Perioperative Management and Strategies to Decrease Sternal Wound Infection

Introduction:

Sternal wound infection is one of the most dreaded complication after cardiac surgery as it increases the patient`s morbidities and health care cost. This study was undertaken to analyze the frequency of sternal wound infection after changes were implemented to tackle this problem.

Method:

We analyzed retrospectively the data of all patients undergoing cardiac surgery between 2008-2010 and 2012. In the period of 2012 there were few changes implemented to decrease the rate of sternal infection: hand disinfection technique, sternotomy, sternal and skin closure technique, efficient operation time, strict guideline in post-operative wound care and the use of the strict use of Posthorax®. Sternal wound infections were classified according to the guidelines of the Center of Disease Control and Prevention.

Result:

There were a total of 1689 patients. 1250 patients underwent cardiac surgery during the first period 2008-2010 and 439 patients during the second period 2012. There was no difference in age, gender, diabetes, BMI, creatinine, euro score, and type of surgery between the two groups. History of hypertension, surgical time, intubation time, postoperative peak creatinine kinase (CKMB) and the unit of blood transfusions was significantly lower in the second period ($p=0.001$, $p=0.007$, $p=0.005$, $p=0.004$ respectively) use of noradrenalin was higher in the second period ($p=0.009$). Bilateral mammary artery (BIMA) was used in 31% bypass patients in the first period and 62% in the second period (p 0.006). There was a significantly reduction in both pre-sternal infection 3.4% versus 1.1% and deep sternal infection 3.2% versus 1.6% in the second period ($p=0.007$). There was no association between sternal infection, age, gender, hypertension, diabetes, COPD, BMI, preoperative creatinine value, euro score, type of surgery, postoperative peak CKMB, rethoracotomy. Sternal infection was associated to surgical time, intubation time, blood transfusion and use of noradrenalin and BIMA ($p=0.017$, $p=0.001$, $p=0.040$, $p=0.016$, $p=0.021$ respectively)

Conclusion:

Strategies to reduce sternal infection have shown a significant reduction of sternal infection despite increase in BIMA.

Introduction:

Sternal wound infections can lead to major morbidity and mortality in patients undergoing cardiac surgery1. It is also found recently to have an impact on long-term survival.
Since sternal wound infection (SWI) may lead to an extended length of hospital stay additional surgical procedures, vacuum-assisted wound dressing and antibiotic therapy Its impact on the health care cost are enorm as they may almost triple the costs for patients undergoing CABG 2. The rate of SWI varies in different reports. Approximately 0.3% - 5.0% of median sternotomy surgical approaches result in infection3. Since there are risk factors that are hard change and may contributes to poor wound healing leading to sterna infection such diabetes, obesity, history of smoking, COPD, immunosuppression 4,5

Method:

After obtaining an approval from our institutional review board (including a waiver of signed informed consent) a database review was conducted. We analyzed retrospectively the data of all patients undergoing cardiac surgery between 2008-2010(first period) and 2012(second period). Data from 2011 were not included since changes were implemented in this year and was considered as a transition period. In the second period we introduced evidence-based practice changes to reduce sterna infection. Education of all health care members including physiotherapist, nurses and surgeons was provided to implement changes. The changes implemented were hand disinfection technique, sternotomy, sternal and skin closure technique, efficient operation time, strict guideline in post-operative wound care and the use of the Posthorax® vest in all patients. Sternal wound infections were classified according to the guidelines of the Center of Disease Control and Prevention Fig 1, 6: superficial if only the skin and subcutaneous tissue are involved, deep when the infection reaches the sternum but does not involve it and organ/space when sternal osteomyelitis or medistinitis occurs. Continuous data are presented as mean" standard deviation (S.D.) and Mann–Whitney test was used to compare the data. Categorical data are presented as number and percentage and are compared using the x2-test or Fisher's exact test.

