Clinical Microbiology & Case Reports

A Delayed Case of Sternal Wound Infection after Coronary Artery Bypass Graft Surgery

Shagufta Ahsan*
Division of Infectious Diseases, Saint Michael's Medical Center, USA

Abstract

Deep sternal SSI is an uncommon infection with an incidence rate of 1.5%.

Here I represent a rare case of deep sternal wound infection due to methicillin resistant *staphylococcus aureus* which occurred beyond twelve months after the Coronary artery bypass graft surgery. The nationwide incidence rate of sternal surgical site infection has decreased significantly in recent years. With the decreasing sternal surgical site infection rate, question I addressed from this case report is why this patient developed a late sternal SSI.

Keywords: Sternal wound, Delayed surgical site infections, Methicillin resistant *Staphylococcus aureus*, Universal decolonization

Introduction

Deep sternal surgical site infection is an uncommon infection with an incidence rate of 1.5% [1]. It is one of the feared complications in patients undergoing cardiac surgery. Predicting their occurrence is essential for future prevention [2]. Prevention and better treatment of sternal wound must be a major goal in assuring the highest quality of cardiovascular life [3].

Here I represent a rare case of deep sternal wound infection due to methicillin resistant staphylococcus aureus which occurred beyond twelve months after the Coronary artery bypass graft surgery. The nationwide incidence rate of sternal surgical site infection has decreased significantly in recent years [1]. With the decreasing sternal surgical site infection rate, the question I addressed from this case report is why this patient developed a late sternal SSI. Also we focus on identifying potentially modifiable risks for major infections like deep sternal wound infection and current infection control strategies.

Case Description

A 45 year old man with Past medical history of Obesity, Insulin dependent Diabetes Mellitus, Hypertension and End stage renal disease on hemodialys is via left arm arteriovenous fistula (AVF) came to an outpatient office in Brooklyn, New York with complaints of sub sternal chest pain for two weeks duration. Patient did not have any cardiac symptoms after a Coronary artery bypass graft surgery 14 months prior. The patient noticed a sterna bulge for the last two weeks too. Later on his sternal margins were apart and non- bloody, purulent drainage was coming out of the swelling.

The patient did not have any recent weight loss, lack of nutrition or any trauma to the sternal area. He did not recall any illness except coughing for few weeks before this happened. However, cough went away without any antibiotic treatment.

His Coronary Artery Bypass Graft (CABG) surgery was done 14 months prior and his CABG wound healed completely. There was no complication during next four months' follow up visit, though after that he did not follow up with cardiothoracic surgeon further. Since his CABG surgery, patient underwent multiple non-cardiac surgeries including right toe amputation and left arm arteriovenous fistula (AVF) placement and eventually started on Hemodialysis six months before this presentation. From chart review, it was found that patient was nasal methicillin resistant Staphylococcus aureus

*Corresponding authors: Shagufta Ahsan, Division of Infectious Diseases, Saint Michael's Medical Center, 111 Central Avenue Newark, NJ 07102, USA, Tel: 973-877-5465, Fax: 973-877-5767, Email: shaguftaahsan@yahoo.com

(MRSA) smear negative and the patient was given intravenous cefazolin before his initial Coronary artery bypass graft surgery as per Cardiothoracic Intensive care unit protocol .Extra nasal MRSA screening of the oropharynx, rectum or axilla was not performed.

On examination, patient looked distressed, but surprisingly, no fever was noted. Purulent non-bloody discharge was coming out from open deep sternotomy wound and the surrounding area of the sternotomy wound was tender on palpation. There were no other significant findings except a healed sinus tract in the amputated left knee area. No swelling, excessive redness or any other signs of inflammation was seen around the left arm AVF site.

The patient did not have any clinical or laboratory findings suggestive of sepsis. On admission, his total WBC was 5.43 with neutrophils 69.9%. Hemoglobin was 9.9, hematocrit was 31.9 and platelets were 330 (Before starting empiric antibiotics). HIV test performed was negative. His HBA1C was always beyond the upper limit as blood sugar was never well controlled.

