Sternal Wound Infections
Diagnosis, Prevention and Treatment

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Definition- SSWI vs DSWI

SSWI- Superficial Sternal Wound Infection

- Skin
- SC tissue
- Pectoralis Fascia

DSWI- Deep Sternal Wound Infection

- + culture of mediastinal tissue or fluid
- Evidence of mediastinitis
- Chest pain, sternal instability, fever
- Purulent drainage

Diagnosis

- Positive Culture
- Dehiscence
- Fever
- Pain
- Erythema
- Purulent Drainage
- Instability (click)

Only about 33% are identified pre-discharge in many studies

- Staph Epi- for SWI
- Staph Aureus for DSWI/Mediastintis

Incidence and Demographics

- 3008 Adults, 291 SSI (9.7%)
- Deep Sternal Wound infections 1.6% (47)
- Post-op Mediastinitis 1.7%
- Superficial Wound complications 6.4%

Preoperative Risk Factor for DSWI/Mediastinitis

- Obesity
- IDDM
- Tobacco
- PVD
- High NYHA class

Incidence/Risks/Outcomes

CABGs n=9021

2002-2006

SWI= 0.47% total

DSWI= 0.22%

Mortality

9.1% (vs 1.1% without)

14%

Risks:

- Female
- Preop HTN
- DM
- Obesity
- Prolonged Vent Time
- Re-Exploration for bleeding

Age and Smoking were not a risk factor

Omran et al, Tehran heart Center BMC ID 2007:112

Table 1: Pre-intra-and postoperative characteristics among patients with and without SWI

Variables	Group 1* (n = 9157)	Group 2** (n = 44)	P value
Age (mean ± SD)	58.5 ± 9.7	60.1 ± 8.7	0.173
BMI (mean ± SD)	27 ± 4	28.3 ± 4	0.032
Female %	25.5	52.3	< 0.001
Smoking %	39.5	34.1	0.467
Diabetes %	33.7	59.1	< 0.001
Hypercholesterolemia %	61	65.9	0.508
Hypertension %	49.7	90.9	< 0.001
PVD %	1.8	2.8	0.666
Length of preoperative hospital stay (days) (mean ± SD)	8.2 ± 4.9	9.4 ± 6.1	0.098
CCS (Functional class) (mean ± SD)	2.1 ± 0.8	2.6 ± 0.7	< 0.001
LVEF (mean ± SD)	49.1 ± 10.2	50.7 ± 11.2	0.260
Graft number (mean ± SD)	3.6 ± 0.9	3.6 ± 1	0.928
Cross clamp time (minute) (mean ± SD)	42.4 ± 41.5	45 ± 16.4	0.686
Perfusion time (minute) (mean ± SD)	70.1 ± 26	75.2 ± 23.5	0.207
Re-exploration for bleeding	1%	13.6%	< 0.001
Intubation time (hours) (mean ± SD)	8.9 ± 13.6	54.1 ± 172.1	< 0.001

Body mass index, BMI; Peripheral vascular disease, PVD; Canadian Cardiovascular Society classification, CCS; left ventricular ejection fraction, LVEF
* Without sternal wound infection
** With sternal wound infection

Table 2: Results of multivariate analysis in development of SWI

Variables	Odds ratio	95% CI*	P value
Re-exploration for bleeding	13.415	4.521–39.802	< 0.0001
Hypertension	10.763	3.297–35.128	< 0.0001
Female	2.707	1.446–5.071	0.0019

* Confidence Interval

Prevention and Treatment

- Avoid retained blood- dry before closure
- Early extubation
- Early removal of urinary catheter/central line
- I+D of superficial infection with VAC if needed
- Early OP/Definitive Rx for DSWI
  - Debridement of all devitalized tissue/resection
  - Drainage of all infected spaces
  - Abx treatment
  - Closure of sternal space
    - Flaps or closure/Abx irrigation

Staph Aureus Colonization and Sternal Wound Infection

Screening for Staph with nasal swabs (PCR)
Class I Recommendation, Level of Evidence A

Intranasal Treatment

- MSSA >90% decolonization, but
- MRSA only 45-50% effective decolonization

Routine use of Mupirocin- Class I recommendation, Level of Evidence A

How many of you practice this?

