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Current management of sternal wound infection after cardiac surgery

Alfred TABLEY

- **No Disclosure**

The first aim in the management of sternal wound infection is to obtain a clean mediastinum

Free of germs

Free tissue necrosis

Presenting a well granulated and well vascularized tissue

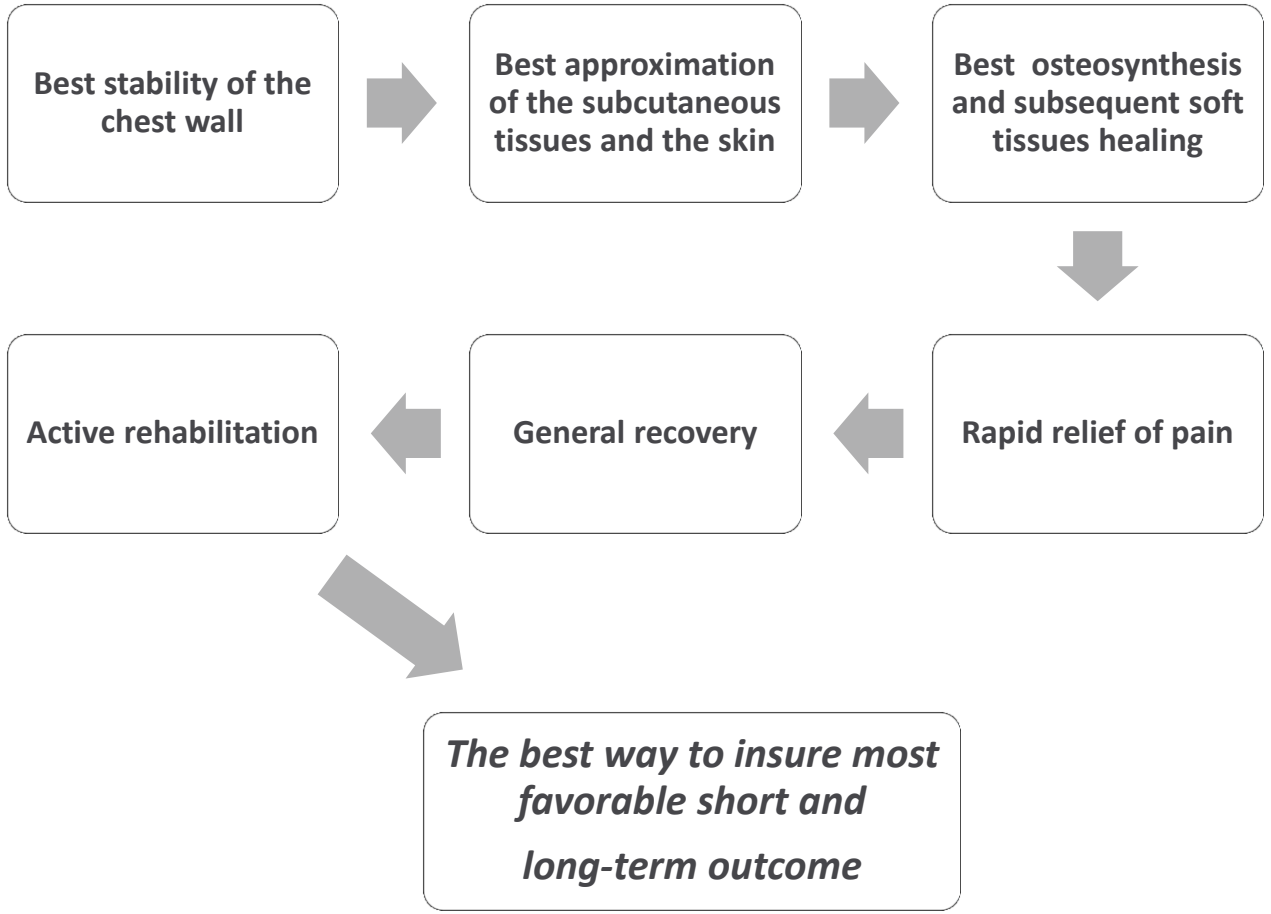
<u>In association of the appropriate antibiotic therapy:</u>

