**Surgical site infection; effect of contamination and duration of**

**surgical procedure**

**Abstract**

**Introduction**. Surgical site infections are responsible for increased treatment cost, prolonged hospital stay and increased morbidity on surgical floor. Increased level of per operative contamination and prolonged surgery increases the incidence of surgical site infections.

**Objective**: To know the effect of contamination and duration of surgery on the incidence of surgical site infections in emergency surgical patients so that the specific strategies can be developed to decrease the morbidity and mortality caused by these infections.

**Methods:**

All the patients who underwent general surgical operations on emergency basis at –removed for blind review---from 01-01-2019 to 31-12-2020 were evaluated for surgical site infections. Level of contamination per operatively and duration of surgery were documented. Surgical site infections suspected clinically were confirmed by culture and sensitivity.

**Results:**

Among 2202 emergency operated patients, two hundred and thirty seven patients (10.76%) had surgical site infection confirmed on culture and sensitivity (C/S) report. About sixty five percent patients were male. Of two hundred and thirty seven positive patients, seventy (29.09%) patients underwent laparotomy for penetrating and blunt abdominal trauma. About fifty eight percent SSI patients had contaminated wound per operatively. Operative time was one to three hours in about sixty seven percent SSI positive patients. Staph aureus was present in one hundred and forty five (79.67%) patients. E.coli was the commonest Gram-ve micro-organism (70.95%).

**Conclusion:**

Surgical site infection causes a significant rise in morbidity on surgical floor. Increased level of contamination per operatively and prolonged operative time increase the incidence of SSI in emergency surgical operations.

**Key words;**

Emergency surgical operations, surgical site infection, contamination, duration of surgery, Staph aureus

**INTRODUCTION**

Surgical site infections (SSIs) are defined as infections occurring up to 30 days after surgery (or up to one year after surgery in patients receiving implants) and affecting either the incision or deep tissue at the operation site1. SSI may present clinically as redness, delayed healing, fever, pain, tenderness, warmth, swelling or discharge of pus2.

Surgical site infections (SSI) are a major cause of morbidity in surgical patients and they increase health care costs considerably due to prolonged stay in hospital and extra usage of the hospital facilities like costly antibiotics and use of ventilatory support etc. 3. Patients with an SSI have a 2–11 times higher risk of death, compared with operative patients without an SSI9.

SSI accounts for 14-17 % of overall hospital acquired infections and nearly 38% of hospital acquired infection in surgical patients postoperatively 4.

Patient factors like old age, co-morbidities i.e. diabetes, cardiovascular diseases, hypertension, immune-compromised state, smoking, alcohol, obesity, stress, malnutrition enhance the risk of SSI. It also depends on operative intervention, emergency/ elective setting, duration of operation, perioperative infusion, type of wound and length of hospital stay5.

The incidence of SSI is much higher in patients undergoing emergency surgery than in elective surgery5,6. Emergency procedures are defined as unplanned operations and include reoperations after previous procedures24. Contaminated and dirty wounds, prolonged duration of the operation, patient comorbidities, and high American Society of Anesthesiologists (ASA) score are commonly present in this type of surgery 5,6. Gastrointestinal tract procedures especially large bowel surgery carry high chance of SSI due to high level of contamination 5,6,7,8,9.

Wounds are classified by their level of contamination as clean, clean contaminated, contaminated and dirty10.

Operative duration is an independent and potentially modifiable risk factor for SSI. The

likelyhood of SSI increases with increasing time of surgery 11,22.

Causative pathogens are acquired endogenously from the patient’s own flora or exogenously from contact with operative room personnel or the environment12. Most SSIs are caused by Staphylococcus aureus, E.coli and Enterococci 12,13.

# We must adhere to guidelines for the prevention of SSIs in form of good patient preparation,

# aseptic practice, minimizing operative time, attention to surgical technique, minimizing the

# operative contamination and broad spectrum antimicrobial prophylaxis 14.

# 

**Purpose of the study**; This study was conducted at our teaching hospital to know the effect of wound contamination and length of operative time on the causation of SSI in emergency surgical procedures so that we can develop the specific strategies to decrease the morbidity and mortality caused by SSIs.

