Diagnostic Pathology: Open Access
ISSN: 2476-2024

Jackson and Zeigler. Diagn Pathol Open 2020, 5:4

Case Series Open Access

Important Considerations in Rapidly Fatal COVID-19 Infections

Nicole R Jackson* **and Karen Zeigler**

Office of the Medical Investigator, University of New Mexico, Albuquerque, New Mexico, United States of America

Abstract

Despite the massive toll the latest member of the *Coronaviridae* family has taken on the world, much remains unknown about SARS-CoV-2 infection and resultant COVID-19 disease. Herein we present three cases of rapidly fatal SARS-CoV-2 infection diagnosed at autopsy examination and discuss important aspects of each including important clinical and public health implications.

Keywords: COVID-19; Autopsy; Forensic pathology; Therapeutics; New Mexico

Introduction

Originating in Wuhan, the capital of the Hubei Province in the People's Republic of China, in December 2019, SARS-CoV-2 has since traveled to every corner of the Earth [1]. Over the past eight months, it has infected over 27.4 million people globally, resulting in more than 890,000 deaths and impacting the lives of millions more [2]. While COVID-19 has been compared to respiratory diseases like the flu and other members of the *Coronaviridae* family, its pathogenicity has yet to be fully elucidated. Despite being considered a respiratory virus, severe SARS-CoV-2 infection appears to extend beyond the lungs to affect other organ systems [3-5].

Throughout the COVID-19 pandemic, the Office of the Medical Investigator (OMI) in Albuquerque, New Mexico, United States has been able to perform full autopsy examinations on those who died outside of medical care in which COVID-19 was suspected to contribute to death. Three of these cases were selected that best represent rapidly fatal COVID-19 infection and worrisome sequela of infection.

Methods

Decedents who died outside of medical care in the state of New Mexico were brought to the OMI for further examination by trainees in Anatomic and Clinical Pathology, Forensic Pathology, and/or board-certified Forensic Pathologists. All postmortem examinations were conducted in a biosafety level 3 laboratories in one of four isolation suites. All pathologists, trainees, and morphology technicians who were involved in handling the body wore proper personal protective equipment (PPE) including surgical gowns, shoe covers, and double pairs of gloves. N-95 respirators were worn in conjunction with some form of eye protection or a reusable Powered Air Purifying System (PAPR) was worn.

All decedents underwent a full autopsy examination consisting of removal and examination of all organs of the thorax, abdomen, pelvis, and cranial vault, as well as assessment of soft tissue and bone by both visual inspection and by postmortem computed tomography. Included in this assessment was swabbing of the nasopharynx and lungs for viral and bacterial studies.

As per 45 CFR 46, decedents are not considered human subjects and are not subject to Institutional Review Board oversight.

Case Series

Case 1: Characteristic pulmonary infection

An 82-year-old woman with a history of obesity and hypertension reported a severe cough, backache, chest pain, and sore throat before becoming unresponsive at home. She was unable to be resuscitated and was transported to the OMI for a postmortem examination to determine her cause of death.

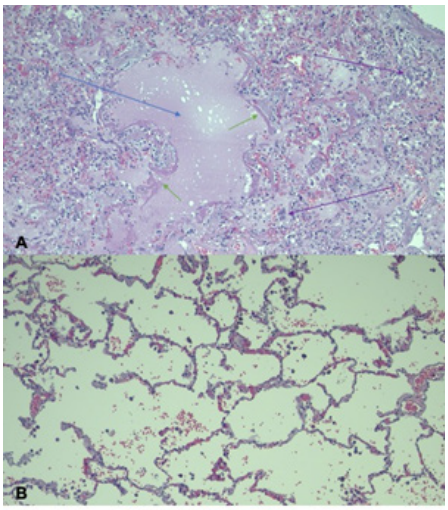

Figure 1: Microscopic examination of the lungs of a classic fatal COVID-19 lung infection. A: The lungs of the decedent showed classic histologic changes seen in the proliferative phase of diffuse alveolar damage characterized by thick densely eosinophilic hyaline membrane formation on the alveolar walls (green arrows), type II pneumocyte hyperplasia with sloughing (purple arrows), and pulmonary edema (blue arrow) (H&E 20X). B: By contrast, the lungs of a decedent who died of a drug overdose showed relatively empty alveolar spaces with only a few scattered hemosiderin-laden macrophages, intact intra-alveolar erythrocytes, and ample room for air.