-Well documented micro-organisms

-Well defined targets tissues (soft tissue, bones, lungs, etc…)

-Taking in account patient condition(renal, respiratory…

In order to proceed as soon as possible to primary closure of the sternum by appropriate rewiring



Early diagnosis of the sternal wound infection is one of the key of succes

- Chest pain
- Sternal instability
- Fever > 38°C
- Purulent discharge from the mediastinum
- Hyperleucocytosis
- CRP reascending

Early diagnosis : presence of risk factors of SWI may be helpfull

Related to the patient

- Diabetes
- BMI >40 or <18
- Dialysis
- BITA
- Chronic lung or kidney disease
- Chest wall Rx

Related to the outcome

- Prolonged mechanical ventilation
- Pneumopathy and severe coughing
- Dehiscence or superficial SWI
- Anti-inflammatory and analgesic medication that may minimaze pain and fever
- Micro-organism isolated from blood cultur or CV catheter cultur at removal

The need for *a early diagnosis*

- **The major cause of death due to DSWI is intractable septic shock with multi-organ failure: rôle of delayed management**

- ***The real incidence of DSWI is likely to be 5-8 % at 30 days but 6-10% at 2-3 months****

- ***The management of late DSWI is often challenging***

  - **Risk of dreadfull hemorrage at reopening , due to adhesion of inflammatory tissue**

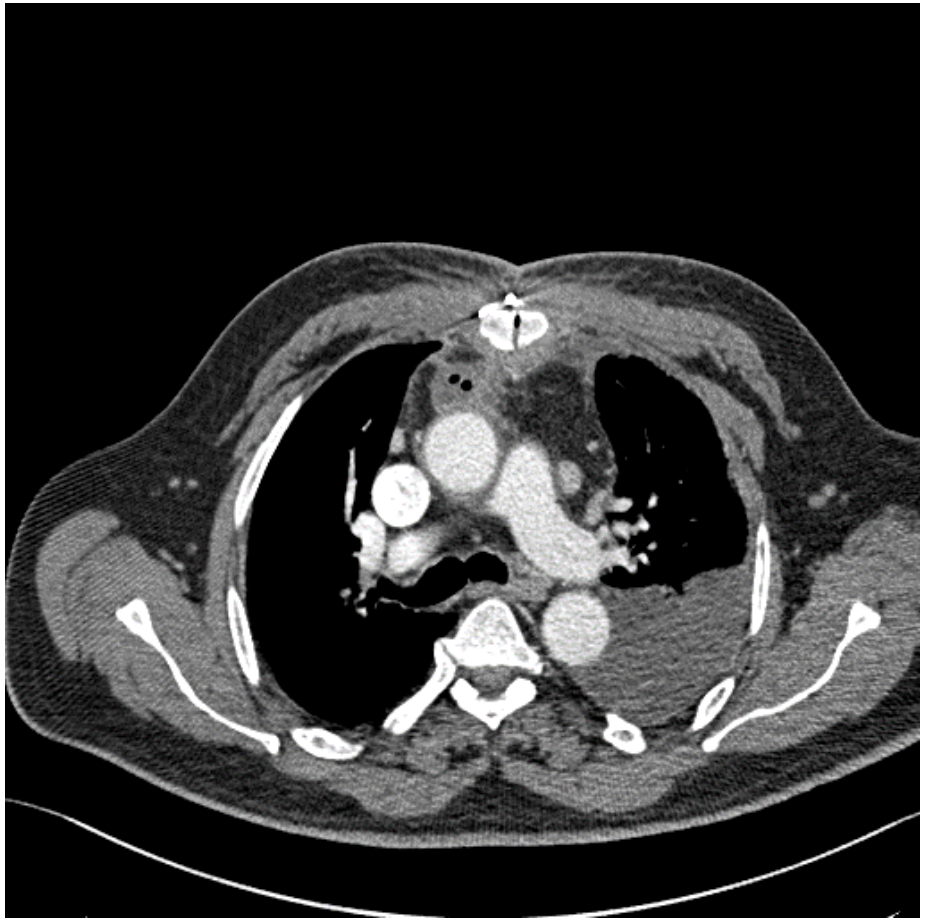
  - **Extensions of infection in particular to the sternum, driving to large sternectomy and resulting in complex/invasive surgical strategies for chest reconstructiion**