The diagnosis was made, a deep sternal surgical site infection with sinus tract formation; Vancomycin 1 gram intravenously with Hemodialysis and Piperacillin/tazobactum 2.25 gram every six hours intravenously were started. Blood cultures were obtained before starting antibiotics. Exploration of mid sternotomy wound and removal of necrotic tissue and drainage of deep sternal wound abscess were performed. In addition, removal of all infected (protruding) sternal wires were performed, except one which could not be removed due to technical difficulty. Wound debridement was done for superior and inferior infected sinus tracts with purulent drainage. Intraoperative taken wound culture including bone marrow aspiration culture grew MRSA. Blood cultures remained sterile. Thus piperacillin/ tazobactum was discontinued. Serum Vancomycin trough level ranged from 11 to 20 microgram per milliliter during hospitalization. PO rifampin600 mg daily was added with IV vancomycin for possible chronic sternal osteomyelitis. Because serum concentrations of rifampin increase dramatically at doses >450 mg / day [4,5] and rifampin achieves concentrations in bone near, or exceeding, those in serum [6-9], this dose of rifampin should be sufficient as a reasonable adjunctive agent for combination therapy of chronic osteomyelitis. Searching for MRSA sources in the whole body was non revealing. Transthoracic Echo was normal.

No repeat microbiologic cultures from the sternotomy wound were obtained. Advanced wound treatment, Vacuum assisted closure (VAC) device was placed on postoperative day 2 for wound closure. After 7 days of advanced wound VAC treatment with 5% reduction in the wound surface area each day, the patient was returned to the operating room for surgical closure of the sternal wound.

Based on the symptoms, physical examinations and microbiology result, it was concluded that the patient developed a very late methicillin resistant staphylococcus aureus sternotomy wound infection fourteen months after the Coronary Artery Bypass Graft surgery. He was discharged from the hospital on intravenous vancomycin with Hemodialysis and rifampin 600 mg orally daily for a duration of six weeks because of the retained wire and possible chronic sternal osteomyelitis [10] and with a plan to follow up with an infectious diseases doctor.

Figure 1. Poststernotomy mediastinitis: purulent material and sternal necrotic fragments with open sternum (Hanuman syndrome) [12].

Discussion

Complications of CABG surgery, including surgical site infection (SSI), particularly deep sternal SSI (Figure 1), are a cause of substantial morbidity and mortality and significant hospital costs. Furthermore, the prevalence of CABG surgery in patients at high risk for infection is increasing due to an aging US population and increasing frequency of conditions conferring cardiovascular and infectious risks (particularly obesity and diabetes mellitus) in the population.

The mortality rate in patients with sternal SSI has ranged from 14% to 42% [3,11] and the incidence rate decreased over time with a statistically significant linear trend [1]. The mortality rate in patients with sternal SSI has ranged from 14% to 42% and the incidence rate decreased over time with a statistically significant linear trend [1]. The adjusted odds ratio (95% CI) of SSI showed a decreasing linear trend: 0.39 (0.19-0.81) vs. 0.50 (0.27-0.93) vs. 0.83 (0.48-1.42) vs. reference for 2005-2008 vs. 2001-2004 vs. 1997-2000vs 1993-1996.

Post Operative MRSA Wound Infections

Shortly after the introduction of penicillin in the 1940's, penicillin-resistant Staphylococcus aureus isolates were described in hospitals and subsequently in the community [13]. Now the vast majority of staphylococcal isolates carry plasmids encoding a penicillinase rendering penicillin resistance Methicillin, a penicillinase –resistant semisynthetic penicillin, was introduced in 1961. Less than 1 year later, MRSA was reported [13]. Since he first MRSA was described in the same year 1961, methicillin –resistant staphylococcus aureus (MRSA) has become a common nosocomial pathogen. Methicillin resistance is

mediated via a chromosomally incorporated resistance gene, mec A, which confers altered binding of beta –lactams to penicillin binding protein 2a. The mec a gene is packaged in a cassette called the staphylococcal cassette cartridge (SCC), which aids in successful chromosomal incorporation [14]. Today, MRSA is a common nosocomial isolate and accounts for more than 50% of s aureus isolates from intensive care units in the United States [15].