Result:

There were a total of 1689 patients. 1250 patients underwent cardiac surgery during the first period 2008-2010 and 439 patients during the second period 2012. Off pump coronary bypass was the major procedure in both periods 47.5% and 43.1% respectively, followed by isolates valve surgery 19.2% and 21.4% respectively, followed by combined coronary bypass and valve surgery 17.7% and 18.5% respectively. There was no difference in age, gender, diabetes, BMI, creatinine, euro score, and type of surgery between the two groups. There was significant difference in history of hypertension 79.5% and 68.0% respectively ($p<0.0001$), ejection fraction average 53.4% and 54.6% respectively ($p=0.018$) and CRP 12.32 mg/ml and 11.95 mg/ml ($p<0.001$) between the two groups Table 1. But no correlation was seen between those variables and sternal infection table 2. There was no difference in the percentage of type of surgeries performed during those two periods Fig2. Use of BIMA was significantly more in the second period. BIMA was used in 31% bypass patients in the first period and 62% in the second period (p 0.006) Fig3. Surgical time (average minutes hours versus 251 minute, $p<0.0001$) intubation time (average 27.5 hours versus 24 hours, $p<0.0001$), postoperative peak creatinine kinase (average 57.6ug/L versus 53.7ug/L, $p<0.0001$) and the unit of blood transfusions (average 3.49 packet red blood cell versus 3.02 packed red blood cell, $p=0.030$) was significantly lower in the second period and the use of noradrenalin (average 9.35mcg/min versus 11.1 mcg/min, $p=0.009$) was higher in the second period Tab 3. In the first period 3.4% developed pre-sternal infection, 3.2% deep sternal infection and in the second period 1.1% developed pre-sternal and 1.6% deep sternal infection. There was a significantly reduction in both pre-sternal infection and deep

sternal infection in the second period Fig4. Sternal infection was associated to surgical time, intubation time, blood transfusion and use of noradrenalin and BIMA Tab 4.

Strenal Wound Infection classification according guidelines of the Center of Disease Control and Prevention 6: Fig 1

Superficial surgical site infection (SSI) must meet the following criterion:
Infection occurs within 30 days after surgery involving only skin and subcutaneous tissue and at least one of the following:

- purulent draining from the superficial incision
- organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision
- at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, and superficial incision is deliberately opened by surgeon, unless incision is culture-negative
- diagnosis of superficial incisional SSI by the surgeon or attending physician

Deep SSI must meet the following criterion:
Infection occurs within 30 days after the operative procedure and nvolves deep soft tissues (e.g., fascial and muscle layers) of the incision and patient has at least one of the following:

- a. purulent drainage from the deep incision but not from the organ/space component of the surgical site
- b. deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever (☐38° C), or localized pain or tenderness, unless incision is culture-negative
- c. an abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination
- diagnosis of a deep incisional SSI by a surgeon or attending physician

Organ/space SSI (medistinitis) must meet the following criterion:
Infection occurs within 30 days after the operative procedure and

- a. infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure
- and
  patient has at least one of the following:
- b. purulent drainage from a drain that is placed through a stab wound into the organ/space
- c. organisms isolated from an aseptically obtained culture or fluid or tissue in the organ/space
- d. an abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination
- e. diagnosis of an organ/space SSI by a surgeon or attending physician

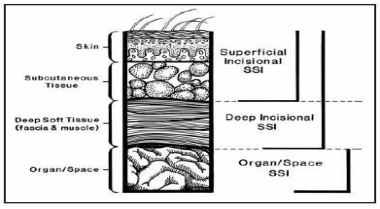


Table 1 Preoperative data

	2008-2010 (1250)	2012 (439)	p
Age	66.42	65.8	ns
BMI kg/m2	28.6	27.6	ns
WBC 109/l	8.13	7.98	ns
CRP mg/ml	12.3	11.95	0.000
Creatinine µmol/l	84.8	87.74	0.043
Albumin(g/L)	40.55	41.65	ns
EF%	53.4	54.6	0.018
Gender (F)%	27.4	26.9	ns
Hypertension%	79.5	68.0	0.000
Diabetes%	22.8	22.2	ns
COPD%	7.6	8.1	ns
Euroscore	6.25	5.97	ns

