Surgical Wound Infection Following Heart Surgery

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Introduction

The treatment of surgical wound infections still represents a challenge. The advances made so far have brought about new treatment options which have reduced the morbidity and mortality of severe infections. Evidence indicates that aggressive and early approaches associated with the use of antimicrobial agents represent important forms of treatment. The team in charge of the clinical and surgical care provided to these patients should use the best evidence available to personalize treatment with safety and efficacy.

Surgical site infection is the process by which a microorganism penetrates, establishes itself and multiplies in the surgical incision. Normal tissues can tolerate the presence of 10^5 bacteria/gram of tissue and no infection develops. The infection of a surgical wound is one of the most frequent surgical complications and accounts for a high rate of morbidity and mortality, with the consequent increase in medical and hospital expenses[1]. Several factors can influence the establishment and severity of the infections process. Diabetes mellitus, obesity, malnutrition, extremes of age and smoking habit are the major risk factors associated with the increase in the incidence of surgical site infections, and should be identified preferably in the preoperative period[2] (Chart 1).

As a consequence of the aging of the population, surgeons, especially cardiovascular ones, have been working with a greater number of patients with associated co-morbidities, which increases the risk and severity of infections postoperatively. This is why the fundamental principles of dieresis, hemostasis and synthesis should be followed strictly so as to allow the obtainment of satisfactory results with lower morbidity, thus favoring the prompt recovery of patients from a functional and esthetic standpoint.

For the prophylaxis of surgical wounds, the contamination that originates in the operating rooms has to be reduced to a minimum. The laminar circulation of ambient air, the use of UV rays, the disinfection of floors and walls, the correct sterilization of surgical material and the restriction of the number of people that circulate in the operating room are measures that should be adopted[3]. Correct hand scrubbing of all the team involved in the provision of care to the patient, especially of the operating team, has great impact in reducing wound contamination. This procedure aims at removing transitory hand flora and reducing permanent hand flora.

Chart 1 - Risk factors for infection in heart surgery

Relating to the patient	Relating to the surgery
Age – children and old individuals	Operative time
Gender – male	Type of surgery
Obesity – BMI*>30	Emergency surgery
Chronic and degenerative diseases – diabetes mellitus, kidney failure or chronic heart failure	Opening of pleural cavity
Malnutrition – serum albumin < 4.5 g/dl	Cross-clamp time
	Insertion of intra-aortic balloon
	Intubation time
	Length of stay in the ICU
	Bleeding and/or need for blood transfusion

** Body mass index calculated as follows: weight (kg) divided by square of height (m).*

The patient's skin is the major source of endogenous contamination of the surgical wound. Microorganisms have access to or settle in the operative field in the period between the incision and its complete closure. Therefore, adequate skin preparation is fundamental. The shaving of hair with a blade should be avoided as the blade causes small injuries and may contribute to increase the incidence of postoperative infection. At present, the removal of hair right before the surgical incision is considered the ideal procedure. In the operating room, the skin should be scrubbed with degerming PVP-I, followed by alcoholic PVP-I to facilitate the dispersion of iodine[3].

There is a consensus on the recommendation of prophylactic antimicrobial agents with the objective of reducing the incidence of surgical infections in operations that are classified as potentially contaminated and contaminated. Heart surgery, which is classified as a clean surgery, is an exception as regards the use of prophylactic antimicrobial agents (Chart 2). These agents should be used because heart surgery is a complex and long procedure that frequently employs prosthetic materials, which in turn warrants the use of antimicrobial agents[4]. Cephalosporines are the class

Palavras-chave

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Chart 2 - Classification of wounds relative to the microbial content

Type of wound	Characteristic	Examples
Clean	Free from microorganisms	Heart surgery
Clean contaminated	Non-significant contamination and less than 6h elapsing until medical care	Biliary and gastric surgeries
Contaminated	Without local infection and more than 6h elapsing until medical care	Colon surgeries
Infected	Intense inflammatory reaction and frank infectious process	Appendicitis and colecistitis

of prophylactic antimicrobial agents that is used the most because of their broad spectrum of action against Gram- and Gram+ bacteria. Other options are ampicillin, tetracyclines and vancomycin[3].

The early diagnosis of postoperative infection requires a high degree of suspicion. In general, surgical wound infections appear between the 5th and 7th day postoperatively. The patient may present a worsening in his general condition, anorexia and fever. Despite its non-specific nature, fever is the first most common clinical sign of infection. However, in the normal heart surgery postoperative period, fever may occur in the absence of infection for up to 4 to 5 days and it may persist for weeks in exceptional situations. Adverse reaction to drugs, phlebitis, atelectasis and pulmonary embolism in addition to postpericardiotomy syndrome are the major causes of fever after the 6th day postoperatively[5].