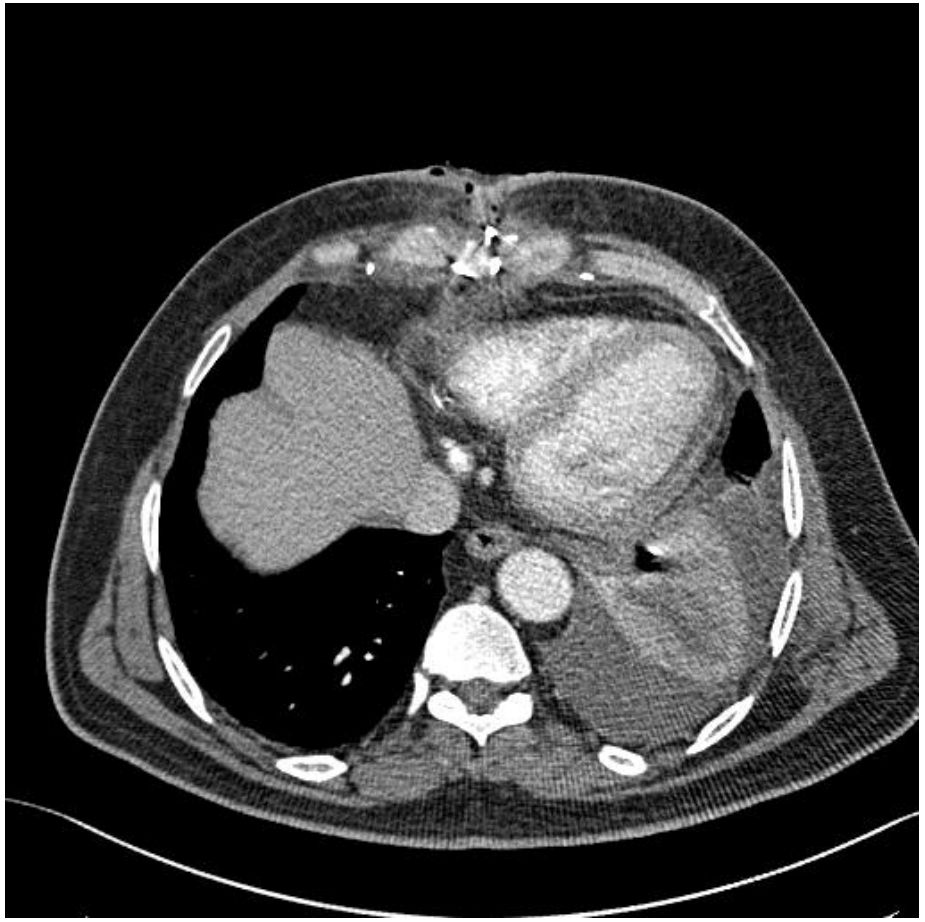
  - **Non optimal late outcome in terms of mortality and morbidity**

- ***Friberg and Bodin:Thorac.Cardiovasc.Surg. 2013:61;(3):185-93***

The need of early diagnosis:

- Needle aspiration
- Imaging





Primary revision is the mandatory first stage of any treatment of DSWI

- *<u>As far as possible before the onset of antibiotic therapy</u>*
  - Rigorous microbial multisite sampling and swabing in order to detect all the germ that may be involved
- ***Confirms the diagnosis, allows the assessment of the extension of the infection and follow the principles of septic surgery***
  - Removal of the wires,purulent and necrotic tissues. Debridement of the wound and the soft tissues …
  - Large irrigation of the mediastinum with antimicrobial solutions…
  - ***Permits to assess the type of management that may be implemented subsequently***…

Closure strategies Vacuum-Assist Treatments

VAC using NPWT devices is the newest option for treatment of DSWI.