EF, ejection fraction; BMI, body mass index; COPD, chronic obstructive pulmonary disease; WBC,White blood cell count; CRP, C reactive protein

Fig. 2 Type of surgery 2008-10 and 2012

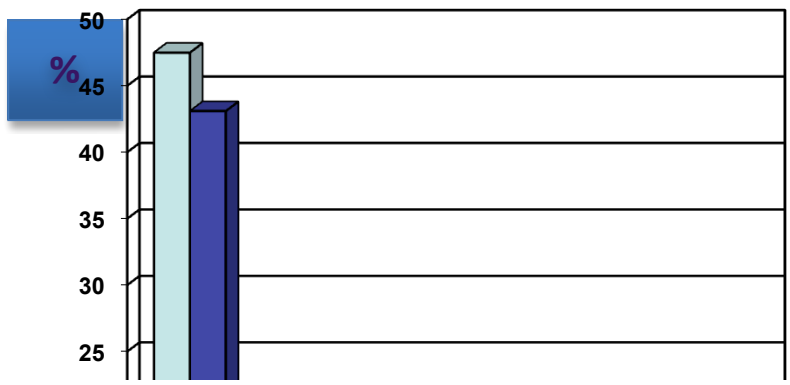


Fig. 3 use of BIMA 2008-10 and 2012

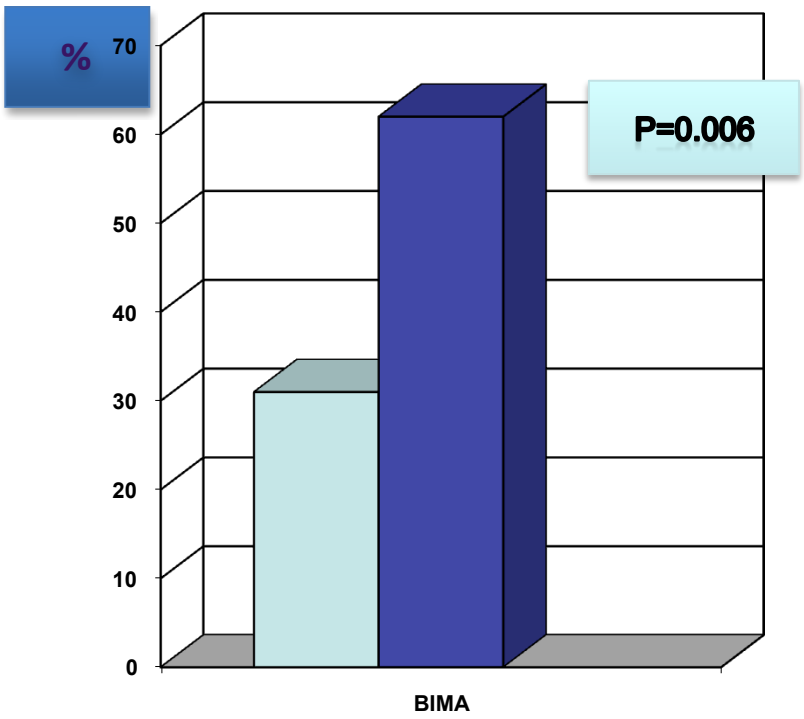


Table 3 Intra and postoperative data

	2008-2010 (1250)	2012 (439)	p
Surgical time(mi)	287	251	0.000
Intubation time(h)	27.5	27.9	0.000
CKMB peak µg/l	57.6	53.7	0.000
Creatinine peak	108.4	105.2	0.915

µmol/l			
PRBC	3.49	3.02	0.03
Noradrenalin(mcg/min)	9.35	11.1	0.009
Rethoracotomy%	7.2	5.3	ns

