POST OPERATIVE WOUND INFECTION IN SURGICAL WARD AT TVMCH

A Dissertation submitted to the

TAMILNADU DR. M.G.R MEDICAL UNIVERSITY

In partial fulfillment of the requirements

for the award of degree

M.S. General Surgery

Department of Surgery,
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CERTIFICATE

This is certified that this dissertation titled **"Post operative wound infection in surgical ward at TVMCH"** is the bonafide work of **Dr. D.L. Amuda,** Post Graduate in Department of Surgery, who carried out the work under my guidance **Dr. S.S. Pandi Perumal, M.S.**, Professor of Surgery in partial fulfillment of the requirements for the award of degree M.S. General Surgery.

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Introduction

Surgical wound infection is a common post operative complication and causes significant post operative morbidity and mortality, prolongs hospital stay and adds between 10-20% to hospital costs.

The understanding of wound infection has come a long way from the days when pus was "laudable". Far reaching advances in therapeutics, techniques in surgery and maintenance of asepsis have contributed to controlling scourge of surgery which is post operative wound infection.

Infection was accepted as an inevitable sequalae of surgery a century ago. The infection rate which was about 75% has now dropped to about 10% or less. Yet today infections accompanying surgical procedures contribute significantly to morbidity and mortality.

Although the total elimination of wound infection is not possible, a reduction in the infection rate to a minimal level could have significant benefits in terms of both patient comfort and medical resources used.

Clear understanding of pathogens and their pathogenicity, advances in the field of asepsis and aseptic technique, the advent of antibiotics and reliable suture materials have furnished the surgical armamentarium in countering infection.

Hence a constant awareness of the ever present threat of infection must be a way of life for the entire surgical fraternity.

In 1992, the Surgical Wound Infection Task Force replaced the term 'Surgical Wound Infection' with 'Surgical Site Infection' - SSI.

Aim

1. Determining the incidence of post operative wound infection and application of scoring system based on various risk factors in all abdominal surgeries in TVMCH.

2. Identifying the common pathogens causing surgical site infection and their sensitivity to antibiotics in TVMCH.

3. Studying commonest complications of surgical site infection and analysing various preventive measures which reduce the incidence of surgical site infection.

4. Reviewing literature on wound healing, wound infection and prophylaxis in (post - operative) surgical site infection.

5. Studying the role of prophylactic antibiotics in reducing surgical site infection.

LITERATURE

Historical background

- Susuruta - Father of surgery mention made regarding cleanliness of surgeon and maintenance of instruments amply stressed in the ancient Hindu text "Susuruta Samhita".
- 1683 - Antony Van Leeuwenhoek - credit for having first observed and reported bacteria.
- Joseph Lister (1826 - 1912) father of modern surgery, great contribution to surgery by demonstrating that antisepsis could prevent infection.
  - 1865 - Lister began placing pure carbolic acid into wounds.
  - 1871 - Lister began using carbolic acid spray to reduce contamination of the operating room atmosphere.
- William Stewart Halsted (1852 - 1922) introduced rubber gloves for his scrub nurse, Caroline Hampton because the corrosive sublimate used to sterilize instruments mercuric chloride irritated her skin.
- Joseph Bloodgood - introduced the routine use of gloves by the entire operating team.
- 1928 - Alexander Fleming - discovery of antibiotic Penicillin from Penicillium notatum.
- 1940 - Howard Florey first clinically administered penicillin.
- Robert Koch (1843 - 1910) - laid down the first definition of infective disease (Koch's postulates)
  - 1876 - Discovered anthrax bacillus
  - 1882 - Discovered bacillus of tuberculosis
  - 1883 - Discovered cholera Vibrio
- Louis Pasteur - clearly showed the relationship of microorganism to pus formation - propounded the germ theory of diseases.

- Von Bergmann, 1866 - introduced steam sterilisation.
- 1944 - Streptomycin was discovered followed by chloramphenical, tetracycline, aminoglycosides and new β lactum agents.

Post operative wound or surgical site infections (SSI) place a significant burden on both patients and surgeons. SSI's are the second most common nosocomial infection accounting for 24% of all hospital -acquired infections and are a major source of morbidity, prolonged hospital stay and increased health care costs.

Sources of wound contamination

- Direct inoculation
  - Patients residual flora or skin contamination
  - Surgeon's hands
  - Contaminated instruments or dressings
  - Contaminated procedure
  - Drains, catheters, intravenous lines
- Airborne contamination
  - Skin and clothing of staff and patients
  - Air flow in operating theatre or ward
- Haematogenous spread
  - Intravenous lines
  - Sepsis at other anatomical sites (Remote infection)

Factors that influence infection rate

Altemeier has stated that the risk of wound infection varies according to the following equation,

$$\frac{\text{Dose of bacterial contamination x Virulence}}{\text{Resistance of the host}}$$

Risk factors for surgical site infection includes 3 main determinants.

1. Bacterial factors

- Bacterial number (load), virulence and bacterial resistance
- Length of pre operative stay

- Remote site infection
- Duration of procedure
- Wound class
- Prior antibiotic therapy
- Pre operative shaving

2. Local wound factors

- Surgical techniques
- Haematoma / Seroma
- Necrosis
- Sutures
- Drains
- Foreign bodies

3. Patient factors

- Age - extremes of age
- Immunosuppression
- Steriod - long term use
- Malignancy
- Obesity
- Diabetes mellitus
- Malnutrition
- Transfusion
- Cigarette smoking
- O_2 tension
- Temperature
- Glycemic control

The effect of pre-existing illnesses on wound infection

In the Study on the Efficacy of Nosocomial Infection Control (SENIC) of 1970, 58,498 patients undergoing operations were monitored for the presence and progress of wound infection. Stepwise multiple logistic regression techniques identified four independent risk factors: (1) procedures lasting more than 2 hours (2) wound contamination (3) three or more diagnosis at the time of discharge (excluding those related to surgical wound infections and their complications) and (4) abdominal operations - SENIC RISK INDEX

SENIC risk index was replaced by the American Society of Anesthesiologists (ASA) pre operative assessment score which was validated in a large study involving 44 hospitals from 1987 to 1990. The wound infection rate among ASA class I or II was 1.9%, whereas among patients in class III to V was 4.3%.

American society of Anesthesiologists (ASA) preoperative assessment score

Class I - A patient in normal health

Class II - A patient with mild systemic disease resulting in no functional limitations

Class III - A patient with severe systemic disease that limits activity but is not incapacitating

Class IV - A patient with severe systemic disease that is a constant threat to life

Class V - A moribund patient not likely to survive 24 hours

US Centers for Disease Control and prevention (CDC) developed the NNIS Risk Index System (National Nosocomial Infections Surveillance Risk Index System) which include the traditional wound classification system proposed by Altemier *et al*. as clean, clean contaminated, contaminated and dirty / infected and additional variables. This simplified risk index has a range from 0 to 3 points. A point added to the patients risk index for each of the following 3 variables.