**Material and methods**

**Data collection and analysis**

This study was conducted in the surgical department of the –removed for blind review---from 01-01-2019 to 31-12-2020 after the approval of ethical committee. All the patients admitted in surgical wards after emergency surgery were included in the study. Patients who died after admission to the hospital and before undergoing surgical procedures were excluded from the study. Elective surgeries were excluded from the study as most of such cases are clean surgeries. Informed consent was taken from all the patients or their attendants. Each patient eligible for the inclusion in this study were enrolled consecutively and followed from the time of admission until time of discharge.

Before the start of the study, the pathological department of the same hospital was taken into laison. All the patients were operated with full anti septic protocol by senior registrars and registrars having good surgical experience. Level of contamination and time duration of each surgery was recorded. Post operatively all the patients were managed in surgical ward on merit. Patients were discharged when they were hemodynamically stable and regularly followed in out patients department till end of first month. Clinical specimen of apparent pus and wound discharge from clinically suspected SSI patients was taken under full aseptic measures in sterile container. They were sent to the pathological department with patient profile under sterile conditions for culture and sensitivity examination using standard machines. Statistical analysis of data was done using Statistical Package for Social Sciences version 21 (SPSS 21).Frequencies and percentages were calculated for qualitative data like number of positive SS patients, level of contamination, operation time, pathogens and their sensitivity to antibiotics.

**Results**

Out of the total 2202 operated patients, 237(10.76%) developed surgical site infection (SSI).

One hundred and fifty five (65.40%) SSI patients were male and eighty two (35.59%) were female. The most involved age groups were 11-20 and 21-30years (30.80% and 27.00%) respectively. Of the total 237 patients with SSI, fifty (21.09%) had laparotomy for acute abdomen, seventy (29.09%) had laparotomy for penetrating and blunt abdominal trauma and thirty five (14.76%) had appendectomy (Table 1).

One hundred and thirty nine (58.64%) patients wounds were contaminated at time of surgery while forty nine (20.67%) were dirty (Table 2 & table 3).

Duration of surgery was 01-02 hours in ninety five patients, 02-03 hours in sixty five patients and 1/2 – 01 hours in sixty one patients (Table 4).

Gram positive organisms were identified in seventy three percent SSI patients and Gram negative organisms were reported in twenty six percent. Staph aureus was the commonest organism detected (Table 5).

Most of the organisms were resistant to the commonly used antibiotics like Ceftriaxone and Ciprofloxacin. Twelve out of one hundred and eighty two (06.59%) Staph aureus cultures were Methicillin resistant Staph aureus (MRSA) while two patient (01.09%) had Vancomycin resistant Staph aureus (VRSA). Six (50%) MRSA patients were sensitive to Linezolid and six (50%) MRSA patients were sensitive to Vancomycin. Two (0.84%) patients were sensitive to Tigecyclin.

**Discussion**

This study was conducted in 2202 patients who underwent emergency surgeries. The incidence of surgical site infection varies worldwide from 2.5% to 41.9% as per different studies6. Incidence of SSI in our study was 10.76%, while Alkaaki A et al 15reported incidence of 16.03%. and Akter B et al16 reported incidence of 26.70 % after emergency laparotomy for perforated viscus. About sixty five percent patients in our study were male .Such high male preponderance is also reported by many other studies like Aghdassi, S.J.S et al  17 and Mukagendaneza, M.J et al20.This might be due to the more incidence of penetrating and blunt abdominal trauma occurs in males. The incidence of SSI was higher in younger age groups .This might be due to the fact that most of our study population was young due to high poly trauma rate in young people. Ntundu, S.H., Herman, A.M., Kishe, A. et al alsorecorded higher younger age incidence19. In our study 21.09% of SSI cases underwent laparotomies for acute abdomen. Mostly the causes were perforated peptic ulcer, perforated appendix, enteric perforation and intestinal perforation proximal to obstructed gut due to ileocecal tuberculosis and recto sigmoid tumors. Such patients were mostly in sepsis due to contamination and shock due to multisystem injury at the time of presentation. This fact jeopardizes the immune system of the patients. Such an observation was also noticed by Patterson JW et al 18 . In our study 29.53 % of SSI patients underwent laparotomy for penetrating and blunt abdominal trauma. Most of these patients had multiple gut injuries and solid viscera injuries like liver or splenic laceration causing feculent and chemical peritonitis. These contaminating factors increase the chance of development of SSI. Such finding were also observed by Ntundu, S.H., Herman, A.M., Kishe, A et al 19. Level of wound contamination is an important factor for development of SSI. In our study 58.64 % SSI patients had contaminated wounds and each 20.64 % patients had clean contaminated and dirty wounds . Mukagendaneza, M.J et al20 noticed that SSI incidence was 8.5 times high in contaminated and dirty wounds compared to clean surgical wounds. Berríos-Torres, SI. et al also observed such findings21.

