STERNAL WOUND INFECTION

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DESCRIPTION

Sternal wound infection, a potentially life-threatening complication of cardiac surgery, may result in increased mortality and morbidity and significant revenue loss. Poststernotomy wound infection has been categorized as a superficial presternal infection or deep retrosternal infection.[24] Superficial wound infection will be evident within the first week of surgery, probably caused by contamination, and is treated with local drainage and wound care. Deep retrosternal infection involves infection of the mediastinum and sternum. Mediastinitis requires re-operation for removal of mediastinal infection and necrosis and rewiring the sternum. Long-term parenteral antibiotic therapy and muscle flap reconstruction are usually required.

The incidence of sternal wound infection has been reported recently to range from 0.16% to 1.86%.[20,26,31,34] Stiegel et al. reported a 0.94% incidence of mediastinitis in a pediatric cardiac surgical population of 2242.[44] Mortality rates quoted in the literature vary widely and range from 52% to 70% due to mediastinitis, and 5.3% in patients with mediastinitis treated with muscle flap reconstruction.[8,30,39]

Early diagnosis and treatment of mediastinitis is critical in order to reduce morbidity, mortality, length of stay (LOS), and consumption of resources. Re-operation, long-term wound care, and extensive intravenous antibiotic therapy are often part of the extended care of patients with mediastinitis. This complication frequently occurs in the elderly. Cost was noted to increase by $8500 for an infection of a saphenous vein incision, $9000 for a deep subcutaneous incision infection, $40,000 for a sternal infection, and $73,000 for mediastinitis in one study alone.[23] Another study compared cardiac surgery patients who were without infection to patients who had sternal wound infections, leg incision infections, or prosthetic valve endocarditis. The infected group showed doubled hospital cost and an increase of 19 days in average LOS.[4]

Nurses caring for cardiac surgery patients must be expert in promotion of wound healing and early recognition of wound infection and sternal dehiscence. Timely, collaborative care will improve patient outcomes and, as a result, reduce cost. In the event that a sternal wound infection cannot be prevented, some have recommended less costly home care for patients who require extended parenteral antibiotics and wound care.[16]

PATHOPHYSIOLOGY

Median sternotomy is the most common approach used for patients requiring cardiac operations. It provides access to the heart and great vessels and has less respiratory complications and pain when compared to a thoracotomy incision. Mediastinitis is most likely to occur as a result of delayed wound healing and poor host defenses. Contamination of the mediastinum is less frequently the cause. Table 24-1 compares four studies that identified risk factors in the development of mediastinitis.

Advanced age, diabetes mellitus, impaired immunocompetence, inadequate perfusion, inadequate oxygenation, infection, malnutrition, obesity, and preoperative illness increase the risk of impaired wound healing.[33] Sternal wound infection rates in two studies of cardiac surgery patients 80 years or older were found to be 5% rather than the 1.86% seen in other adult cardiac surgery patients.[14,45]

Wound healing is impaired in diabetics because of deficits in wound perfusion and oxygenation caused by small-vessel disease and hyperglycemia. Diabetics who undergo cardiac

TABLE 24-1 Mediastinitis Risk Factors

Loop et al. n = 6504 1.1% developed mediastinitis or sternal dehiscence 1990	Ottino et al. n = 2579 1.86% developed mediastinitis 1987	Grossi et al. 0.97% developed mediastinitis 1985	Edwards and Baker Nine pediatric patients 1983
• Bilateral internal thoracic artery grafting in a diabetic • Obesity • Prolonged operating time • Blood transfusions	• Hospital environment (operating room had moved) • Preoperative length of stay • Reoperation • Blood transfusions • Early chest reexploration • Sternal rewiring	• Combined revascularization and valve replacement • Early reexploration for bleeding • Prolonged low cardiac output syndrome • Prolonged ventilatory support • Severe concomitant infection	• Bypass time of greater than 1 hour • Excessive postoperative bleeding • Low cardiac output for ≥24 hours postoperatively • Reexploration for bleeding • Inadequate antimicrobial prophylaxis

Adapted with permission from Norris, SO: Managing postoperative mediastinitis, *J Cardiovasc Nurs* 3(3):52-65, 1989.

surgery require careful assessment of serum glucose and continuous regulation of insulin to achieve control of hyperglycemia and minimize their added risk of sternal wound infection.