- 1 point - the patient has an operation that is classified as either contaminated or dirty.
- 1 point-the patient has an American Society of Anesthesiologists (ASA) preoperative assessment score of 3, 4 or 5.
- 1 point-the duration of the operation exceeds the 75^{th} percentile where a standard T point (75% percentile) was determined from the NNIS database; the T point is defined as the length of time in hours that represent 75^{th} percentile of procedures reported the NNIS survey.

The T point for common surgical procedures

Operation	T point (hrs)

Coronary artery bypass graft	5
Bile duct, liver or pancreatic surgery	4
Craniotomy	4
Head and neck surgery	4
Colonic surgery	3
Joint prosthesis surgery	3
Vascular surgery	3
Abdominal or vaginal hysterectomy	2
Ventricular shunt	2
Herniorrhaphy	2
Appendectomy	1
Limb amputation	1
Cesarean section	1

Pathophysiology of SSI (Surgical site infection)

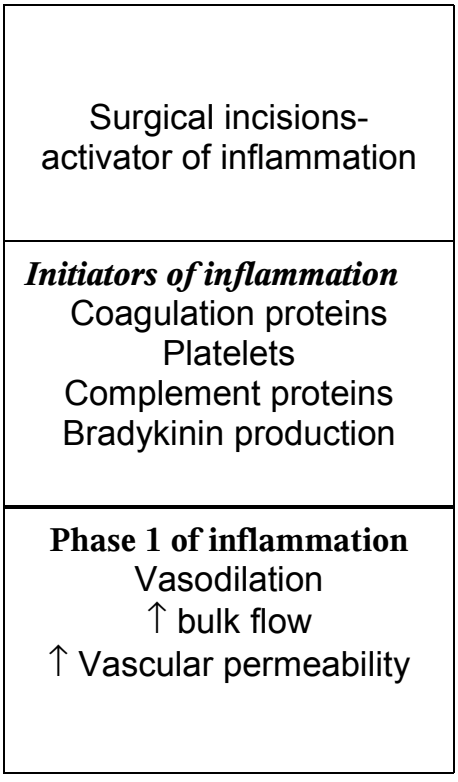
All surgical wounds are contaminated by bacteria, but only a minority actually demonstrate clinical infection. In most patients, infection does not develop because innate host defenses are quite efficient in the elimination of contaminants at the surgical site.

The interplay of four important determinants lead to either uneventful wound healing or surgical site infection.

1. Innoculam of bacteria
2. Virulence of bacteria
3. Adjuvant effects of micro environment and
4. Innate and acquired host defenses

With the creation of the surgical incision through the skin and into subcutaneous tissues five critical initiators are activated - coagulation proteins, platelets, mast cells, complement protein and bradykinin.

The net effect of these five factors is vasodilatation and increased local blood flow at the site of the surgical incision. While bulk flow is increased flow velocity is decreased in preparation for margination of phagocytes. Non specific chemoattractant signals and some specific chemokine signals are released that "draw" specific neutrophil, monocyte and other leukocyte populations into the area of surgical site. Important point is that tissue injury from the incision initiates the mobilization of phagocytes into the wound before bacterial contamination actually occurs from the procedure itself. This mobilisation of the innate host defenses before significant intra operative contamination occurs undoubtedly gives the patient an advantage against infection as an outcome.



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Phase 2 of inflammation
Phagocyctic infiltration
Phagocytosis of microbes
Eradication of dead tissue
Pro-inflammatory cytokines

By 24 hrs monocy e Tumor Necrosis Factor - alpha (TNF - α), a potent paracrine signal activity.

IL-1, IL-6 (Interle ndocrine signals responsible for fever, stimulation of acute-phas

The net effect of vigorous neutrophilic stimulation, tissue autolysis and sustained stimulation of inflammatory initiation is the creation of a wound space that is a host-pathogen battle field. Ultimately the wound space is filled with necrotic tissue, neutrophils, bacteria and proteinaceous fluid that together constitute pus. The discharge of pus from the wound interface via the incision completes the natural history of surgical site infection.

Classification of wound according to the type of surgery

I. Clean wound - No infection encountered, no break in aseptic technique and no hollow muscular organ opened.

II. Clean contaminated wound - A hollow muscular organ was opened but minimal spillage of contents occurred.

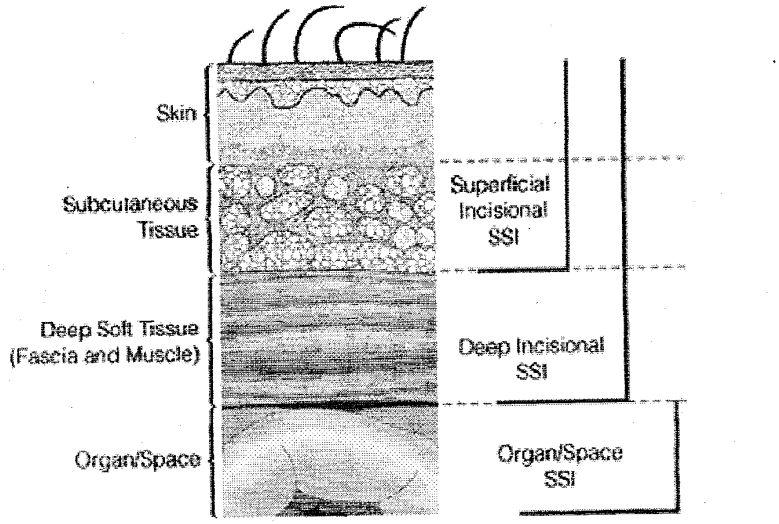
III. Contaminated wound - A hollow muscular organ was opened with gross spillage of contents or alternatively acute inflammation without pus formation was encountered.

IV. Dirty wound - Pus encountered at operation or a perforated viscus found.

Diagnosis of surgical site infection

The diagnosis of surgical site infection had lacked a standardized nomenclature and standardized definition. Most surgeons have generally simplified the process by considering a site to be infected when pus is discharged from the wound.

The definition of SSIS according to the National Nosocomial Surveillance Infections is given below,



Superficial incisional SSI

- ❖ Occurs within 30 days after the operation
- ❖ Involves only the skin or subcutaneous tissue and
- ❖ At least 1 of the following
  - Purulent drainage (Culture documentation not required)
  - Organisms isolated from fluid / tissue of superficial incision
  - At least 1 sign of inflammation (eg. pain or tenderness, induration, erythema, local warmth of the wound)
  - Wound is deliberately opened by the surgeon
  - Surgeon or attending physician declares the wound as infected

Deep incisional SSI

- ❖ Occurs within 30 days of operation or within 1 year if implant is present
- ❖ Involves deep soft tissues (eg. fascia and/or muscle) of the incision and
- ❖ At least 1 of the following
  - Purulent drainage from the deep incision but without organ/space involvement
  - Fascial dehiscence or fascia deliberately separated by the surgeon due to signs of inflammation
  - Deep abscess is identified by direct examination or during reoperation, or by histopathology or by radiologic examination
  - Surgeon or attending physician declares that deep incisional infection is present

Organ / space SSI

- ❖ Occurs within 30 days of operation or within 1 year if an implant is present
- ❖ Involves anatomic structures not opened or manipulated during the operation and
- ❖ At least 1 of the following
    - Purulent drainage from a drain placed by a stab wound into the organ / space
    - Organisms isolated from organ/space by aseptic culturing technique
    - Identification of abscess in the organ/space by direct examination, during reoperation or by histopathologic or radiologic examination
    - Diagnosis of organ/space SSI by surgeon or attending physician

Clinical manifestation

Wound infections are usually not identifiable until the fifth to tenth post-operative day, although these patients often have fever beginning early in the post-operative course. The wound sometimes look inflamed and odematous and skin sutures appear tight. The patient may complain of wound pain and on palpation firm or fluctuant areas with tenderness can be elicited.

