"STUDY ON SURGICAL SITE INFECTIONS IN ELECTIVE ABDOMINAL SURGERIES"

Dissertation submitted to

THE TAMILNADUDr.M.G.R. MEDICAL UNIVERSITY

CHENNAI – 600 032

With partial fulfillment of the regulations

For the award of the degree of

M.S. GENERAL SURGERY

BRANCH – I

COIMBATORE MEDICAL COLLEGE

COIMBATORE

APRIL 2015

Certificate

CERTIFICATE

This is to certify that the dissertation **"STUDY ON SURGICAL SITE INFECTIONS IN ELECTIVE ABDOMINAL SURGERIES"** is a bonafide research work done by **Dr.N.Priya,** Post Graduate in M.S. General Surgery under my direct guidance and supervision to my satisfaction, in partial fulfillment of the requirements for the degree of M.S. General Surgery.

Date: **Professor & Unit chief S3**

Date: **Professor & Head Of The Department**
Department of General Surgery

Date: **The Dean Coimbatore medical college**

Coimbatore Medical College

COIMBATORE, TAMILNADU, INDIA - 641 014

(Affiliated to The Tamilnadu Dr. MGR Medical University, Chennai)

ETHICS COMMITTEE

CERTIFICATE

Name of the Candidate : N. PRIYA

Course : M.S GENERAL SURGERY.

Period of Study : 2012 - 2015

College : COIMBATORE MEDICAL COLLEGE

Dissertation Topic : STUDY ON SURGICAL SITE INFECTIONS IN ELECTIVE ABDOMINAL SURGERIES.

The Ethics Committee, Coimbatore Medical College has decided to inform that your Dissertation Proposal is accepted / ~~Not accepted~~ and you are permitted / ~~Not permitted~~ to proceed with the above Study.

DEAN
Coimbatore Medical College & Hospital,
Coimbatore

Declaration

DECLARATION

I hereby declare that this dissertation entitled **"STUDY ON SURGICAL SITE INFECTIONS IN ELECTIVE ABDOMINAL SURGERIES"** is a Bonafide and Genuine Research Work carried out by me under the Guidance of Prof. Dr.D.N.Renganathan M.S., Department of General Surgery, Coimbatore Medical College, Coimbatore .

Date:

Place: **Dr.N.Priya**

Acknowledgement

ACKNOWLEDGEMENT

With great reverence, first of all, I would like to express my deep sense of gratitude to my guide and teacher, **Dr.D.N.Renganathan M.S.,** Professor of Surgery, Coimbatore Medical College, Coimbatore. He has been more than a guide, a good mentor and a source of constant inspiration throughout my course. I also thank him for his able guidance, suggestion and supervision throughout the making of this dissertation.

I would consider it my privilege to extend my respect and gratitude to **Dr.V.Elango M.S.,** Professor and Head of the Department of Surgery, Coimbatore Medical College, Coimbatore, for all the encouragement and guidance throughout the course and for this dissertation.

I also take this opportunity to thank **Prof.Dr.P.Swaminathan, Prof.Dr.S.Natarajan, Prof.Dr.G.Ravindran, Prof.Dr.Saradha** for their moral support and guidance.

I also sincerely express my thanks to my Assistant Professors **Dr.V.S.Venkadesan** and **Dr.R.Radhika** for their support and guidance throughout the course of this study.

I would also like to express my thanks to THE DEAN, Professor **Dr.REVWATHY M.D., D.G.O.** for her able guidance and encouragement throughout, I am also thankful to the administration and other allied departments of the Coimbatore Medical College for their support in helping me carrying out this study.

I also express my heartfelt sincere thanks to all my fellow postgraduates, for their unconditional support and guidance, and for just being there. No words can express the support extended by my family in all these years; thank you.

My biggest gratitude will always be towards my patients, without whose cooperation this study would have been incomplete. I thank the Almighty for his abundant blessings.

Date:

Place: **Dr.N.Priya**

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	221211306.ms General Surgery PRI...
Assignment title:	TNMGRMU EXAMINATIONS
Submission title:	STUDY ON SURGICAL SITE INFEC...
File name:	REVIEW_OF_LITERATURE_correcte...
File size:	2.95M
Page count:	102
Word count:	11,752
Character count:	65,466
Submission date:	06-Oct-2014 01:56PM
Submission ID:	450325960

"STUDY ON SURGICAL SITE INFECTIONS IN ELECTIVE ABDOMINAL SURGERIES "

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI - 600 032

Partial fulfillment of the regulations

For the award of the degree of

M.S. GENERAL SURGERY

BRANCH – I

COIMBATORE MEDICAL COLLEGE

COIMBATORE

APRIL 2010

List of Abbreviations

ABBREVIATIONS

SSI	→	Surgical Site Infection
PDGF	→	Platelet Derived Growth Factor
TGF	→	Transforming Growth Factor
IGF	→	Insulin like Growth Factor
vWF	→	von Willibrand Factor
ECM	→	Extra Cellular Matrix
CDC	→	Center for Disease Control and prevention
NNIS	→	National Nosocomial Infection Surveillance
SENIC	→	Study on Efficacy of Nosocomial Infection Control
EPA	→	Environmental Protection Agency
HAI	→	Hospital Acquired Infection
S. aureus	→	Staphylococcus aureus
AIDS	→	Acquired ImmunoDefieciency Syndrome
UTI	→	Urinary Tract Infection
ASA	→	American Society of Anaesthesiologists
B.C.	→	Before Christ

Abstract

ABSTRACT

Title: study on surgical site infections in elective abdominal surgeries.