***Corresponding author:** Dr. Nicole R. Jackson, M.D., M.P.H., Assistant Medical Examiner, Cook County Medical Examiner's Office, 2121 W. Harrison St., Chicago, IL 60612, USA, Tel: (+1) 312-997-3041; Fax: (+1) 312-997-4544; E-mail: Nicole.Jackson2@cookcountyil.gov

Received: September 15, 2020; **Accepted:** September 29, 2020; **Published:** October 06, 2020

Citation: Jackson NR, Zeigler K (2020) Important Considerations in Rapidly Fatal COVID-19 Infections. Diagn Pathol Open 5: 175.

Macroscopic examination of the lungs revealed severely edematous lungs, with the right lung weighing 690 grams and the left lung weighing 525 grams. Microscopic examination revealed diffuse alveolar damage characterized by diffuse hyaline membrane formation, pulmonary edema, type II pneumocyte hyperplasia, and numerous intra-alveolar macrophages. Postmortem infectious disease studies were significant for SARS-CoV-2 isolation from samples of the nasopharynx and both lungs (Figure 1).

Case 2: Thrombotic complication

A 58-year-old woman with a history of chronic ethanol abuse reported lethargy, rapid breathing, decreased oral intake, dry heaving, upper abdominal pain, and weakness for days before becoming unresponsive at home. She was unable to be resuscitated and was transported to the OMI for a postmortem examination to determine her cause of death.

On macroscopic examination, the lungs were diffusely edematous-the right lung weighed 730 grams and the left lung weighed 630 grams. Sectioning of the lungs revealed multiple small, subsegmental pulmonary thromboemboli in both lungs. Microscopic examination of the lungs revealed diffuse alveolar damage in the proliferative phase. Postmortem infectious disease studies were significant for SARS-CoV-2 isolation from samples of the nasopharynx and both lungs (Figure 2).

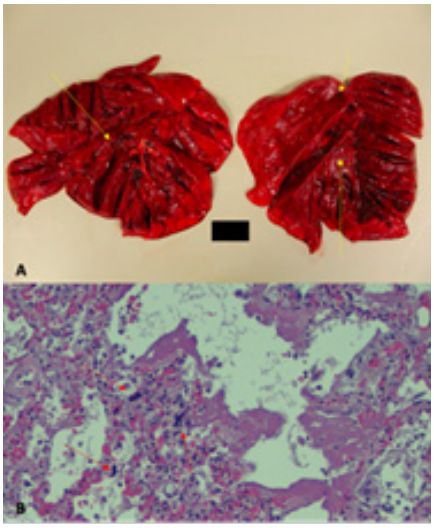

Figure 2: Examination of the lungs of a decedent found to have developed thrombotic complications in a fatal COVID-19 infection. A: Macroscopic examination of the lungs demonstrated numerous small-caliber, subsegmental pulmonary thromboemboli in severely edematous lungs (yellow arrows). B: Microscopic examination revealed hyaline membrane formation, type II pneumocyte hyperplasia, as well as an increased presence of interstitial megakaryocytes (red arrows) (H&E 20X).

Case 3: Bacterial co-infection

A 62-year-old homeless man with a history of chronic ethanol abuse was found unresponsive. He was unable to be resuscitated and was transported to the OMI for a postmortem examination to determine his cause of death.

On macroscopic examination, the lungs were severely edematous. The right lung weighed 1325 grams and the left lung weighed 725 grams, both exhibiting severe pulmonary edema, with consolidation observed in the right lower lung lobe. Microscopic examination of the lungs revealed diffuse alveolar damage consisting of hyaline membrane formation and intra-alveolar fibrin as well as acute inflammation and basophilic diplococci (Figure 3).

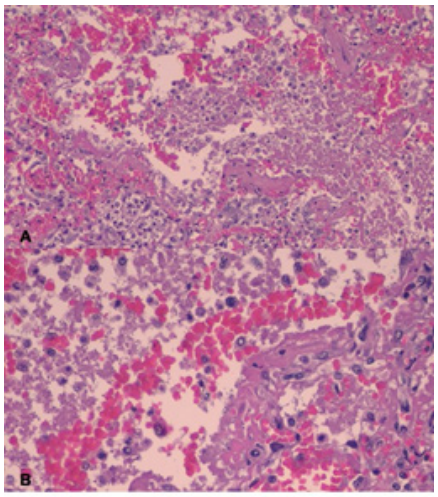

Figure 3: Microscopic examination of the lungs of a decedent with a fatal COVID-19 and *Streptococcus pneumoniae* co-infection. A: Scattered eosinophilic hyaline membrane formation, an abundance of intra-alveolar fibrin deposition, inflammatory cells, and intra-alveolar hemorrhage were seen on low-power microscopy (H&E 20X). B: A high-power view additionally demonstrated small basophilic-staining diplococci associated with a neutrophilic inflammatory infiltrate (H&E 40X).

