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What is sepsis?

Named by Hippocrates with the meaning of the organic decomposition in 400 BC, sepsis has been long deemed as a life-threatening disease that till now remains to be incurable, with approximately a third of sepsis victims die from this condition and the major cause of death in the Intensive care units (ICU). Under infection, patients that suffer from sepsis may have an unstable immune response, and the excessive amount of chemicals, like cytokines, that triggers a large scale inflammation in the body, damaging organs. Normally inflammation should gradually diminish during the healing process, yet in sepsis, it can occasionally pose further damage to the site of infection. Besides the faulty and harmful cells, they also kill healthy ones that contribute to survival. Blood clots may also be formed during the process, blocking blood flow to organs, resulting in the deficiency of nutrients and oxygen.

Causes of sepsis

It is usually due to exposure of bacterial, viral, fungal, or parasite infection, for example in the lungs, digestive or urinary system, or in the blood. Infection in different parts of the body, such as pneumonia, urinary tract infection, cellulitis, meningitis, etc., potentially lead to sepsis. In some cases, during surgery, such as the Cesarean section, organ transplant to name just a few, one may be exposed to bacteria or virus during incision, hence infection in the wound and development into sepsis.

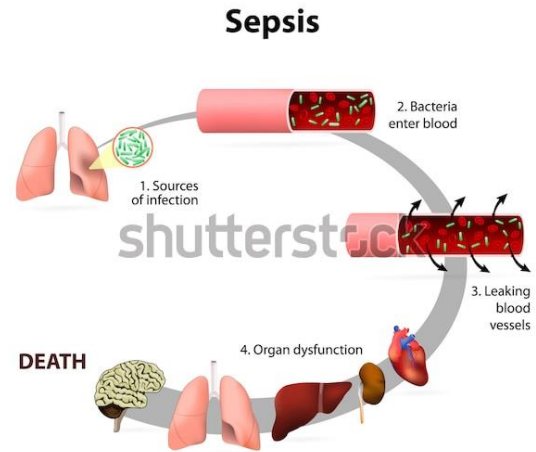
Symptoms of sepsis

For early stages, one may have mild vital signs, such as increased body temperature, tachycardia, increased respiration rate, and white blood cell count (leucocytosis). There may also be a fluctuation in glucose regulation under a hypermetabolic state and a decrease in venous oxygen saturation and urine output from organ damage.

As the severity increases, one's temperature may drop due to systemic response and vasoconstriction and a rise in venous oxygen saturation with the decreased ability of delivery of oxygen and cardiac output.

What is septic shock and how does it affect the body?

If a sepsis patient receives insufficient treatment or is unresponsive to the treatment, septic shock (a subset of sepsis) may occur. When this happens, there is a massive release of cytokines.



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Under normal circumstances during a local infection, bacteria may invade and enter the bloodstream, where it may be encountered white blood cells. The latter would release cytokines, in order to eliminate intruder bacteria by signalling more white blood cells to a certain location. Nevertheless, in sepsis, this infection is omnipresent in the body and this immune response in the contrary may do harm rather than good for these patients. Besides cytokines, white blood cells also release pro inflammatory mediators and nitric oxide, which causes blood vessels to dilate, resulting in a drop in systemic vascular resistance and thus blood pressure in vessels everywhere. These two factors are then further exacerbated by the opening of space between endothelium lining. This action typically occurs during an infection to allow white blood cells to reach the infected area. Nevertheless, since this is occurring in every single part of the body, it leads to the leaking of intravascular fluid out of the vessels. Consequently, accompanied by the decreased systemic vascular resistance, blood pressure further drops, less red blood cells pass through (perfusion), it is increasingly difficult for oxygen to be transported, with the more fluid surrounding cells and tissues. Additionally, lytic enzymes are secreted from white blood cells, and their function is to destroy foreign infectious materials in a normal infection. However when this is occurring in a significantly larger scale, it also damages and even kill healthy blood vessels and endothelial cells. This promotes the leaking out of intravascular and when the impaired area is large enough, blood may even pass through. As a result of this damage, platelet aggregators factors are then present in attempt to terminate the bleeding, and gradually accumulate and grow in numbers. Yet these may ultimately form clots and break off and travel around the circulation system. Occasional blockage of blood vessels due to the clots may lead decrease or even block blood flow and eventually affect the oxygen and nutritional supply to vital organs and thus their function.