Classification

Post operative wound infections are classified as follows:

(a) Stitch Abscess (Grade I)

Redness or pustules near one or more stitches.

(b) Mild Infection (Grade II)

Minor infection of the wound without separation of wound edges slight seropurulent or purulent discharge. No systemic reaction.

(c) Moderate Infection (Grade III)

Frank infection in relatively a small portion of a wound with purulent discharge and possibly some systemic reaction present.

(d) Severe Infection (Grade IV)

Frank infection of a large portion of the wound with abscess formation usually with systemic reaction and wound dehiscence.

Local manifestations

1. Cellulitis

2. Wound abscesses
3. Necrotising soft tissue infection-less common clostridial myonecrosis, more serious nonclostridial infective gangrene, Meleney's post operative synergistic gangrene
4. Intra abdominal infection

Systemic manifestation

1. Post operative fever
2. Bacteraemia and septicaemia

Systemic inflammatory response syndrome (SIRS)

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Multiple organ dysfunction syndrome (MODS)

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Multiple system organ failure

Complications

1. Wound dehiscence
   - A. Incomplete
     - Superficial → Wound gaping
     - Deep → Late incisional hernia
   - B. Burst abdomen
2. Local stitch sinuses and fistulous tract
3. Antibiomas
4. Calcification and ossification
5. Regional lymphangitis
6. Ugly keloid scar

Preventive measures

Many surgeons have genius without industry; others have industry without genius while many who have both are still deficient in judgement.

- John Abernathy

The essence of modern surgery-quality called judgement, ability to know what to use, where to use it and for how long?

Preoperative planning

1. Careful selection and fitness of patient for surgery.
2. Correction of nutritional, haemoglobein status and fluid and electrolyte disturbance.
3. Decrease in weight in obese patient.
4. Shower and scrub the surgical site with antiseptic soap on the evening prior to procedure which reduces surface contamination.
5. Shaving or clipping the surgical site should be reserved for the operating room immediately prior to the skin incision.
6. The presence of open skin wounds or infection of the hands or arms of the surgeon makes postponement of the operation desirable.
7. Avoiding extensive preoperative hospitalization (more than 4 days) which avoids colonization of the patent with hospital based microbes.
8. Adequate antibiotic prophylaxis in an appropriate fashion.
9. Tetanus prophylaxis is mandatory.
10. Adequate bowel preparation in case of colonic surgery.

Operative care

Most of the local factors that make a surgical site favourable to bacteria are under the control of the surgeon. The "Halstedian Principles" are to be adhered to prevent surgical site infection-perfect haemostasis, sharp dissection, fine sutures, anatomic dissection and the gentle handling of tissues, minimizing cautery use.

Mass ligatures, large or braided non absorbable sutures, necrotic tissue and creation of hematomas or seromas must be avoided and foreign materials must be judiciously used because these techniques and materials change the size of innoculam required to initiate infective process.

Povidone iodine should be allowed to dry before the incision is made to allow optimum antiseptic effect.

Double gloving prevents blood borne occupational infection and also reduces the risk of contamination of the surgical site by bacteria from surgeon's hands.

Blood and fluid break through on the surgical gown and drapes on the minimised which prevent the passage of bacteria into the operative area.

Gas sterilization of instruments after thorough cleansing of any particulate matter is obviously important for infection control.

Adequate inventory of instruments minimise the need for the rapid steam sterilization of dropped or contaminated instruments during the procedure.

Desirable to avoid dead space in surgical wound, especially so in the obese patient. Use of closed suction drains preferable.

When surgical site is severely contaminated or frankly dirty, the skin and subcutaneous tissues should be left open for topical post operative management.

Postoperative care

Three "natural" methods to enhance the host response attempted.

1. Increased oxygen delivery
2. Optimizing core body temperature
3. Blood glucose control

Adequate antibiotic prophylaxis used based on the type of wound.

Bacteriology

Normal microbial flora of the human body

The normal microbial flora are more or less constant and are broadly divided into residents and transients. The former constitute a constant population which cannot be completely removed permanently while the latter vary from time to time and are impermanent.

The residents prevent permanent colonisation of the body by other organisms. A knowledge of the normal flora of the body is essential to an understanding of the interaction of human beings and

their pathogen laden environment. The normal microbial flora play an important role in body economy. They can

a. Become pathogenic when host defenses falter
b. Prevent or interfere with colonisation/invasion of the body by pathogens
c. Raise the overall immune status of the host against pathogens having related or shared antigen
d. Cause confusion in diagnosis due to their ubiquitous presence in the body and their resemblance to some of the pathogens

The microflora of intestinal tract synthesise vitamin K and several B vitamins. Antibiotic substances produced (eg.) colicins, have a harmful effect on pathogens. The endotoxins liberated by them may help the defense mechanism of the body by triggering the alternative complement pathway.

Normal body flora

- Skin - *Staphylococci*, *streptococci*
- Nasal cavity - *Staphylococci*, *streptococci* and *anaerobes*
- Nasopharynx - *Staphylococci*, *Streptococci*, *Haemophilus* and *anaerobes*
- Large bowel - Gram negative rods, *enterococci* and *anaerobes*
- Urinary tract - Normally sterile

If normal flora at one site is present in another unusual site, then it causes infection (eg.) Bacteroides fragilis from intestinal lumen enter into peritoneal cavity causing peritonitis.

Microorganisms most commonly causing post operative infection

Site of operation	Aerobic	An aerobic
Mouth	*Streptococci*	Bacteriodes other than *B. fragilis, Peptostreptococci fusobacterium*
Esophagus	*Streptococci*	Bacteriodes other than *B. fragilis, Peptostreptococci fusobacterium*
Stomach	Enteric gram negative bacilli, *streptococci*	Bacteriodes other than *B. fragilis, Peptostreptococci fusobacterium*
Biliary	Enteric gram negative bacilli Group D *Streptococci*	*Clostridia*
Distal ileum	Gram negative enteric bacilli	Bacteriodes other than *B. fragilis, Peptostreptococci clostridia*
Colon	Gram negative enteric bacilli	Bacteriodes other than *B. fragilis, Peptostreptococci clostridia*

Review of literatures regarding studies carried out by various authors in connection with post operative wound infection done in our study.

Butalari, A., Ferri, M. *et al*. (1996). Studied the probability of operative mortality and morbidity in a large number of patients over 80 years of age. Post operative mortality and morbidity rates were 10.1 and 32.2 percent respectively which was higher when compared with mortality and morbidity rates in younger patients which was 1.2 and 12.4 percent respectively.