Major infections in surgical sites

Saphenectomy

Although the use of arterial conduits for grafts in myocardial revascularization procedures has grown in recent years, saphenectomy, a technique used to obtain a venous graft during surgery, is one of the most widely used procedures all over the world[6,7]. The dissection of the saphena magna vein is generally performed by means of an open technique, with single or multiple staggered incisions[8]. Complications relating to the surgical technique occur in up to 30% of the patients submitted to saphenectomy. Data from the Society of Thoracic Surgery of 1999[9], which considered only the complications observed during the hospital stay period, report a 4.5% rate of complications in saphenectomy sites. Hematoma, seroma, suture dehiscence, necrosis of incision borders or infections increase hospital stay and delay the patient's rehabilitation[10]. DeLaria et al[11] demonstrated a 12-day increase in hospital stay due to complications in saphenectomy sites. There was an average increase of U$ 9,900/patient in hospital costs for these patients.

Infections may present as localized cellulitis or even as a clear involvement of soft parts, with drainage of secretions and areas of extensive necrosis[8]. Infections occur in 1 to 5 % of saphenectomies and bad cicatrization may reach 10 %. Olsen et al[12] identified age above 75, obesity (BMI>35), female gender, previous cerebrovascular accident, insulin-dependent diabetes and the use of more than 5 erythrocyte concentrates for blood transfusion as independent risk factors for infection in saphenectomies. There was no increase in mortality due to problems relating to saphenectomy, which may indicate the superficial nature of most infections.

New saphenectomy techniques have been proposed to reduce postoperative complications. Chukwuemeka and John[13] proposed to begin the incision on the leg 5 cm above the inner malleolus and extend it proximally, avoiding the more distal area. Saphenectomy with small staggered incisions was one of the first techniques proposed. When this technique is used, small intercalated incisions along the saphena vein are performed, with the interposition of "islands" of skin. This technique had few followers, probably because is more time-consuming and affords dubious results. At first, the avulsion of venous branches and hematoma in skin tunnels were observed. With the use of clips to ligate the branches of the saphena vein, these complications improved and the technique gained more acceptance. Some surgical instruments were developed to facilitate the saphenectomy procedure with small incisions. Tevaearai et al[14] reported that patients recovered earlier from the surgery when mini-incisions were used, since it prevented the formation of large skin flaps, and allowed a smaller degree of injury in lymphatic vessels, thus providing better esthetic results. These authors propose that this technique should be used preferably in patients with ischemic limbs.

Minimally invasive techniques performed by means of endoscopic and non-endoscopic instruments in an attempt to further reduce surgical incisions and improve the visibility of the saphena vein have been proposed since 1996[15]. There is a reduction in the trauma of adipose tissues, reduction in the injuries to the vessels that feed the skin and in postoperative infections. Pagni et al[8] demonstrated a 60% reduction in the risk of infection in patients undergoing saphenectomy using the video-assisted technique. The conversion rate of the video-assisted group to the open group varied from 5% to 22%. These authors recommended a cost analysis of the technique and of graft quality postoperatively prior to recommending it as a routine procedure. Although the video-assisted group presented a larger number of minor complications (hematoma, cellulitis, seroma), these patients presented a more satisfactory result from a esthetic standpoint in addition to earlier ambulation with a smaller rate of severe infections.

Pain, erythema, heat, drainage of secretions, hardening of incisions and fever that start in the 3rd or 4th day postoperatively are the most frequent signs of infection on the site of saphenectomy. Infections after the 14th day postoperatively are rare. However, there are cases where they occur after months or even years. The definitive diagnostic may be accomplished on clinical examination and must be followed by immediate surgical assessment. The most prevalent bacteria are G+ ones such as *Staphylococcus* and *Streptococcus*, G- and G+ aerobic bacilli, *Enterococcus* and *E. coli*. In cellulitis processes the inflammation of dermal and subcutaneous tissues can be severe, but typically there is no macroscopic suppuration. Patients present with moderate fever, poor general state, wound edema and intense hyperemia with increased local sensitivity, which makes ambulation difficult[5].