With the modern hospital hygiene standards and the use of prophylactic antibiotics, the overall incidences of post sternotomy mediastinitis have been decreasing. Thus the answer we explore here are reasons for the occurrence of a delayed MRSA sternal wound infection. The exact mechanism by which mediastinitis develops is unknown and multifactorial. Even staphylococcal isolates are susceptible to the antimicrobial drugs used in prophylaxis, inoculum and virulence probably explain failure of prophylaxis. The origin of inoculum is not established with certainty for most infections. The patient's endogenous skin flora, with gram-positive organisms, in general and staphylococcal species, in particular, are the predominant cause of incisional infections of clean surgical procedures [16]. The direct inoculation of a patient's endogenous flora at the time of surgery is believed to be the most common mechanism; However others undoubtedly occurs, such as transmission from contaminated surgical instruments or surgical material, hematogenous seeding from preexisting skin, mucous membranes, or clothing of operating room staff, or a microbial contamination. There are several possibilities for development of latemediastinitis. One theory is that a low inoculum of Staphylococcus is present during the surgery, which may remain dormant for many years. This low inoculum later multiplies and results in a late postoperative infection. This is not a very well accepted or well studied theory. However, in this case scenario, with a delayed case of sternal wound infection after CABG surgery, this theory applies well.

The other theory, which is of course a better studied theory, is that hematogenous seeding of the surgical wound at any point of time after surgery is the cause of surgical site infections. Evidence of this route of seeding of surgical wound site has been mainly noted with procedures involving implantation of prosthetic devices [16]. The regular use of intra vascular catheters probably increases the risk of bacteremia. Athough there was no dialysis catheter access in this patient, the possibility of AVF as a source of bacteremia cannot be ruled out. If late late hematogenous seeding of a surgical wound with or without prosthetic material can occur, it is reasonable to assume that wounds are even more vulnerable to seeding and secondary infection during immediate postoperative period [16]. The fact is that it is difficult to ascertain with certainty whether a late postoperative infection results from intraoperative bacterial seeding of the prosthetic device followed by prolonged dormancy or from a true postoperative hematogenous event [16]. *S. aureus* colonization of the patient's nares is a major risk factor for developing a S. aureus SSI, a particular concern in selected populations such as diabetic individuals and recepients of hemodialysis, who have *S. aureus* colonization rates in excess of 50% [16].

Although the magnitude of bacterial inoculation into the wound still has some predictive value regarding the risk of developing a wound infection, patient and procedure related risk factors also contributed to this risk (Table 1).

Clinical Predictors of Mediastinitis after Cardiac Surgery

To identify host and operative risk factors of post sternotomy mediastinitis, a case control study was conducted at Beth Israel Hospital (Boston, Mass) between 1975 and 1979. Post-operative mediastinitis complicated 21 (3.4%) of 616 median sternotomy procedures [17]. For the analysis of risks of mediastinitis, these 21 patients with post operative mediastinitis were compared with a control group of 42 patients who had undergone median sternotomy but had not developed mediastinitis (Table 2).

Eighteen patients with mediastinitis (86%) had a history of serious underlying non cardiac illnesses as compared with 14 controls (33%; P =.001) (Table 2). Chronic lung disease, diabetes, and obesity accounted for most of this difference. In this study, mediastinitis complicated a diversity of procedures: seven coronary revascularizations, seven valve replacements, and seven other procedures. Infection rates increased with increasing complexity of surgery (P=.04). Four (9%) of the 44 patients who required reoperation developed mediastinitis as compared with 17 (3%) of the 572 patients who did not require require reoperation (P=.03) [17]. This increased risk of mediastinitis in reoperated patients may stem from intraoperative contamination of the mediastinal space with bacteria that had colonized superficial layers of the initial wound. Additionally, mediastinal hematomas, tissue trauma, and the emergent nature of this surgery, also may contribute to increased infection [17]. Repeat median sternotomy generally requires more extensive dissection because of mediastinal adhesions, and this may increase the length of the procedure and risk for intra operative contamination. In this intensive study where follow up was 32 months (range, one to 69 months), Staphylococcus aureus caused the three latest infections (33 days, 36 days, and 416 days

Patient Factors	Procedural Factors
Diabetes mellitus/perioperative hyperglycemia	Shaving of site the night prior to procedure
Concurrent tobacco use	Use of razor for hair removal
Remote infection at time of surgery	Improper preoperative skin preparation
Obesity	Improper antimicrobial prophylaxis (wrong drug, wrong dose, wrong time of administration)
Malnutrition	Failure to timely redoes antibiotics in prolonged procedures
Low preoperative serum albumin	Inadequate OR ventilation
Concurrent steroid use	Increased OR traffic
Prolonged preoperative stay*	Poor surgical technique (poor hemostasis, tissue trauma)
Prior site irradiation	Break in sterile technique and asepsis
Colonization with *S. aureus*	Perioperative hypothermia, hypoxia
	Improper use of flash sterilization of instruments

Table 1: Selected Patient and Procedural Characteristics Associated with Increased Risk for Surgical Site Infections [16].

