



Original Research Article

How effective is intrawound vancomycin with multidiscipline approach for preventing surgical site infections (SSI) in arthroplasty and orthopedic surgeries: a study in non Covid 19 to Covid 19 era

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ARTICLE INFO

Article history:

Received 27-10-2020

Accepted 26-11-2020

Available online 30-12-2020

Keywords:

Arthroplasty

Orthopaedic

Vancomycin

Multidiscipline approach Introduction

ABSTRACT

Introduction: Surgical site Infections (SSI) of the musculoskeletal system leads to High morbidity, mortality and sometimes limb amputation. In 1999 US Centre for Disease Prevention and Control (CDC) gave guidelines for prevention and hoped for preventing emergence of antimicrobial resistance for surgeries. Orthopaedic surgeries and arthroplasty inferences from high turnover centers of developing countries with cost effectiveness are always awaited with development of new surgical skill and techniques, better instruments and better anti-infective approach.

Objectives: To study the effectiveness of intrawound vancomycin Powder and Special Multidisciplinary approach to control SSI in musculoskeletal surgeries.

Materials and Methods: We have analysed (n=210) patients operated for trauma, joint reconstruction and arthroplasty orthopedic surgeries during 12 months duration retrospectively. Mean age was 51 and all operated with multidiscipline approach. Patients were evaluated by ASEPSIS Score.

Results: In our study SSI rate was 13.88% in open fractures surgery out of (n= 36) patients and 1.33% in closed procedures out of (n=150) patients and total rate of Surgical site infection was 3.33% in our study with 95% confidence Interval (95% CI).

Conclusion: Intrawound vancomycin Powder with strict adherence and implementation of Multidiscipline approach is effective to control SSI which allows major step forward in Preventing SSI and reducing national morbidity.

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1. Introduction

Orthopedic Surgical Site Infections (SSI) and Health care associated Orthopedic infections constitute serious complications to any Institute's and Country's Health care and financial burden to the patients.¹ Commonly performed orthopedic procedures are arthroplasty, Trauma fracture fixations, Arthroscopy, Spine and other Orthopedic surgeries. These procedures have inherent property of getting infections because of high tissue trauma, reasonable lack of mobility and Implant environment.

From patient related factors, surgical team related factors, Implant related factors to Perioperative Environment related factors all lead the outcome to the safe non infective post-operative period. Surgical site infections especially when Implant in situ will sometimes lead to the Biofilm² related chronic infections and significant morbidity to the patients and epidemiological and financial burden.^{1,3} There has not been many specific guideline prevail as far as orthopedic Surgical site Infections (SSI)⁴ even though the US National Institutes of Health Centers for Disease Control and Prevention (CDC) guideline available which separates superficial to the deep infection.⁵ Open fractures have significantly higher chances of infection

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as compared to the closed fractures. The open fractures leads to significant lodging of the bacteria which are commonly found in the surrounding skin and environment and fracture hematoma with disrupted local tissues and hematoma all will provide excellent environment for the bacterial proliferation and Multiplication.⁶⁻⁸ The Multidisciplinary approach after guidelines of CDC and world Health Organisation (WHO)⁹ emphasis on reducing SSI with the help of Surgeon, Nurse Assistant, Anesthetist, Microbiologist, Infectious disease specialist and pharmacist. Out of that surgeon plays most important role in all the phases of patient care since patient's first reasonably first contact to the good fracture outcome.^{10,11}

In the era of corona virus disease 2019 (COVID 19) the immunity of the patient is compromised with subclinical to clinical infections and carriers phase and sometimes that leads to higher rates of complications may be because of surgical site compromised immunity.¹²