Widely spreading do to amount of favorable results

Modalities of implementation are various

Comparisons are difficult and many conventional treatments are still in use in many centers

Closure strategies: Conventional methods

Open dressing.

Closed irrigation/drainage

Use of musculocutaneous flaps or omental flaps.

Close drainage using Redon catheters.

Used mainly in case of failure of first-line option or in specific indications but also as primary option.

Open wound dressing

Consists in multiples open dressing changes

- Followed by secondary rewiring
- Or secondary healing process

↓

Thoracic instability

Mechanical ventilation

Prolonged immobilisation(thrombosis, weakness…

↓

High mortality (up to 45 %) and morbidity

Closed Irrigation/Drainage

First introduced by Mandelbaum and Schumaker in 1963
Resulted in a important reduction of morbity/mortality of DSWI.

-Stabilisation of the thorax
-Mechanical cleansing of the site by irrgation

Consist in primary closure associated to irrigation/drainage of closed mediastinum with antimicrobial agents via thoracostomy tubes.

Continuous or intermittent irrigation, up to 4000 ml/ 24h

Generaly irrigation is stopped after 7days. Drains are removed when swab cultur from drains are negative with biological/clinical signs of healing.

Closed Irrigation/Drainage

Disadvantages

- The patient is attached to the drainage aspiration system
- Burden of quantification of the balance inflow/outflow in case of leakage
- Iodine toxicity*

Failure of wound healing and primary closure is high, up to 21%

Rate of reccurrence of infection is high as well

Molina, in modern era published a series of 114 patients treated as a primary option with no death.
Cure rate of 98% , mean hospital stay duration of 14 days

Risnes compared closed drainage to vacuum-assisted-closure and found a failure rate of 21% in drainage versus 6% in VAC.

No difference in mortality rate, length or long term mortality.

- *Molina JE, Nelson EC: J.Thorac Cardivasc.Surg 2006;132:782-7*
- *Risner I, Abdelnoor M: Int Woud J 2012 ;10.1111/j. 1742-48*

Musculocutaneous flaps

Introduced by Jurkiewicz in 1979 was also an important step in management DSWI

Bilateral Pectoralis muscles flaps are used in different patterns in order to cover the lack of substance and impossibility to rewire sternum.

Is an invasive and more complex procedure performed most of the time in collaboration with plastic surgeons

The mortality rate is low but the complication rate is up to 18%, due to

- Flap related morbidity

Musculocutaneous Flaps

- The mortality rate is low but the complication rate is up to 18%:
  - Flap-related morbity: hematoma, necrosis, sepsis
  - Long term muscular weakness, painfulness
  - Physical disfigurements
- **But became a key part of the armamentarium in management of DSWI**
  - **Many surgeons use it for secondary closure after irrigation drainage or NPWT**
  - **Other use it as primary closure when confronted to poor sternal condition**

Omental flap

- Transposition in the mediastinum of a flap of the greater omentum based on either right or left hastrepiploic artery
- Sometimes in adjunction to musculocutaneous flaps
- The main disadvantage is adding a laparotomy with its potential morbity in the context of septic surgery

Omental Flap

- But because of his specific interesting caracteristics
  - Antimicrobial activity and immunologic function
  - Promotion of angigenesis and tissue-generation
  - Main interest when multi-resistant pathogens are involved
  - Diabetics patients
  - Presence of important foreign material(ascending aorta grafts

Many surgeons use it as a specific adjunct to sternal closure

Milano compared **Omental and Pectoralis flaps** in patients with equivalent characteristics and founded more favorable outcome with omental transposition

Death rate: 4.8 vs 10.5 %,

Early complications: 9.5 vs 27.7%,

Hospital stay: 10.7 vs 18.8 days

Milano CA, Georgiade G: Ann Thorac Surg 1999; 67: 377-81

Closed drainage using redon drains

- Proposed by Durandy &coll in 1989
- After meticulous debridement
- Primary sternum closing under drainage of all infected areas: mediastinum, pericardium et subcutaneous space by small drains catheters (10 Fr).
- Each catheter is connected to a bottle providing a strong negative pressure, about 600-700 Hgmm (Redon Drain devices)
- Effluent from the redons are cultured two to three times a week in order to adapt antibiotic therapy and asses the evolution of the sepsis.
- After 10 days of closed drainage, Redon catheters are progressively removed, (2cm daily), until complete removal of all drains.