Operative time contributes a lot for the development of SSI and it depends on many factors like complexity of surgical procedure,hypovolemia, ,expertise of the operating surgeon ,level of contamination and findings of the operative field. In our study operative time was one to two hours in 40.08% , two to three hours in 27.42 % and half hour to one hour in 25.73% SSI patients. In our study seventy (29.09%) SSI patients underwent laparotomy for penetrating and blunt abdominal trauma and fifty (21.09%) patients had laparotomy for acute abdomen like perforated appendix, enteric perforation and perforated tumors of the intestine. All these procedures are technically difficult and lengthy. Improper triage, improper pre operative preparations ,delayed shifting of patients to operation theatre and induction and reversal of anesthesia also increase the exposure of the operative field to the external environment. Cheng H et al found that on average, across various procedures, the mean operative time was approximately 30 min longer in patients with SSI compared with those patients without22.

Zejnullahu VA et al observed that duration of the operation less than 1 h decreases the incidence

of SSI 23.

In our study Gram positive microorganisms were present in 181(76.79%) SSI patients and Gram negative microorganisms were present in 55(23.20%) patients. Staph aureus was the commonest Gram positive organism present in 145(79.67%) patients followed by Enterococcus and streptococcus. E.coli was the commonest Gram-ve organism in our study, present in thirty nine (70. 67%) patients, followed by Klebsiella and P.aeruginosa. Baker, A et al also observed such epidemiology 25.

Twelve out of one hundred and eighty two (06.59%) Staph aureus cultures were Methicillin resistant Staph aureus (MRSA) while two patient (01.09%) had Vancomycin resistant Staph aureus (VRSA). Many other studies have reported such increased incidence of MRSA and VRSA30,31.

In our study the most common used empirical antibiotics were Co-amoxiclave, Ceftriaxone, Ciprofloxacin and Cefoperazone used either as monotherapy or in different combinations. Metronidazole was prescribed for anaerobic coverage. These medicines were used because they were available in the hospital pharmacy.

19.40% patients were sensitive to Cefoperazone, 08.86% to Amikacin and Linezolid each, 08.43% to Piperacillin followed by 03.79% to Vancomycin, Doxycyclin, Ciprofloxacin, Clarithromycin, and Ceftriaxone each and 06.75% to Co- amoxiclav. 09.70% patients had mixed sensitivity. This trend shows that isolated bacteria are becoming resistant to the commonly used empirical antibiotics. These strains are becoming more sensitive to new broad-spectrum antibiotics as Linezolid and Piperacillin. Six (50%) MRSA patients were sensitive to Linezolid and six (50%) MRSA patients were sensitive to Vancomycin. Two VRSA (Vancomycin resistant Staph aureus) strains were sensitive to Linezolid. In two (0.84%) SSI patients managed in intensive care unit after surgery, Acinetobacter was found which was sensitive to Tigecyclin 26,27.

Such drug resistance pattern was also observed by Mouiche, M.M.M et al 28 and Hemmati, H et al 29. Most of the newer antibiotics are much costly and generally not available in hospital pharmacy of our hospital. They have to be purchased from private pharmacies on high cost putting extra financial burden on the hospital resources and prolongs hospital stay 32 .

**Conclusion and recommendations**

1. Increased incidence of blunt abdominal trauma increases the chances of SSI, so every

possible efforts should be made to decrease this incidence by better traffic regulations .

1. Pre operative resuscitation time can be decreased if adequate pre transfer

team like 1122 services are more vigilant.

1. Thorough per operative wound wash decreases the spread of contamination which can

lead to decreased incidence of SSI.

1. Operative time can be managed by better trauma management training of the trauma

surgical team .

1. Operative time can also be managed by if major surgeries are performed by the

experienced senior surgeons.