Immunosuppressed cardiac transplant patients have an increased incidence of mediastinitis of 1% to 10%.[17,22] One cardiac transplant study reported subclinical manifestation of fatal mediastinitis that demonstrated the role of immunosuppression in masking the true extent of the mediastinitis.[6]

Cardiopulmonary bypass temporarily causes vasoconstriction, anemia, and hypovolemia. Vasoconstriction directly reduces wound perfusion and the delivery of oxygen to the healing tissues.[47] Factors contributing to vasoconstriction include hypothermia, severed afferent nerves, hypovolemia, fear, pain, surgical stress, and sympathetic nervous system response.[47] Aggressive management of vasoconstriction and hypoxia reduce the risk of wound complications.

Excessive wound stress may cause wound dehiscence, herniation, and nonunion. Reduced tensile strength is seen in wounds of the obese. Sternal dehiscence risk factors include obesity, repeated sternotomy, bleeding or tamponade, debilitated patients, and osteoporosis.[32] Wound stress also may be caused by exaggerated coughing, vomiting, struggling with arm restraints, external cardiac massage, fighting the ventilator, or strenuous pulling or flexing activity of the upper extremities. Use of a circumferential ribcage splint increases patient comfort and decreases wound stress during coughing and deep breathing and movement in and out of bed (Figure 24-1). Large-breasted women should be encouraged to wear a supportive bra to minimize the weight of the breasts on the sternal incision. It is beneficial if the surgeon alerts the nursing staff of sternums that may be at risk due to poor bone quality.

Figure 24-1 The *Heart Hugger* is a circumferential ribcage splint used to increase patient comfort while decreasing mechanical stress on the sternotomy. It is used during coughing and deep breathing, incentive spirometry, and moving in or out of bed or chair. The device's handles are positioned over the mid-sternal area a generous handwidth apart. When needed, the patient squeezes the handles together, thereby tightening ribcage support and lessening surgical incision stress. The *Heart Hugger* is applied early postoperatively and used for several weeks after hospital discharge. (Used with permission of General Cardiac Technology, Mountain View, California.)

The association between the internal mammary artery graft and the risk of sternal wound infection has been debated in the literature. An early study found a sternal wound infection rate of 1.1% to saphenous vein grafting, 2.3% for left internal mammary artery grafting, and 8.5% for bilateral internal mammary artery grafting.[12] However, diabetes mel-

litus and advanced age were the risk factors for sternal wound infection found in a study that employed multivariate logistic regression analysis to matched groups of patients receiving saphenous vein grafting, single internal mammary artery grafting, and bilateral internal mammary artery grafting.[10,21] In a comparison of saphenous vein grafts versus internal mammary artery grafts to the left anterior descending artery, no difference was seen in wound complication rates.[42] A fourth study demonstrated no statistical difference in sternal wound infection rates in nondiabetic patient groups receiving saphenous vein grafting, single internal thoracic artery grafting, or bilateral internal thoracic grafting.[26]

Delayed sternal wound closure due to myocardial edema or uncontrolled hemorrhage secondary to postcardiopulmonary bypass coagulopathy does not appear to be a risk factor for mediastinitis providing the mediastinum is isolated from the environment. In a study of 13 patients requiring delayed sternal wound closure until postoperative day 2 to 5, no sternal wound infection was seen.[29] In all patients, only the skin was closed and they were mechanically ventilated from the initial surgery to sternal wound closure.[29] No mediastinitis was found in a second study where the mediastinum was isolated from the environment by either skin approximation, patching a synthetic membrane to skin edges, or use of a plastic drape in situations where delayed sternal closure was necessitated by cardiac edema or uncontrolled hemorrhage.[27]

While not all factors that impair wound healing can be altered, early awareness of those risk factors and interventions to promote wound healing can reduce wound complications.

LENGTH OF STAY/ANTICIPATED COURSE

The usual LOS for uncomplicated myocardial revascularization or valve surgery is approximately 10 to 18 days according to HCFA data.[43] Some centers have demonstrated LOS as short as 4 to 5 days with a program built to support early transition to home. Some insurers have announced that a 5-day LOS for coronary artery bypass grafting will be the reimbursed standard.