Closed drainage using Redon drains

- ***Main adventages:***
  - ***Provide a single shot procedure***
  - ***Surveillance is easy compared to closed irrigation drainge or early surveillance of flaps***
  - ***Provide optimal comfort, allowing patient to walk in the ward which is, a key factor to rapid rehabilitation***

Kirch and also Calvat and compared primary closed Redon drainage and Irrigation/ drainage.They showed significanttly reduced mortality rate and failure rate using Redon catheter.

More recently, Vos and al performed a prospective study comparing primary closure with Redon catheters and VAC closure;
Hospital stay was significantly shorter in Redon group (45+/-38days vs 74+/-61days)

In hospital mortality rate were similar

Re-infection rate was higher in the VAC group

Closed drainage using Redon drains

Our first-line option

- In case of fracture of the sternum, rewiring + reinforcement by total skin Bourdonnets sutures.
- In case of poor sternum condition, reccurence of or mediastinitis in patient after aortic ascending remplacement,
- We perform Omentoplsty + Bourdonnets full skin closure

- Our last evaluation:
- 42 DSWI patients, aged 45 to 83 years
- Treated by closed redon drainage
- 7,1 % mortality rate
- 35 primary closure (83,3 %)
- Treatment duration 25 +/- 7 days
- 4 failures
- 1 case of pseudo-arthrosis at 3 years

Closed Redon drainage

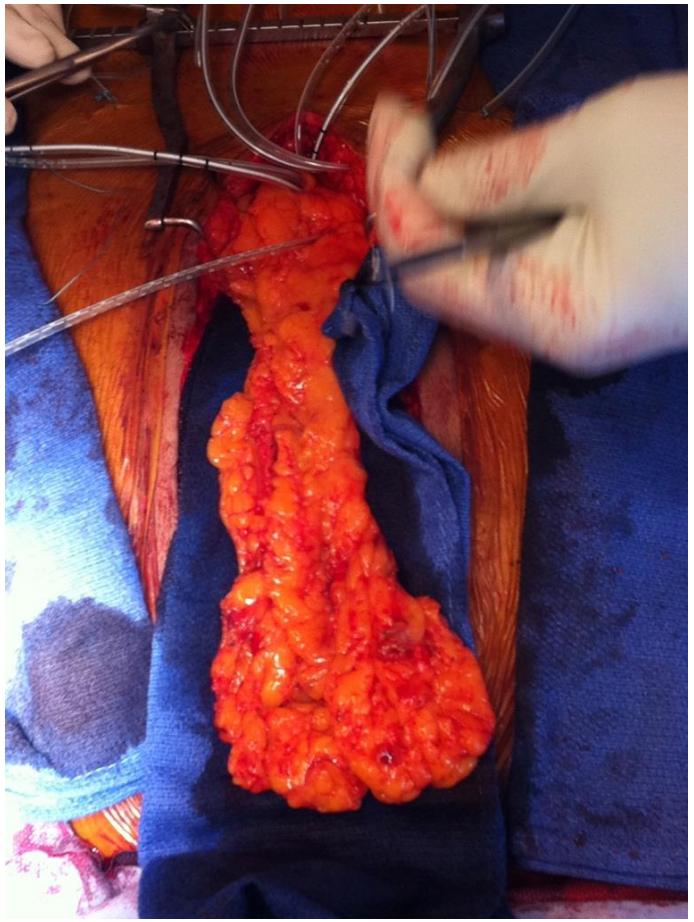
- **Provide sternal wound healing without repeat intervention while significantly reducing hospital stay**