Characteristic	Control patients (n=42)	Patients with mediastinitis (n=21)
Mean age in years (range)	59.4 (36-81)	59.0 (32-78)
Sex		
M	36 (86%)	18 (86%)#
F	6	3
History of serious noncardiac disease*	14 (33%)	18 (86%)
Surgical procedures		
Revascularizations only	14 (33%)	7 (33%)
Valve Replacement only	14	7
Other		
Revascularization and Valve Replacement	11 (26%)	3 (14%)
Repair of aneurysm	2 (5%)	2 (9.5%)
Repair of ventricular septal defect	1(2.4%)	2 (9.5%)
Death during hospitalization	0	5(24%)

*Noncardiac diseases for control patients were chronic obstructive pulmonary disease (five), obesity (five) and peripheral vascular disease (five), and those for patients with mediastinitis were chronic obstructive pulmonary disease (eight), diabetes (six), obesity (six), and peripheral vascular disease (three).

#P=.001

Table 2: Characterization of Patients with Mediastinitis after Cardiac Surgery and Control patients [17] .

after surgery, respectively). The last infection, which is a case of very late sternal wound infection like our case report, was also atypical. The patient was not in a toxic condition at the time of diagnosis, and his maximal temperature was 100.5 F. An indolent sinus tract burrowing to the pericardium in this post cardiac surgery mediastinitis patient was associated with a fragment of retained pacemaker wire [16].

Special features of cardiovascular surgery employing the median sternotomy incision pose potential risks of infection: the incision through bone; the use of bone wax; the length of operation, with prolonged exposure of the mediastinum; the use of bypass pump; the groin incision for vein harvest; the frequent need for a second procedure; the emergent nature of many of these operations; and the large number of operating personnel. Extensive dissections, with attendant accumulation of fluid and blood and bleeding in this closed space, and insertions of foreign bodies or prosthetic devices, enhance growth of bacteria and their evasion of the host's phagocytic defenses. Additionally, after skin closure, secondary contamination of the mediastinum might occur either by blood-borne route or by retrograde spread of surface bacteria through discontinuities in the sternal wound closure, a process aided by negative intrathoracic pressure during inspiration [17].

Milano et al. [18] also performed a study on 6459 patients who underwent both cardiac catheterization and CABG at Duke University Medical center between January 1987 and January 1994, to determine preoperative and intra operative variables that predict mediastinitis. Out of 20 variables, four independent predictors of mediastinitis were identified by multivariate analysis: NYHA CHF class (p .05), obesity (P .002), prior heart surgery (P.008), and duration of CPB (P .05) [18]. The most important independent predictor of mediastinitis in this study was the presence of obesity. The exact mechanism by which obese patients are predisposed to wound infection are not known. Perioperative antibiotics are generally not adjusted for the increased volume of distribution in these patients at this institution, and tissue drug levels may be inadequate. Furthermore, deep skin folds in obese patients make skin preparation difficult and probably at times inadequate. The inflammatory creases and the lower extremity vein harvest site can be particularly difficult areas for preparation and require special attention. Large amounts of adipose tissue probably also serve as a better substrate for wound infection. Attention to sterile technique and efforts to reduce the length of the procedure are probably critical in obese patients in whom the risk of mediastinitis is increased. Prior heart surgery and prolonged Cardio Pulmonary Bypass time were closely linked variables in this study [18]; both were significant independent predictors of mediastinitis. Interestingly, Milano et al. concluded extensive coronary atherosclerosis has also been associated with an increased risk of mediastinitis. This risk factor probably, at least to some extent, a general atherosclerotic condition, which may predispose patients to poor wound healing in combination with longer procedure times [18] (Table 3).