The DRG system does not specify major complications to cardiac procedures. Additional payment is not automatically made if postoperative wound infections occur. While hospitals will seek a discharge diagnosis for patients that best matches the resources used to care for the patient, the original DRG for the cardiac surgery typically demonstrates a longer average LOS and commensurate reimbursement than the DRGs specific to the medical or surgical management of sternal wound infection.

Sternal wound infection results in longer LOS and increased costs as demonstrated in a study of patients experiencing sternal wound infection, saphenous vein donor site infection, or prosthetic valve endocarditis when compared with controls.[4] In the presence of one of these infections, LOS increased 18.5 days and cost doubled.[4] A mean increase of 43 days in LOS and a median cost increase of 2.8 times that of noninfected patients was determined in another study of patients with mediastinitis.[26]

Signs and Symptoms of Sternal Wound Infection

Wound

Erythema
Edema
Warmth
Drainage, positive culture
Infected or necrotic tissue
Sternal instability or dehiscence
Tenderness
Atypical or excessive wound pain

Chest

Unilateral or bilateral pleural effusions
Pulmonary infiltrates
Pericardial effusion
Widened superior mediastinum
Crepitus of chest wall
Drainage from chest tube stab wounds or epicardial pacer wire site
Dyspnea or tachypnea

Systemic

Fever
Tachycardia
Elevated WBC count or differential
Elevated sedimentation rate
Weakness

The course of sternal wound infection includes diagnostic techniques, antibiotic therapy, debridement procedures, complex wound care, and muscle flap and/or skin grafting. LOS may be extended an average of 14 days to several months with systemic complications. Strategies to reduce LOS and costs include early diagnosis and treatment of the infection, early involvement of a plastic surgeon, and, if the wound is open and healing by secondary intent, discharge home once the wound is covered with a bed of granulation tissue.

MANAGEMENT TRENDS AND CONTROVERSIES

Early diagnosis and treatment of mediastinitis reduces mortality, complications, and costs. Infection involving the sternum or substernal space (mediastinal area) is required to make the diagnosis of mediastinitis.[11] The presentation of mediastinitis may be diverse: at times obvious, at times occult. Signs and symptoms of mediastinitis are listed in the following Box. Mediastinitis usually presents on the sixth to twenty-first postoperative day.[1] This has discharge teaching ramifications for all cardiac surgery patients, since they could develop mediastinitis after hospital discharge.

Diagnostic Tests for Mediastinitis
White blood cell count and differential
Wound culture
Chest x-ray
Retrosternal aspirate culture
Computed tomography
Indium-111 leukocyte scan
Epicardial wire culture
Chest wall thermography
Plasma protein trends

In one study of 7949 cardiac surgery patients, temperature greater than 38.6° C, white blood cell count >12,000/mm^3, and drainage from the sternal wound or chest tube site correlated with mediastinitis.[20] Fever >38° C after the third postoperative day is abnormal and may signify respiratory or wound infection.[36] Wound drainage in combination with sternal instability is associated with advanced mediastinitis.[40] However, sternal drainage does not always indicate infection. Drainage may occur with hematoma or fat necrosis as well as mediastinitis or superficial tissue infection.[11] Sternal instability may also occur in the absence of infection.

Diagnostic tests may be used to confirm mediastinitis or if manifestations are unclear. The following Box describes the tests to diagnose mediastinitis. Negative wound or cardiac prosthesis cultures were found in 23% to 36% of patients with mediastinitis.[8,35] Staphylococcus was cultured in mediastinitis in 60% to 77% of patients in other studies.[9,20,30] *S. aureus* and *S. epidermidis* predominated in these studies, with gram negative pathogens occurring next in frequency. Survival has been shown to be enhanced when early antistaphylococcal and gram negative antibiotics are used.[38] However, more than half of patients with mediastinitis may be infected by the pathogens that are resistant to the prophylactic antibiotics most often used.[20]

Computed tomography (CT) scan provides a safe, rapid, noninvasive means to define mediastinitis, thereby expediting treatment. It accurately demonstrates sternal defects, fluid and gas collection, and abscesses of the presternal tissue, sternum, and retrosternal space.[5] Indium-111 leukocyte scan and epicardial pacer wire culture have also been identified to have diagnostic value in poststernotomy mediastinitis.[5]