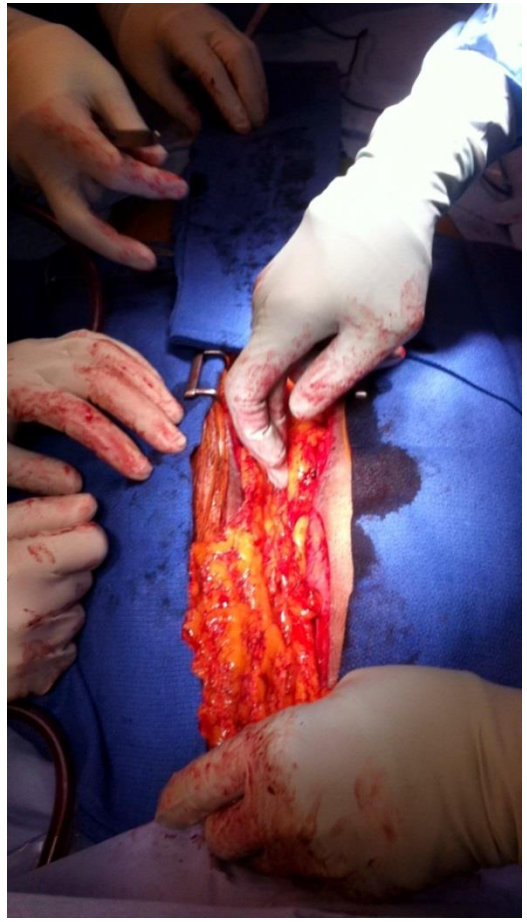
- *Durandy Y, Batisse A: J Thorac Cardiovasc Surg 1989;97: 282-5*
- *Calvat S, Trouillet JL Ann Thorac Surj 1996; 61: 195-201*
- *Kirch M, Mekontso-Dessap a Ann Thorc Surg 2001;71:1580-6*
- *Vos RJ, Ylmaz A Eur J Cardiothorc Surg 2012; 42:*

Closed drainage

Case of reccurent DSWI

Closed drainage +Omentoplasty





Closed redon drainage

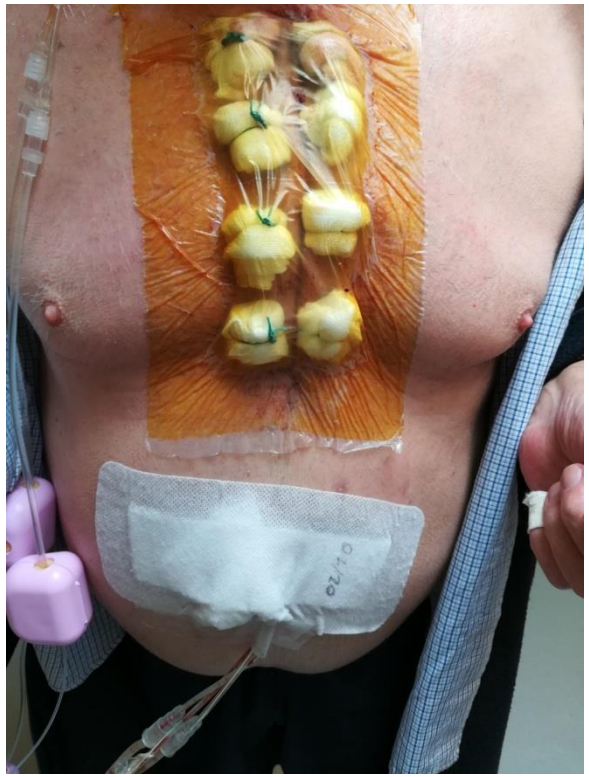
Multiples redon drains

Because of poor quality of the sternum, we do minimal rewiring and reinforcement by full skin Bourdonnets sutures

The laparotomy is closed in the same manner to minimize the risk of hernia

Close redon drainage

Final dressing with Bourdonnets sutures



- Duration of reconstruction with Bourdonnets is 21 days
- Removal of the bourdonnets before last redons