Introduction: Following surgeries, surgical site infections (SSIs) still remaina significant problem.

Objectives: To study the incidence of SSIs in patients undergoing elective abdominal surgeries.To study about the risk factors associated with SSIs. To find out common organisms causing SSIs.

Materials and methods: A prospective study was carried out in 100 patients underwent elective abdominal surgeries in Coimbatore medical college hospital. Samples from infected wound are collected under aseptic precautions and sent for microbiological analysis.

Results and Conclusion: The overall incidence of SSI was found to be 16%. The incidence increases with increasing age. It also shows significant increase in incidence in patients with increased pre operative hospitalization. Obesity and systemic illnesses increases the rate of SSIs. If the duration of surgery is prolonged then it would be associated with increased incidence of SSIs. The use of drain also increases the rate of wound infection.

Contents

TABLE OF CONTENTS

List of Tables

LIST OF TABLES

List of figures

LIST OF FIGURES

Introduction

INTRODUCTION

Surgical site infections (SSIs) are associated with any surgical procedure and represent a significant burden in terms of patient morbidity, inconvenience to surgeon and extended hospital stay.SSIs have been shown to compose upto 20% of all healthcare associated infections and constitute significant burden to healthcare services. Atleast 5% of patients undergoing surgical procedures develop SSIs. SSIs may range from spontaneous limited wound discharge to life threatening complications.

Most SSIs are caused by contamination of an incision with microorganisms from patient's own body during surgery than from outside. Majority of SSIs are preventable. The study of organisms causing SSIs are used for selecting appropriate antibiotic prophylaxis.

Surgical site infections can be divided into major and minor surgical site infections. A major SSI is defined as a wound with significant quantity of pus draining spontaneously or it needs a secondary procedure to drain it. Thepatient may have systemic signs like pyrexia tachycardia and raised white blood cell count.

Minor wound infections may discharge pus or infective serous fluid which should not be associated with excessive discomfort, systemic signs or delay in returning home. The differentiation between major and minor wound infections are important in audit and trials of antibiotic prophylaxis. Localized wound infections are either abscesses or cellulitis and lymphangitis. Abscesses need drainage.[1]

