkers are reported to be increased; however, ALT is more specific for liver injury and is also less affected by pre-analytical factors such as hemolysis.
4. **Tests which may indicate improvement**
   Following recovery and 7-days post-convalescent plasma transfusion, CRP levels decreased by > 10-fold, which was more pronounced than IL-6 and procalcitonin (~2-fold difference) [4]. Procalcitonin is a useful indicator for bacterial infections, though not all patients with COVID-19 have bacterial co-infections [3,4].
5. **Prognostic biomarkers**
   D-dimer and high-sensitivity cardiac troponin can also identify COVID-19 patients who are at low- and high-risk for death [1,2,5]. D-dimer is used in decision making for disseminated intravascular coagulation, deep vein thrombosis or pulmonary embolism and is given a high priority of testing in patients with COVID-19 [5]. While

Table 1
Emerging key laboratory tests for patients with COVID-19.

Laboratory Test	Role in COVID-19
Lymphocyte count	• At least 75% of patients have a count $< 1.5 \times 10^9$/L [1–3]. • Patients with persistently low counts during hospitalization have a poor prognosis [1].
C-reactive protein (CRP)	• CRP median concentrations differ between non-survivors (n = 113) versus survivors (n = 161) (113 mg/L vs. 26 mg/L) as does ferritin (1418 μg/L vs. 481 mg/L) and IL-6 (72 ng/L vs. 13 ng/L) [2]. • Before convalescent plasma transfusion the median CRP concentration in 5 COVID-19 patients was 163 mg/L and at 12-days post-transfusion with no virus detected the median CRP concentration was 6 mg/L [4]. Of note, CRP concentrations < 10 mg/L typically indicate no appreciable acute phase response.
Alanine Aminotransferase (ALT)	• Using an overall cutoff of > 40 U/L approximately 30% of COVID-19 patients had liver injury at admission [1,3]. • The rate of liver injury could be higher in females as the upper limit of normal is typically lower in females as compared to males.
D-dimer	• At admission 50% of patients who survived had concentrations < 0.6 μg/mL while the non-survivors at least 75% had concentrations > 1.3 μg/mL [1,2].
High-sensitivity cardiac troponin	• At admission, 50% of the survivors had a high-sensitivity cardiac troponin I concentration ≤3 ng/L (a low normal level) [1,2].
Clinical Scores	• Creatinine, total bilirubin, pO_2 and platelet count are used for the SOFA (sequential organ failure assessment) score; while urea is used for the CURB-65 (confusion, urea, respiratory rate, blood pressure and age ≥65 years) score [1]. Lactate levels are also used to identify septic shock.

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for high-sensitivity cardiac troponin, normal or low concentrations (typically below 5 ng/L, but cutoffs are assay specific) identifies patients at low-risk for cardiovascular outcomes and death in many different populations, including COVID-19 patients [1,2].

6. **Clinical scores**
   Two clinical scores that may also identify patients with COVID-19 at low- and high-risk for death are the sequential organ failure assessment (SOFA) score used in sepsis and the confusion, urea, respiratory rate, blood pressure, and age ≥65 years (CURB-65) score in the assessment of severity in patients with community acquired pneumonia. Both clinical scores require laboratory testing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clinbiochem.2020.04.008.

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