Staph Aureus Preoperative Nasal Colonization Treatment

- 2% Mupirocin for 5 days
  - 45% reduction in SSI if known colonization
  - No MRSA post-sternotomy mediastinitis seen.
  - Isolates identical in preop and surgical site cultures in general

Staph Aureus Colonization and Sternal Wound Infection

- A known fact that colonization with Staph A. increases risk of Surgical Site Infection
- Techniques Proposed to Reduce this Risk
  - UD (Universal Decolonization of all Patients)
  - TD (Targeted Decolonization (if culture positive)
  - ND (None)
- Cost Savings:
  UD $426 on average, prevented 19 SSI
  TD $205 on average, prevented 10 SSI
- <u>For 220,000 CABGs done:</u>
  UD would save 102 Million
  TD would save 45 million

Hong et al, Ann Thorac Surg 2018 105:147-53

Glycosylated Hgb and Risk of SWI

N	2130 (CABG)
SWI	5.4% (114)
HgBA1C w SWI	54 +/- 17mmol/mol
HgBA1C s SWI	45 +/- 13mmol/mol

6.3%
7.1%

HgBA1C > 70mmol/mol (8.6%)
20.6% vs 4.6%

Circ J 2016, 81:36-43

Sternal Wound Infection

Glycemic Control

Results in reduction of SWI and DSWI rates

3065 adult patients, program instituted to simplify glycemic control during an 18 month period

SWI incidence from 2.6% to 1.0% (60% reduction)

Goal Glucose: <110mg/dl for 3 days of control minimum

BG 110-219 mg/dl 2U/hr insulin infusion
BG 220-299 5 U push + 2U/hr
BG 300-400 15U push + 2U/hr

Hypoglycemia rate was only 0.004%

Cramer et al, Arch Surg 2008 Vol 143

Glycemic Control

Simplify and Multidisciplinary Approach

The 1% incidence now is related to co-morbidities such as poorly controlled diabetes preoperatively.

Sternal Wound Infection

IMA and Diabetic Patients

126,235 Diabetic Patients

122,465	**LITA**	**1.6%**
3770	BITA	3.1%

Risk ratio BTA vs. LITA= 1.71

Skeletonized superior to pedicle
If BITA skeletonized the risk is equal to LITA

Deo et al, Ann Thorac Surg 2013, 95:862-9

Sternal Wound Infection

Risks and Prophylaxis: Evidence

Preoperative Nutritional Status

Hypoalbunemia < 3.0gm/ml is a risk factor

Class I/Level B

Preoperative Glycemic Control

HgB A1c >7.5%, Glucose <180-200mg/dl

Class I/Level B

Smoking Cessation

Class I/Level B

Sternal Wound Infection

Risks and Prophylaxis: Evidence

Perioperataive Antibiotics
Within 60 minutes, no longer than 48 hours
Cephalosporin (Vanco not indicated routinely)
Class I/Level A

Topical Antibiotics
To cut edges of sternum on opening and closing
Class I/Level B (Vanco slurry)

Bone Wax
Avoid Class III/Level B but often used still

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Sternal Wound Infection

Intraoperative Risk Factor for DSWI/Mediastinitis

- Bilateral IMA (2.9 vs 3.9%)

Postoperative Risk Factor for DSWI/Mediastinitis

- Prolonged Ventilatory Support
- Air Leak (lung)