Figure:1 Minor wound infection that settles spontaneously

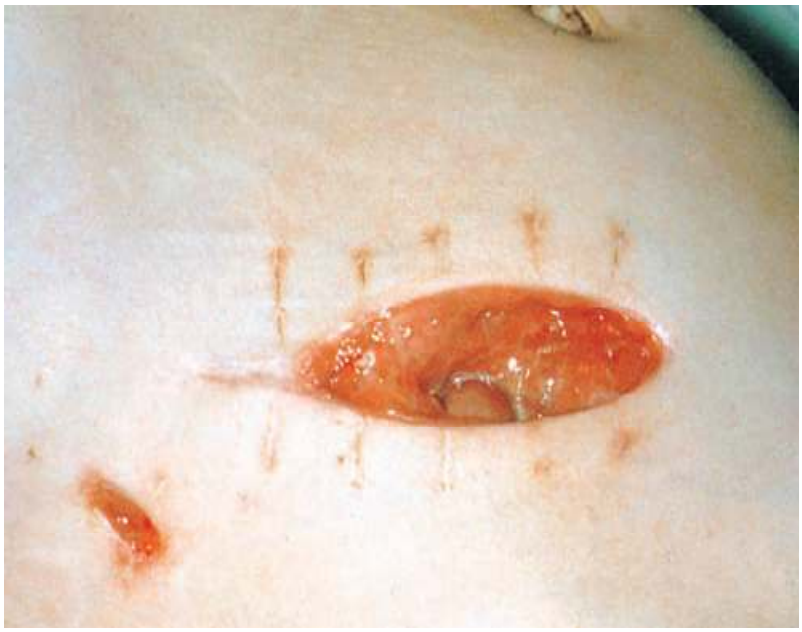


Figure: 2 Major wound infection with superficial skin dehiscence

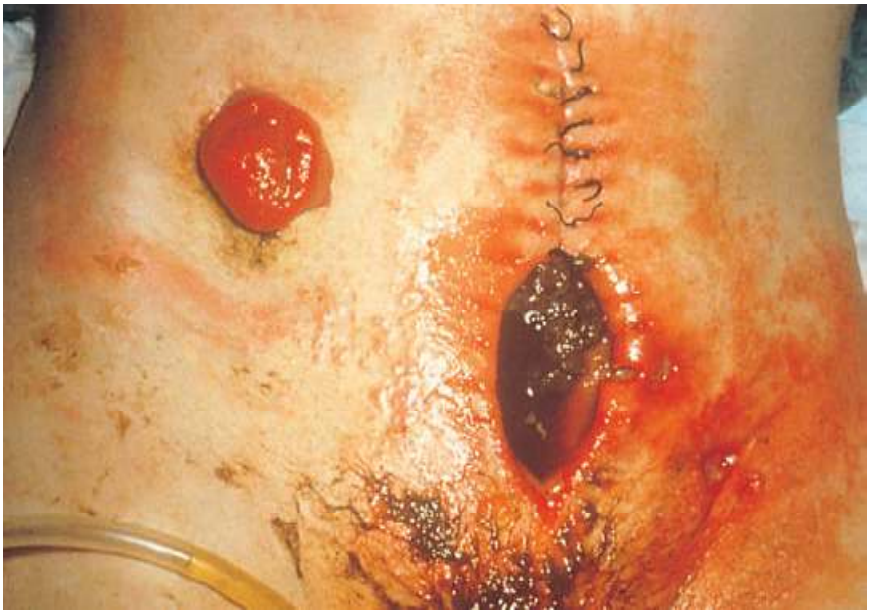


Figure : 3 Major wound infection with faecal fistula

Modern imaging techniques may be used for guided drainage. Antibiotics are indicated if the abscess is not localized or the cavity is not left open to drain freely. Healing by secondary intention is encouraged.

Wound infections are characterized by breach in mechanical or anatomical barriers.[2]Though the management of infection becomes an integral part of surgeon's practice, the present knowledge about surgical site infections gains its credit from germ theory and antisepsis. The development of preventive modalities in this field has occurred only in the last few decades.

Aim

AIM

To study the incidence, risk factors and causative organisms causing surgical site infections in patients undergoing elective abdominal surgeries in the Department of General Surgery from October 2013 to September 2014 in Coimbatore Medical College Hospital.

Review of literature

REVIEW OF LITERATURE

Historical aspect

The ancient Egyptians were the first civilization in treating the physical ailments by trained physicians. Detailed information in management of diseases including wound care using various potions and grease described by Edwin smith papyrus and Eber papyrus.[2,3]

Nineteenth century physicians and investigators gained the creditofput forth guidelines for prevention and treatment of SSIs by their extensive studies in gaining knowledge about pathogenesis of wound infections. A Magyar physician, Ignar Semmelveis in 1846, noticed that the mortality due to puerperal sepsis was found to be higher in teaching ward compared to that in deliveries conducted by midwives.

He then hypothesized that puerperal sepsis was caused by the organisms acquired from autopsy room by physicians and medical students who spread the infection. The reduced mortality rate in those deliveries conducted by midwives is because they didn't participate in autopsies. Then he posted a notice on the door for the caregivers to cleanse their hands in chlorine water before entering into delivery room. This simple intervention reduced the puerperal mortality significantly.

Based on his practice he published his classic work on puerperal sepsis in 1861.

The father of medicine Hippocrates (Greek physician and surgeon, 460-377 BC) who used vinegar for irrigating open wounds and cover the dressings around wounds to prevent injury.

Galen (Roman surgeon) was the first to recognize that pus from wounds interfere in wound healing. The concept of wound healing was a mystery for a long. " I dressed the wound. God healed it.", the famous saying by a French military surgeon 1510-1590.[4]

During war times wound infections are more evident. Erysipelas and tetanus were the major cause of death during AmericanCivil War. Infected compound fractures lead to most of lower limb amputations and subsequent stump infections.

Louis Pasteur proposed the 'germ theory during the end of nineteenth century that provided the basic concepts for modern microbiology. He elucidated the principle that contagious diseases are caused by specific microbes. This principle is used in sterilization techniques and also useful in identifying the organisms causing human illnesses.

The first intraabdominal surgery for treating infection by the concept of 'source control' was appendectomy. This new intervention of eliminating the source of infection was first initiated by Mc Burney at New York college of physicians and surgeons. This concept was first presented in 1889 before the NewYork Surgical Society.

The era of using effective antimicrobials started in twentieth century. Sir Alexander Fleming started his work in innateantibacterial effect of blood and antiseptics. While studying influenza virus, he noted the zone of inhibition around a mould colony (Penicillium notatum) from which penicillin was derived which is the first antimicrobial agent. This leads to production of countless effective antimicrobials which are used in our day to day practice. These antimicrobials are used in prophylaxis and treatment of lethal surgical infections.

Clinically penicillin was first used by Howard Flory in 1940. The new era of wound infection management commenced with the use of antibiotics. Because of emergence of drug resistant strains eradication of infective plagues in surgical wounds became a failure.

Subsequently, by clinical observations made by Frank Meleney and William Altiemier showed that serious soft tissue and intra abdominal infections are caused by the synergistic actions of aerobes and anaerobes.