Tonnesen, H. and Kehlet, H. *et al*. (1999) did prospective and retrospective studies and demonstrated a two fold to three fold increase in post operative morbidity in alcohol abusers. The most frequent complication being infections, bleeding and cardio pulmonary insufficiency. The pathologic mechanisms include preoperative immune incompetence, subclinical cardiac insufficiency and haemostatic imbalance.

Klotz, H.P., Candinas, D. *et al*. (1996) used a simple preoperative risk scoring system using 4 variables *viz.,* severity of operative procedure, higher American Society of Anesthesiologists (ASA) grade, symptoms of respiratory disease and malignancy. Class A (upto 5 points) was defined as a low risk group (systemic complication rate 5.0 percent), class B (5-7 points) was intermediate risk (systemic complication rate 17.9 percent) and class C (8-10 points) was high risk (systemic complication rate 33.3 percent).

Cruse, P.J.E. and Floord, R. (1980) had done 10 year prospective study of 62,939 adult surgical wounds. Rate of wound infection was increased for longer procedure. Operations lasting one hour or less had a wound infection rate of 1.3 percent, where as those lasting 3 hours or more had a rate close to 4.0 percent.

Farinas, C., Alvarez, M.C. *et al*. (2000) analysed the risk factors for nosocomial sepsis in surgical patients. During follow up 99 cases and 99 controls were identified. The main risk factors for sepsis found in the multivariate analysis were coma within 48 hours before sepsis, low serum albumin level at admission, two or more intrinsic co-morbidities and parenteral nutrition. Emergency surgery, abdominal surgery and number of surgical interventions were the variables related to surgery that significantly increases the risk of sepsis.

Jeffrey R. Horwitz, Walter J. Chwals *et al*. (1998). Prospectively followed all infants and children undergoing operation during a 17 month period and followed 30 days after surgery. Total of 846 of 1021 patients were followed for 30 days. The over all wound infection incidence was 4.4%. Factors found to be significantly associated with a post-operative wound infection were the amount of contamination at operation and the duration of the operation.

Rajeev M. Joshi, Mehta, N.N. *et al*. (2002). Studied the efficacy of Netilmycin and ceftriaxone in clean contaminated and contaminated surgical cases in 250 patients. Clean contaminated cases received a single dose of Netilmycin (300 mg) in combination with ceftriaxone (1 gm) pre-operatively. Contaminated cases were administered Netilmycin (200 mg) along with ceftriaxone (1 gm) once daily for 5 consecutive days including the pre-operative dose. The overall response to the therapy showed a success rate of 98.71% in clean contaminated and 84.04% in contaminated cases with infection rate of 1.29% and 15.96% respectively.

Wilson, A.P.R., Gruneberg, R.N. *et al*. (1988) assessed the wounds of 517 patients after cardiac surgery by a wound scoring method and a close comparison was made of the appearance and clinical outcome of 89 wounds, from which bacteria were isolated. There was no significant difference in the scores of 49 wounds where *Staphylococcus epidermidis* was the sole isolate and 13 wounds infected with *Staphylococcus aureus*.

Krukowshi, Z.H., Irwin, S.T. *et al*. (1988) reviewed the literature over the last 25

years and emphasized both the importance of adequate study size and of stratification of the severity of the sepsis found at operation wide variations in outcome for similar antibiotic regimens reflect the importance of technical factors in determining the frequency of wound sepsis.

Targarona, E.M., Balague, C. *et al*. (2000) observed that the metabolic response to surgical injury is less after laparoscopic surgery than after open surgery. Laparoscopic surgery is associated with better preservation of the immune system than open surgery, diminished release of various markers including interleukin-6 and c-reactive protein. Although carbondioxide pneumoperitoneum affects the peritoneal response to injury it seems to have no harmful effect in terms of intra abdominal infection. Prospective study of 500 patients undergone laparscopic surgery the infection rate was only 1.2%.

Weigelt, J.A., Dryer, D. *et al*. (1992) confirmed the necessity of wound surveillance after discharge for accurately assessing the incidence of SSI. They found that 35% of all surgical wound infections occurred after discharge and that approximately 22% of all wound infections would have been missed had the surveillance period not extended beyond 14 days.

Phillip S. Brachman *et al.,* (2001) confirmed that the longer a patient stays in hospital before an operation the more susceptible he is she becomes to wound infection. With a one day pre-operative stay the infection rate is 1.2%; with a one week pre-operative stay is 2.1 and for a stay of more than 2 weeks is 3.4%.

R.A. Kulkarani, P.H. Kochhar *et al.* (2005) studied the patterns of antimicrobial use by surgeons in India. A survey was conducted among surgeons from all over India attending the ASICON-2003 conference to ascertain the prevalent prescribing trends for treatment of intra abdominal infections and surgical prophylaxis and the average duration of treatment. It was observed that third/fourth generation cephalosporin plus an anti-anaerobic agent were preferred for treating intra abdominal infection (84%) for an average duration of 6.38+2.2 days. They came to the conclusion that the high use of antimicrobials especially for a prolonged duration is a matter of concern and that there is an urgent need to promote rational antimicrobial prescription among surgeons.

Materials and methods

The following clinical materials, were selected in this prospective study, patients selected from general surgical ward at TVMCH admitted between 1/1/05 - 31/12/05.

Patients with clean post operative wounds were excluded from the study. Only clean contaminated, contaminated and dirty wounds included for this study.

Collection and transport of pus

Cotton swabs - 2 in number collected intra operatively, subcutaneous tissue before wound closure and from the wound, post operatively when infection suspected.

Special care taken to avoid contaminating the specimen with commensal organisms from the skin. As far as possible specimen from the wound was collected before antiseptic dressing was applied.

Using sterile technique upto 5 ml of pus was collected from the drainage tube which was transferred to a leak-proof sterile container. When pus is not being discharged, a sterile cotton-wool swab was used to collect the sample from infected site.

Special care was taken to sent the specimen with a completed request form to reach the microbiology laboratory within 6 hours.

One swab was used to make a smear of the material in clean slide - For gram staining done in day 1.

Other swab was used for culture. Media used for pus culture were blood agar and nutrient agar plates incubated for 24 hours aerobically. Isolates identified based

on colony morphology and coagulation test. If culture turns out to be positive then antibiotic sensitivity was performed (Muller Hilton method).

Patients analysed for risk of wound infection by applying following major and minor criteria.

Major criteria	**A**	**B**
1. Nature of operation	Elective	Emergency
2. Type of wound	Clean contaminated	Contaminated
3. Type of surgery	Gastro intestinal	Hepatobiliary
4. Pre operative hospital stay	Early/< 2 weeks	Late/> 2 weeks
5. Order of surgery (I, II or III Round) and Duration of surgery	Early < 2 hours	> 2 hours
6. Other predisposing factors (anaemia and malnutrition diabetes mellitus and malignancy)	Absent	Present
7. Pre operative antibiotics	given	Not given

Minor criteria	**A**	**B**
1. Age distribution	Younger	Elder
2. Sex	Male	Female
3. Seasonal variation	Summer	Winter
4. Pre operative hair removal	1 hour before	1 day before

One point was given to the risk factors mentioned in column A and two were points given to the factors mentioned in column B. Incidence of wound infection more when score is high.