Table 2 Correlation between preoperative data and infection

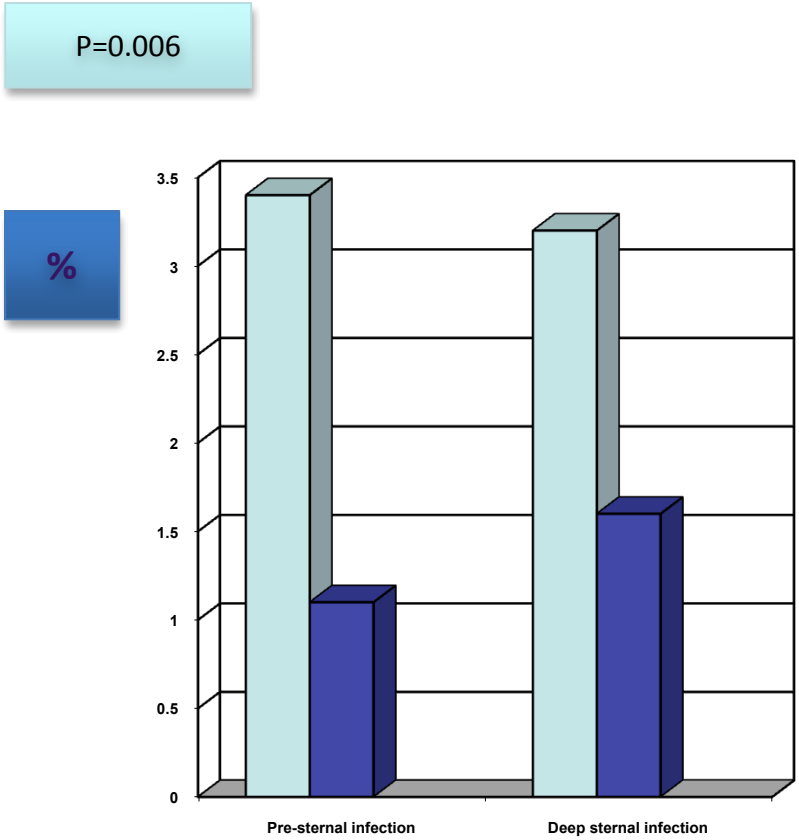
	No infection(1595)	Pre-sternal infection (47)	Deep sternal infection (47)	p
Age	66	65.8	65.4	ns
BMI kg/m2	28.38	27.6	27.9	ns
WBC 109/l	8.09	7.98	8.43	ns
CRP mg/ml	12.2	11.95	15.65	ns
Creatinine µmol/l	78	87.74	88.5	ns
Albumin(g/L)	41.2	41.65	40.94	ns
EF%	53.4	54.6	50.2	ns
Gender (F)%	27	27.7	36.2	ns
Hypertension%	76.5	78.8	76.6	ns
Diabetes%	22.2	36.2	25.2	ns
COPD%	7.5	8.5	7.7	ns
Euro score	6.25	5.97	6.87	ns

Tab 4 Correlation between intra and postoperative data with sterna infection

	No Infection(1595)	Pre-sternal infect ion(47)	Deep ste rnal infection(47)	p

Surgical time(mi)	278	329	327	0.017
Intubation time(h)	27.1	20.87	48.53	0.001
CKMB peak µg/l	56.85	53.7	56.7	ns
Creatinine peak µmol/l	85	119	124	ns
PRBC	3.22	3.79	7.98	0.04
Noradrenalin(mcg/min)	9.77	7.53	12.5	0.016
Re-thoracotomy	6.4	10.9	13.3	ns
BIMA%	24.7	43.9	25.9	0.021

Fig.4 % of sterna infection in 2008-2010 and 2012



Discussion:

This study has shown a significant reduction of sternal infection after concrete changes are implemented in our institution.