Staphylococcus Aureus, Staph. Epidemidis and Methicillin Resistant Staph. Aureus (MRSA) are the majority of bacteria those will contaminate the fracture traumatic or Incisional wound.¹³ Health care workers can contaminate the wounds if they handle the surgical instruments with bare skin, by touching the nares with sterile gloves and gowns, failed to recognize the tear in the gloves or sneezing with not properly wearing the masks. In a study done by Thyagarajan D. et al., shows Incidence of MRSA as a colonizing bacterium as high as 5.2% and nares are major route of transmission.¹⁴

Topical antibiotics have also been applied locally in irrigation solutions, ointments, pastes, beads etc.⁴ Local wound powdered antibiotics were very popular in mid 19th Century as they provide high concentration locally.¹⁵ Vancomycin has good mean inhibitory concentration (MIC) against Staphylococcus and Gram positives Especially MRSA.¹⁶ They have been used in Hip arthroplasty surgeries.¹⁷ Studies for pharmacokinetics of vancomycin powder administered locally shows that after administration of 2 grams of vancomycin, surgical site levels during the first day postoperatively reached nearly 1500 mg/L and remained elevated above 100 mg/L through the third day. Serum levels were undetectable (<0.6 mg/L) in 80% of patients on the other side.¹⁸⁻²⁰ Study evaluated for changes in the microbiologic properties of a methicillin-resistant Staphylococcus aureus (MRSA) strain in a patient receiving chronic exposure to vancomycin for a 9-month period. No resistance was detected, and only minimal changes in vancomycin susceptibility²¹ Study found safe for use in paediatric patients for topical and powdered use with no reported anaphylaxis, nephrotoxicity, red man syndrome, thrombophlebitis or rash.¹⁹

2. Objectives

To study the effectiveness of Intra wound vancomycin powder and special multidisciplinary approach in reasonably rural high patient traffic tertiary care centre of developing country to control SSI in musculoskeletal trauma and joint reconstruction orthopedic surgeries.

3. Materials and Methods

This retrospective study was conducted at our unit for (n=210) patients operated for arthroplasty, orthopedics including trauma surgeries and arthroscopic surgeries between July 2019 to June 2020. (N=126) Patients(60%) were male and (n=84) patients were female(40%). Minimum age was 5 years and maximum age was 96 years old with the mean age was 52 years[Chart 1]. 186 patients(88.57%) were operated for fracture surgeries, 18 for arthroplasty(8.57%)surgeries and 6 patients (2.85%) were operated for knee arthroscopy surgeries. Out of 186 fracture patients 36(19.35%) patients had open fractures classified by Gustilo Anderson classification²²[Table 1] and 150(80.65%) patients had closed fractures.

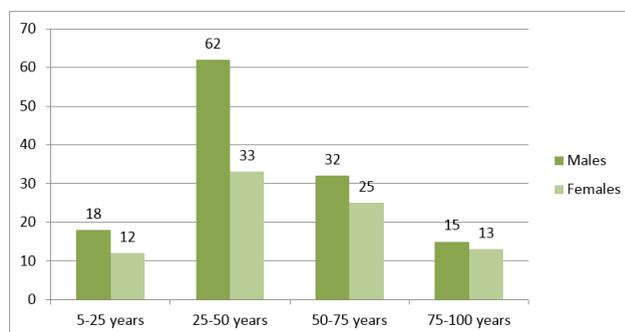


Chart 1: Age with Sex distribution

All the patients were operated according to the medical and anesthetic fitness by ASA (American Society of Anesthesiologist) criteria, soft tissue swelling condition at the fracture and preoperative necessary orthopedic radiological evaluation and ethical informed written consent of the patient.

3.1. Exclusion criteria

Out of patients treated at our unit the patients having polytrauma involving head, chest or abdomen injuries were excluded. Patients whose fractures and Injuries treated non operatively patients which were medically unfit having cardiac and renal end stage diseases, fractures indeed warrant conservative treatment, patients not willing for surgery, died within hospital premise periooperatively and preexisting soft tissue infection/osteomyelitis were also excluded.