Observation

Total patients studied - 415

366 (88.2%) - Wound healed by first intention

49 (11.8%) - Post operative clinical as well as bacteriological wound sepsis

1. Nature of operation

Out of 415 patients

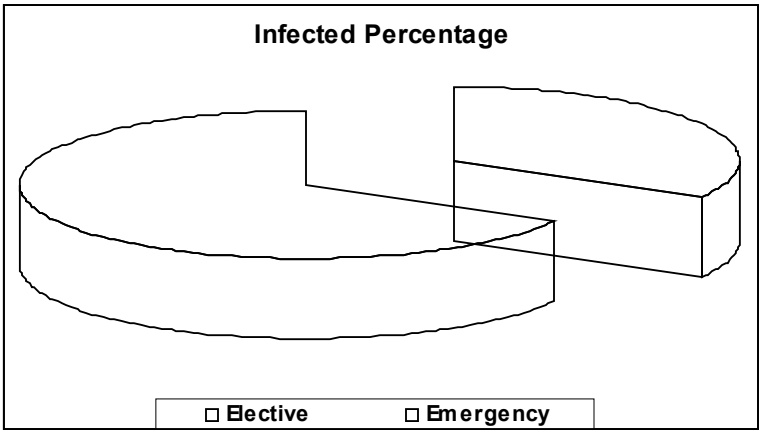
240 Elective cases - 20 cases infected

175 Emergency cases - 29 cases infected

Over all wound infection rate 11.8%

Table 1.

S. No.	Surgical procedure	*Total cases*	Infected cases	Percentage (%)
1.	Elective	240	20	8.3
2.	Emergency	175	29	16.5
	Total	415	49	11.8



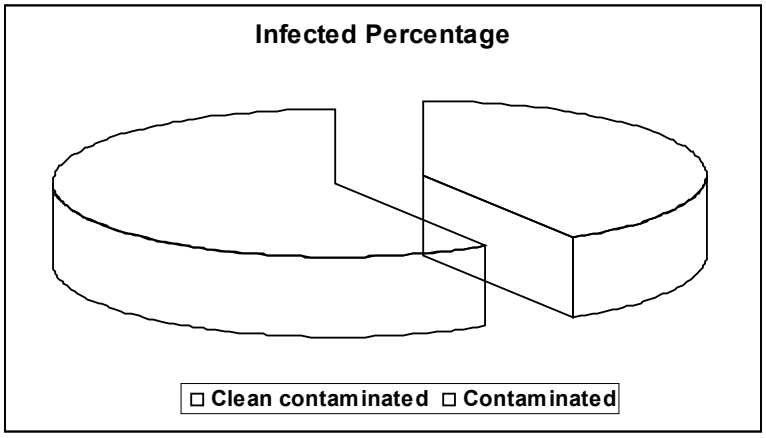
2. Type of wound

A. Clean contaminated

B. Contaminated

Table 2.

S. No.	Type of wound	*Total cases*	Infected cases	Percentage (%)
1.	Clean contaminated	312	34	10.8
2.	Contaminated	103	16	15.5



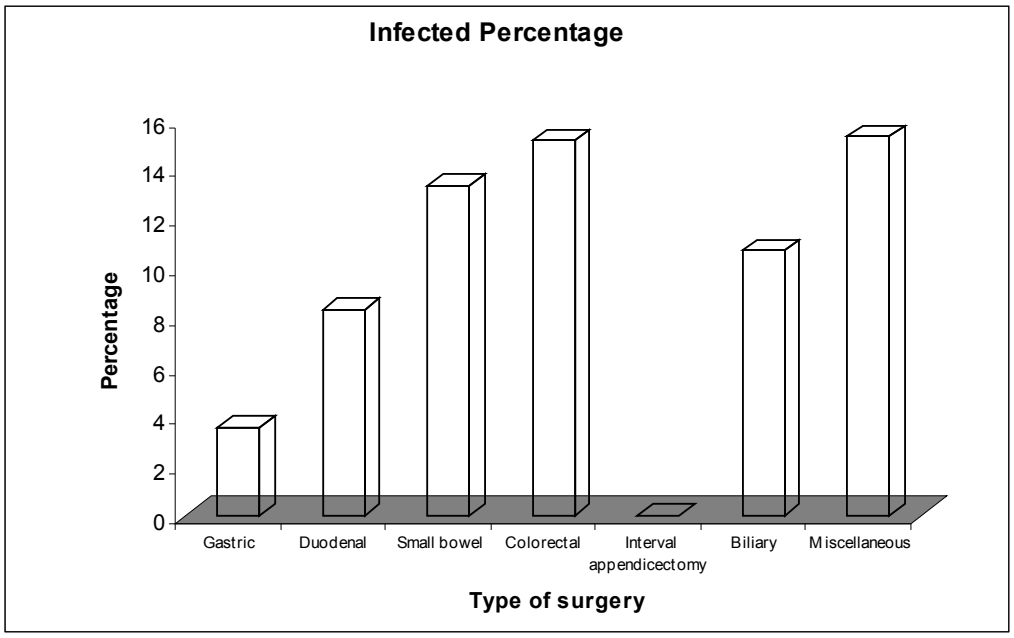
Number of cases infected in contaminated wound is higher than in clean contaminated wounds.

3. Types of surgery

More infections in colorectal, bowel perforation and biliary surgery.

Table 3.

S. No.	Surgical procedure	*Total cases*	Infected cases	Percentage (%)
1.	Gastric	84	3	3.57
2.	Duodenal	12	1	8.33
3.	Small bowel	15	2	13.33
4.	Colorectal	33	5	15.15
5.	Interval appendicectomy	27	1	3.70
6.	Biliary	56	6	10.7
7.	Miscellaneous	13	2	15.3