In our patient population, according to the classification of the Center of Disease Control and Prevention6, there was no mediastinitis seen. Nevertheless sternal wound infections superficial or deep can have a devastating impact on patients and the finances. Our multidisciplinary strategies to tackle this problem have brought positive results. The importance of proper hand disinfection cannot be overemphasized. In 2012 we switched our antisepsis to alcohol based Sterillium™ (Bode Chemie GmbH, Hamburg, Germany) and chlorhexidine based Hibiscrub™((Mölnycke Health Care, Dietikon, Switzerland). Waterless Scrub times of 2 minutes are recorded and scrubbing technique is standardized according the Guideline for Hand Hygiene in Health-Care Settings. The optimum duration of surgical scrub is unclear 7. In this clinical trial, surgical hand antisepsis with alcohol-based hand rub resulted in similar bacterial reduction regardless of if it is applied 3 or 1.5 minutes 8. Marchetti MG et.al 9 have demonstrated that the bactericidal activity surgical hand rubs sterillium and softaman, hibiscrub and betadine achieved a reduction of test bacteria within 3 min of >10(5)-fold to fulfilling the chemical disinfectants and antiseptics quantitative suspension test. But Hibiscrub, Sterillium and Softa Man gave a mean reduction of resident microorganisms immediate and sustained effect, which was not significantly lower than the reference alcohol.

All of our patients underwent median sternotomy after median skin incision.

The **Safe Surgery Saves Lives** initiative was established by the World Alliance for Patient Safety as part of the World Health Organization's(WH0)10 efforts to reduce the number of surgical deaths across the world.

Before starting skin incision SSSL (Safe Surgery Saves Life) according to the WHO checklist10 is performed to identify the patient and to illustrate diagnoses and type of operation. These check list have shown a reduction in-hospital complications and mortality occurring within the first 30 days after surgery. 11.Sternotomy is performed by an oscillating saw (Stryker™ GmbH, Duisburg, Germany). The closure technique is done by using surgical steel wires in single loop technique in comparison to the double loop technique as it was felt that not only is easier to perform but also may cause less tissue damage with comparable mechanical support Figure 7, 12 **.** Seven or eight wires are used per patient. The presternal soft tissue is readapted by a running Vicryl™ suture of the periostium avoiding the subcutaneous tissue. Skin is also adapted intracutaneous by an absorbable running suture. In 2012 redon catheter is no longer used as it is postulated this may be the entry for infection and study has shown dose not reduce the incidence of surgical site infections13. After end of surgery there is a sign out period to report if the surgery is performed as originally planned, additional unplanned interventions or the occurrence of unexpected complications. The surgeon, anesthesiologist and perfusionist verify this process by their signature. SSSL may certainly have accounted for reduction of surgical time, intubation time, and blood transfusion11. An OPSITE Post-Op Visible (Smith & Nephew, Inc.) Fig 6 instead the normal gauze dressing is introduced in 2012. The OPSITE Post-Op Visible is made of three layers : low adherent wound contact layer, lattice shaped absorbent pad and top layer that is waterproof. This is applied immediately after sternal wound closure and left in place for 5 days. This type of dressing provides several important benefits: barrier to bacteria, reduce the risk of maceration, keeps the wound dry through a highly absorbent pad and breathable film and allows us to constant monitor the wound14. By discharge the patient is instructed to apply a waterproof dressing when showering and to keep the wound dry and clean until all wound crust fall out to prevent maceration. Lotions, creams, oils, or powders on incision are strictly avoided until all crust fall. Sternal dehiscence generally manifests 3-5 days postoperatively and may be due sudden wound straining. Consistent use of the Posthorax® vest has demonstrated to prevent deep sternal wounds infections 15 by providing stabilization of the thorax. The Posthorax® sternum support vest Fig 5 (Epple, Inc., Vienna, Austria) through its excellent design allow by acting as anteroposterior sternal stabilizer while fixing the two halves of the sternum in place. It also acts as shock absorber due to the cushions present on the front left and right side of the vest 15. In 2012 we have introduced the Postthorax vest in our clinic to be worn by all sternotomy patients. During the timing of obtaining informed consent the surgical team informs the patient over Posthorax® vest. This is crucial step in enforcing the compliance in weaning the vest after surgery. Next, the patient is fitted by our physiotherapy team with an exact vest size, which he has to wear day and night for 6 weeks post sternotomy. BIMA use provides significantly better survival than SITA use 16 but the sternal wound infection has been documented to