Figure 1

Table 1. Demographic and pathological characteristics of SSI cases

|  |  |  |  |
| --- | --- | --- | --- |
| **Serial.no.** | **Characteristics** | **No. of patients(n)** | **Percentage (%)** |
| Age groups  (years) | 11-20 | 73 | 30.80 |
| 21-30 | 64 | 27.00 |
| 31-40 | 40 | 16.87 |
| 41-50 | 37 | 15.61 |
| 51-60 | 23 | 09.70 |
| Gender | Male | 155 | 65.40 |
| Female | 82 | 35.50 |
| Surgery | Laparotomy (acute abdomen) | 50 | 21.09 |
| Laparotomy ( penetrating and blunt trauma) | 70 | 29.09 |
| appendectomy | 35 | 14.76 |
| Vascular injury repair | 09 | 3.79 |
|  | Open fractures | 20 | 8.43 |
|  | Debridement of infected and gangrenous wounds | 27 | 11.39 |
|  | Below knee amputations | 9 | 14.76 |
|  | Above knee amputations | 4 | 01.68 |
|  | Repair of obstructed hernia repair | 7 | 02.94 |
|  | Fasciotomy | 2 | 0.84 |
|  | Miscellaneous | 4 | 01.68 |
| Growth | Mono growth | 152 | 64.13 |
| Poly growth | 85 | 35.86 |

Table 2; Distribution of SSI according to the presence of contamination

|  |  |  |  |
| --- | --- | --- | --- |
| **Serial number** | **Type of contamination** | **No. of patients** | **Percentage %** |
| 1 | clean | 0 | o |
| 2 | Clean contaminated | 49 | 20.67 |
| 3 | contaminated | 139 | 58.64 |
| 4 | Dirty | 49 | 20.64 |
| 5 | total | 237 | 100 |

**Table 3. Distribution of SSI cases according to the presence of contamination**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Serial no** | **Procedure** | **clean** | **Clean contaminated** | **contaminated** | **dirty** | **Total** |
| 1 | Laparotomy for blunt and penetrating abdominal trauma | 0 | 15 | 50 | 5 | 70 |
| 2 | Laparotomy for acute abdomen | 0 | 2 | 35 | 13 | 50 |
| 3 | Appendicectomy | 0 | 14 | 16 | 5 | 35 |
| 4 | Debridement of Gangrenous wounds | 0 | 2 | 12 | 13 | 27 |
| 5 | Management of type 3 & 4 open fractures | 0 | 9 | 8 | 3 | 20 |
| 6 | Below knee amputation | 0 | 0 | 5 | 4 | 09 |
| 7 | Above knee amputation | 0 | 0 | 2 | 2 | 04 |
| 8 | Surgeries for complicated hernias | 0 | 2 | 3 | 2 | 07 |
| 9 | Fasciotomies | 0 | 1 | 1 | 0 | 02 |
| 10 | Miscellaneous | 0 | 0 | 2 | 2 | 04 |
| 11 | Total | 0(0.00%) | 49(20.67%) | 139(58.64%) | 49(20.67%) | 237(100.00%) |

Table 4; **Duration of emergency operation**

|  |  |  |  |
| --- | --- | --- | --- |
| **Serial number** | **Duration of surgery (Hours)** | **No. of patients (n)** | **Percentage (%)** |
| 1 | Half hour-- one hour | 61 | 25.73 |
| 2 | 1-2 | 95 | 40.08 |
| 3 | 2-3 | 65 | 27.42 |
| 4 | 3-4 | 14 | 05.90 |
| 5 | >4 | 02 | 00.84 |
| 6 | Total | 237 | 100 |

**Table 5. Micro-organisms distribution**

|  |  |  |  |
| --- | --- | --- | --- |
| **Serial no.** | **Micro- organism** | **No of patients** | **Percentage (%)** |
| Gram positive  n= 182(76.79%) | Staph aureus | 145 | 79.67 |
| Enterococcus | 18 | 9.80 |
| Streptococcus | 11 | 6.04 |
| Clostridium | 06 | 3.29 |
| Acinobacter | 2 | 0.84 |
| Gram negative  n= 55(23.20%) | E.coli | 39 | 70.90 |
| Klebsiella | 10 | 18.18 |
| Pseudomonas | 06 | 10.90 |

