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Gram-Negative Bacteria and Sepsis

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Introduction

Today's medical world encompasses an environment in which gram-negative bacteria that once were defeated with common antibiotics, have now become resistant. Gram-negative bacteria like *Klebsiella pneumoniae, Pseudomonas aeruginosa, Enterobacter,* and *Acinetobacter* are pathogens that are an emerging threat causing sepsis due to multidrug-resistance (Pop-Vicas & Opal, 2014, p. 189). The multidrug-resistance mechanisms of gram-negative bacteria coupled with a patient population commonly seen in hospital settings, that consist of immunocompromised adults due to advancing age, comorbidities (e.g. AIDS, history of transplants, diabetes, and chemotherapy), and immunotherapies, create an environment for advanced infection or sepsis to take place.

Complications of multidrug-resistant gram-negative bacteria can cause infection and ultimately sepsis in the host. Sepsis is also a very deadly condition with high morbidity and mortality rates. Chong et al., (2015), estimated that there are approximately 258,000 people killed in the US annually due to sepsis with a mortality rate between 18% and 40% for those that contract the disease (p. 111).

The topic of gram-negative bacteria and sepsis was chosen due to the medical challenge presented to healthcare providers and the high mortality rates associated with gram-negative bacteria. Traditional management and treatment of sepsis resulting from gram-negative bacteria is no longer effective and healthcare providers are having to update and modify current sepsis protocols to fight the infection.

Signs and Symptoms

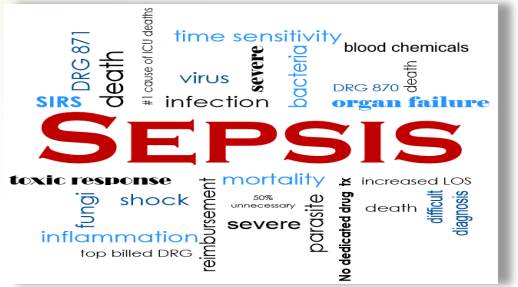
- Sepsis is defined as the manifestation of two or more signs of systemic inflammatory response syndrome (SIRS) criteria and a documented suspected infection (Palleschi, Sirianni, O'Connor, Dunn, & Hasenau, 2014, p. 23).
- SIRS is a group of symptoms/responses within the patient that are activated by bacteria (gram-positive and gram-negative), viruses, fungus, and non-infectious agents like trauma and burns. SIRS can be defined as having two or more of the following symptoms: Body temperature higher than 100.4 degrees Fahrenheit or lower than 96.8 degrees Fahrenheit, heart rater greater than 90/min, hyperventilation evidenced by respiratory rate greater than 20/min or PaCO2 lower than 32 mm Hg, and white blood cell count greater than 12,000 cells/ uL or lower than 4,000/ uL (Chong et al., 2015, p. 112).
- In addition to meeting two or more symptoms of SIRS, the identification of a causative or suspected microorganism/infection must be identified (Sagy, Al-qaqaa, & Kim, 2013, p. 260).

Underlying Pathophysiology

- Gram-negative bacteria contain an assortment of mechanisms that enable them to evade the hosts immune system and become resistant to a multiple antibiotics resulting in sepsis in the host.
- Mechanism's of evasion include: the production of extended-Beta-lactamases (ESBL) (this enzyme inactivates a variety of antibiotics [i.e. penicillin, cephalasporins, and aztreonam], modification of drug targets, and production of the endotoxin Lipolysaccharide (LPS) which causes the release of pro-inflammatory mediators like macrophages, cytokines, leukotrienes, and chemokines in the patient resulting in local inflammation vasodilation, increased capillary permeability, clot formation and the pathogenesis of sepsis (Chong et al., 2015, p. 114).
- In a septic host this response is exaggerated and adversely effects the patient. The increased capillary permeability results in fluid shift from the intravascular space to the interstitial tissues resulting in hypotension inadequate tissue perfusion, lactic acidosis, systemic vasodilation, and cellular hypoxia (Dunkley & McLeod, 2015).
- The hosts innate immune system continues its pro-inflammatory response by activating the complement system and clotting cascade.
- In summation, the pathogenesis of sepsis can be broken down into three mechanisms. Mechanism 1: The pro-inflammatory response, mechanism 2: Failure of the compensatory anti-inflammatory response (CARS), and mechanism 3: immunoparalysis which is the result of inflammation overpowering the patient's immune system paralyzing it, leading to the failure of the immune system to neutralize pathogens (Sagy et al., 2013, p. 261).

Significance of Pathophysiology

- Understanding the pathophysiology of gram-negative bacteria and sepsis is imperative to successfully treat and reduce the risk of mortality of the patient.
- Understanding the bodies response to severe infection causing sepsis has led to the development of sepsis treatment bundles. Lu et al., 2015, defines sepsis treatment bundles as a group of evidence-based interventions that provide greater benefit for the patient when administered together as compared with any single intervention (p. 1045.)
- The interventions applied in the sepsis treatment bundles are directed towards the pathophysiology of sepsis and the course the pathogen takes in the patient's body (i.e reversing hypotension, glucose control to minimize optimal environment for pathogen, and broad spectrum antibiotics due to pending blood culture results).



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Implications for Nursing

- Sepsis treatment bundles require that blood cultures are drawn to determine the source of infection. However, results from the cultures take up to three days to grow and result. A nurse practitioner's knowledge of the high probability of a gram-negative infection and the prevalence of multi-drug resistant bacteria should guide her to the proper antibiotic treatment (Pop-Vicas & Opal, 2014, p. 192).
- With the prevalence of gram-negative bacteria related sepsis and multi-drug resistance, combination broad-spectrum antibiotic therapy proves to be beneficial.
- Once blood culture results are obtained the combination antibiotic treatment can be de-escalated or limited to those that the bacteria is responsive to (Pop-Vicas & Opal, 2014, p. 192).

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Conclusion

- The Nurse Practitioners understanding of the pathophysiology of sepsis and gram-negative bacteria is imperative to successfully treat the patient and reduce mortality.
- With this high level of knowledge and understanding, efforts to deliver combination therapy antibiotics and resuscitation earlier has led to new approaches to sepsis that have shown success (Wunderink & Walley, 2014, p. 28).
- A practitioner's knowledge of the course of sepsis and gram-negative bacteria drug resistance allows for rapid assessment and can lead to practice changes to antibiotic therapy and sepsis bundles.

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