Aspiration of retrosternal fluid in poststernotomy patients with suspected mediastinitis or evidence of infection of unknown etiology provides a mechanism of evaluation of mediastinal fluid. A technique of low-risk mediastinal tap in postcardiac surgical patients has been shown to document early mediastinitis in 9 of the 24 patients in a sample of 4000 cardiac surgery patients prior to the appearance of wound drainage or sternal instability.[40] The 15 remaining patients had a negative mediastinal culture and did not develop mediastinitis.[40]

TABLE 24-2 Flaps for Wound Closure in Postcardiotomy Mediastinitis*

Bypass conduit	Flap
Vein grafts or single internal mammary artery	Contralateral split pectoralis turnover Contralateral rectus abdominus Ipsilateral pectoralis rotation advancement
Bilateral internal mammary artery	Segmental pectoralis flap Pectoralis rotation advancement Bipedicled pectoralis-rectus flap Rectus abdominus (intercostal blood supply) Omentum Latissimus dorsi.

*Flaps are listed in order of preference.

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Chest radiography may be abnormal in mediastinitis and seen as a widened mediastinum, gas or fluid accumulation, or pulmonary changes.[7] However, chest x-ray changes may not occur until after clinical manifestations are apparent.

Changes in the skin temperature of patients with sternal wound infection have been detected noninvasively with thermography.[37] Plasma protein monitoring has also been investigated as an early indicator of mediastinitis in open-heart surgery patients. In a study of 188 poststernotomy patients, deviations in alpha$_1$-acid glycoprotein and C-reactive protein were highly predictive in the development of mediastinitis.[28] In another study, C-reactive protein increases occurring after the third day were found in all patients who developed mediastinitis.[46] Temperature elevation and white blood cell increase were seen in most but not all patients who developed mediastinitis.[46]

Mediastinitis is managed by eradicating the infection and healing the wound. Upon strong suspicion or confirmation of infection, incision and debridement are done to remove all infected or necrotic tissue and assess the extent of the infection. The entire wound is opened, sternal wires are removed, and infected or necrotic tissue is removed to the level of inducing bleeding in the tissue or bone.[1] The mediastinum is then irrigated with normal saline or an antimicrobial solution. Broad-spectrum intravenous antibiotics are begun until the drug sensitivities of the infecting organism are known. Incomplete debridement of infected tissue, bone, or rib cartilage often results in recurrent mediastinitis.[2,35] After debridement, the patient is closely monitored for evidence of infection. In one study, 25% of patients with mediastinitis required a second debriding.[20]

Wound management choices, following debridement, may be summarized as (1) muscle flap closure of the mediastinum, (2) closure of the mediastinum and continuous