Table 1: Types of open fracture patients in the study

Open fractures (According to Gustilo Anderson Classification)	No. of patients out of (n=36) open fracture patients out of total 210 patients.
Open grade 1	20 (55.55%)
Open grade 2	8 (22.22%)
Open grade 3A	4 (11.11%)
Open grade 3B	3 (8.33%)
Open grade 3C	1 (2.77%)

We used (poured) 2 gm. of vancomycin powder in the operative wound for the patients between age group of 18-95 years and 1 gm. for 5-18 years of patients. All the Patients were approached by our unit's unique Multi-disciplinary approach. Some of those rules as follows.

3.2. Patient related care

Operative site hair removal did at OT room only by the Orthopedic Surgeon only before scrubbed in the sterile attire but after applying povidone iodine at the site for minimum 3 minutes. All the patients were given wash at the operative site by povidone iodine scrub wash for 5 minutes minimum contact time followed by >75% alcohol solution. The alcohol solution was not wiped out till painting to get bactericidal effect. Any catheterization if possible was done in the Operation Theatre by orthopedic surgeon or anesthetist. Minimum and optimized (balance between tourniquet ischemia vs bloodless dissection) amount of tourniquet used and proper cauterization of bleeding vessels achieved. Hypothermia of the patient prevented.

3.3. Surgeon related care

Surgeon had used povidone iodine/chlorhexidine scrub. Always double pair of gloves used and preferably outer gloves pair was thick rubber gloves to avoid possible tear. Scrub gown was worn in the OT only. 3 ply mask with disposable head cap worn and during Covid 19 era triple layer of head cap with N95 mask along with triple layer mask and eye protector used. During long surgery hours frequent gloves changed at least after two hour for entire scrubbed team.

3.4. Environment related care

Since the tertiary care setup was at the rural setup we tried to optimize the resources. All the instrument over trolleys and patient limb was isolated from the table by impervious sterile plastic material. Operation theatre temperature maintained below 22 degree Celsius and OT movement minimized. All the instruments on the trolley kept covered after trolley preparation till incision. All the wounds before getting closure given minimum 3 litres of copious wash by only normal saline(NS). All the wounds poured by vancomycin powder before closure and dressing.

Only dry dressing kept. Any abrasion thoroughly scrapped and washed. All the wounds closed properly by nonbraided nylon suture material or skin staples for skin closure and polyglactin for subcutaneous tissue.

Perioperative antibiotics was started one hour before the incision and continued till 3-5 days post operatively and further according to the wound condition followed by second generation cephalosporin oral antibiotics. Generally we used third generation cephalosporin +/- aminoglycoside for perioperative prophylaxis. In open grade 3 injuries we also augmented the prophylaxis with metronidazole standard dose for 3-5 days. Early ambulation of the patient after local swelling subsidence was the main criteria whenever possible. We have used disposable woven gown and drapes of 65-75 GSM [Figure 8]for its water repellantness, plastic cling drapes for hand/foot isolation, iodine skin drape, disposable electrocautery and suction canuula whenever possible and all cases of periarticular reconstructuion, arthroplasty and trauma surgeries. Minimum Operation Theater (OT) traffic discipline in all the pre HEPA filter fixed OT applied. Tourniquet time in any upper limb surgery is not morethan 1.5 hrs. and in every lower limb surgery mot more than 2 hours with Mean time (Mean=102 minutes) and minimally used, all the surgery completed with proper hemostatis and operated with quite senior level orthopedic surgeon in the team. All the surgeries done with minimum required skin incision, MIPPO (Minimal incision percutaneous plate osteosynthesis) whenever possible, aimed towards less iatrogenic tissue trauma and standard implants.

4. Results

We evaluated the patients postoperatively in the wards and till fracture union clinico-radiologically or maximum upto one year. Clinical wound condition, CBC, CRP and wound discharge culture sensitivity and X-rays did for diagnosis of any infection on last follow up.