Berlin hygiene and microbiology professor Robert Koch was the first to recognize the cause of infective foci secondary to microbacterial growth. He cultured Bacillus anthraces by his new techniques and he also proved the capability of this organism to cause anthrax in healthy animals. He postulated the association of organisms with the specific diseases as follows:

TABLE :1 KOCH'S POSTULATES

Koch's postulates proving the agency of infection:

- Must be found in considerable numbers in the septic focus
- Should be possible to culture it in a pure form from that septic focus
- Should be able to produce similar lesions when injected into another host[1,2]

Semmelweis, an Austrian obstetrician demonstrated that hand washing between postmortem examinations and conducting delivary reduces infection rate to about 5 fold.

Lister demonstrated that use of antiseptics prevent infection. He used carbolic acid solution for sterilizingthe wound openfractures so that he could decrease the need for amputation. He used carbolic acid even for sterilizing operation theatre. A Belgian military surgeon Antoine Depage

introduced the concept of wound debridement and secondary suturing relied on microbiological assessment of wound brushings.[5]

Even till the end of nineteenth century surgeries were not done under strict asepsis as a routine. During 1880s there comes the sterilization of instruments, use of gowns, masks and gloves. The use of rubber gloves which was originally gains its importance in preventing skin irritation due to chemicals used to sterilize instruments is first introduced by Halsted. Use of gloves as a routine was suggested by Halsted's student J.Bloodgood.

Incidence of SSIs:

The earliest incidence of sepsis was reported by Theodor Kocher (1889),sepsis rate of 2.3% . In the pre antibiotic era, reported sepsis rate was 4.8 – 5 %. There was a fall in the incidence of SSIs after introduction of antibiotics.

In 1945, Devenish and Miles reported an infection rate of 8.4%. However, even with the use of antibiotics the infection rate had gone up from 1.09% in 1949 to 3.9% in 1953 and 5.3% in 1955. In 1956, he had reported fall in the rate of penicillin resistant staphylococci, after the institution of a simple judicious program of preventingcontamination and

use of antibiotics.[6] Clarke in 1957, Reported a sepsis rate of 13.6% which leads to mean extra stay in hospital was found to be 8.1 days.[7]

The National Research Council in 1964, during 2½ year collaborative study of 15,613 consecutive operative procedures done in five American University Centres with the support of United States of Public Health Service , designated the operative wounds as clean, clean contaminated, Contaminated and dirty wounds. In 11,690 clean elective operations in this series, the average wound infection rate was 5.1% and the overall incidence rate in all types of wounds was 7.4%.

Following Hernioplasty the incidence rate was 19%, 10% for partial colectomy, 6.9% for cholecystectomy and 6.1% for hystrectomy.[6]It became apparent that the incidence of wound infection varies with the type of infection.

Cruse and Foord studied the association of risk factors like age, sex, type of operation, pre operative hospital stay, wound drainage and special factors like diabetes.[8]

In a study by Mary Olson et al (1990) the overall wound infection rate for a total of 1032 wound infections out of 40,915 wounds, at the Minneapolis VA Medical Center during the study period of 1977-1986

was 4.2% in the first year and was significantly lower in subsequent years ,being 2.5% in 1986.[9]

Anvikar et al, from Agra government medical college in 1999 reported the incidence rate of 6.09%.[10]Hernandez K et al, from Peru conducted a cohort study from January to June 1998. 125 patients developed SSIs out of 468 patients, among them 18% were identified after discharge. The overall incidence rate was 26.7%. The infection rate for clean wound was 13.9%, for clean contaminated wound was 15.9%, and 47.2% for dirty wounds.[11]

Inigo JJ et al conducted a five year study and analyse according to National Nosocomial Infection Surveillance (NNIS) index, there were 513 patients developed SSI out of 6218 patients (8.25%). The infection rate for clean surgery was 2.27%, for clean contaminated surgery was 9.17% and for dirty surgeries it was 19.14%.[12]

MAGNITUDE OF PROBLEM:

Of the estimated 2million nosocomial infections, Surgical Site Infections (SSI) account for about 14 – 16 % affecting inpatients in the United States.[13] The incidence of SSIs arevery tough to monitor because of lack of standardization of using standard guidelines and diagnostic criteria.

WHO survey reveals the prevalence of nosocomial infections varying from 3-21% in which wound infections account for 5-34%.[14]Collected data probably underestimate the real picture because of most infections occur after discharging the patient which is treated in the community without hospital notification.

MORTALITY AND MORBIDITY:

Surgical site infections associated with increased morbidity and also the mortality. Medical costs and financial burden to the country shows the importance of knowing it to the root level. Some studies proved that SSIs can be considered as a hospital quality measurement.

DEFINITION:

Defining SSI exactly is found to be difficult because of wide spectrum of clinical features. SSIs range from simple wound discharge to life threatening complications secondary to sepsis. SSIs are most common nosocomial infection in surgical patients.

Following major abdominal surgeries infectious complications are difficult to treat. Because of using modern prophylactic measures the incidence of getting SSIs becoming comparatively less.

In elective abdominal surgeries the rate of postoperative wound infections range from 2% to 26% which is even higher in emergency surgeries. SSIs not only increase the length of hospital stay but also morbidity and mortality. Hence preventive measures should be included in surgical decision making in all elective abdominal surgeries. This preventive measure starts with identification of patients with high risk for SSIs.