The treatment of wounds with the presence of exudation includes removing manually the necrotic tissues, surgical threads, hematomas and clots. In cellulitis processes, the treatment consists basically of elevating the limb, applying heat locally to increase the supply of oxygen into the area affected, and the use of broad-spectrum antimicrobial agents that should be prescribed according to the isolation profile and the bacterial resistance of each department[4].

Open wound treatment

The healing process is systemic and dynamic and is directly related to the general conditions of the body. In order to characterize it better, it is divided into three phases. The inflammation phase that lasts 4 to 5 days is characterized by an increase in vascular permeability and abundant exudation. The migration of cells that will promote biological cleaning is observed. Within 48 to 72 hours, epithelial tissue is formed that does not provide tensile strength to the wound. The fibroplasia phase extends from the 5th to the 15th day and is characterized by abundant formation of collagen. The contraction and maturation phase is practically complete on the 28th day. However, remodeling continues for up to one year, when the tensile strength of the wound is at its maximum. The treatment of an open wound is a process that depends on systematic assessments, different prescriptions regarding the frequency and type of dressing, according to each stage of the healing process.

The current proposal for treating wounds includes the occlusion of the injury and the maintenance of a moist environment for healing. The moist environment facilitates cell migration, the formation of granulation and reephithelization tissues and protects superficial nervous terminations thus reducing pain, accelerating healing, preventing de-hydration and cell death, and promoting fibrinolysis. Moist dressings prevent the formation of crust, a structure that can delay the healing process.

The purposes of the dressings are: cleaning the wound, protecting it against mechanical traumas, preventing exogenous contamination, absorbing discharges, reducing the accumulation of fluids through local compression and immobilizing the wound. Dressing should be carried out following basic asepsis principles. Sterile techniques are recommended when the patient is in a hospital environment, and the clean technique is advised when the patient is at home.

In wounds with first intention healing, for example, in dry surgical incisions, cleaning with 0.9% saline solution and dressing with sterile gauze is recommended. The dressing should be changed daily or whenever saturated. Keeping dressings postoperatively is justifiable for a maximum of 72 hours, when the wound should be kept open.

Generally speaking, in open wounds, PVPi (povidine) and local chlorhexidine should not be used. PVPi is rapidly neutralized by the presence of organic matter, pus or necrosis and chlorhexidine may alter the healing process, harming and reducing the tensile strength of tissues. It can also irritate the skin and cause allergic reactions. In open wounds with little exudation, washing with jets of 0.9% saline solution to prevent friction is recommended. The removal of devitalized tissue should be carried out manually (Chart 3).

Dressings with long-chain triglycerides (LCTs), DERSANI™, were introduced in 1994 by Declair[16]. These substances accelerate the tissue granulation process, promote chemotaxis and angiogenesis. There are no contraindications to their use in wounds, whether there are signs of infection or not. It is recommended that the wound be washed first with saline solution, and then covered with gauze soaked in DERSANI. The dressing should be changed daily and whenever necessary.

Dressings with hydrocolloid have an inner layer that is a good environment to absorb discharges and maintain a moist environment (gelatin and pectin) that stimulates angiogenesis and autolytic debridement. The outer layer is composed of polyurethane foam and serves as a thermal barrier against gases and liquids. They should be used on clean wounds, with no infectious processes or necrotic tissues. Dressing should be changed whenever the gel overflows or the dressing is displaced and within 7 days at most.

Calcium alginate dressings derive from brown marine algae. They're best indicated for wounds with abundant exudation, with or without infection and for cavity injuries. They have a high absorptive power and help in the autolytic process. Dressings should be changed daily in infected wounds. In injuries with little exudation, dressings can be changed every 3 or 4 days.

There are several products on the market and others in an advanced stage in terms of production and research for use in different types of wounds. Careful analysis of different products is required to select the best treatment.

With the objective of preventing major complications, it is advisable to identify risk patients; assess, when necessary, the anatomy of peripheral vessels and define the best surgical site to perform the saphenectomy procedure; employ a meticulous surgical technique; recognize complications promptly and begin the recommended treatment early[17].

Chart 3 – Treatment of wound

Type of wound	Treatment
Dry and first intention	Saline solution (SS) at 0.9%, coverage with sterile gauze. Change at least once a day or when dressing saturates. Keep for up to 72h.
Open and with little exudation	SS jets, manual debridement, coverage with gauze soaked in SS or medium-chain triglycerides or hydrocolloid. Change daily or when saturated.
Open and with abundant exudation	SS jets, manual debridement, coverage with gauze soaked in calcium alginate. Change daily or when saturated.