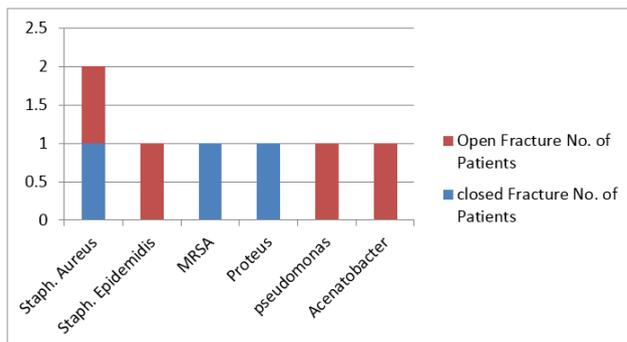
All the patients evaluated by ASEPSIS score²³ [Table 2]. For the purposes of wound behavior ASEPSIS score, makes assessment more objective and reproducible for the appearance of the wound within some days of postoperative period and later on sequel of that.

In our study out of (n= 210) patients no patient of arthroplasty and arthroscopy got infected of total 24

Table 2: Wound healing and Infection according to ASEPSIS Score

Asepsis score	Severity	n (%)	Trauma type
No infection			
0-10	Satisfactory wound healing	202	Closed/Open
11-20	Disturbed wound healing	1	Open
Infection developed			
21-30	Mild wound infection	4	Closed/Open
31-40	Moderate wound infection	2	Open
41-70	Severe wound infection	1	Open

procedures (patients) of those. Out of 186 Fracture, trauma and orthopedic surgeries 7 patients got infected. Diagnosis of infective organism by microbiology culture reveals organism as per the [Chart 2]. Out of 7 Infected patients 5(71.42%) were male and 2(28.57%) were female. In <50 years age groups 6 Patients (85.71%) and >50 years age group 1(14.28%) patient got infected. Out of 174 operations done in clean closed wound 3(1.72%) got infected and in 36 operations done in open wound 4(11.11%) got infected as per the [Table 2]. Three (n=3) patients had HRCT changes that might suggest of Covid 19 infection though Antigen test turned out negative. No patient of any doubtful HRCT changes of Covid 19 were got infected locally.

**Chart 2:** Microbial culture analysis of infected patients (n=7)

One (n=1) patient had infected Hip nonunion clinicoradiologically and implant failure of PFN (Proximal Femoral Nail) at 3 months operated for revision surgery and united with DHS (Dynamic Hip Screw), Intra-wound vancomycin powder with copious saline wash and our multidisciplinary approach with stabilization of fracture principally. Other (n=5) patients of fractures presented with infection subsequently united and showed wound healing with no signs of further active infection. One patient (n=1) showed infection with implant in situ and shows sign of delaying of fracture union.

In our study SSI rate is (n= 5) patients(13.88%) in open fractures surgery out of (n= 36) patients presented with open wound injuries and (n= 2) patients(1.33%) in closed procedures out of(n=150) patients and total rate of

**Fig. 1:** Patient: 1, Infected nonunion**Fig. 2:** Patient: 1, Resurgery and union

Table 3: Relativerisk (Risk ratio) and some variables analysis

Factors	With SSI out of (n=7)	Without SSI out of (n=203)	Relativerisk (RR).
Age:			
<50 years	6	118	RR 4.172 (>1)
>50 years	1	85	
Sex:			
Male	5	121	RR 1.668 (>1)
Female	2	82	
Smoking/Tobacco	5	108	RR 2.145 (>1)
Non Smoking/Tobacco	2	95	
Diabetes	2	18	RR 3.802 (>1)
Non Diabetic	5	185	
ASA Score >2	1	5	
HRCT COVID 19 changes	0	3	

**Fig. 3:** Patient: 2, Infected nonunion

surgical site infection is (n=7)3.33% in our study with 95% confidence Interval(95% CI). This result is quite satisfactory as compared to the study done by Maksimović J. et al., In 277 patients showing SSI rate 22.7% (95% CI) with 70% in dirty wounds infection in his study.²⁴