Closed drainage with Redon drains

Removal of bourdonnets

Day 8 after removal

Vacuum-Assisted Closure

NPWT has be introduced in the management of DSWI since 1997

Many studies have validated the effectiveness of NPWT in the treatment of DSWI

Resulting in widespreading of the method

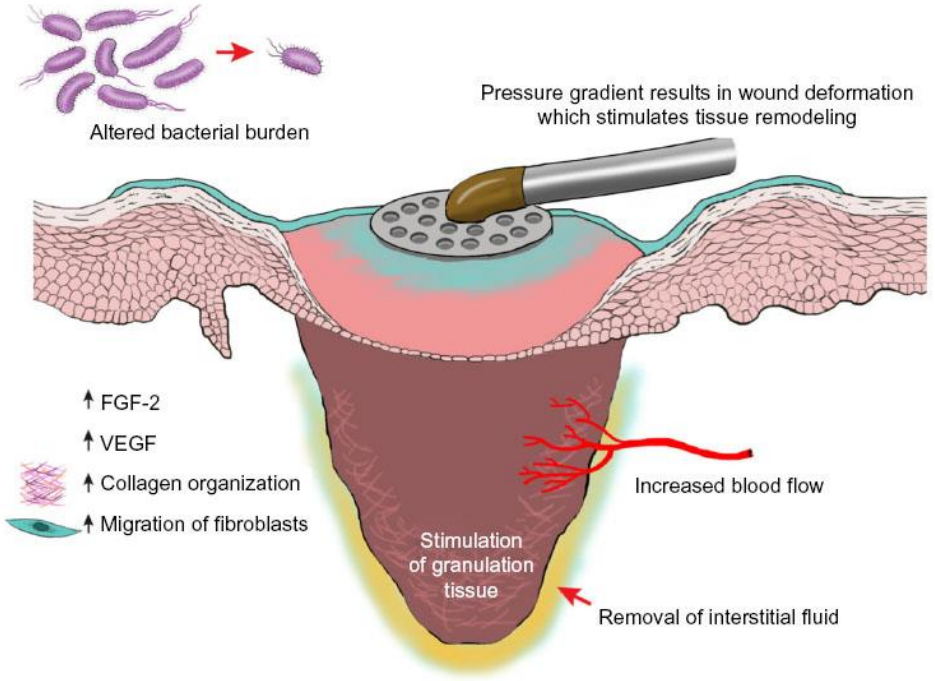
Over the past 10 years, the potential of NPWT has been increasingly reported,so that it is now the first line therapy for DSWI

That large use has showed the limitations and risks associated to the method

Vacuum–Assisted Closure

- NPWT
  - Remove the wound exsudates
  - Reduce accumulation of inflammatory mediators
  - Reduce edema and intertial fluids
  - Reduce bacterial colonisation
  - Increase dermal perfusion and granulation tissue formation
  - Reverse the tissue expansion
  - Facilitate reapproximation of wound margins

  - ***This seems to be the best condition to insure the succes of primary closure of the chest***



Vacuum-Assisted Closure

After debridement, the heart is protected by various form of paraffin gauze

Sterile polyurethane foam dressing is trimmed inside the cavity.
The dressing is completed by a transparent drape and via a special port connected to a pump.

The device produces the chosen negative pressure (125Hg mm is recommended) and collects the effluent.

The dressing are changed every 48 to 72 hours, under aseptic conditions

That also allows stepwise cleaning of necrotic tissus

And swabbing of the mediastinum for assessment of AB therapy

Vacuum-Assisted Closure

NPWT is discontinued generaly after 3 to 4 dressing, based on:

Obtention of free of germs, well granulated and vascularized tissue
Abscence of fever
Decrease of biological signs of infection: manly leucocytosis an CRP

Then the sternum is reclosed in various options:

Primary closure by rewiring

- Various reconstruction strategies involving muscle and/or omental flaps
- In some cases, Vacuum-assist secondary closure*