Preoperative Risk Factor for SWI

- Obesity
- Age > 75years

Riddderstolpe etal, Europ Journal of CT Surgery 2001 (20:1168-1175

Sternal Wound Infection

Risks and Prophylaxis: Evidence

Chlorhexidine bathing/shower
Class IIb/Level B

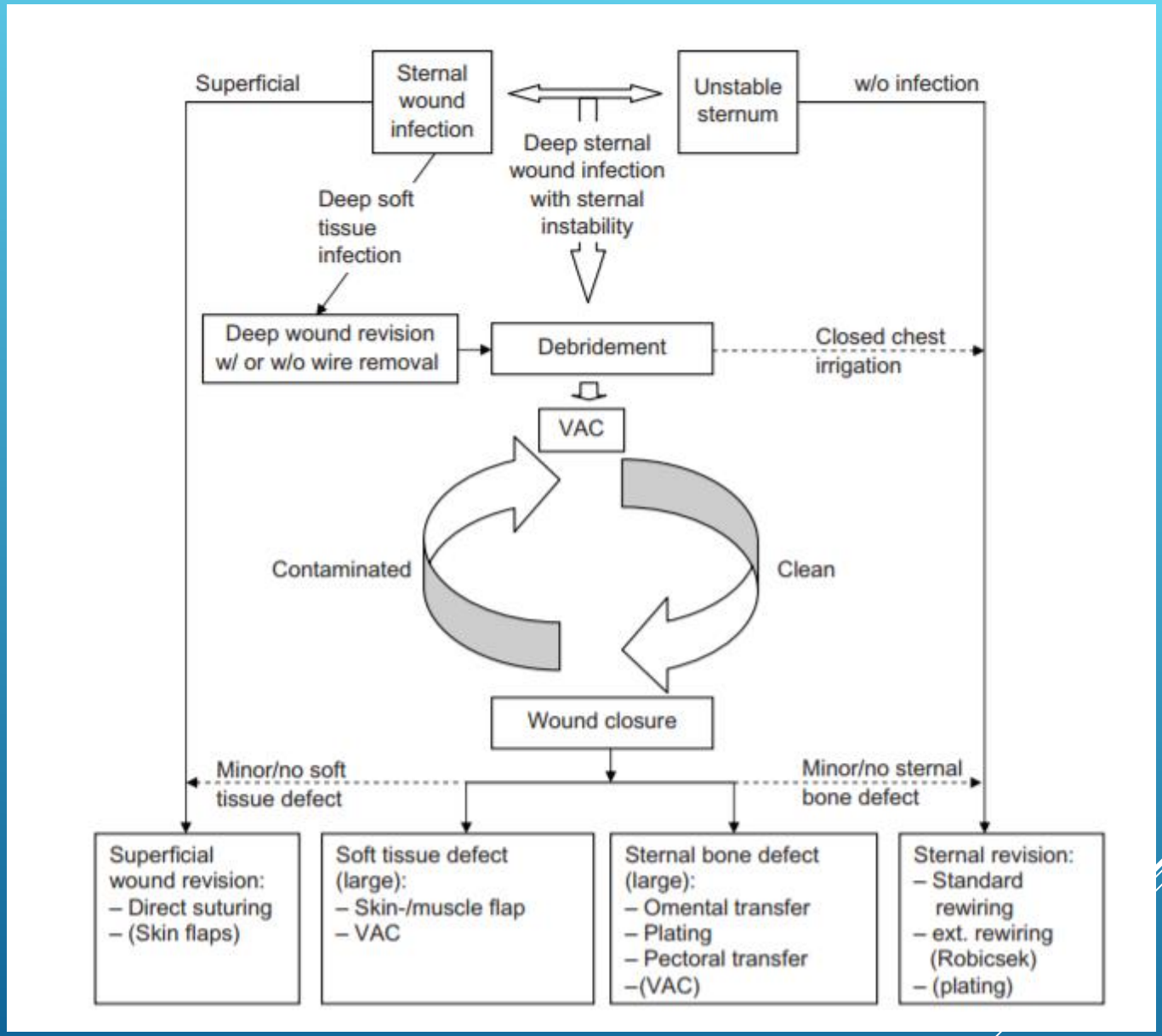
Figure 8 or Bands in high risk patients
Class IIb/Level B

Robicsek Weave if indicated
IIa/B

Treatment Options

- Closed Suction
- Abx Catheter Irrigation
- VAC Dressing
- Omental Transposition
- Pectoralis Flaps- "turnover" or "rotation"
- Rectus Abdominus Flap
- Latissimus Dorsi Flap