5. Discussion

In our study drug of choice for preoperative chemoprophylaxis for infection was cephalosporin as it has shown great effectiveness on gram positive and also on gram negative organisms.²⁵ Orthopedic surgical site

**Fig. 4:** Patient: 2, infection with sinuses

Infections leads to complications those are incomparable in terms of financial burden, quality of life index and Functional outcome of any orthopaedic surgery and National and Province Health care programmes.^{26,27}

Since the tradition of local antibiotic delivery systems in orthopaedics the vancomycin has been extensively used in different forms. For initial and early post-operative prophylaxis vancomycin shows higher wound concentrations, suppress the Gram positive Organisms till the local immunity will regain back from Incisional dissection and till hematoma clears off¹⁷. Our strict Multidisciplinary approach with intrawound vancomycin yields SSI 3.33% which is quite satisfactory when it involves open wound orthopaedic injuries.

Our tertiary care centre caters majority population of lower socioeconomic status. Smoking and tobacco has been



Fig. 5: Trolleys with disposable impervious sheets



Fig. 8: Strict HEPA filter OT multidiscipline approach team work with experienced surgeon in the team

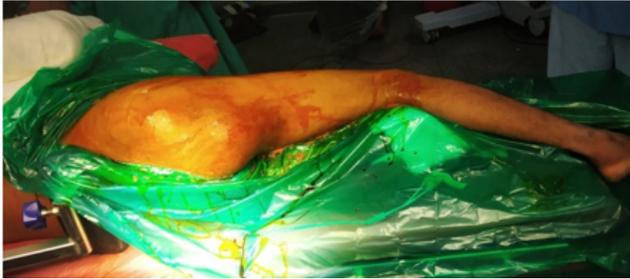


Fig. 6: Limb isolation with sterile impervious disposables and povidone iodine/alcohol scrub



Fig. 7: Optimise use of tourniquet with proper painting



Fig. 9: Optimise use of disposables

majorly found prevailing factors in them and especially in male gender that leads to decreased local immunity and wound problems. In our study age <50 years and males sex have more infections because of high velocity trauma and open injuries (RR>1, positive exposure association). Our patients also have bad hygienic practices and dressing maintenance that also leads to non-compliance by them in the follow up and we observed (n=3) patients developed SSI because of this especially by Staphylococcus species.

Many studies done describing prediction of SSI by NNIS (National Nosocomial Infection Surveillance) scoring

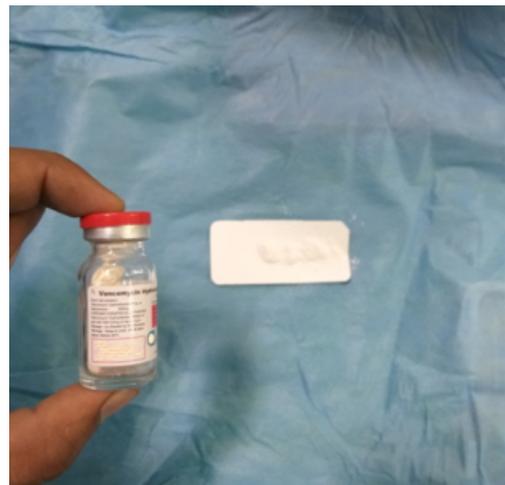


Fig. 10: Vancomycin powder



Fig. 11: Strict isolation of the operative area



Fig. 12: Intrawound vancomycin powder

system²⁸ and risk index classification by ASA. In the developing countries the patient compliance, follow up and standardized criteria to be followed those all are questionable in scarcity of resources. Many studies shows that operation theatre and patient care discipline whenever breached leads to higher rates of SSI.²⁴ That studies did by Meskimovic et al.,²⁴ also strengthens our Approach.

