



INFECTIONS FOLLOWING HEART SURGERY

Francesco Massi^{1*}, Martina Di Emidio² and Davide Cardinelli³

¹ Department of Cardiovascular and Thoracic Surgery, Mazzini Hospital, Teramo, Italy;

² Medical School, University of L'aquila, Italy;

³ Department of Maxillofacial Surgery, Mazzini Hospital, Teramo, Italy.

*Correspondence to:

Francesco Massi, MD,

Department of Cardiac Surgery,

Mazzini Hospital, ASL4 Teramo,

64100 Teramo, Italy.

e-mail: francescomassi78@gmail.com

ABSTRACT

Postoperative infections, including those that affect the heart, can be very serious and complex and prolong hospital stay and recovery. Infection with microorganisms can occur through the contamination of surgical instruments or through other routes of microbial entry. Surgical infections can be superficial or severe, as occurs in endocarditis. Severe or deep mediastinal infections may involve the sternum and cause fever and pain. These infections can be treated with either surgery or antibiotics. Sepsis is a serious infection that occurs when bacteria enter the bloodstream and causes rapid heart rate and breathing, and in some cases, death. Postoperative infection involves complex biochemical and biological mechanisms. Pathogen-associated molecular patterns (PAMPs) are recognized by pattern recognition receptors (PRRs) located on immune cells such as macrophages and dendritic cells. The immune reaction leads to the production of inflammatory cytokines and chemokines, with vasodilation and increased vascular permeability. Chemokines attract leukocytes such as neutrophils and monocytes to the site of infection. Infections can occur after surgery where the pathogenic organism activates the immune system resulting in inflammation.

KEYWORDS: *Infection, heart surgery, postoperative, immune system, pathogen*

INTRODUCTION

Postoperative infection involves complex biochemical and biological mechanisms and may be a serious complication (1). Infections of the heart can lead to delayed recovery, prolonged hospital stay, and in severe cases, can be life-threatening (2). During surgery, pathogens, such as bacteria, viruses, fungi, or other microorganisms, can enter the body through the incision and activate immune cells that cause inflammation (3). Contamination can occur through the patient's skin, surgical instruments, the air, or the hands of the surgical team (4). Factors that may influence susceptibility to postoperative infection include the patient's age, immune status, and the presence of comorbidities (such as diabetes).

Postoperative infections can be located anywhere in the body and vary in severity. Infections can be superficial, involving the skin, with burning, heat, and pain, but they can also be internal, involving the lining of the heart, such as the heart valves. The common types of heart infections are superficial wound infections, mediastinitis, and endocarditis (5). Superficial infections mainly involve the skin and the area around the surgical site, with the classic symptoms of inflammation: "*calor, rubor, tumor, dolor, and fectio laesa*". Mediastinitis is inflammation in the mediastinum which contains the heart, large blood vessels, esophagus, trachea, thymus gland, lymph nodes, and connective tissue. Endocarditis is inflammation that occurs in the inner lining of the heart's chambers and valves, which can be severe and life-threatening.

Received: 16 October, 2024

Accepted: 18 December, 2024

1972-6945 (2024)

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DISCUSSION

Infection involves a series of complex biochemical and biological mechanisms that occur as the body attempts to protect itself from invading microorganisms, which first activate the innate immune system, the first line of defence of the body (6).

Pathogen-associated molecular patterns (PAMPs) on the surface of microbes are recognized by pattern recognition receptors (PRRs) such as Toll-like receptors (TLRs) on immune cells. Recognition of PAMPs leads to the activation of immune cells, such as macrophages and dendritic cells, which release cytokines and chemokines to recruit more immune cells to the site of infection (7). This results in the release of cytokines and chemokines, causing vasodilation, increased vascular permeability, and the recruitment of neutrophils and other leukocytes to the site of infection (7,8).

Neutrophils are first responders and play a critical role in the phagocytosis of pathogens, engulfing and digesting pathogens, and the release of antimicrobial substances. Immune cells also produce reactive oxygen species (ROS) and nitric oxide (NO) (9). Peptides are released by immune cells and epithelial cells and have antimicrobial properties that help kill and degrade pathogens.