Early wound exploration, debridement, and sternal fixation as first step to preserve sternum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Sternal wound infection
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Superficial wound revision:
– Direct suturing
– (Skin flaps)
Soft tissue defect (large):
– Skin-/muscle flap
– VAC
Sternal bone defect (large):
– Omental transfer
– Plating
– Pectoral transfer
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Sternal revision:
– Standard rewiring
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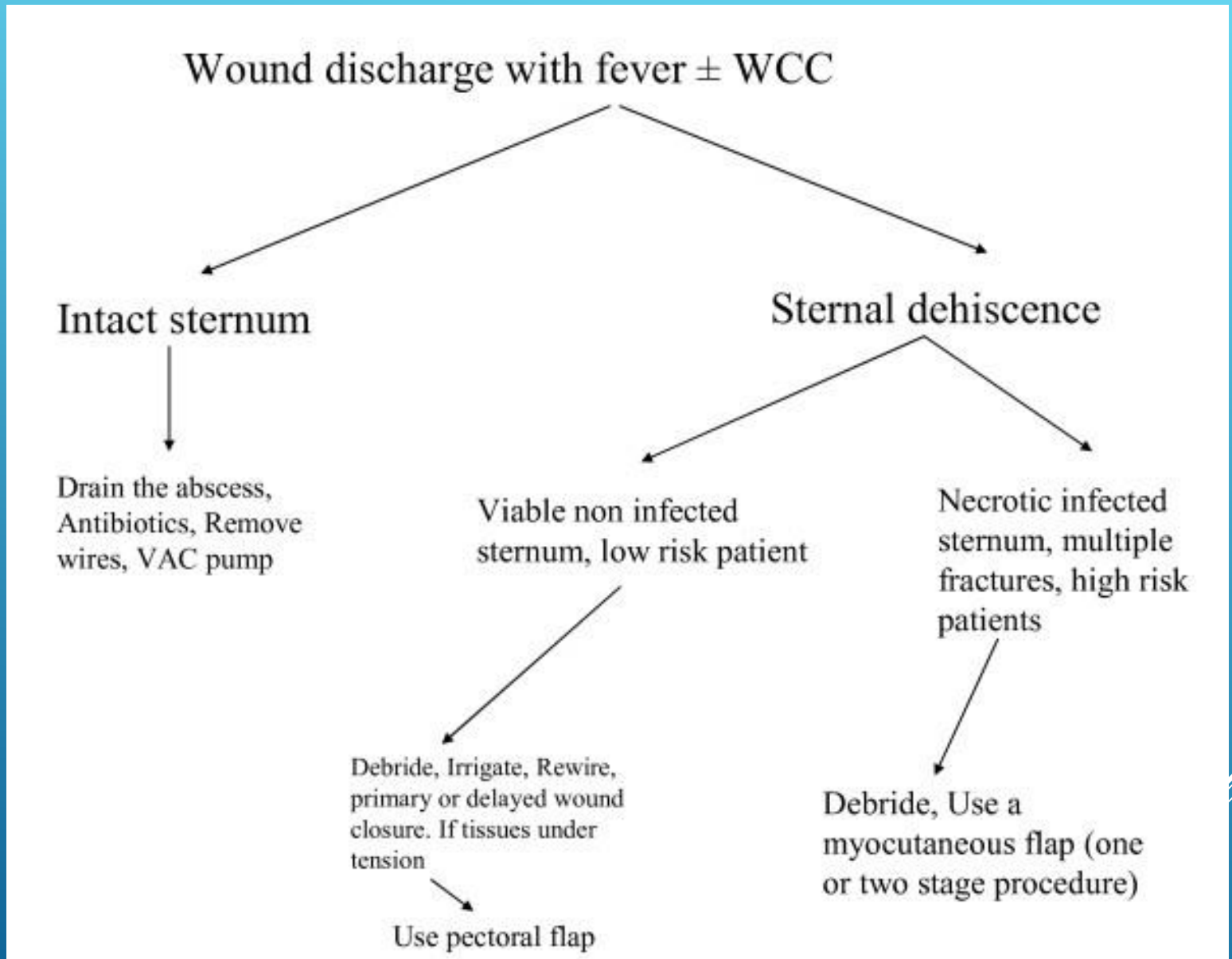
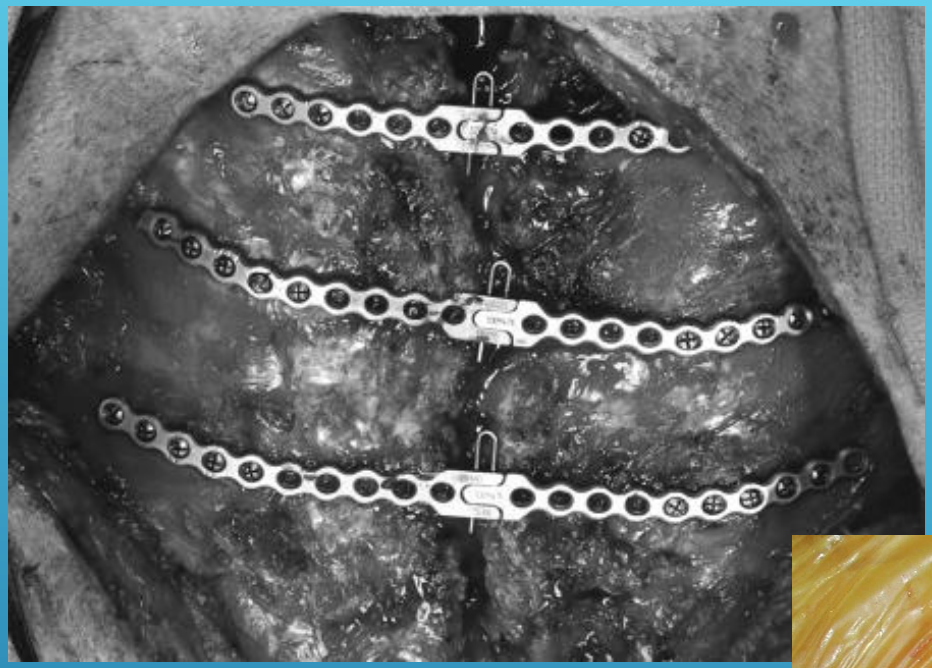
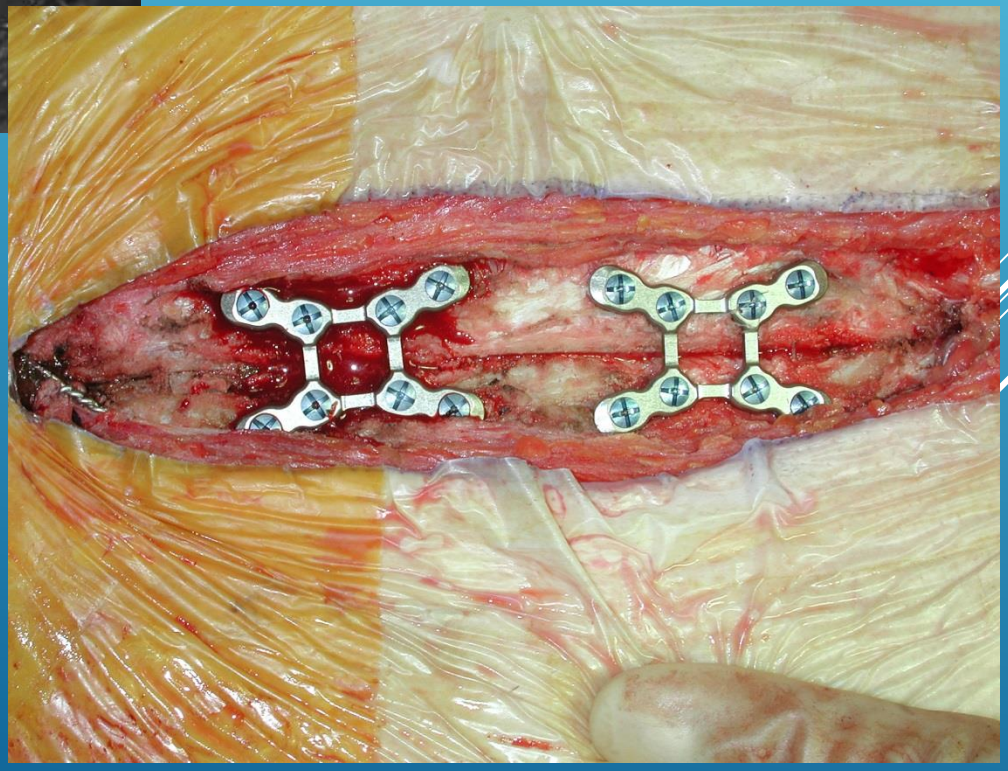