Glycated hemoglobin in Diabetes (RR>1) leads to decreased wound healing by carrying less oxygen to the tissues and less fibroblast proliferation.²⁹ Diabetes Control and lifestyle changes, Tobacco cessation and hygiene maintenance all can contribute majorly in control of SSI.

6. Conclusion

Infection Control goal in joint replacement, arthroscopy and musculoskeletal injury surgery emphasis on prevention rather than cure. It's outcome is based on multifactorial causality and not merely countable factors. It narrates importance of our regime and multimodal approach especially in the developing countries with scarcity of

some resources. Administration of local antibiotics in conjunction with parenteral antibiotics is attractive to surgeons seeking to reduce the incidence of SSI. But it also requires strict implementation of all together; to control the emergence of drug resistance. Although Microbial existence in human have been long battle and specifically after highly complicated implant in situ musculoskeletal surgeries. It requires very long year's multicentric International Randomized control trials for some specific Regimes and core strategies internationally. Our Initial and fair study showed good and promising results provided that it is backed by good knowledge of surgical subject and extra effort multidiscipline team work.

7. Sources of Funding

Nil.

8. Conflicts of Interest

Nil.

9. Acknowledgement

Nil.

References

1. Hak DJ, Fitzpatrick D, Bishop JA, Marsh JL, Tilp S, Schnettler R, et al. Delayed union and nonunions: Epidemiology, clinical issues, and financial aspects. *Injury*. 2014;45(2):3–7.
2. Zimmerli W, Sendi P. Orthopaedic biofilm infections. *APMIS*. 2017;125(4):353–64.
3. Olesen UK, Pedersen NJ, Eckardt H, Meyer LL, Bonde CT, Singh UM, et al. The cost of infection in severe open tibial fractures treated with a free flap. *Int Orthop*. 2017;41(5):1049–55.
4. Metsemakers WJ, FMoriarty T, Morgenstern M, Kuehl R, Borens O, Kates S, et al. Letter to the Editor: New Definition for Periprosthetic Joint Infection: From the Workgroup of the Musculoskeletal Infection Society. *Clin Orthop Relat Res*. 2016;474(12):2726–7.
5. Mangram AJ, Horan TC, Pearson ML. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol*. 1999;20(4):250–78.
6. Trampuz A, Zimmerli W. Diagnosis and treatment of infections associated with fracture-fixation devices. *Injury*. 2006;37(2):59–66.
7. Metsemakers WJ, Kuehl R, Moriarty TF. Infection after fracture fixation: current surgical and microbiological concepts. *Injury*. 2016;49(3):511–22.
8. Metsemakers WJ, Reul M, Nijs S. The use of gentamicin-coated nails in complex open tibia fracture and revision cases: A retrospective analysis of a single centre case series and review of the literature. *Injury*. 2015;46(12):2433–7.
9. WHO (2016) Global guidelines for the prevention of surgical site infection.
10. World Health Organization, Geneva. Geneva.
11. Goff DA, Kullar R, Goldstein E. A global call from five countries to collaborate in antibiotic stewardship: united we succeed, divided we might fail. *Lancet Infect Dis*. 2017;17(2):56–63.
12. Baysari MT, Lehnbohm EC, Li L, Hargreaves A, Day RO, Westbrook JI, et al. The effectiveness of information technology to improve antimicrobial prescribing in hospitals: A systematic review and meta-analysis. *Int J Med Inform*. 2016;92:15–34.