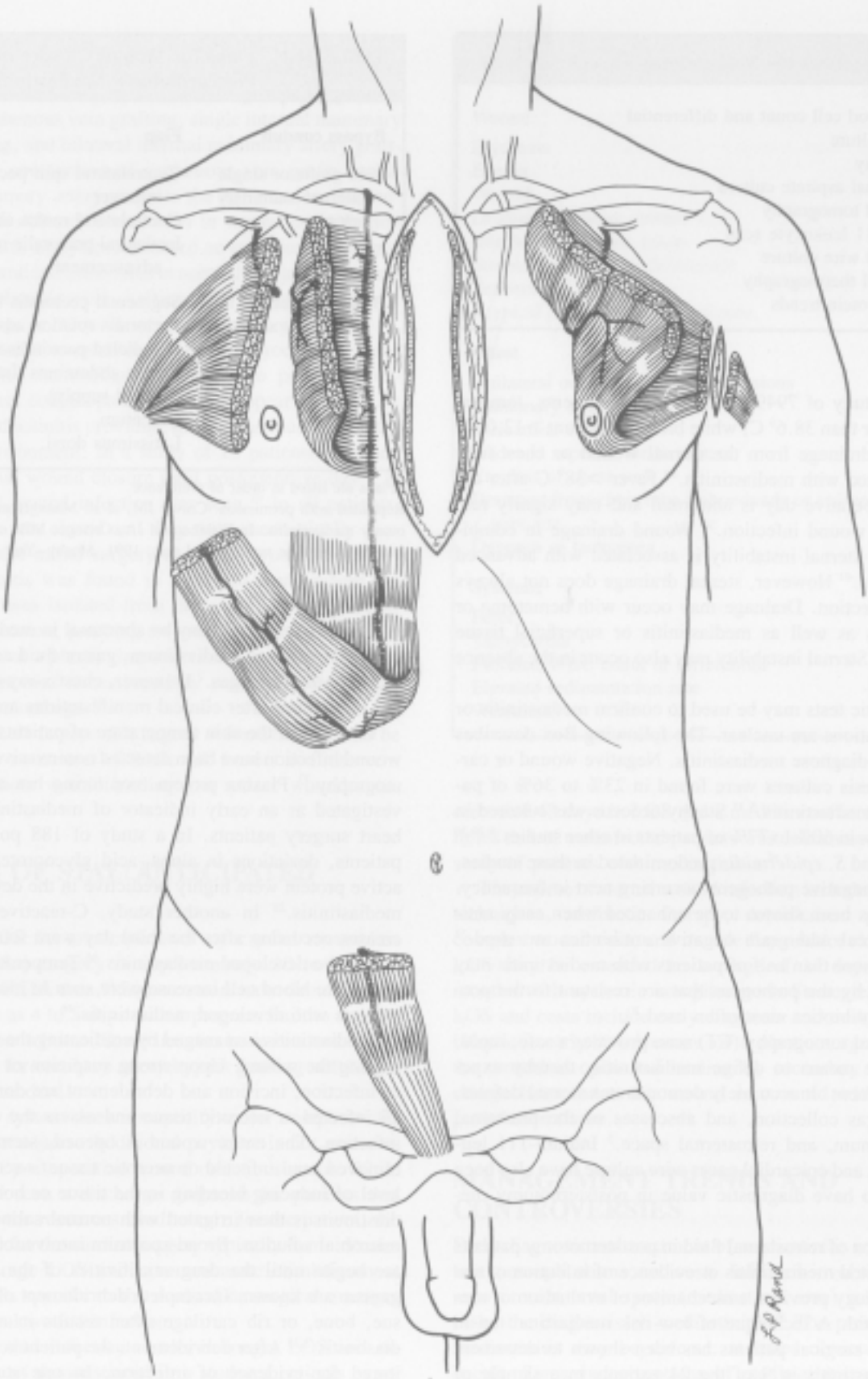

Figure 24-2 Examples of multiple muscle flaps: right pectoralis flap; left pectoralis rotation advancement flap; right rectus abdominus muscle flap. (Used with permission from Craver JM, et al: Management of postcardiotomy mediastinitis. In Waldhausen JA, Orringer ME, editors: *Complications in cardiothoracic surgery,* St Louis, 1991, Mosby.

mediastinal irrigation, or (3) wound care and monitoring with the mediastinum open.

Muscle flap reconstruction obliterates mediastinal dead space, speeds healing by providing well-vascularized tissue, reduces the risk of further infection, protects underlying tissue, and strengthens respiratory mechanics. Types of muscle flap procedures are listed in Table 24-2. Figure 24-2 illustrates muscle flap procedures.

In the early 1980s muscle flaps were used for refractory mediastinitis, extensive mediastinal defects, and sternal loss. However, recent research has demonstrated that muscle flap reconstruction results in significantly lower mortality, fewer complications, and shorter LOS, and should be the primary method of treatment for mediastinitis.[9,30,44] Using muscle flap reconstruction as the primary treatment of poststernotomy mediastinitis, a fourfold decrease in mortality and decreased LOS were realized when compared to closed-chest irrigation or wound packing.[30] The use of muscle flap reconstruction rather than chest irrigation has been recommended in children with postoperative mediastinitis based on evidence that ventilator support could be shortened by up to 21 days, ICU stay could be reduced by 17 days, wound complications could be reduced, and emotional and physical trauma of otherwise extensive wound care in the child could be eliminated.[15,44] A comparative study showed 33% mortality in patients with mediastinitis treated with chest irrigation alone, while mortality was absent in the muscle flap reconstruction groups.[9] One group had wound closure after 3 to 5 days following debridement, while the other group had omentum reconstruction immediately after mediastinal debridement and sternal rewiring.[9]

Following muscle flap reconstruction, most patients are ready for hospital discharge within 2 weeks. No change in mobility of the shoulder girdle or torso, function, or final anesthetic outcome were found in a group of patients who received pectoralis major muscle flaps.[41]

Another treatment option, continuous mediastinal irrigation, is used to create a sterile wound and mediastinum. The sternum is rewired over a catheter placed in the chest used to infuse a broad-spectrum antimicrobial solution or an antibiotic specific to the cultured organism. Chest tubes are used to drain the solution. The chest drainage must be equal to the irrigation volume. The catheter is removed when the drainage is sterile and there is no evidence of infection.