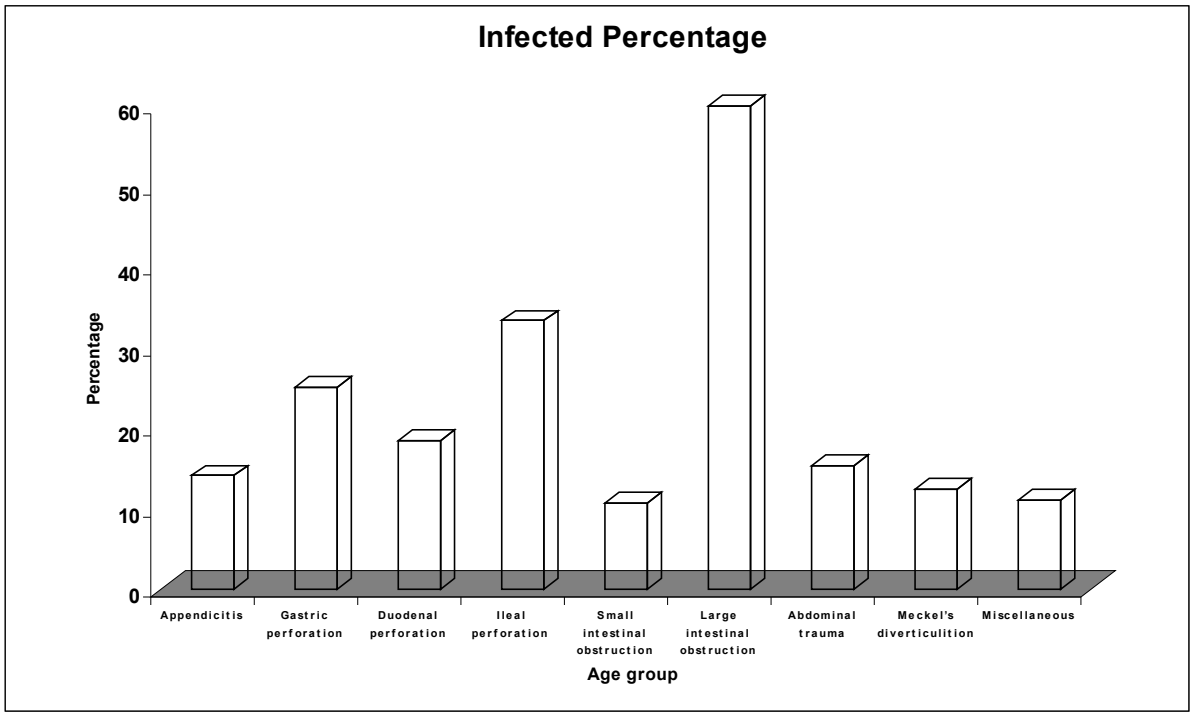


Emergency

Table 4.

S. No.	Surgical procedure	*Total cases*	Infected cases	Percentage (%)
1.	Appendicitis	64	9	14.06

2.	Gastric perforation	4	1	25
3.	Duodenal perforation	38	7	18.42
4.	Ileal perforation	6	2	33.3
5.	Small intestinal obstruction	28	3	10.7
6.	Large intestinal obstruction	5	3	60
7.	Abdominal trauma	13	2	15.38
8.	Meckel's diverticulitis	8	1	12.5
9.	Miscellaneous	9	1	11.11



4. Pre operative hospitalization

Hospital stay < 2 weeks - I

Hospital stay > 2 weeks - II

Table 5.

S. No.	Pre operative hospital stay	*Total cases*	Infected cases	Percentage (%)
1.	0 (Emergency)	175	29	16.5
2.	0-7 days	150	10	6.6
3.	8-14 days	62	6	9.6
4.	> 2 weeks or 15 days	28	4	14.2

5. Order (round) and duration of surgery

Order of surgery

Sepsis gradually increase in cases operated towards later part of the day.

Table 6.

S. No.	Order	*Total cases*	Infected cases	Percentage (%)
1.	I	96	4	4.16
2.	II	82	6	7.31
3.	III	62	10	16.12

Duration of surgery

Duration of operation also influences the incidence of post operative wound infection.

Table 7.

S. No.	Duration	*Total cases*	Infected cases	Percentage (%)
1.	1 hour	35	3	5.4
2.	2 hours	89	8	8.9
3.	> 3 hours	96	9	9.37

6. Predisposing factors Vs wound sepsis

There was increased incidence of post operative wound infection in patients with following predisposing factors - anemia, malnutrition, diabetes mellitus, malignancy.

Table 8.

S. No.	Predisposing	*Total cases*	Infected cases
1.	Anaemia < 9 gm%, malnutrition	50	25
2.	Diabetes mellitus	17	8
3.	Gastric and colorectal malignancies	37	9

7. Antibiotic prophylaxis

Infection rate was less in patients who had undergone elective surgery and had received appropriate antibiotic prophylaxis when compared to patients who had not received prophylactic antibiotics.

Table 9.

S. No.	Antibiotic prophylaxis	*Total cases*	Infected cases	Percentage (%)
1.	Cases given prophylatic antibiotics	120	6	5
2.	Cases not given prophylactic antibiotics	120	14	11.6

Minor criteria

1. Age distribution

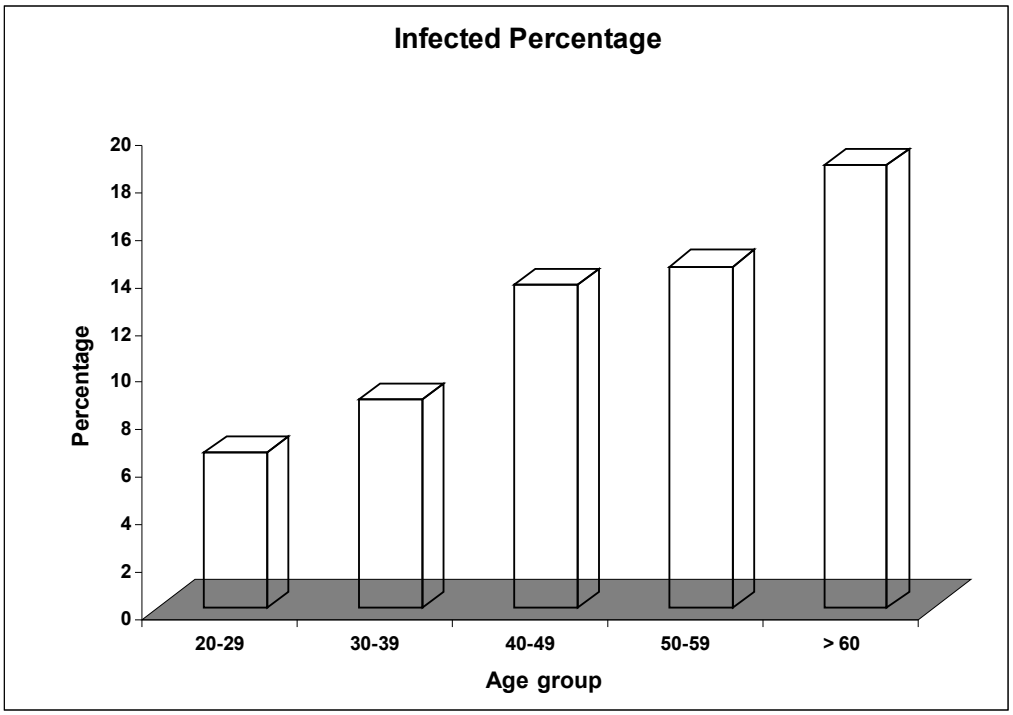
Incidence of wound infection was little higher in older people.

6.5% in 2nd decade

15.6% in 6th decade

Table 10.

S. No.	Age group	*Total cases*	Infected cases	Percentage (%)
1.	20 - 29	92	6	6.5
2.	30 - 39	90	8	8.8
3.	40 - 49	81	11	13.6
4.	50 - 59	104	15	14.4
5.	> 60	48	9	18.7



2. Sex distribution

No significant influence of sex in the incidence of wound infection.

Table 11.

S. No.	Sex	*Total cases*	Infected cases	Percentage (%)
1.	Male	253	29	11.4
2.	Female	162	20	12.3

3. Seasonal variation

Very minimal increase in the incidence of Postoperative infection was observed in winter.

4. Pre operative hair removal

Only elective cases were taken into account.

Table 12.