Prolonged duration of the surgical procedure should intuitively increase the risk of intra operative contamination and length of surgery has been demonstrated in previous studies to be a risk factor for post sternotomy mediastinitis [18]. Correlations between rates of sternal wound infections and objective measures of surgical skills and types of conduits received have been described in various studies. Bilateral IMA grafting was not a predictor of mediastinitis by either univariate or multivariate analysis by Milano et al. Furthermore, the combination of bilateral IMA grafting and DM was not predictive of mediastinitis [18]. Loop et al. also demonstrated that in the absence of other risk factors, bilateral IMA grafting was not a risk factor for mediastinitis [3]. Bilateral internal thoracic artery grafting increased the risk of wound complication only in the presence of diabetes (relative risk, 5.00; 95% confidence interval 2.4 to 10.5). Bilateral internal thoracic artery grafting in non-diabetic patients carried no greater risk than vein grafts only or with one internal thoracic artery graft [18]. Also, diabetic patients who require use of an intraaortic balloon pump are more prone to wound complications [18]. Of note is that techniques for IMA takedown may vary between institutions and may affect preservation of collateral blood supply to the sternum [18-20]. Bilateral IMA grafting probably has a minimum effect on the development of mediastnitis, and its influence on the development of mediastinitis may be important when other risk factors are present [3,18,19]. In most centers, the IMA is isolated from the chest wall as a pedicle, together with the vein,

Risk factor	Odds ratio	Mediastinitis score AHA/ACC (Eagle and Guyton et al.	Author	Year
Male gender	2.2		Borger et al.	1998
	NA		Demmy et al.	1990
Obesity/ severe obesity	6.49	2.5/3.5	Abboud et al.	2004
	1.27		Bitkover et al.	1995
	2.67		The Parisian Mediastinitis Group	1996
	3.59		Milano et al.	1995
	3.8		Nagachinta et al.	1987
	2.65		Ridderstolpe et al.	2001
	3.46		Sjogren et al.	2005
Diabetes meilitus	5.82	1.5	Ridderstolpe et al.	2001
	2.6		Borger et al.	1998
	5		Lu et al.	2003
	3.24		Sjogren et al.	2005
	2.6		Nagachinta et al.	1987
Smoking	3.27		Abboud et al.	2004
	1.8		Nagachinta et al.	1987
	2.41		Ridderstolpe et al.	2001
COPD	NA	3.5	Demmy et al.	1990
Heart failure/NYHA Class 3-4	3.36		Ridderstolpe et al.	2001
	1.33		Milano et al.	1995
Low LVEF	3.02	2	Sjogren et al.	2005
Renal failure	6.93	2.5	Sjogren et al.	2005
Peripheral vascular disease	3.7		Lu et al.	2003
	2.11		Ridderstolpe et al.	2001
Cornonary disease/coronary surgery	2.67		The Parisian Mediastinitis Group	1996
	6.85		Sjogren et al.	2005
	3.2		Munoz et al.	1997
Use of BIMA	3.2		Borger et al.	1998
	4.23		Ridderstolpe et al.	2001
Length of surgery	1		Milano et al.	1995
Re-do surgery	2.2		Milano et al.	1995
Re-exploration	9.2		Munoz et al.	1997
	NA		Ottino et al.	1987
	3.3		The Parisian Mediastinitis Group	1996
Transfusion	NA		Ottino et al.	1987
Prolonged mechanical ventillation	1.04		Lu et al.	2003
	1.004		Ridderstolpe et al.	2001
Prolonged use of inotropic drugs	2.37		The Parisian Mediastinitis Group	1996
	3.5		Munoz et al.	1997
ICU stay > 2days	4.5		Abboud et al.	2002

NA: not available; COPD: chronic obstructive pulmonary disease; NYHA: New York Heart Class; LVEF: ventricular ejection fraction; BJMA: bilateral internal mammary artery; ICU: Intensive care unit.

Table 3. Independent risk factors for mediastinitis observed in previous studies [22]

muscle, fat, and accompanying endothoracic fascia. Harvesting is relatively quick (10 to 20 minutes) because cautery is used to separate the pedicle from the chest wall. However, cauterization damages the blood supply to the sternum and devascularization of the sternum as a result of mobilization of one or both IMAs has been postulated as a mechanism for the development of sternal wound infection after myocardial revascularization [19].