Unfortunately, fatal iodine toxicity has been reported in a three-year old child with postoperative mediastinitis who was treated with povidone-iodine chest irrigation.[19] Povidone-iodine irrigation for mediastinitis caused significant metabolic complications in three other pediatric patients resulting in one death.[44] Systemic and local absorption of iodine manifested in part by severe chemical pericarditis was demonstrated in a canine model following povidone-iodine chest irrigation.[19] The study authors advise extreme caution in the use of povidone-iodine chest irrigation, a dilution of 1:1000, and frequent assessment of serum iodine levels.

When gentamycin is used in the irrigating solution, size-related outcomes of toxic levels of the antibiotic in small patients and subtherapeutic levels in large-sized patients have resulted in the recommendation to carefully monitor gentamycin blood levels during mediastinal irrigation.[25]

The third wound treatment option, open wound care, has the advantage of ongoing visualization of the wound and ability to readily debride nonviable tissues. The wound may be allowed to heal by secondary intent, or muscle flap reconstruction may be done once the infection is resolved. However, open management of the wound may result in impaired respiratory dynamics, contamination of the wound, or prolonged LOS. If the sternum is not intact, a decision must be made and communicated regarding the handling of cardiac massage in the event of cardiac arrest.

Wound dressings should provide a slightly moist environment within the wound and, upon removal, minimize injury to newly healing tissue.[13] Wet-to-damp dressings of normal saline are an example of this type of dressing. The dressing is wrung out and interfaced with all wound surfaces in a thin layer. This is then covered with a dry dressing and secured with Montgomery straps, paper tape, stretchy nonadherent tape, or a lightweight body stocking. The dressing will need tape across the top to hold it in place during ambulation. The wet-to-damp dressing must be moist when removed to avoid disruption of healing tissue. If the wound bleeds after dressing removal, healing tissue has been disturbed. If it is stuck to the wound, the dressing must be moistened with sterile saline as it is removed. Once the saturated dressing can be easily removed, it should be taken off.

Ongoing wound monitoring and documentation of wound appearance should include wound size; presence of necrosis, exudate, and granulation tissue; and new capillary development.

ASSESSMENT

PARAMETER	ANTICIPATED ALTERATION
Sternal wound appearance	Approximated versus separated wound edges Possible loss of wound tissue Wound may have evidence of normal, infected, and/or necrotic tissue. Skin around wound may be indurated, reddened, warm, or edematous. There may be pain, tenderness, or a change in sensation associated with the wound. Wound drainage may be malodorous, serous, serosanguineous, or purulent. The drainage may come from the wound, chest tube site, or epicardial pacer wire site.

Sternal integrity	Sternal instability or dehiscence evidenced by grating, clicking, or sternal separation with breathing or coughing. Patient may report chest "giving way." Patient may experience dyspnea. Sternal sucking or bubbling on deep breathing Palpation of a separated sternum Widened mediastinum may be seen on chest x-ray
Temperature	Elevated: >38° C after postoperative day 3
WBC	Elevated: >10,000/mm^3
Wound culture	Positive or negative wound culture
Chest x-ray	Sternal fragmentation, pleural effusion, or widened mediastinum

Cardiovascular Status

HR	Tachycardia: HR >100 bpm at rest
Rhythm	NSR, atrial dysrythmias
MAP	Decreased: <70 mm Hg *if septic syndrome accompanies mediastinitis*
SVR	Decreased: <800 dynes/sec/cm^{-5} *if septic syndrome accompanies mediastinitis*
Cardiac index (CI)	Elevated: >4 L/min/m^2 *if septic syndrome accompanies mediastinitis*
Pulmonary status	Hypoventilation and respiratory distress *if sternal dehiscence occurs*
RR and pattern	Tachypneic with change in respiratory pattern
ABG	Respiratory acidosis and hypoxia • pH: <7.35 • P_{CO_2}: >45 mm Hg • P_{O_2}: <80 mm Hg
LOC, behavior	May change *due to hypoventilation or sepsis*

Uncontrolled infection often results in sepsis, which may trigger hemodynamic deterioration, acute respiratory distress syndrome (ARDS), renal failure, and other system dysfunction. Sternal dehiscence may cause disrupted respiratory and cardiovascular dynamics.