**REFERENCES**

1. Onyekwelu I, Yakkanti R, Protzer L, Pinkston CM, Tucker C, Seligson D. Surgical Wound Classification and Surgical Site Infections in the Orthopaedic Patient. *J Am Acad Orthop Surg Glob Res Rev*. 2017;1(3):e022. Published 2017 Jun 13. doi:10.5435/JAAOSGlobal-D-17-00022
2. Armstrong AW, Read C. Pathophysiology, Clinical Presentation, and Treatment of Psoriasis: A Review. JAMA. 2020;323(19):1945–1960. doi:10.1001/jama.2020.4006)
3. Iskandar, K., Sartelli, M., Tabbal, M. *et al.* Highlighting the gaps in quantifying the economic burden of surgical site infections associated with antimicrobial-resistant bacteria. *World J Emerg Surg* 14, 50 (2019). https://doi.org/10.1186/s13017-019-0266-x
4. R Jindal, M Swarnkar.  [a cross sectional patient specific study of risk factors for surgical site infections in major abdominal surgeries](http://www.jkimsu.com/jkimsu-vol9no1/JKIMSU,%20Vol.%209,%20No.%201,%20January-March%202020%20Page%2043-50.pdf). – jkimsu 2020
5. de Carvalho RLR, Campos CC, de Castro Franco LM, Rocha ADM, Ercole FF. Incidence and risk factors for surgical site infection in general surgeries. Rev Lat Am Enfermagem 2017; 25: e2848.
6. Wang, Z. *et al.* Surgical site infection following abdominal surgery in China: a multicenter cross-sectional study. *Zhonghua Wei Chang Wai Ke Za Zhi* 21, 1366–1373 (2018)
7. Hamza, W. S., Salama, M. F., Morsi, S. S., Abdo, N. M. & Al-Fadhli, M. A. Benchmarking for surgical site infections among gastrointestinal surgeries and related risk factors: multicenter study in Kuwait. *Infect Drug Resist* 11, 1373–1381 (2018
8. Kazuhiro Imamura, Kensuke Adachi, Ritsuko Sasaki, Satoko Monma, Sadaaki Shioiri, Yasuji Seyama, Masaru Miura, Yoshihiko Morikawa, Tetsuji Kaneko. 2016. Randomized comparison of subcuticular sutures versus staples for skin closure after open abdominal surgery: a multicenter open-label randomized controlled trial. J Gastrointest Surg 2016; 20:2083208330.
9. Troughton R, Birgand G, Johnson AP, Naylor N, Gharbi M, Aylin P, Hopkins S, Jaffer U, Holmes A. Mapping national surveillance of surgical site infections in England: needs and priorities. The Journal of Hospital Infection. 2018. (100;4), P378-385).

10 Onyekwelu I, Yakkanti R, Protzer L, Pinkston CM, Tucker C, Seligson D. Surgical Wound Classification and Surgical Site Infections in the Orthopaedic Patient. J Am Acad Orthop Surg Glob Res Rev. 2017;1(3):e022.)

11.Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. Surgical Infections. 2017;18(6):722–35. )

12.Hassan, R.S.E.E., Osman, S.O.S., Aabdeen, M.A.S. *et al.* Incidence and root causes of surgical site infections after gastrointestinal surgery at a public teaching hospital in Sudan. *Patient Saf Surg* 14, 45 (2020). <https://doi.org/10.1186/s13037-020-00272-4>

1. [Kobayashi K, a](https://www.sciencedirect.com/science/article/abs/pii/S0949265820301809#!) Seasonal variation in incidence and causal organism of surgical site infection after PLIF/TLIF surgery: A multicenter study[Journal of Orthopaedic Science](https://www.sciencedirect.com/science/journal/09492658), [Volume 26, Issue 4](https://www.sciencedirect.com/science/journal/09492658/26/4), July 2021, Pages 555-559

# Surgical site infections: prevention and treatment.NICE guideline [NG125]Published: 11 April 2019 Last updated: 19 August 2020