Another recently used technique is to dissect the IMA as a skeletonized vessel. The skeletonized artery is isolated gently with scissors and silver clips without the use of cauterization. One advantage is that the dissected artery is particularly long, and its spontaneous blood flow is greater than that in a pedicled IMA, allowing the use of both IMAs as grafts to all necessary coronary vessels. Using bilateral skeletonized IMAs, deep sternal infection rate was 1.7% [20]. However, in this study, after adjustment for all other demographic, clinical and surgical predictors, chronic obstructive pulmonary disease (OR 13.0, 95% CI 3.3 to 50.8) and

emergency operation (OR 3.8, 95% CI 0.9 to 16.5) were found to be the only independent predictors of deep infection. So routine arterial myocardial revascularization using bilateral skeletonized IMAs is safe even in elderly patients and those with diabetes. Authors recommend avoiding the use of bilateral skeletonized IMAs only in patients with chronic obstructive pulmonary disease and emergency operations [20]. Maintaining serum glucose < 180 mg / dl with continuous insulin infusions in patients with or without diabetes mellitus in ICU lowers the incidence of sternal wound infections, reduces hospital length of stay and enhances long term survival [21].

Also if perioperative antibiotics do not have MRSA coverage, the chance of post-operative MRSA infections is high [16]. With the increasing prevalence of community and hospital –acquired MRSA, and since MRSA is the most common pathogen associated with surgical site infections, the use of vancomycin prophylaxis has been increasing. Thus if peri operative antibiotics do not have

Variable	Topical vancomycin	No vancomycin	P value
Number	1075	2190	-
Superficial sterna infection, n(%)	0(0)	34(1.6)	<.0001
Deep sterna infection, n(%)	0(0)	16(0.7)	.005
All sterna infections, n(%)	0(0)	50(2.3)	<.0001
All sterna infections among patients with diabetes mellitus (%)	0(0)	24(3.3)	.0004
Data are presented as the absolute values and %.			
Lazar et al. Topical vancomycin in combination with perioperative antibiotics and tight glycemic control helps to eliminate sterna wound infection. J Thorac Cariovasc Surg 2014;148:1035-1040			

Table 4. Incidence of sternal infections [24].

MRSA coverage, the chance of post-operative MRSA infections is high [16]. Topical vancomycin can be used to eliminate sternal wound infection (Table 4). It has been also shown that daptomycin and tigecycline have broader effective dose ranges than vanco mycin as prophylaxis against staphylococcus aureus surgical implant infection [23].

Understanding the pharmacokinetics of the various antimicrobials used in perioperative prophylaxis is vital to ensure adequate antibiotic levels at the surgical wound site during the entire procedure. The initial dose of systemic antibiotics must be administered in a timely fashion at the time of the incision and must be adequate [16]. Administration too early before or after the time of incision will result in suboptimal tissue levels and potentially increased risk of postoperative wound infection. Guidelines and studies vary somewhat on the exact timing, ranging from 2 hours to no more than 30 minutes before incision [16].

Importance of Mrsa Surviellance

SSIs caused by MRSA are typically more severe and have worse outcomes than those caused by MSSA [25]. That is why MRSA surveillance is very important. Since there are currently no universally accepted guidelines regarding discontinuation of contact precautions, through a recent randomized controlled trial design conducted at Massachusetts General Hospital (MGH) in Boston, investigators found that active, targeted screening with a single PCR in individuals with a history of MRSA resulted in a significantly higher rate of discontinuation of CPs than the current local standard of clinician-initiated screening [26]. This was based on a recent randomized controlled trial design conducted at Massachusetts General Hospital (MGH) in Boston. The study also showed under the current local standard of care in the USA, in the absence of active, targeted screening, few eligible individuals who cleared MRSA will ever be identified; A single PCR assay has high sensitivity (93.9%) and specificity (92%) compared to three MRSA cultures (clinician initiated screening). Therefore discontinuation of contact precautions (CPs) based on a single negative PCR may offer a reasonable and streamlined strategy to address the growing pool of those designated as MRSA colonized, although acceptance of such an approach is likely to depend upon institutional and patient-mix characteristics. Overall, the active screening with single PCR offers substantial clinical and operational advantages. These benefits include rapid determination of precaution status, which has the potential to inform clinical care decisions and alleviate capacity constrains [26].