Mediastinitis

Mediastinitis is a severe and frequently disastrous infectious complication that involves the mediastinal space and the sternum. Some anatomical and physiological characteristics favor the severe nature of infections in the mediastinum[18]. The large quantity of loose cell tissue favors the dissemination of infection. The abundant vascular network allows the fast and massive absorption of toxins. Pressure variations within the mediastinal cavity contribute to mobilize septic liquids.

Although there are many protocols for hospital infection control, improvement of treatment with antimicrobial agents and of care with operative antisepsis, the incidence of dehiscence and deep sternal infection has not decreased in recent years. The incidence of mediastinitis varies from 0.15 to 8%, with a mean of 1 to 2%[18]. In concomitant procedures the incidence of infection may reach 3%. Infection increases hospital stay and costs. The average expenses with patients who present with mediastinitis are three times higher than with those who have no infection[19]. Its mortality remains high (10% to 47%), despite the latest advances in its treatment[18].

The exact physiopathological mechanism of mediastinitis is probably multifactoral and has not been defined yet. However, noncompliance with asepsis techniques is probably the major cause of sternal dehiscence and mediastinitis.

Some risk factors, pre and postoperative, contribute to the increase of mediastinal infection (Chart 4).

The risk of mediastinitis increases with age. Patients below 50, between 50 and 70 and above 70 years of age presented an incidence of 0.9%, 2.7%, and 3.1% respectively[20].

Males are at a higher risk of mediastinitis, probably due to the higher tension (tensile strength) of sternal wounds in males. Obese individuals (>20% of the ideal weight) present a higher incidence of sternal infection, probably due to the presence of adipose tissue that may act as a substrate for infection[20].

Chronic smoking associated with COPD causes ventilatory problems, leading to sternal instability, and favoring a higher incidence of mediastinitis[21]. In the group of *Instituto Dante Pazzanese de Cardiologia*, the rate of infection was 4.8 times higher in patients kept in the ICU for more than 48 hours postoperatively as compared with patients who remained there for a shorter time[20]. The presence of infection in other sites preoperatively increases the risk of the patient presenting mediastinitis postoperatively by 8 times, probably because of the hematological displacement of/blood-borne bacteria[22].

Chart 4 - Risk factors for mediastinitis

Age – above 70
Gender – male
Obesity
Diabetes (indirect factor)
Bleeding
Type of procedure
Kidney dysfunction
Lung dysfunction and infection
Heart dysfunction and low heart output
Tracheostomy
Sternal instability
Operative time

Diabetic patients present alterations in microcirculation and cicatrization, thus contributing to a higher incidence of operative infection. The incidence of mediastinitis when two internal thoracic arteries are used, especially in diabetic patients, is significantly higher[21]. This fact can be explained by the impairment of 90% of the irrigation of the hemisternal when the internal thoracic artery is used in myocardial revascularization.

Elective heart reoperation increases the incidence of mediastinitis from the range 1% to 2% up to 20%. Reoperation due to acute bleeding in the early postoperative period has also been associated with mediastinitis[1,4,5,18].

Some other factors which are difficult to measure may be implied in the increased incidence of mediastinitis, namely: preoperative kidney dysfunction; hemodialysis; heart dysfunction and low output syndrome; excessive use of electrical scalpel and poor surgical technique. The need for postoperative tracheostomy is directly related with the occurrence of mediastinitis, in that an incidence of 8.6% and an associated mortality of 43% have been reported. The use of percutaneous tracheostomy improves these results[19]. Bhatti et al[23] emphasize the need to use bone wax carefully since its use has been associated with a higher incidence of mediastinitis and systemic embolization in experiments.

Diagnosis

According to the Center for Disease Control and Prevention of the United States (CDC), the criteria that define mediastinitis are: isolation and culture of microorganisms from mediastinal tissues or secretions obtained through fine needle puncture; evidence of mediastinitis seen during surgery or hystopathological study; sternal instability, chest pain, fever (>38° C) associated with the culture of sternal secretion and/or positive hemoculture[24].

According to Braxton et al[25] mediastinitis includes the presence of two of the following findings: identification of microorganisms in the fluid obtained from the mediastinal space; culture of microorganisms from mediastinal tissues; radiological evidence of infection and mediastinal dehiscence that require reoperation.