S. No.	Timing of hair removal	*Total cases*	Infected cases	Percentage (%)
1.	1 hour before surgery	100	4	4
2.	1 day before surgery	140	16	11.4

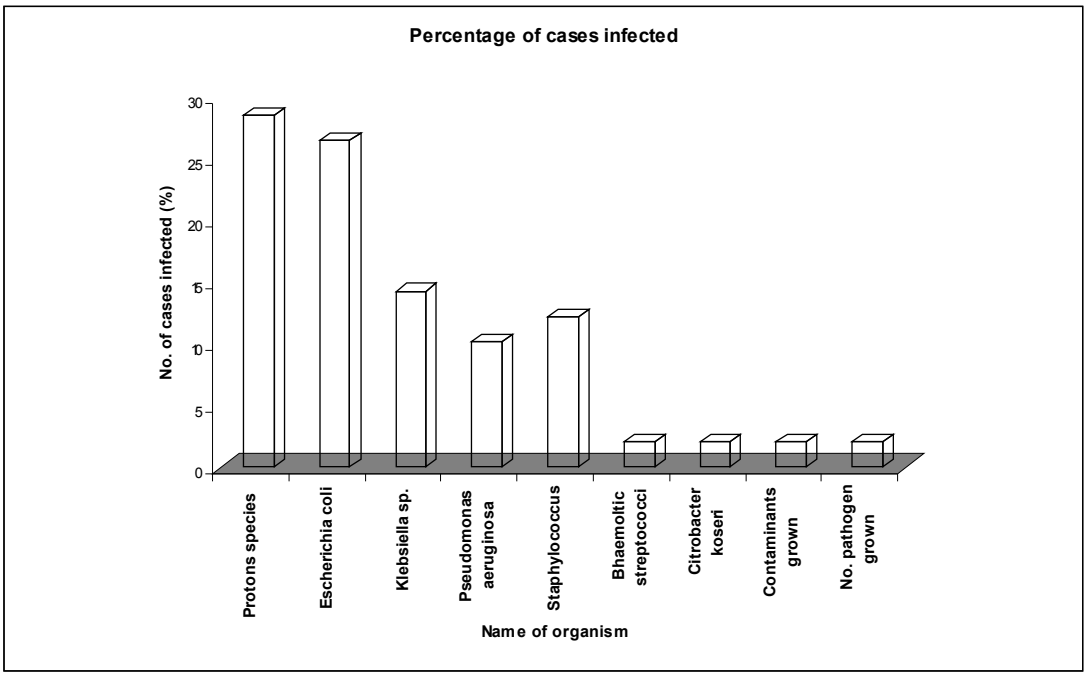
Significant increase in incidence was observed when local preparation was done one day before the timing of surgery.

Bacteriological surveillance

Among 49 cases of wound infection, gram negative bacilli were very often responsible for post operative wound infection than gram positive organisms.

Table 13.

S. No.	Name of the organism	Infected cases	Percentage of cases infected
1.	Proteus species	14	28.5
2.	***Escherichia coli***	13	26.5
3.	*Klebsiella* sp.	7	14.28
4.	***Pseudomonas aeruginosa***	5	10.2
5.	***Staphylococcus***	6	12.2
6.	***Bhaemoltic streptococci***	1	2.04
7.	***Citrobacter koseri***	1	2.04
8.	Contaminants grown	1	2.04
9.	No. pathogen grown	1	2.04



Antibiotic sensitivity

The following antibiotics were tested for sensitivity when culture was proven to be positive. The sensitivity pattern was as follows,

Name of the organisms	Amikacin	Ciprofloxacin	Gentamycin	Cefotaxime	Amoxycillin	Norfloxacin	Streptomycin	Ampicillin	Cephalexin	Vancomycin
Proteus	+	+		+	+					
Escherichia coli	+	+	+			+		+	+	
Klebsiella	+	+	+		+	+				
Pseudomonas	+	+	+							
Staphylococci	+		+	+						
Betahaemolytic streptococci				+	+				+	+
Citrobacter koseri					+		+			

In this study most of the organisms were sensitive to Amikacin, Ciprofloxacin and Gentamycin in descending order of frequency.

Discussion

The incidence of post operative infection (surgical site infection) as studied by various authors are given below

S. No.	Name of the authors	Year of study	Percentage
1.	Agarwall *et al.*	1972	20
2.	Subramian *et al.*	1973	23
3.	Rao *et al.*	1975	25
4.	Doig *et al.*	1976	28
5.	T.V Taylor *et al.*	1984	26
6.	M.A. Khan *et al.*	1985	20.2
7.	Donald *et al.*	1985	10.2
8.	Butalari *et al.*	1996	12.4
9.	Jeffrey. R. Horwitz *et al.*	1998	4.4
10.	Targarone *et al.*	2000	1.2
11.	Phillip S. Brachman *et al.*	2001	2.4
12.	Present study	2005	11.8

The surgical site infection was almost double in case of emergency surgeries (16.5%) when compared to elective surgeries (8.3%). The high rate in emergency cases may be attributed to the delay in patient reaching our hospital, treated elsewhere and most cases brought to our hospital with established peritonitis and few of them with pre renal uremia.

In the study conducted by Phillip S. Brachman wound infection rate of 2.1%, when the pre operative hospital stay was within 1 week and about 3.4 when the preoperative hospitalization exceeds 2 weeks. In our study the corresponding rates were 6.6% and 14.2% respectively.

There is a steady increase in rate of infection as the order of surgery progresses. First round surgery infection rate in 4.16%, almost 4 times it is increased in third round surgery i.e. 16.2%. Adequate number of instruments are needed to minimize the need for the rapid steam sterilization of dropped or contaminated instruments during the procedure, prevent reuse of the instruments in later rounds of surgery.

Cruse P.J.E. and Floord (1980) studied the relationship between rate of infection and duration of the procedure. It was 1.3% for surgeries lasting one hour or less and 4.0% for those lasting 3 hours or more. In our study the rate of infection, 5.4% when procedure lasted one hour or less and 9.37% when procedure lasted for more than 3 hours.

Rajeev M. Joshi, Mehta N.N. *et al.* (2002) studied the efficacy of Netilmycin and ceftriaxone as prophylactic antibiotics and showed a success rate of 98.71% in clean contaminated and 84.04% in contaminated cases with infection rate of 1.29% and 15.96% respectively. In our study injection cefataxime sodium 1 gram intravenously along with injection metronidazole 500 mg intravenously was used. Out of 240 elective cases studied, 120 cases were given prophylactic antibiotics the infection rate is 5%, 120 cases were not given prophylactic antibiotics infection rate in 11.6%.

Our study was aimed to standardize the use of prophylactic antimicrobial agents in association with surgical procedures and thus to reduce the incidence of wound infections and minimize the expenses and adverse reactions attributable to over use of

antibiotics (favouring the emergence of antimicrobial resistance). The agent is chosen in such a way that it is effective against the pathogen most often recovered form infections occurring after that specific procedure and against the endogenous flora of the region of the body being operated upon.

Butalari, A., Ferri, M. *et al.* (1996) studied the probability of operative mortality and morbidity in a large number of patients over 80 years of age. Post-operative mortality and morbidity rate were 10.1 and 32.2 percent respectively which was higher when compared with mortality and morbidity rate in younger patients which was 1.2 and 12.4 percent respectively. In our study cases infected in age group of 20-29 and >60 yrs is 6.5% and 18.7 percent respectively.