13. Doglietto F, Vezzoli M, Gheza F, LLussardi GL, Domenicucci M, Vecchiarelli L, et al. Factors Associated With Surgical Mortality and Complications Among Patients With and Without Coronavirus Disease 2019 (COVID-19) in Italy. *Jama Surg.* 2020;155(8):1–4.
14. Chen AF, Wessel CB, Rao N. Staphylococcus aureus Screening and Decolonization in Orthopaedic Surgery and Reduction of Surgical Site Infections. *Clin Orthop Relat Res.* 2013;471(7):2383–99.
15. Thyagarajan D, Sunderamoorthy D, Haridas S, Beck S, Praveen P, Johansen A, et al. MRSA colonisation in patients admitted with hip fracture: implications for prevention of surgical site infection. *Acta Orthop Belg.* 2009;75(2):252–7.
16. Huiras P, Logan JK, Papadopoulos S, Whitney D. Local Antimicrobial Administration for Prophylaxis of Surgical Site Infections. *Pharmacother.* 2012;32(11):1006–19.
17. Tang J, Hu J, Kang L, Deng Z, Wu J, Pan J, et al. The use of vancomycin in the treatment of adult patients with methicillin-resistant Staphylococcus aureus (MRSA) infection: a survey in a tertiary hospital in China. *Int J Clin Exp Med.* 2015;8(10):19436–41.
18. Omrani F, Emami M, Sarzaem M, Zarei R, Yeganeh A. The Effect of Intra-wound Vancomycin Powder Application in Reducing Surgical Site Infections After Total Hip Arthroplasty. *Cureus.* 2015;12(3):2383–6.
19. Sweet FA, Roh M, Sliva C. Intrawound Application of Vancomycin for Prophylaxis in Instrumented Thoracolumbar Fusions. *Spine.* 2011;36(24):2084–8.
20. Gans I, Dormans JP, Spiegel DA, Flynn JM, Sankar WN, Campbell RM, et al. Adjunctive Vancomycin Powder in Pediatric Spine Surgery is Safe. *Spine.* 2013;38(19):1703–7.
21. Rao N, Kim DH. Perioperative risk factors and patient optimisation: risk assessment and prevention. *AAOS.* 2015;p. 13–23.
22. Wilson AP, Sturridge MF, Treasure T, Grüneberg RN. A scoring method (asepsis) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. *Lancet.* 1986;327(8476):311–3.
23. Sakoulas G, Gold HS, Cohen RA, Venkataraman L, Moellering RC, Eliopoulos GM, et al. Effects of prolonged vancomycin administration on methicillin-resistant Staphylococcus aureus (MRSA) in a patient with recurrent bacteraemia. *J Antimicrob Chemother.* 2006;57(4):699–704.
24. Armaghani SJ, Menge TJ, Lovejoy SA, Mencio GA, Martus JE. Safety of topical vancomycin for pediatric spinal deformity: Nontoxic serum levels with suprathereapeutic drain levels. *Spine.* 2014;39(20):1683–7.
25. Maksimović J, Denić LM, Bumbaširević M, Marinković J, Vlainjac H. Surgical Site Infections in Orthopedic Patients: Prospective Cohort Study. *Croat Med J.* 2008;49(1):58–65.
26. Wise R. Introduction: treatment of Gram-positive infections. *J Antimicrob Chemother.* 2003;51(2):5–7.
27. Olesen UK, Pedersen NJ, Eckardt H, Meyer LL, Bonde CT, Singh UM, et al. The cost of infection in severe open tibial fractures treated with a free flap. *Int Orthop.* 2017;41(5):1049–55.
28. Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The Impact of Surgical-Site Infections Following Orthopedic Surgery at a Community Hospital and a University Hospital Adverse Quality of Life, Excess Length of Stay, and Extra Cost. *Infect Control Hosp Epidemiol.* 2002;23(4):183–9.
29. Ercole FF, Starling CEF, Chianca TCM, Carneiro M. Applicability of the national nosocomial infections surveillance system risk index for the prediction of surgical site infections: a review. *Braz J Infect Dis.* 2007;11(1):134–41.

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Cite this article: Patel VA, Pushkarna VA. How effective is intrawound vancomycin with multidiscipline approach for preventing surgical site infections (SSI) in arthroplasty and orthopedic surgeries: a study in non Covid 19 to Covid 19 era. *Indian J Orthop Surg* 2020;6(4):303-310.