If this progresses, the body may not be able to endure such large scale impairment and gradually run out of coagulation factors. With continuous bleeding and clotting all over the body, one may have disseminate intravascular coagulopathy(DIC).

Sepsis risk groups

Young infants are one of the risk groups for sepsis, and the site of infection may originate from the feeding tube or catheter during their stay in the hospital. Those who are born preterm are in even more serious risk and may even be fatal. Chronic diseases, weakened immunity and loss of physical activities in elderly due to ageing also serve as a risk factor for the infection of sepsis. In their cases, site of infection mostly occur in the respiratory tract or genitourinary. Pregnant women or who have recently given birth are also particularly at risk of have it sepsis, even though a minority develops sepsis after infection.

Diagnosis of sepsis

According to qSOFA score (quick sequential organ failure assessment score), there are criteria that have to be met in order to determine the diagnosis of sepsis. It includes having increased breathing rate, varying level of consciousness and hypotension. To commence with, a blood test and urine test are normally carried out, to identify the abnormal rise of white blood cell count. Arterial blood gas is also carried out to access oxygenation. Lactate level and C-reactive protein (CRP) to check whether it has reached a high level, indicating a sign of infection and inflammation. Platelet counts are also carried out, to see whether it is too low, which implies the formation of unseen blood clots within vessels. Moreover the prothrombin time (PT) and partial thromboplastin time (PTT) are accessed to monitor the clotting ability of blood. While a high level of d-dimer may indicate the formation of an enormous clot or accumulation of smaller clots. Chest x-ray and sometimes CT scans may also be used to track the site of infection. Usually rise in body temperature, rapid breathing and heat rate serve as base line for diagnosis of baseline. When taking the patients' history, their medical history are particularly significant to learn if a recent infection, surgery or use of catheter has taken place. A urine culture provides the information of the exact bacteria or infectious materials that invades the body.

Treatment of sepsis

Patients are often kept in intensive care unit (ICU) in hospitals, since their rate of infection and organ damage and change in blood pressure must be strictly monitored. The main aim of the treatment is to terminate the infection, safeguard the vital organs and increased the lowered blood pressure. When the individual is admitted into hospital and tests are run to confirm the type of sepsis infection, intravenous broad-spectrum antibiotics is used to give preliminary

treatment. Once the test results comes out and the causation of the specific type of bacterial or fungal infection has been determined, they will switch to use tailored antibiotic therapy to maximise the chance of suppressing the condition..

Usually a pressor is used to increase the blood pressure, and antibiotics and intravenous fluids are used to improve the survival chances of sepsis. For extreme cases, surgery may be necessary to remove tissue that is seriously damaged by infection.

Unfortunately, even if one survives from sepsis, there is an extremely high possibility that they may still suffer from other symptoms such as impaired post-traumatic stress disorder (PTSD), dysfunction of the organs, long-lasting pain and fatigue, and sometimes amputations.

Reduction of inflammation and activity of the immune system are considered to be the targeted investigation for the suppression of sepsis.

Possible cure for sepsis?

Since 2017, there has been a heated debate whether sepsis should be treated with intravenous vitamin C. Even there is evidence that shows that this medication does not significantly improve the symptoms of sepsis patients. In many scientific studies, the low levels of vitamin C in blood seems to be a recurring pattern in sepsis patients, thus leading to the prediction of vitamin C may be beneficial. In Marik's study in 2017, Dr.Paul Marik has carried tried this hypothesis by treating a dying sepsis patient with medication consisting fo vitamin C, thiamine and steroids, which immediately improves the patient's condition. However there are teams that tried to carried out similar treatments to the sepsis patients, for example Fowler at Virginia Commonwealth University and his team showed that vitamin D did not cause great improvement on organ failure, inflammation and vascular injury. Therefore there has not been any deciding evidence to prove the validity of this theory.

Relation of COVID-19 with sepsis

According to the Global Sepsis Alliance, it is confirmed that COVID-19 does cause sepsis. Due to the direct viral invasion and its notorious invasion of the lungs, and other organs of the body. Pneumonia may then act as a inflammatory response towards this infection and may subsequently lead to sepsis. The co-infection of the virus and bacteria also serve as a contributing factor for sepsis.

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