In the adaptive response to pathogens, dendritic cells and macrophages present antigens to helper and cytotoxic T cells, initiating the immune response. B cells are also activated to produce antibodies against pathogen antigens (10). The adaptive immune system forms memory cells that provide long-lasting protection against future infections by the same pathogen.

Microbes activate nuclear factor-kappa B (NF- κ B), a transcription factor activated by PRRs (11). NF- κ B plays an important role in the expression of pro-inflammatory cytokines. The complement system is a series of activated proteins that enhance phagocytosis, lyse bacteria, and mediate inflammation, which also plays a role in the immune response. In postoperative infections, matrix metalloproteinases (MMPs) are involved in tissue remodelling and repair but can also contribute to tissue damage (12).

Microorganisms evade the immune response through various strategies, including the formation of biofilms on surgical implants which protect them from immune cells and antibiotics (13). In addition, bacteria defend themselves from the immune system by producing factors that inhibit complement activation and phagocytosis or alter antigen presentation (14).

In surgical infections, the site of infection must be monitored continuously, and blood tests and cultures should be performed to identify and control systemic infections. If the infection is deep, a chest x-ray or CT scan is performed (15). Follow-up with the surgical team and infectious disease specialists is also crucial.

Superficial infections are treated with wound cleaning and topical antibiotics, or oral antibiotics if necessary (16). In deep mediastinal infections, the sternum may also be involved and there may be fever and pain (17); these infections are treated surgically with removal of the infected tissue, or with intravenous antibiotics. In endocarditis involving the inner lining of the heart, particularly the heart valves, symptoms include fever, heart murmur, night sweats, chills, and fatigue (2). Treatment for endocarditis consists of long-term use of antibiotics, or surgery which may be needed to repair or replace infected heart valves (2).

Internal heart infections can cause fever, fatigue, and a heart murmur. Systemic infections caused by bacteria entering the bloodstream can cause sepsis infection with low blood pressure, fever, rapid heartbeat and breathing, and confusion. Sepsis is a severe condition that can be life-threatening if left untreated. Certain individuals are at higher risk of developing this type of infection, and the duration of surgery, type of surgery, and use of implants or prostheses may also increase the risk of infection (18) (Table I).

Table I. Risk factors for the development of sepsis infection.

<i>Patient risk factors</i>	<i>Surgical risk factors</i>
<ul style="list-style-type: none"> • Diabetes • Advanced age • Obesity • Immunocompromised state (e.g., due to medications or conditions) • History of smoking • Poor nutritional status 	<ul style="list-style-type: none"> • General surgical factors • Prolonged surgery duration • Use of extracorporeal circulation (heart-lung machine) • Reoperation • Improper surgical technique

Treatment of sepsis should be done immediately by administering broad-spectrum IV antibiotics, with supportive care in an intensive care unit (ICU), including fluids, vasopressors, and organ support. Preoperative measures, including the use of antibiotics and proper preparation, execution, and care of the surgical site, are of the utmost importance to avoid the risk of infection (19) (Table II).

Table II. *Surgical measures that lower the risk of sepsis.*

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| • Use of prophylactic antibiotics. | • Early removal of invasive devices (e.g., catheters, drains). |
| • Proper antiseptic preparation of the surgical site. | • Proper wound care and hygiene. |
| • Sterile surgical techniques. | • Monitoring for early signs of infection. |
| • Minimizing the duration of surgery and use of invasive devices. | • Continued use of prophylactic antibiotics as appropriate |

CONCLUSIONS

Infections can occur after surgery with a complex dynamic involving the host immune system and the pathogen. Understanding these mechanisms could lead to better pharmacological antibiotic and surgical therapy. However, infections can be effectively managed with early diagnosis and appropriate treatment. Accurate prevention significantly reduces the incidence of infections and rigorous preoperative, intraoperative, and postoperative strategies are important to minimize the risk and impact.

Conflict of interest

The authors declare that they have no conflict of interest.

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