Postmortem infectious disease studies detected SARS-CoV-2 from samples of the nasopharynx and both lungs as well as *Streptococcus pneumoniae* growth in bacterial lung cultures.

Discussion

These cases demonstrate the rapidity with which COVID-19 infection can lead to death. Two of the decedents exhibited symptoms for only a few days, yet were found to have severe findings on microscopy, and died at home without reaching medical care. Information pertaining to the circumstances surrounding death is lacking in the third case as he was homeless and unknown to the bystanders that discovered his body.

The differential for diffuse alveolar damage (DAD) is long, encompassing infection, drug reactions, trauma, inhalants, autoimmune diseases, and collagen vascular diseases [6]. The most common microscopic correlate to the clinical diagnosis of acute respiratory distress syndrome, DAD, can also be induced as a form of ventilator-associated lung injury-an important association to recognize as most published series of COVID-19 autopsy findings consist of people who received in-patient hospital management including intubation with mechanical ventilation [7-9]. Notably, all three of the individuals presented here showed some degree of diffuse alveolar damage on microscopy, reinforcing this process as being an early development in severe COVID-19 cases.

In one decedent, pulmonary thromboemboli were seen with a corresponding increase in interstitial megakaryocytes in the lungs, speaking to the need to investigate anti-thrombotic agents as early intervention in cases of severe infection. In another case, florid co-infection was seen with *Streptococcus pneumoniae*, the most common cause of secondary bacterial infections following viral pneumonia. This microorganism has a history of increasing morbidity and mortality during previous influenza epidemics [4,10]. Many of the same conditions that predispose people to Streptococcus infection

are conditions that predispose to COVID-19 morbidity and mortality including chronic conditions such as heart, lung, and liver disease and poorly controlled diabetes. As winter, influenza season, and a possible second-wave of COVID-19 cases approaches, it is prudent that those at highest risk of *Streptococcus pneumoniae* infection are vaccinated.

Conclusion

SARS-CoV-2 pulmonary infection can be rapidly fatal with thrombotic events and bacterial co-infection seen as possible early complications. This series highlights the need for further research into anti-thrombotics as early treatment and for vigilant campaigns for both influenza and pneumococcal vaccinations in all high-risk groups.

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, et al. (2020) A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 382: 727-733.
2. World Health Organization (2020) WHO Coronavirus Disease (COVID-19) dashboard.
3. Pirzada A, Mokhtar AT, Moeller AD (2020) COVID-19 and myocarditis: What do we know so far? CJC Open 2: 278-285.
4. Rapkiewicz AV, Mai X, Carsons SE, Pittaluga S, Kleiner DE, et al. (2020) Megakaryocytes and platelet-fibrin thrombi characterize multi-organ thrombosis at autopsy in COVID-19: A case series. E Clinical Medicine 24: 100434.
5. Baig AM, Khaleeq A, Ali U, Syeda H (2020) Evidence of the COVID-19 Virus Targeting the CNS: Tissue distribution, host-virus interaction, and proposed neurotropic mechanisms. ACS Chem Neurosci 11: 995-998.
6. Hughes KT, Beasley MB (2017) Pulmonary manifestations of acute lung injury: More than just diffuse alveolar damage. Arch Pathol Lab Med 141: 916-922.
7. Fox SE, Akmatbekov A, Harbert JL, Li G, Quincy Brown J, et al. (2020) Pulmonary and cardiac pathology in African American patients with COVID-19: An autopsy series from New Orleans. Lancet Respir Med 8: 681-686.
8. Sauter JL, Baine MK, Butnor KJ, Buonocore DJ, Chang JC, et al. (2020) Insights into pathogenesis of fatal COVID-19 pneumonia from histopathology with immunohistochemical and viral RNA studies. Histopathology.
9. Morris DE, Cleary DW, Clarke SC (2017) Secondary bacterial infections associated with influenza pandemics. Front Microbiol 8:1041.
10. Brundage JF (2006) Interactions between influenza and bacterial respiratory pathogens: Implications for pandemic preparedness. Lancet Infect Dis 6: 303-312.