The possible outcomes that can occur following a microbial invasionare as follows:

1. Eradication
2. Containment
3. Locoregional infection
4. Systemic infection

The manifestation of systemic infection indicates that there is failed host defenses at the local level. This results in significant morbidity and mortality. It is not uncommon that locoregional infection may progress and may lead to concurrent systemic infection.

For every patient standard basic rules should be followed according to Centres for Disease Control (**CDC)** and Prevention to minimize the incidence of SSIs. Important risk factor in developing **SSI**s is the presence of bacterial colony count at surgical site. The threshold of which is 10^4counts/gm of tissue.

Good surgical technique to minimize tissue trauma and avoiding excessive use of sutures reduce wound infection. Other risk factors to be considered are age, malnutrition, obesity, duration of surgery, smoking, presence of remote site infection and use of surgical drains.

Surgical wound infections constitute about more than 77% of deaths of surgical patients. According to Kirkland et al (1999) relative risk of 2.2 is attributable to wound infections when compared to matched surgical patients without infection.

SSI has been defined by the centre for disease control and prevention (CDC) to standardize data collection for the National Nosocomial Infections Surveillance (NNIS) program (CDC,1996).[12,13]SSIs are classified into incisional SSIs, which may be superficial or deep, or organ / space SSIs , which affect the rest of the body other than body layers.

- **Superficial incisional SSIs:** Infection only involves the skin and subcutaneous layers of the incision.
- **Deep incisional SSIs:** Infection involves deeper tissues such as fascial and muscle layers. This includes infection involving both superficial and deep incisional SSIs and organ space SSIs draining through incision.

- **Organ / space SSI:** Infection involving any part of the anatomy in organs or spaces other thanthe incision , which was opened or manipulated during surgery.

Criteria for Diagnosis:[17,18]

NNIS program defines SSIs as follows:[19]

Superficial Incisional SSIs:

- Infection occurring at the site of incision within 30 days of postoperative period.
- Only skin and subcutaneous tissues involved
- Any one of the following findings:
    i. Purulent discharge
    ii. Organism cultured from the discharge or tissue
    iii. Pain, tenderness, redness, localised swelling or heat
- Diagnosed by surgeon or treating physician

Deep Incisional SSIs:

- Infection occurring at operative site
    a. Within 30 days after surgery without implant
    b. Uptoone year after surgery if any implant is left in place

- Infection seems to be related to surgery
- Infection involving deep tissues especially soft tissues
- Any one of the following:
    i. Pus discharge from deeper part of incision site
    ii. Wound dehisces or opened by surgeon if patient is febrile and / or pain which is localized and / or tenderness
    iii. Abscess or other evidence of infection involving deep incision observed clinically or radiologically
    iv. Diagnosed as deep incisional infection by surgeon or treating physician

Organ / Space SSI criteria:

- Infection occurs
    i. Less than 30 days after surgery without implant
    ii. Within one year after surgery ifsuppose implant is left in place
    iii. Infection appears to be in relation to surgery
    iv. Infection involving any part of anatomy other than the incision opened or manipulated during operative procedureAtleast one of the following

1. Pus discharge from the drain site that is fixed by a stab wound into the organ/ space.
2. Micro organisms cultured from the fluid or culture obtained in aseptic manner from the organ space

- Any evidence of infection in the form of abscess or by someother means involving organ / space diagnosed clinically or radiologically
- Diagnosis by surgeon or treating physician

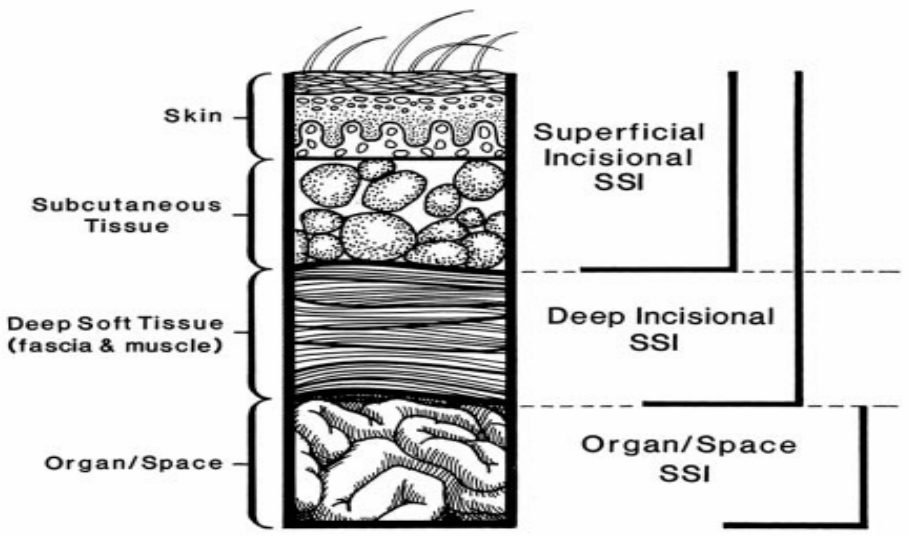


Figure: 4 Types of SSIs

PHYSIOLOGY:

Micro organisms are normally prevented from causing infection in tissues by intact epithelial surfaces. The epithelial surfaces are either broken down by trauma or surgery. Along with these mechanical barriers there are other protective mechanisms which can be divided into

1. Chemicals like low gastric pH
2. Humoral :antibodies, complement and opsonins
3. Cellular : phagocytic cells, macrophages, polymorphonuclear cells and killer lymphocytes

   These natural mechanisms may be compromised by surgical intervention and treatment.