occur in 3.1% with the use of BITA and 1.6% LITA 17. In 2012 we have almost doubled our use of BIMA. The use to noradrenaline is found to be higher in the period 2012 for reasons not clear to us. Noradrenaline use is found in our study to significantly correlate to sternal infection, which may be due to micro vascular vasoconstriction. Despite the higher BIMA use and noradrenalin use in 2012, our multidisciplinary strategies in this year have resulted to fewer sternal infections. Our institution being a teaching hospital we stress the importance of giving the proper instructions to new rotating young resident surgeons on the implemented changes to decrease sternal infections. We have also developed institution guidelines help us to maintain standards.
There should be a universal guideline to minimize sternal wound infection for cardiac surgical patients not only to optimize patient's quality care but also to overcome the struggle over health care cost.

Figure 5: Posthorax® sternum support vest.

Figure 6: OPSITE Post-Op Visible (Smith & Nephew, Inc.)

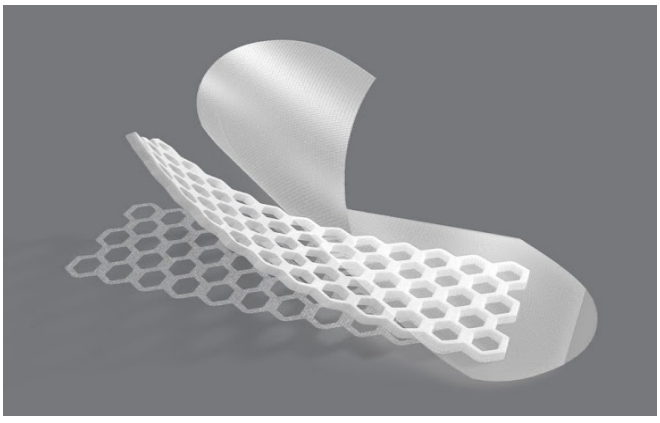
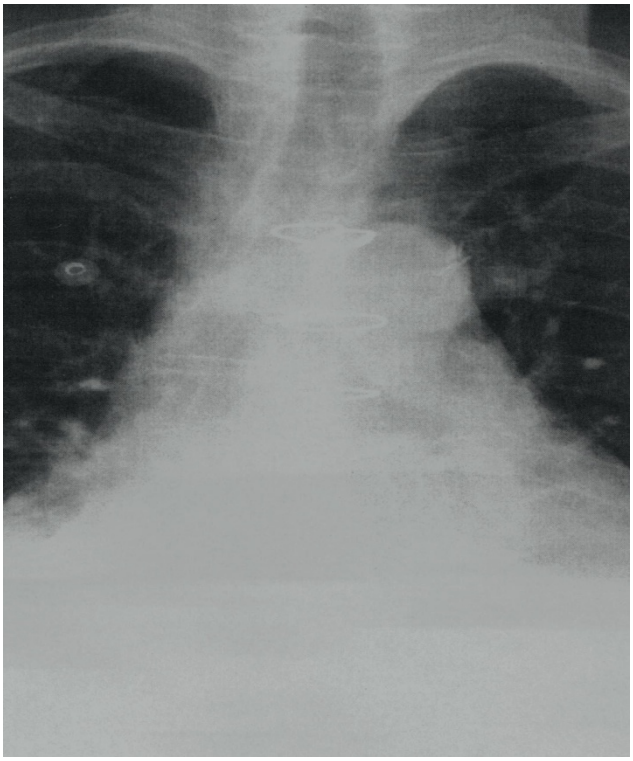


Figure 7: single loop technique



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