**Tamura A, Kouichi A Ann Vasc Dis 2013;6:206-8*

Vacuum-Assisted Closure

- ***It is clearly another major step forward in the management of DSWI***
- Many meta-analyses and systematic reviews have validated the efficacity of NPWT in DSWI.
- It results inan important reduction of short and long term mortality rate in all studies
- It is used as the first-line option in many centers
- Many use it as a single line treatment, as or a bridge to more complex plastic chest reconstruction.
- Thererfore, results concerning reduction of hospital stay and duration of treatment are inhomogenous and more controversial
- ***Morisaki in a propensity score matching analysis showed decrease mortality with NPWT associated to tissus-flaps chest reconstruction, especially in MRSA-infected patients***

Vacuum-Assisted Closure

- Nevertheless there are two concerns about NPWT :

NPWT has caused multiple **cases of major bleeding** from injury to Right ventricular free wall, coronary vein grafts or ascending aorta. Some of them has been lethal.

Factors favouring are insufficent protection of RV from the sternal edges, high negative pressure or excess duration of VAC

In a recent study, Vos and al, published results showing a higher re-infection rate in the VAC group, attributed to increased risk of contamination during multiple dressing changes.

Other authors suggested that prolonged application of NPWT can result in chronic infection

Bacteremia, high degree of bony exposure are predictors of NPWT failure, as lung emphysema and corticosteroids .

In conclusion

DSWI is still a devastating and potentially life-threatening complication.

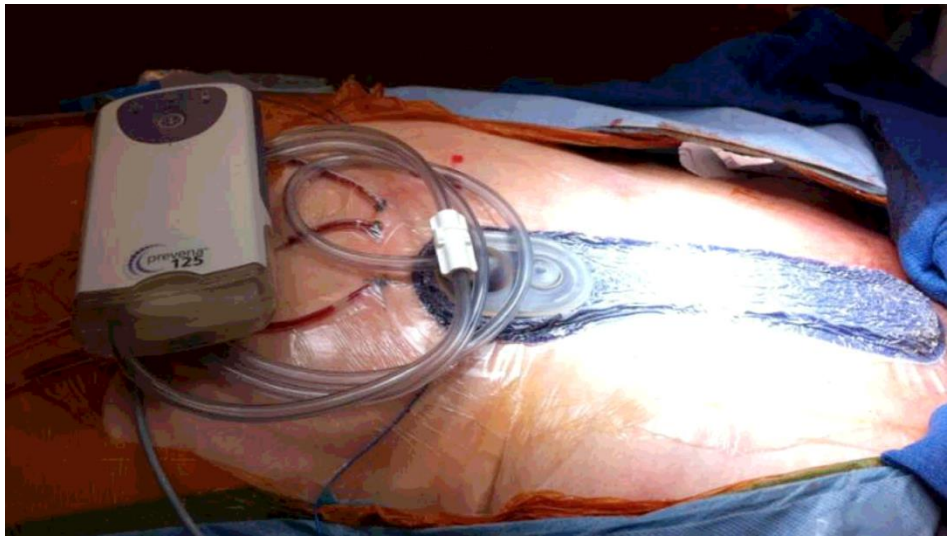
The mortality and morbidity has drastically been reduced by constant surgical innovations and medical progress over the years.

Yet, management of mediastinitis is still standardized but NPWT is a new major step- forward, if not cornerstone, in the management of that condition currently.

It allows successfull primary closure in a more important number of patients.

It is also an helpfull adjunct and improve the outcome when conventional methods are needed .

Incisionnal NPWT



Incisionnal NPWT

Incisionnal NPWT

- Series of 147 patients
- From july 2015-June2017
- At least 3 DSWI risk factors(Diabetes, Obesity/Denutrition, Bilateral AMI, chronic lung or kidney disease)
- Compared to 84 patients with equivalent status fom january to june 2015
- Observational study
- Significant reduction of DSWI
- DSWI rate of 4,1 % vs 10,9%
- Same reduction of Superficial infection or aseptic dehiscence

No disclosure