CAUSES OF REDUCED HOST RESISTENCE TO INFECTION:

- Metabolic: malnutrition which includes obesity, diabetes, uremia
- Disseminated disease: cancer and AIDS
- Iatrogenic : radiotheraphy, chemotheraphy and steroids

When enteral feeding is suspended during perioperative period particularly in patients with underlying diseasesbacteria tend to colonise in the gastrointestinal tract and makes it susceptible to the development of wound infection.

The following figure illustrates the healing response mechanism:

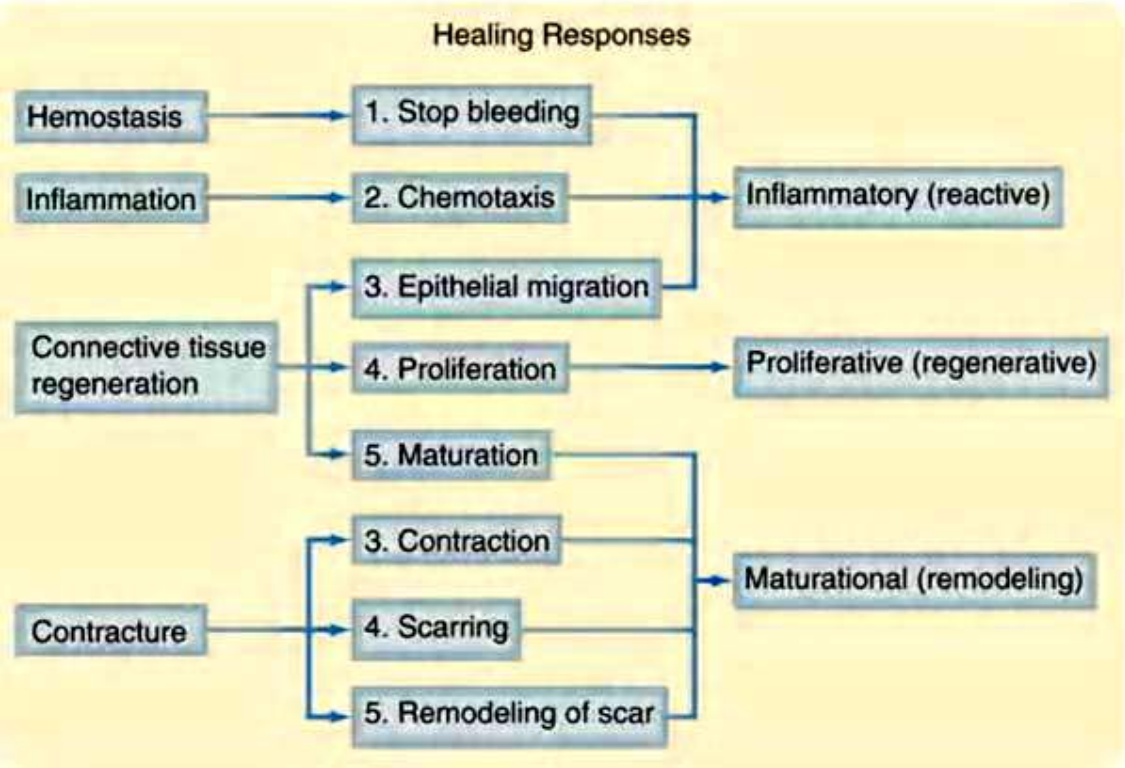


Figure: 5 Healing response

INFLAMMATORY PHASE:

The inflammatory phase is characterized by

- Increased permeability of blood vessels
- Chemotaxis by which cells migrate to the site of inflammation,

Cytokines and growth factors are secreted into the wound. They may translocate to mesenteric nodes and release endotoxins which leads to systemic inflammatory response by means of excessive release of proinflammatory cytokines and macrophages activation.

If the host resistance to infection is reduced microorganisms which are commensals may behave as pathogens. This is known as opportunistic infection.

The chance of developing an SSI after surgery can also be determined by pathogenicity of the organisms present and size of bacterial inoculum. The presence of devitalized tissues, excessive dead space or hematoma resulting from poor surgical techniques may also increase the chance of acquiring SSI's.

Foreign body materials including sutures and drains may also increase the probability of getting infection.

RISK FACTORS FOR INCREASED RISK OF WOUND INFECTION:

- Malnutrition → obesity, weight loss
- Metabolic diseases → diabetes, jaundice, uremia
- Immunosuppression → chemotherapy, radiotherapy, steroids, cancer
- Colonization and translocation of bacteria in the gastrointestinal tract.
- Presence of foreign body
- Poor surgical technique

The acute inflammatory, humoral and cellular defences require 4 hours to be mobilized. This is called as ‘ decisive period ‘ during which the invading bacteria reach the tissues. It is therefore logical to give prophylactic antibiotic at this time to prevent infection from developing. The tissue level of antibiotics should be above the minimum inhibitory concentration (**MIC$_{90}$**).