Besides screening and isolation /contact precautions, decolonization has been used to reduce MRSA transmission and prevent diseases in *S. aureus* carriers, primarily carriers of methicillin –resistant strains but also carriers of methicillin sensitive ones. Decolonization commonly involves a multi-day regimen of intra nasal mupirocin and chlorhexidine bathing. Another randomized control study in the USA conducted in intensive care units only, included MRSA screening, contact precautions and decolonization regimens consisting of twice daily intra nasal mupirocin and daily bathing with chlorhexidine –impregnated cloths; Statistically significant finding of this study is that universal decolonization (no screening for MRSA on admission in ICU and decolonization of all patients) was more effective than targeted decolonization (MRSA screening, and contact precautions and decolonization of MRSA carriers) or screening and isolation in reducing rates of MRSA clinical isolates [27]. The group of patients who received universal decolonization was not placed on contact precautions unless they had a prior history of MRSA or their clinical culture grew a pathogen requiring precautions.

Conclusion

A patient's risk for major *S. aureus* infection after cardiac surgery can be reasonably predicted using preoperative patient characteristics. However, most patients who eventually develop post-operative infections do not belong to the high –risk category. Preoperative prophylactic measures specially designed to prevent *S. aureus* infections should therefore target the entire patient population to efficiently decrease the risk of infection [28]. Strategies could include weight loss and / or smoking cessation efforts, continuous intravenous insulin therapy and interventions targeting *Staphylococcus aureus.*

In conclusion, at this point, there has not been enough information to judge the relative contributions of intraoperative vs. postoperative hematogenous seeding of infections involving surgical incisions. Due to this lack of information, preoperative risk control measures should be strictly implemented which include but not limited to preoperative judicious administration of correct antibiotics with correct dose in appropriate time, maintaining adequate and feasible aseptic techniques in the operative field. Also on the basis of current infection control strategies in various hospitals we should reemphasize the importance of MRSA surveillance and implement contact precaution measures. Nevertheless universal decolonization with mupirocin and chlorhexidine irrespective of MRSA screening results should be taken seriously to reduce the incidences of postoperative MRSA infections.

References

1. Alasmari, Faisal A, Tleyjeh IM, Riaz M, et al. Temporal Trends in the Incidence of Surgical Site Infections in Patients Undergoing Coronary Artery Bypass Graft Surgery: A Population-Based Cohort Study, 1993 to 2008. *Mayo Clinic Proc*. 2012;87(11):1054-1061.

2. Fowler VG Jr, O'Brien SM, Muhlbaier LH, et al. Clinical Predictors of Major Infections after Cardiac Surgery. *Circulation.* 2005;112(9 Suppl):1358-1365.

3. Loop FD, Lytle BW, Cosgrove DM, et al. Sternal Wound complications after isolated Coronary Artery Bypass Grafting : early and Late Mortality , Morbidity , and Cost of Care. *Ann Thorac Surg.* 1990;49(2):179-187.

4. Peloquin CA, Jaresko GS, Yong CI, Keung AC, et al. Population pharmacokinetic modeling of Isoniazid, rifampin, and pyrazinamide. *Antimicrob agents Chemother.* 1997;41(12):2670-2679.

5. Acocella G. Pharmacokinetics and metabolism of rifampin in humans. *Rev Infec Dis.* 1983;5(Supp l3):S428-32.

6. Roth B. Penetration of parenterally administered rifampin into bone tissue. *Chemotherapy.* 1984;30(6):358-365.

7. Dworkin R, Modin G, Kunz S, Rich R, Zak O, Sande M. Comparative efficacies of ciprofloxacin, pefloxacin, and vancomycin in combination with rifampin in a rat model of methicillin-resistant staphylococcus aureus chronic osteomyelitis . Antimicrobial agents. *Chemotherapy.* 1990;34(6):1014-1016.

8. Iversen P, Nielsen OS, Jensen KM, Madsen PO. Comparison of concentrations of rifampin and a new rifamycin derivative, DL 473, in canine bone. *Antimicrob Agents Chemotherapy.* 1983;23(2):338-340.

9. Norden CW, Fierer J, Bryant RE. Chronic staphylococcal osteomyelitis: treatment with regimens containing rifampin. *Rev infect Dis.* 1983;5(Suppl 3):S495-501.

10. Spellberg B, Lipsky BA. Systemic antibiotic therapy for chronic osteomyelitis in adults. *Clin Infect Dis.* 2012;54(3):393-407.

