Complications from COVID-19 – *Not for the faint of heart*
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Anytime a person suffers a health event there is always the risk for complications. For example, if you are walking through the living room and bump your leg into the coffee table, you will get a superficial bruise. You may not have any complications at all. But, if you also get a tiny cut on your shin from the corner of the coffee table and bacteria that normally live on the skin get into the cut, you will develop a complication in the form of a skin infection (cellulitis). If you are on blood thinners, you may bleed more than the average person and develop the complication of a deeper, lumpy, more painful bruise called a hematoma.

The same is true for COVID-19. When an individual gets the virus, they may or may not go on to develop complications. Some of the complications are more likely than others and some of them are temporary while others may become permanent.

The most common complications of COVID-19 are the development of blood clots and low oxygen levels. Patients can form blood clots in the veins or arteries anywhere in the body. The most common locations are in their legs (deep vein thrombosis or DVT) and lungs (pulmonary embolism or PE.) Some patients who get blood clots need to be on blood thinners, like Warfarin, Xarelto or Eliquis, for months while others need them for the rest of their lives. COVID-19 disrupts the iron in patient's red blood cells, making it harder for their blood to carry oxygen from their lungs to the organs of their body, resulting in low oxygen levels.

The complications affecting the heart, kidney, liver and neurologic organs (brain, spine and nerves) are moderately common, and not as common as blood clots or low oxygen levels. Pertaining to the heart, complications include damage to the heart muscles (acute myocardial injury), abnormal heart rhythms (arrhythmias), and/or a decrease in the effectiveness of the heart's ability to pump blood (cardiomyopathy). When the kidneys are affected, blood flow to the kidneys is diminished resulting in injury that can progress to kidney failure. If it progresses to severe kidney failure, a patient would need dialysis at least temporarily. If the kidneys do not recover, the patient would need dialysis permanently or a kidney transplant. Patients can also sustain acute liver injury and liver failure although the reasons why are not completely understood. Unfortunately, dialysis for livers is not readily available, so patients with permanent liver failure would need a transplant. There are many, many neurologic complications. Some of them include hearing loss, strokes, unsteadiness (ataxia), seizures, numbness and tingling in the hands and feet (neuropathy), fatigue, impaired consciousness (delirium), meningitis/encephalitis, psychosis (seeing and hearing things that don't exist), and dementia-like syndromes.

Less common complications include lung complications, septic shock, other abnormal bleeding problems, and inflammatory conditions. In terms of the lungs, patients can develop pneumonia when the air sacs (alveoli) become inflamed and fill with pus. These warm moist air sacs can then serve as a breeding ground for bacteria resulting in a secondary pneumonia. When the air sacs (alveoli) in the lungs can no longer effectively exchange oxygen and carbon

dioxide, patients develop acute respiratory failure. If patients don't get better, they progress to a condition called Acute Respiratory Distress Syndrome (ARDS) where the lungs are so severely damaged that they begin to fill with fluid from leaky blood vessels.

As a patient's body tries to fight the COVID-19 infection it releases chemicals to fight the infection. These chemicals can cause a person's blood pressure to drop and they can go into shock which leads to multi-organ failure, including kidney and liver failure as discussed above. There is another condition that we see with severe COVID-19 infection as with other severe infections called disseminated intravascular coagulation (DIC). DIC is a disorder of the blood clotting system that results in abnormal clots, which can lead to internal bleeding and organ failure. Rhabdomyolysis can also occur causing muscle cells to break down and die. When the cells die, they fall apart releasing a protein called myoglobin that floods the patient's bloodstream and clogs the kidneys.

Children have been experiencing a new syndrome named Multisystem Inflammatory Syndrome in Children (MIS-C). It is associated with COVID-19 though the biomedical association is unclear and it presents with fever, abdominal pain, vomiting, diarrhea, rash, headache, and confusion. This syndrome is similar to toxic shock syndrome or Kawasaki disease as it also causes blood vessels to become inflamed.

The long-term side effects of COVID-19 include lung fibrosis, heart damage, loss of function from strokes, high blood pressure in the lungs from blood clots, kidney damage, liver damage, male infertility, hearing loss, and fatigue. Specifically, Post COVID Lung Fibrosis is a form of irreversible lung damage and scarring that occurs in the young and old. It is caused by the blood clots blocking blood from circulating to parts of the lung and from the immune systems response to the virus creating inflammation that scars the lungs. Some patients will eventually need transplants. Interestingly, males have been experiencing infertility because there is an abundance of ACE2 in testicular cells. ACE2 is the receptor that COVID-19 binds to when entering cells. These long-term complications seem not to appear months after a COVID-19 infection, but rather persist after they develop during the initial infection. The more severe the initial infection the more likely one is to develop complications that can then become long lasting. Again, from what we know now, I would NOT expect new complications to arise months to years later. Although, decreased fertility may not be discovered until one is trying to conceive.