MICROBIOLOGY :

It is necessary to have microbial inoculums in a susceptible host for establishing wound infection.wound infection may be caused by various factors which include pre operative hair removal, mainly caused by instruments causing abrasions, inadequate preparation of skin with bactericidal solution, immunocompromised host, lack of prophylactic antibiotics or it may be due to incorrect choice of antibiotics.

The concentration of microorganisms proved to be associated with SSIs is that of bacterial counts higher than 10000 organisms per gram of tissue and in burns the organisms considered according to cm^2 of wound (Krizek, 1975).[20]

The infective process mainlydepends on the number of contaminating microbes and on the virulence of the microorganisms. The resistance offered by the host should strong enough to fight off the invading organisms.

In surgical patients, the gram positive bacteria that cause infection include aerobic skin and enteric organisms. Wound infections are most commonly caused by flora present endogenously, which are present in the skin, mucosal surfaces or hollow viscera.

The microbes commonly found in skin and mucosal membranes are gram positive cocci especially staphylococcus aureus. In genital and perianal skin the common organisms present are gram negative aerobes and anaerobes. In gastrointestinal surgeries intestinal flora like gram negative bacilli (eg: Eschericia coli) and gram positive bacteriae like enterococci and anaerobic organisms.

The vast majority of organisms causing wound infections are gram positive organisms particularly staphylococci and streptococci.The common sources of those pathogens are hospital personnel and intraoperative environment which includes surgical instruments,referral articles brought into the surgical field and it may also include operating room air.

WOUND HEALING :

The knowledge about the mechanism of wound healing is useful in achieving optimal results while treating the patient. Based on this knowledge several cellular and microbiological techniques are made to improve the outcome.

Even now the exact mechanism involved in wound healing is incompletely understood. Wound repair is nothing but the effort of injured tissues to restore their normal function and structural integrity following injury.

PHASES OF WOUND HEALING:

The three phases involved in wound healing are inflammation, proliferation and maturation.

- The immediate response of the body to injury is inflammation. It is otherwise called as reactive phase. This defence mechanism is aiming at reducing the amount of discharge which prevents further injury.
- The proliferative or regenerative phase is the process of repair which consists of re-epithelialisation, matrix synthesis and neovascularisation which helps in relieving the ischaemia caused by injury.

- The last phase is the maturational phase, during which scar contraction occurs due to cross linking of collagen, shrinking and loss of edema.

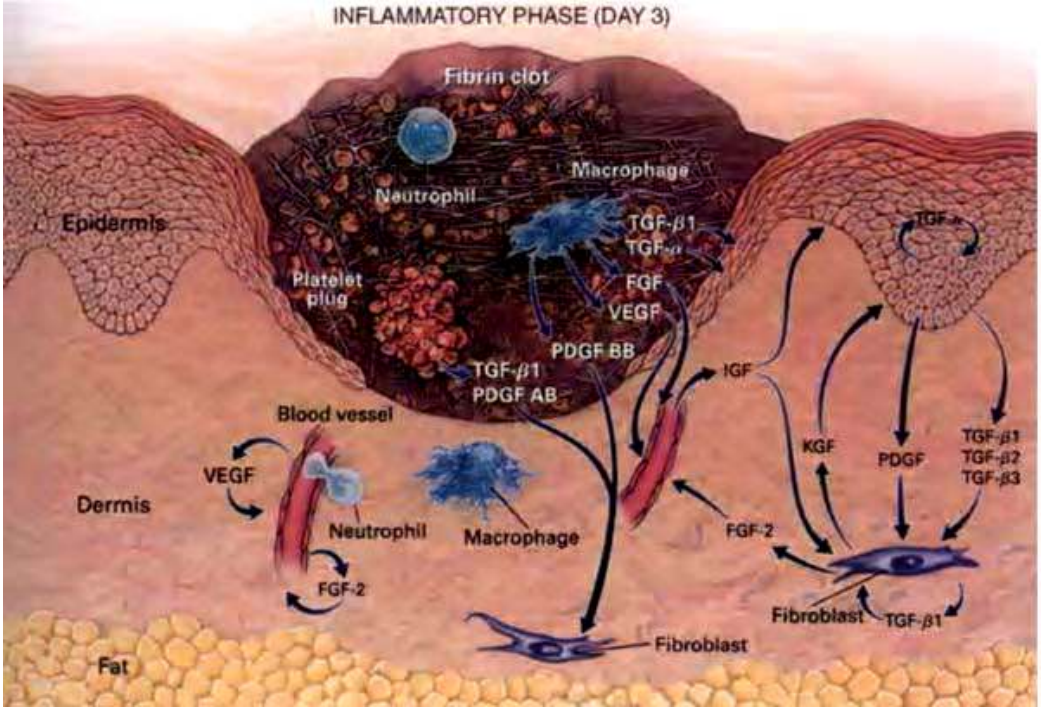


Figure :6 Inflammatory Response (Day 3)

Following an acute tissue injury, subendothelial collagen is exposed due to blood vessel damage which leads to aggregation of platelets and which inturn causes activation of the coagulationpathway.