Wound discharge with fever ± WCC
Intact sternum
Sternal dehiscence
Drain the abscess, Antibiotics, Remove wires, VAC pump
Viable non infected sternum, low risk patient
Necrotic infected sternum, multiple fractures, high risk patients
Debride, Irrigate, Rewire, primary or delayed wound closure. If tissues under tension
Use pectoral flap
Debride, Use a myocutaneous flap (one or two stage procedure)





Rigid Sternal Fixation

(mostly for prophylaxis)

May be used in mild infections, at time of debridement and closure

Contraindicated for treatment of SWI in following:

- Osteoporosis
- Active Infection
- Extreme obesity
- Signs of bone loss

VAC- Vacuum Assisted Closure

Introduced in 1997

- Increased peri-sternal blood flow
- Reduces bacterial levels
- Enhances granulation tissue
- Stabilizes chest

<u>VAC Failures:</u>

- ✓ > 4cm depth of wound
- ✓ Bacteremia
- ✓ Exposed bone
- ✓ Sternal instability

<u>VAC Risk:</u>

- ✓ Bleeding
- ✓ Damage to underlying tissues such as heart
- ✓ Limit to <3 weeks

Barrier between heart and great vessels and VAC (NPWT)

VAC Therapy Improves Outcomes

22 Studies covering 2467 patients
Non-randomized, meta-analysis

VAC	**5.2%**
No-VAC	14.4%

Immediate versus Delayed One-Stage Treatment

N= 583 SWI

497 referred immediately for treatment
- LOS= 4.7 days
- Mortality= 1%

86 Delayed repairs
- LOS= 18 days
- Mortality= 4.7%

Take home point – Do Not Delay

Early vs. Delayed Referral for One-Stage Debridement and Flaps

	Immediate	Delayed
N= 583	**497**	**86**
Mechanical vent	4.4% (4days)	46.5% (18.3days)
Tracheostomy	2.6%	36%
III/IV Decub	4.8%	23.2%
Major Dehiscence	0%	14%
LOS	4.7 days	19.3 days
Mortality	1%	4.7%