1. Alkaaki A, Al-Radi OO, Khoja A, Alnawawi A, Alnawawi A, Maghrabi A, Altaf A, Aljiffry M. Surgical site infection following abdominal surgery: a prospective cohort study. Can J Surg. 2019 Apr 1;62(2):111-117. doi: 10.1503/cjs.004818. PMID: 30907567; PMCID: PMC6440888.
2. Akter B, Anwar A , Tabibul Islam M, Baishnab AK, Abdul Quadir M, Faridul Haque M, Mizanur Rahman M, Kabir A. Incidence of surgical site infections after emergency laparotomy for perforation peritonitis. Int J Surg Sci 2021;5(2):335-338. DOI: <https://doi.org/10.33545/surgery.2021.v5.i2f.718>
3. Aghdassi, S.J.S., Schröder, C. & Gastmeier, P. Gender-related risk factors for surgical site infections. Results from 10 years of surveillance in Germany. *Antimicrob Resist Infect Control* 8, 95 (2019). https://doi.org/10.1186/s13756-019-0547-x
4. Patterson JW, Kashyap S, Dominique E. Acute Abdomen. [Updated 2021 Jul 14]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459328/
5. Ntundu, S.H., Herman, A.M., Kishe, A. *et al.* Patterns and outcomes of patients with abdominal trauma on operative management from northern Tanzania: a prospective single centre observational study. *BMC Surg* 19, 69 (2019). https://doi.org/10.1186/s12893-019-0530-8
6. Mukagendaneza, M.J., Munyaneza, E., Muhawenayo, E. *et al.* Incidence, root causes, and outcomes of surgical site infections in a tertiary care hospital in Rwanda: a prospective observational cohort study. *Patient Saf Surg* 13, 10 (2019). https://doi.org/10.1186/s13037-019-0190-8
7. Berríos-Torres, SI. et al., Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection. JAMA Surg, 152(8): (2017):784912
8. Cheng H, Chen BP, Soleas IM, Ferko NC, Cameron CG, Hinoul P. Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. Surg Infect (Larchmt). 2017 Aug/Sep;18(6):722-735. doi: 10.1089/sur.2017.089. PMID: 28832271; PMCID: PMC5685201.
9. Zejnullahu VA, Isjanovska R, Sejfija Z, Zejnullahu VA. Surgical site infections after cesarean sections at the University Clinical Center of Kosovo: rates, microbiological profile and risk factors. *BMC Infect Dis*. 2019;19(1):752. Published 2019 Aug 28. doi:10.1186/s12879-019-4383-7
10. Collaborative G. Determining the worldwide epidemiology of surgical site infections after gastrointestinal resection surgery: protocol for a multicentre, international, prospective cohort study (GlobalSurg 2)

*BMJ Open*2017;7:e012150. doi: 10.1136/bmjopen-2016-012150

1. Baker, A., Dicks, K., Durkin, M., Weber, D., Lewis, S., Moehring, R., . . . Anderson, D. (2016). Epidemiology of Surgical Site Infection in a Community Hospital Network. *Infection Control & Hospital Epidemiology,* *37*(5), 519-526. doi:10.1017/ice.2016.13

26 Wang, J., Pan, Y., Shen, J. *et al.* The efficacy and safety of tigecycline for the treatment of bloodstream infections: a systematic review and meta-analysis. *Ann Clin Microbiol Antimicrob.2017;* 16(24)

1. Abdallah, M., Alsaleh, H., Baradwan, A. *et al.* Intraventricular Tigecycline as a Last Resort Therapy in a Patient with Difficult-to-Treat Healthcare-Associated *Acinetobacter baumannii* Ventriculitis: a Case Report. *SN Compr. Clin. Med.* 2, 1683–1687 (2020). <https://doi.org/10.1007/s42399-020-00433-7>
2. Mouiche, M.M.M., Moffo, F., Akoachere, JF.T.K. *et al.* Antimicrobial resistance from a one health perspective in Cameroon: a systematic review and meta-analysis. *BMC Public Health* 19, 1135 (2019). <https://doi.org/10.1186/s12889-019-7450-5>
3. Hemmati, H., Hasannejad-Bibalan, M., Khoshdoz, S. *et al.* Two years study of prevalence and antibiotic resistance pattern of Gram-negative bacteria isolated from surgical site infections in the North of Iran. *BMC Res Notes* 13, 383 (2020). <https://doi.org/10.1186/s13104-020-05223-x>,
4. United States Centers for Disease Control and Prevention. Methicillin-resistant Staphylococcus aureus (MRSA). https://www.cdc.gov/mrsa/ (Accessed on November 20, 2020).Topic 4025 Version 25.0

## Cong Y et al, Vancomycin resistant *Staphylococcus aureus* infections: A review of case updating and clinical features; [Journal of Advanced Research](https://www.sciencedirect.com/science/journal/20901232)

[Volume 21](https://www.sciencedirect.com/science/journal/20901232/21/supp/C), January 2020, Pages 169-176 doi:10.1016/j.jare.2019.10.005

# Antibiotic resistance leads to higher medical costs, prolonged hospital stays, and increased mortality. Antibiotic resistance;World health organization

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