PLAN OF CARE

INTENSIVE PHASE

The major goals for this phase include: limit the infectious process within the wound, promote wound healing, minimize anxiety in the patient and significant other, and manage pain. Most patients who remain in the ICU during this phase are there short-term following debridement or muscle flap grafting, or have significant multisystem compromise as a result of mediastinitis. Those patients with respiratory, cardiovascular, or multisystem sequelae of mediastinitis are at risk for suboptimal perfusion and oxygenation of the wound.

PATIENT CARE PRIORITIES

High risk for infection *r/t*
- *Impaired tissue integrity*
- *Impaired wound healing*
- *Immunocompromise*
- *Wound stress*

EXPECTED PATIENT OUTCOMES

Approximated wound edges or, if wound is open, evidence of granulation tissue
No necrotic or infected tissue or wound drainage
Intact sternum
Adequate wound oxygenation and perfusion
Controlled blood glucose if diabetic
Adequate sleep
Minimal wound stress
Temperature: WNL
Optimal nutrition

Plan of Care (cont'd)

Ineffective breathing pattern *r/t* *Dehised sternum* *Increased work of breathing* *Anxiety* *Pain*	WNL/improved respiratory pattern Intact sternum/chest stability Decreased anxiety Improved comfort Activity tolerance
Anxiety *r/t* *Unexpected, significant postoperative complication* *Fear of unknown*	Reduced anxiety Able to rest, sleep, maintain nutritional intake Demonstrates trust in caregivers
Pain *r/t wound infection and treatments*	Verbalizes adequate comfort Able to participate in ADL Able to rest, sleep

INTERVENTIONS

Ensure effective preoperative skin preparation prior to the initial surgery *to reduce the risk of postoperative wound infection.*[3]

Ensure optimal timing of preoperative and perioperative antibiotics at the time of the initial surgery *to reduce the risk of postoperative wound infection.*

Identify patients at risk for poor wound healing (e.g., immunocompromised, elderly, diabetic, malnourished, reexploration) and institute appropriate compensatory or protective measures.

Manage hypothermia, pain, hypovolemia, and vasoconstriction after initial surgery *to minimize wound hypoxia and promote wound healing and resistance to infection.*

Ensure adequate filling pressures, MAP, CI, and Sao_2 *to promote adequate wound oxygenation and perfusion.*

Do not remove original dressing for first 24 hours *to allow adequate time for skin edges to seal and thus reduce the risk of infection.*

Expose nondraining incisions to air after 24 hours *to promote wound healing.*

Practice meticulous handwashing and aseptic wound care *to reduce contamination.*

Splint the entire ribcage when suctioning or coughing *to minimize wound stress.*

Suppress exaggerated coughing, vomiting, struggling with arm restraints, or "bucking the ventilation" *to minimize wound stress.*

Recognize that exaggerated wound stress occurs in patients receiving external cardiac massage and patients who have repeat sternal opening in the immediate postoperative period.

Cover a newly dehised sternal wound with sterile towels moistened with sterile saline and immediately notify physician *to prevent wound contamination.*

Monitor the patient with new sternal wound dehiscence for potential respiratory and cardiovascular deterioration.

Cover sternal wounds that are not intact or are draining with a sterile dressing.

Monitor the color of the muscle flap reconstruction site for evidence of adequate oxygenation *to identify hypoperfused muscle flaps early.*

Protect all sternal wounds from respiratory secretions or drainage contamination by elevating head of bed and covering the chest with a waterproof drape when suctioning.