Sometimes the signs of mediastinitis are not very apparent and the prompt recognition of infection requires a high rate of suspicion. Patients generally present persistent fever after the 4th day postoperatively. Toxemia, left-shifted leukocytosis and drainage of secretions through the sternal wound are common. Dehiscence of surgical wounds is the most frequent finding and occurs in 70% to 90% of the cases, and is normally associated with other local findings such as chest pain and sternal instability[19].

For diagnostic confirmation, in addition to the physical examination, imaging tests are performed. Chest computerized tomography (CT) and nuclear magnetic resonance (NMR) have low sensitivity and specificity in diagnostic[15]. Tomographic findings following sternectomy may include retrosternal hematoma and fluid collection. It is not always easy to set benign findings apart from abscesses and infected collections. However, signs of dehiscence and bone erosion, in addition to subcutaneous collections and bilateral pleural effusion may indicate an infectious process[26].

In 2003, Benlolo et al[27] assessed prospectively the sternal puncture method to diagnose early infection. The needle was coupled to a 10 ml syringe and the aspiration occurred after the needle was introduced one centimeter deep. There was a high rate of positivity which allowed the diagnostic and early treatment.

Classification

Oakley et al[19] proposed a classification of mediastinitis with the objective of establishing the best parameters for diagnostic and treatment.

1) *Mediastinal dehiscence* – Consists of the spontaneous opening of the operative wound with absence of clinical or microbiological evidence of infection.

2) *Infection of mediastinal wound* – Consists of the infection of presternal tissues and sternal osteomyelitis with clinical and microbiological confirmation.

Subtypes - 2.1) Superficial wound infection – infection confined to the subcutaneous tissue. 2.2) Deep wound infection (mediastinitis) – in addition to the wound infection, there is also sternal osteomyelitis with or without infection in the retrosternal space. Mediastinitis is also subdivided into 4 subtypes according to the time of presentation, presence or not of risk factors, and previous treatment (Chart 5).

The CDC protocol considers superficial or deep incisional surgical site infections, or infection of surgical site of organ/space. The superficial infection involves the skin and subcutaneous tissues. The deep infection involves deeper layers such as muscular fasciae. The infection of the surgical site of organ/space may involve any part of the anatomy in addition to the incision that was manipulated or opened by the surgeon[24].

Chart 5 - Classification of mediastinitis

Type	Characteristic
I	Presents in up to 2 weeks postoperatively without risk factors
II	Presents within 2 to 6 weeks postoperatively without risk factors
III A	Presents in up to 2 weeks with 1 or more risk factors
III B	Presents within 2 to 6 weeks with 1 or more risk factors
IV A	Type I, II or III after one failed therapeutic trial
IV B	Type I, II or III after more than one failed therapeutic trial
V	Presentation after 6 weeks postoperatively

The germs that are most commonly associated are Gram positive bacteria in 77% of the cases. Among these, *Staphylococcus aureus* and *Staphylococcus epidermides* account for 49% and 28% of the cases, respectively. The most commonly found Gram negative germs are *Pseudomonas aeruginosa, Serratia , Enterobacter, Proteus*[28].

Treatment

The treatment of mediastinitis varies from the simple use of therapy with antimicrobial agents, with no surgical procedure associated, to complete sternectomy and plastic procedures to reconstruct the thoracic wall[19].

In patients that present dehiscence of subcutaneous tissues without established infectious process, the injury should be treated according to the principles used to treat open wounds, in that primary suture can be an option. In patients who present established infection of the mediastinal wound that affects only the subcutaneous tissue the treatment consists of the initial opening of the injury and the careful analysis of the infectious process and its extension, the targeted use of antimicrobial agents with the concomitant compliance with the principles for treatment of open wounds with dressings. The primary-delayed closure of the operative wound can be followed up clinically.

In the case of established mediastinitis, the management strategy should be aggressive, and early surgical approach is indicated. Conservative management strategies present extremely high mortality. The empirical use of antimicrobial agents is started at the time of diagnosis and later guided by the culture of infected tissues[29].

Surgical treatment of mediastinitis has improved gradually in the last 35 years. The management strategy initially consisted of the complete opening of the incision, broad debridement with removal of necrotic tissues, followed by second intention closure. Daily dressings were associated which caused high morbidity and mortality rates and long hospital stays. There was a high rate of fistula and pathways from the sternum to the skin with chronic drainage of secretions.