Cabbabe et al, Plast Recosntr Surg 2009 129;1490-4

Flap Coverage-Advantages

- Decreased vent dependence
- Decreased need for tracheostomy
- Decreased decubitus
- Decreased LOS
- Decreased mortality

Cabbabe et al, Plast Reconstr Surg 2009, 123:1490-1494

Debridement and Flap Reconstruction vs Traditional Debridement/Rewiring/Closed Drainage

	Major Comps	Mortality
Flap Reconstruction	**22%**	**0%**
Traditional Approach	92%	33%

Brant et al. Plast Recosntr Surg 2002, 109:2231-2237

Sternal Wound Infection

Muscle Flap Repair

13 year single Institution- 1994-2011

N=10404 patients

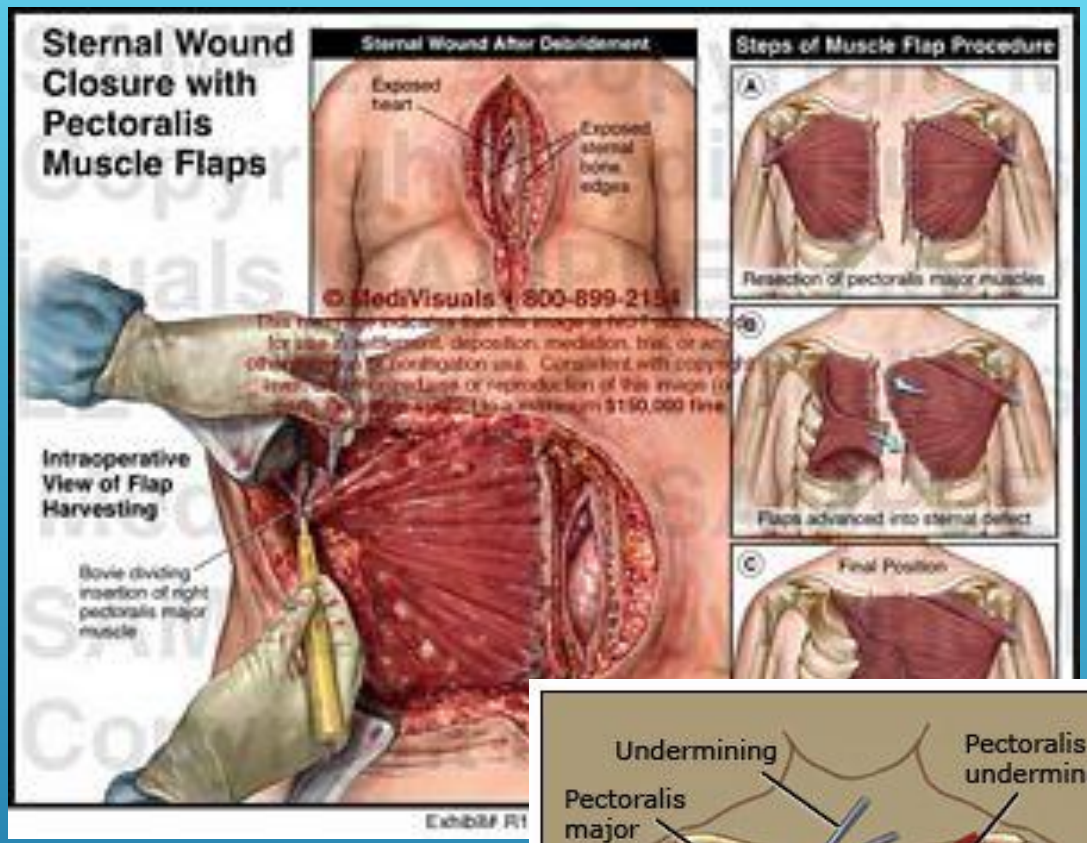
130 infections (1.25%) with 12 deaths

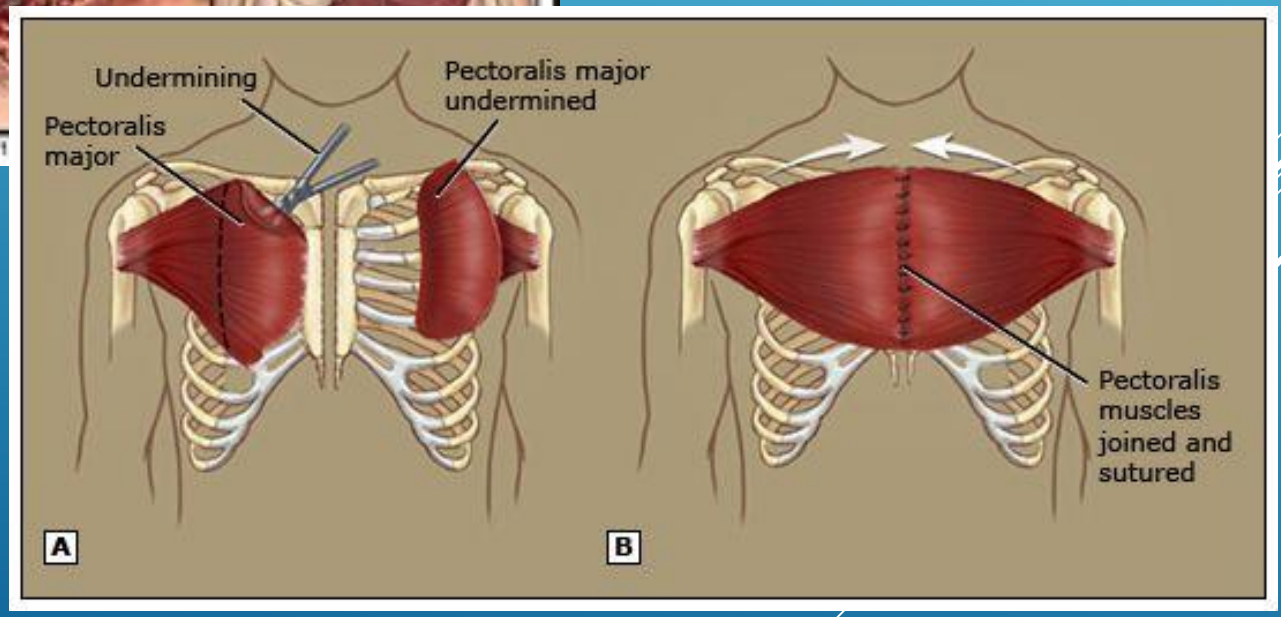
118 for Analysis 42% had muscle flaps- longer hospital stay, good outcome
60 day mortality= 12.3%

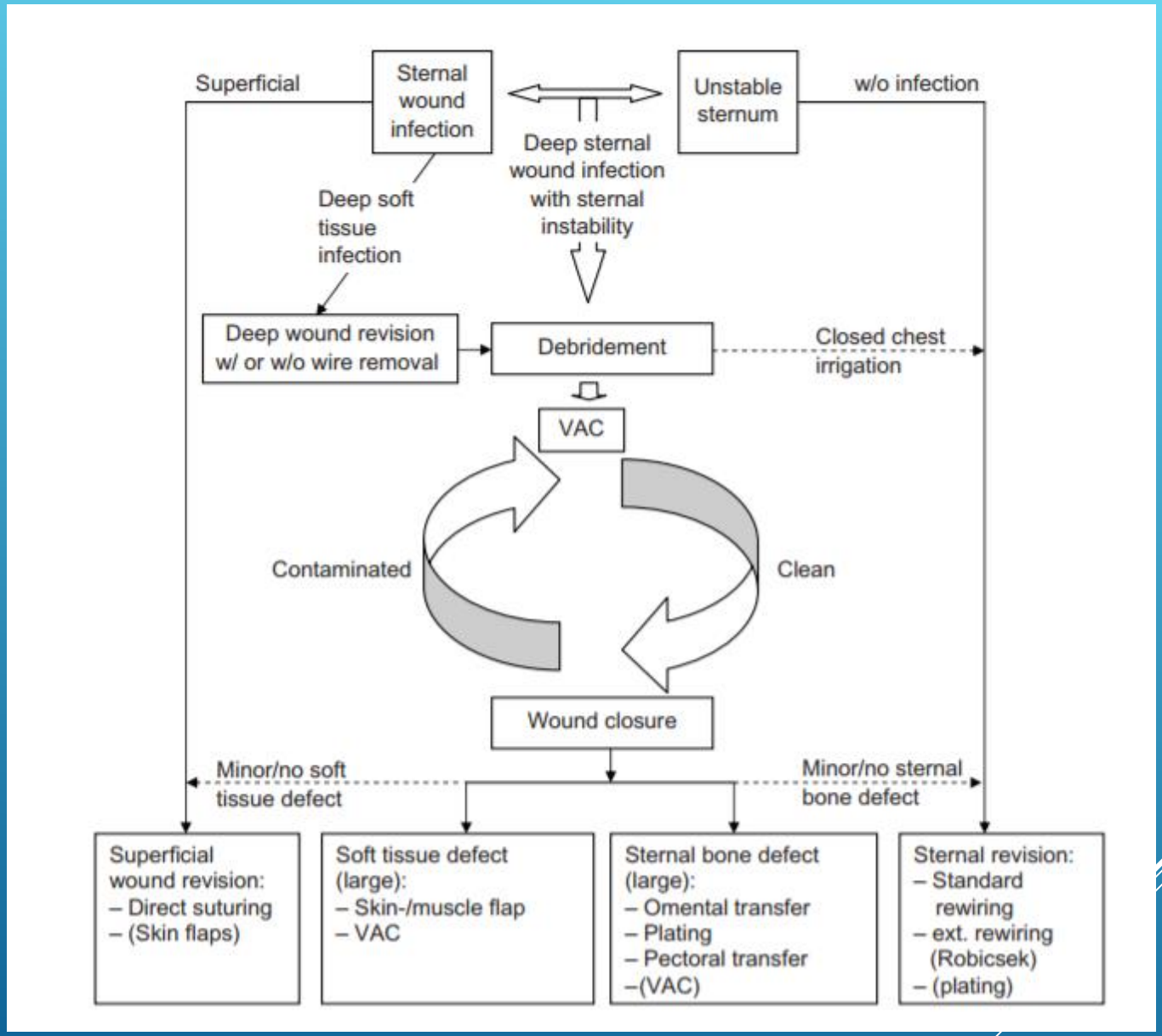
Andersen et al. Ann Thorac Surg 2017 28:76-82