Assess and document the appearance of open wounds with each dressing change *to detect evidence of healing or infection. A healing wound is red or pink in color, is becoming smaller, or may have a healing ridge around the wound and/or granulation tissue in the wound. An infected wound may be yellow in color with purulent drainage and, over time, enlarge in size. A necrotic wound has a black eschar.*[13]

Apply a wet-to-damp dressing in a single layer on the wound *to avoid masceration of the skin.*

Use a net body stocking, Montgomery straps, or Co-ban nonstick tape *to avoid denuding the skin with repeated tape removal during dressing changes.*

Consult with a dietitian, pharmacist, and physician to develop an optimal nutritional plan *to provide wound healing substrates and promote immune function.*

Plan of Care (cont'd)

Monitor weight and intake of calories, protein, carbohydrates, fats, minerals, and vitamins.
Ensure adequate sleep *to improve immune function, tissue regeneration, and ability to cope.*
Maintain normal temperature.
Monitor for respiratory instability if sternum is not intact.
Encourage airway clearance by means of coughing and deep breathing, incentive spirometry, ambulation, repositioning, and postural drainage *to maximize oxygen delivery and exchange.*
Monitor pulse oximetry and pulmonary assessment *to detect changes in oxygenation.*
Ensure accurate perception of condition and plan of care *to reduce anxiety.*
Use the calming strategies of a consistent, supportive, caregiver using a reassuring manner, eye contact, touch, reality orientation, and simple, concrete commands *to reduce anxiety.*
Encourage the use of support, such as family/significant others and/or religion *to reduce anxiety and promote adaptive coping.*
Administer analgesics on a scheduled basis *to maintain adequate pain control and ensure patient cooperation with wound care and ADL.*
Use relaxation, distraction, imagery, and/or music *to enhance pain control and reduce anxiety.*

INTERMEDIATE PHASE

Once the infection is brought under control and potential sepsis-related complications are resolved or controlled, the priority of wound healing continues. In addition, the greater wound care involvement of the patient and/or family/significant other is emphasized to facilitate transition to discharge.

PATIENT CARE PRIORITIES	EXPECTED PATIENT OUTCOMES
High risk for impaired wound healing *r/t prolonged hospitalization and wound care process*	Free from infection Approximated wound skin edges or evidence of granulation tissue within wound Adequate wound perfusion and oxygenation Adequate nutrition Adequate sleep Blood glucose: WNL
High risk for ineffective coping *r/t* *Body image changes* *Dependency in self-care* *Loss of health*	Looks at wound and accurately discusses wound appearance Takes responsibility for wound care as appropriate Demonstrates activities to manage anxiety and cope with implications of illness Progresses activity to full ADL Resumes self-care Practices energy conservation
High risk for inadequate nutrition *r/t increased metabolic demands associated with wound healing*	Consumes adequate calories and protein

INTERVENTIONS

Ensure adequate MAP, SaO_2 *to maintain adequate wound perfusion and oxygenation.*
Ensure adequate nutrition *to provide additional substrate needed for tissue regeneration.*
Promote adequate sleep *to facilitate tissue regeneration, energy for ADL and coping.*
Assist patient and family/significant other in identifying issues related to body image changes and losses.
Discuss wound appearance and plan of wound management with patient and family/significant other.
Encourage the patient and family/significant other to view the wound to establish what the wound looks like *to ensure a realistic perception of the wound.*

Plan of Care (cont'd)

Point out evidence of healing within the wound.
Involve the patient and family/significant other in wound care and self-care.
Encourage the patient and family/significant other to examine the meaning of the losses they have experienced with this illness *to correct any misperceptions.*
Collaborate with cardiac rehabilitation and/or physical therapy *to progress strengthening exercises and ambulation.*
Use distraction techniques *to reduce the boredom and stress of prolonged hospitalization.*
Prior to hospital discharge, ensure that the patient and family/significant other have a clear understanding of activity progression, wound care, indicators of wound infection and healing, and nutrition.

TRANSITION TO DISCHARGE

Hospital discharge following mediastinitis occurs once there is significant wound healing and absence of infection. If the wound has been left open to heal by secondary intent, resistance to reinfection is greater when granulation tissue is present. Once the patient and/or family/significant other has demonstrated proper wound care and can verbalize the indicators of wound reinfection, activity restrictions, and the dosing and purpose of medications, discharge can occur. If sternal osteomyelitis has occurred, additional teaching and home care referral are necessary for at-home intravenous antibiotic administration, intravenous site evaluation and care, and drug and supply acquisition. Follow-up home care may provide important support, prevent reinfection, and ensure optimal, complete recovery in all patients discharged while previously infected sternal wounds are still in a healing phase.

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