In 1963 Shumacker and Mandelbaum[30] described a technique to open the incision with the removal of steel threads, mechanical cleaning of necrotic tissues, including bones, and the implantation of continuous irrigation through drains placed in the mediastinum. Solutions of antibiotics and/or povidine at 0.5% were used. Irrigation was usually maintained for 3 to 4 days. Mediastinal drainage can be performed in a closed manner with continuous irrigation or with suction[31]. These techniques are recommended for acute mediastinitis, with less than 2 weeks. In the method of drainage with suction, a drain with many perforations was used, coupled with a negative pressure system (from – 300 mmHg to – 600 mmHg) that is maintained in the mediastinal place for one week. According to the authors, there was no statistically significant difference when the two drainage systems were compared. Combs et al[32] demonstrated that this approach enables the cure of mediastinitis.

Surgical debridement was described after Shumacker and Mandelbaum's study[30], followed by a greater omentum graft.

This anatomical structure has important advantages, since it contains a large number of active immunological cells with a high anti-infectious power. The reconstruction of the mediastinum using the omentum is associated with fewer septic complications[33].

Schroeyers et al[34] expanded the concept of using omental graft and recommended that muscle graft be used to fill in the space left after debridement. The rectus abdominis muscles can be used by rotating the flap, in addition to the pectoralis major muscles, which are detached and brought to the sternal midline to be sutured, allowing the complete closure of the wound[34]. In 1998 Gamel et al[18] reported low mortality with the treatment of mediastinitis associated with the mobilization of the major pectoralis muscles.

Some reports[35] recommend the combination of pre-established treatment as an alternative for severe cases. This author used irrigation with antimicrobial agents, associated with omental transposition in patients infected by multi-resistant bacteria. The result of the surgery was good, with complete and early recovery, with no deaths. Another author[36] associated omentopexy to pectoralis muscle flap in the treatment of mediastinitis. This procedure provided good results, but the aggressiveness of this approach might not be justified.

It is recommended that antibiotic therapy be kept for at least 6 weeks and, if there is osteomyelitis, the therapy should continue for 3 months. Due to the high degree of catabolism that these patients present, special attention should be given to their nutritional state. Enteral diet is stimulated and optimized. However, sometimes the use of parenteral diet is extremely valuable as it contributes to the early improvement of patients.

Hyperbaric oxygen therapy

Hyperbaric oxygen therapy is a type of therapy that has been used since the 1930's, and consists of breathing pure oxygen (100%) at pressures above atmospheric ones with the patient placed in a special chamber. The amount of oxygen dissolved in tissues increases from 10 to 20 times, thus creating an environment which is not appropriate for bacteria in general, especially anaerobic ones. This treatment is especially recommended in necrotizing infections of soft tissues, severe cellulitis, fasciitis, myosites, suture dehiscence and chronic osteomyelitis. Its basic mechanism of action is the acceleration of the formation of granulation tissue, and it also acts as a coadjuvant in the control of infections to accelerate the healing process.

Lappa et al[37] reported on the treatment of mediastinitis using nasal antimicrobial agents associated with hyperbaric oxygen therapy. After 30 sessions of oxygen therapy, significant improvement was observed in the granulation tissue of the operative wound, and it was possible to rule out treatment with operation. After a 6-month treatment there was complete closure of the wound. New studies are needed to assess these results better.

Prognosis and prevention

The treatment of mediastinitis is still problematic and controversial. However, in recent years, with the early use of muscle grafts in addition to omentopexy, treatment has presented more satisfactory results with a high rate of success and a considerable reduction in hospital stay. The mortality reported in many papers over the last decade varied between 4.8 and 10.8 % for both procedures, associated with closed irrigation or with vacuum. Mortality at levels lower than 4% has not been reported yet.

Some variables determine postoperative survival. Analyses demonstrate that length of stay in the intensive care unit above 8 days, postoperative bleeding above 1,000 ml, wounds with positive cultures and the elapsing of a long time between the symptom and the surgical approach are determinants for hospital mortality. Other variables are associated with longer hospital stay such as: age of patients above 58 years; prolonged time on mechanical ventilation and in the ICU (> 96 hours). In conclusion, the prognosis of deep sternal infection depends primarily on early surgical management. Strangely enough the presence of mediastinitis does not seem to reduce the patency of grafts in the period following myocardial revascularization.

As recommended in the study conducted by Sampaio et al[38], some measures can be used to prevent mediastinitis: strict preoperative assessment of the patient to look for associated infectious processes; adequate pulmonary preparation avoiding smoking; avoiding the use of the two internal thoracic arteries in diabetic patients; use of iodine-coated plastic fields that adhere to the skin; frequent wash of the mediastinum and the subcutaneous tissue with saline solution at the time of closure.

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