Weigelt J.A., Dryer, D. *et al.* (1992) confirmed the necessity for wound surveillance after discharge and found that 35% of all surgical infections occurred after discharge and that approximately 22% of all wound infections would have been missed if surveillance period not extended beyond 14 days. In our study out of 415 cases studied about 42 cases failed to come for follow up after discharge which could mean a minimal increase in rate of infections than the present figure of 11.8%.

The Surgical Wound Infection Task Force in the United Nations published series of guidelines for wound surveillance in 1992. The following are some of the recommendations

1. The definitions of the Centers for Disease Control and Prevention (CDC) regarding wound infection should be adopted without modifications.

2. Either direct observational or traditional infection control surveillance techniques are acceptable for case finding of wound infection.
3. Surgeon-specific wound infection rates should be calculated and reported to individual surgeons and chairman of surgery. The report should be kept coded and confidential and stratified by risk.
4. Studies are needed to determine whether wound infections following outpatient and minor surgical procedures have similar importance to infections that develop after inpatient procedures.
5. Surgical procedures should be classified according to surgical wound class and a measure of patient susceptibility to infection, such as ASA score or duration of operation.
6. The surgical wound class criteria need to be more accurately defined and standardized and
7. Post-discharge surveillance for wound infection is important and should be done. Santos *et al.* in a 6 month prospective surveillance reported that the majority (52.7%) of surgical infections were apparent only after patients have been discharged from hospital.

Bacteriological surveillance

In our study among 49 cases of wound infection gram negative organisms were most often responsible for wound infection than gram positive organisms.

Proteus species were most frequently isolated. Next in order are *E. coli, Klebsiella*, *Pseudomonas* and then comes *Staphylococcus* and *Beta haemolytic streptococci.*

Changing flora

Since 1975 significant change in type of infection noted.

- Increased incidence of gram negative infection.
- Superimposed and secondary infection developing during antibiotic therapy.
- Fungal and viral infections occurring more so in immuno compromised individuals.
- Emergence of multiple antibiotic resistant strains due to unethical use of antibiotics.
- Increased incidence of infection by organisms formerly recognised having little no virulence.
- Growing awareness of anerobic infection and mixed/synergistic infection

Complications

With out a note on complications no study is complete.

All the 49 cases had wound gaping (superficial or deep). Out of 49 cases 25% healed by secondary intention, other patients needed resuturing.

Burst abdomen resulted in two cases, one case of advanced carcinoma of stomach for which palliative anterior gastrojejunostomy with jejunojejunostomy was

done. Another case of obstructive jaundice-*Periampullary carcinoma* where triple anastomosis was attempted.

Enterocutaneous fistula developed in 2 cases, one case of mesenteric vascular occlusion where extensive resection of small bowel with end to end anastomosis done. Another case of sigmoid volvulus where primary resection and anastomosis attempted.

Incisional hernia developed in 3 patients one in the Mc Burney's incision through which an appendicular abscess was drained, another in the upper midline scar where a gastric perforation closure done, another case of enteric ileal perforation brought in a state of a advanced peritonitis and shock opened through mid midline incision.

This topic is chosen for study since surgical site infection (SSI's) are the second most common cause of nosocomial infections. Upto 2%-5% of patients undergoing clean extra abdominal operations and upto 20% undergoing intra abdominal operations will develop surgical site infection. Patients who develop surgical site infection are upto 60% more likely to spend time in an intensive care unit, 5 times more likely to be readmitted to the hospital and 2 times more likely to die than are patients without surgical site infection. Health care costs are substantially increased for patients who develop SSI's. (Dale W. Bratzler Peter M. Houck *et al.,* 2004).

Conclusion

Incidence of surgical site infection (Post-operative infection) in our study is 11.8 percent. Scoring system based on various risk factors (7 major criterias and 4 minor criterias) carried out in our study and it is found that the incidence of wound infection more when score is high. This scoring system is also valuable in assessing the severity of post-operative wound infection.

In this study among 49 infected cases, proteus species were most commonly isolated. Next in order are *E. coli, Klebsiella, Pseudomonas* and then comes *Staphylococcus* and *Beta hemolytic streptococci*. Shift from gram positive to gram negative organisms due to liberal use of antibiotics.

In this study most of the organisms were sensitive to Amikacin, ciprofloxacin and gentamycin in descending order of frequency.

Wound gaping, burst abdomen, enterocutaneous fistula, incisional hernia were observed as post operative complications due to wound infection.

The best way to decrease wound infection is by rigorous surveillance and reporting of wound infection rate.

Surgical site infection (SSI) continues to be the most common complication following surgical procedures. This infections are the biological summation of several factors the innoculam of bacteria introduced into the wound during the procedure, the unique virulence of contaminants, the microenvironment of each wound and the integrity of the patients host defense mechanisms.

Prevention of surgical site infection can be achieved by several methods. The viable innoculam of bacteria in the wound can be reduced via better preoperative preparation of the surgical site, sound infection-control practice while performing operations and adherence to principles of preventive antibiotic therapy, modified surgical technique can reduce the risk of hematoma, tissue injury and foreign bodies within the surgical site that amplify the risk of infection for a given level of innoculam. Enchanced oxygen delivery, better core body temperature control and rigorous blood glucose control in the surgical patients are new areas that have the potential to even further reduce the rate of surgical site infection.

Although surgical site infections cannot be completely eliminated a reduction in the infection rate to a minimal level could have significant benefits by reducing post operative morbidity and mortality and wastage of health care resources.

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proforma

A. General particulars

Name : Age : Sex : IP No:
(or)
Hospital No:

Address :

Date of admission :

Date of surgery :

Date of discharge :

B. Pre-operative status of the patient

1. Preoperative hospitalisation

Date From : To :

2. Nutrient status

a. Normal nutrition
b. Mild malnutrition
c. Moderate malnutrition
d. Severe malnutrition

3. Haemoglobin

a. Normal 10-12 gm%
b. Moderate anaemia 8-10 gm%
c. Severe anaemia less than 8 gm%

4. Presence of systemic infection

5. Diabetes

6. Drugs administered Antibiotics

Steriods

7. Investigations performed (Relavant/predisposing)

Noninvasive Invasive

C. Operative particulars

1. Type of surgery performed
2. Surgeon : experienced surgeon / PG student
3. Duration of surgery
4. Skin preparation and solution used
5. Site of incision
6. Types and number of drains used
7. Condition of the skin
8. Usage of intra operative antibiotics

D. Post-operative assessment

1. Type and frequency of dressings
2. Post-operative antibiotics course and duration
3. Post-operative infection (complications)

a. Uncomplicated and no wound infection
b. Septicaemia
c. Respiratory tract infection
d. Urinary tract infection
e. Shock
f. Gas gangrene
g. Others

E. Nature of wound infection

a. Stitch abscess
b. Mild infection
c. Moderate infection
d. Severe infection

F. Bacteriology of infected wound

a. Type of bacteria identified
b. Sensitivity to antibiotics
c. Response to antibiotics
d. Outcome of the wound