Table 3. Reconstructive plastic surgery options for sternal defects.

Type	Blood supply	Limitations/adverse events
Muscle flaps		
Pectoralis turnover flap	IMA and intercostal perforators	Functional arm impairment
Rotation-advancement pectoralis flap	Thoracoacromial pedicle	Functional arm impairment
Segmental pectoralis flap	Intercostal blood supply	Functional arm impairment
Rectus abdominis myocutaneous (RAM) flap	Epigastric arteries	Abdominal wall herniation
External oblique muscle (EOM) flap	Branches of the intercostals arteries	Only for defects below the 4th costal interspace
Latissimus dorsi muscle (LDM) flap	Thoracodorsal artery and serratus artery branch	Functional arm impairment
Non-muscle flaps		
Omentum	Gastroepiploic artery	Hernia, reflux, dysphagia
Fasciocutaneous flaps	Superior epigastric vessels	Abdominal wall impairment
Split-thickness skin graft	None	Requires a well-vascularized bed
Rare options		
Osteocutaneous flap	Bone related vessel	Functional (arm) impairment
Free flaps	Various	Cosmetic impairment


Sternal Wound Closure with Pectoralis Muscle Flaps
Sternal Wound After Debridement
Exposed heart
Exposed sternal bone edges
Steps of Muscle Flap Procedure
A
Resection of pectoralis major muscles
B
Flaps advanced into sternal defect
C
Final Position
Intraoperative View of Flap Harvesting
Bovie dividing insertion of right pectoralis major muscle


Undermining
Pectoralis major
Pectoralis major undermined
Pectoralis muscles joined and sutured
A
B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Superficial wound revision:
– Direct suturing
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Soft tissue defect (large):
– Skin-/muscle flap
– VAC
Sternal bone defect (large):
– Omental transfer
– Plating
– Pectoral transfer
–(VAC)
Sternal revision:
– Standard rewiring
– ext. rewiring (Robicsek)
– (plating)

Table 4. Check list prevention of infection in cardiac surgery.[a]

Preoperative
- Screening for Methicllin-resistant S. aureus
- MRSA decolonization
- Hair removal with clippers
- Optimal blood glucose level adjustment
- Dental consult (?)

Intraoperative
- Timely application of antibiotics
- Antibiotics adapted to preexisting infection
- Adequate surgical hand disinfection

Postoperative
- Continuing of decolonization
- First dressing change with 24-48 hours
- Regular blood glucose level adjustments
- Termination of perioperative antibiotic prophylaxis at day 1

Note: [a]Joint mediastinitis register of the German Society for Thoracic and Cardiovascular Surgery (DGTHG), Institute for Quality and Patient Safety (BQS), National Reference Center for Surveillance of Nosocomial Infections (NRZ).

Conclusions- **Prevention:**

Preoperative
- Nutritional Status
- Nasal Swab and/or Decolonization (Mupirocin)
- DM control

Intraoperative
- Perioperative ABx (48 hours), Vanco paste
- Skeletonization of IMA
- Dry closure

Post-operative
- Glycemic control
- Early extubation

Sternal Wound Infection

Conclusions- **Diagnosis and Treatment:**

Early recognition
Culture
Antibiotics
Re-exploration debridement, secure closure, ABx irrigation

Or

VAC Dressing

Immediate muscle flap Closure (pec or omental) or Myocutaneous Flap