11. OttinoG, Paulis R, Pansini S, et al. Major sternal wound infection after open-heart surgery. A multivariate analysis of risk factors in 2,579 consecutive operative procedures. *Ann Thorac Surg.* 1987;44(2):173-179.

12. Quiroga Martínez J, Gualis Cardona J, Gregorio Crespo B, et al. Utility of omentoplasty for poststernotomy mediastinitis secondary to myocardial revascularization Surgery. *Arch Bronconeumol.* 2008;44(2):113-115.

13. Chambers HF. The changing epidemiology of staphylococcus aureus? *Emergency Infect Dis.* 2001;7(2):178-182.

14. Katayama Y, Ito T, Hiramatsu K, et al. A new class of genetic element, staphylococcal cassette chromosomal mec, encodes methicillin resistance in staphylococcus aureus. *Antimicrob Agents Chemother.* 2000;44(6):1549-1555.

15. National Nosocomial infections surveillance system. National Nosocomial infections surveillance (NNIS) System report, data summary from January 1992 to June 2002, issued august 2002. *Am J infect Control.* 2002;30(8):458-475.

16. Mandell, Gerald L., ed. "Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases." (2005).

17. David H. Bor, Richard M. Rose, John F. Modlin, Weintraub R, Friedland. Mediastinitis after Cardiovascular Surgery. Clinical Infectious Diseases. 1983;5(5):885-897.

18. Carmelo A Milano, Kesler K, Archibald N, Sexton DJ, Jones RH. Mediastinitis after Coronary artery Bypass Graft Surgery. Risk Factors and Long term survival. *Circulation.* 1995;92(8):2245-2251.

19. Kouchoukos NT, Wareing TH, Murphy SF, Pelate C, Marshall WG. Risks of bilateral internal mammary artery bypass grafting. *Ann Thorac Surg.* 1990;49(2):210-219.

20. Sofer D, Gurevitch J, Shapira I, et al. Sternal wound infections in Patients after coronary artery Bypass Grafting Using Bilateral skeletonized internal Mammary Arteries. *Ann Surg.* 1999;229(4):585-590.

21. Lazar HL, McDonnell M, Chipkin SR, et al. The Society of Thoracic Surgeons Practice Guideline series: blood sugar management during adult cardiac surgery. *Ann Thorac Surg.* 2009;87(2):663-669.

22. Sjogren J, Malmsjo M, Gustafsson R, Ingemansson R. Poststernotomy mediastinitis: a review of conventional surgical treatments, vacuum-assisted closure therapy and presentation of the Lund University Hospital mediastinitis algorithm. *Eur J Cardiothoracic Surg.* 2006;30(6):898-905.

23. Niska JA, Shahbazian JH, Ramos RI, et al. Daptomycin and Tigecycline have broader effective coverage ranges than vancomycin as prophylaxis against a staphylococcus aureus surgical implant infection in mice. *Antimicr agents and Chemotherapy.* 2012;56(5):2590-2597.

24. Lazar HL, Ketchedjian A, Haime M, Karlson K, Cabral H. Topical vancomycin in combination with perioperative antibiotic and tight glycemic control helps to eliminate sternal wound infection. *Journal of Thorac Cardiovasc Surg.* 2014;148(3):1035-1040.

25. Cosgrove SE, Qi Y, Kaye KS, et al. The impact of methicillin resistance in staphylococcus bacteremia on patient outcomes: mortality, length of stay and hospital charges. *Infect Control Hosp Epidemiol.* 2005;26(2):166-174.

26. Shenoy ES, Kim J, Rosenberg E, et al. Discontinuation of contact precautions for Methicillin-resistant Staphylococcus Aureus: A randomized controlled Trial comparing passive and active screening with culture and polymerase chain reaction. *Clin Infec Dis.* 2013;57(2):176-184.

27. Huang SS, Septimus E, Kleinman K, et al. Targeted versus Universal Decolonization to prevent ICU Infection. *N Eng J Med.* 2013;368:2255-2265.

28. Kanafani ZA, Arduino JM, Muhlbaier LH, et al. Incidence of and Preoperative Risk Factors for Staphylococcus aureus bacteremia and Chest Wound infection after cardiac Surgery. *Infect Control Hosp Epidemiol.* 2009;30(3):242-248.