Local vasoconstriction involving arterioles and capillaries at the initial stage later on leading to vasodilatation and increased vascular permeability. Bleeding from the injured site is arrested by capillaries plugged by erythrocytes and platelets which adhere to damaged capillary endothelium.

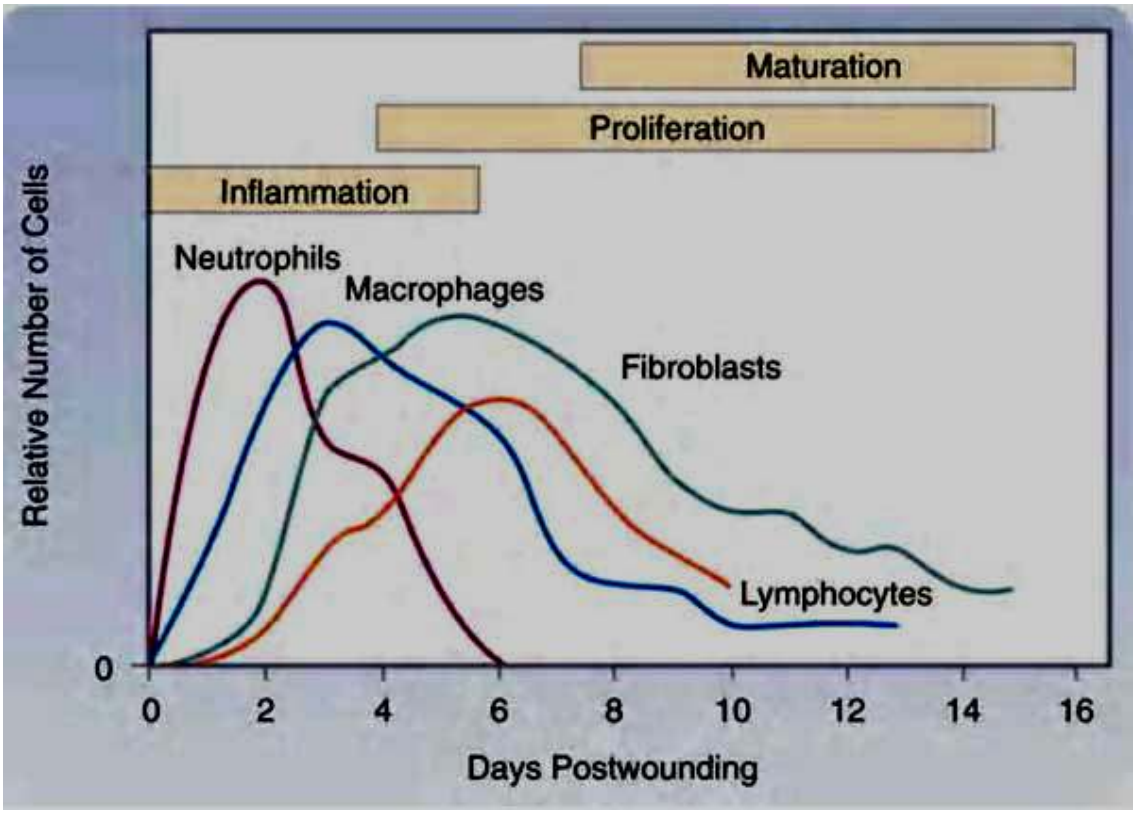


Figure:7 Graph of healing

INCREASED VASCULAR PERMEABILITY:

Binding of platelets to each other results in conformational changes which triggers intracellular signal transduction pathways results in activation of platelets and release of biologically active proteins.

Storage organelles contain platelet-derived growth factor (PDGF), transforming growth factor-β (TGF-β), insulin like growth factor type 1(IGF- 1), fibronectin, fibrinogen, thrombospondin and vWF. Vasoactive amines cause vasodilatation and increased vascular permeability. Mast cells release histamine and serotonin. Initiation of clotting cascade occurs via both intrinsic and extrinsic pathways.

POLYMORPHONUCLEAR CELLS:

Vascular permeability is increased due to release of histamine and serotonin. Complement factors like C5a and leukotriene B_4 promote neutrophil adherence and chemoattraction. Increased capillary permeability causes diapedesis of neutrophils to the inflammatory site.

Tissue swelling is further promoted by fibrin deposition and the fibrin becomes entrapped in lymphatic vessels. Within few days after injury once the wound contamination has been controlled migration of neutrophils get stopped. After 24-48 hours of injury, predominant cells in the wound will be mononuclear cells.

MACROPHAGE:

Macrophages appear in the wound at the sametime that neutrophils disappear. They promote apoptosis of neutrophils. Within 24-48 hours chemotaxis of blood monocytes occur. Complement factors, thrombin, fibronectin, collagen, TGF-β and PGDF causes migrating cell activation.

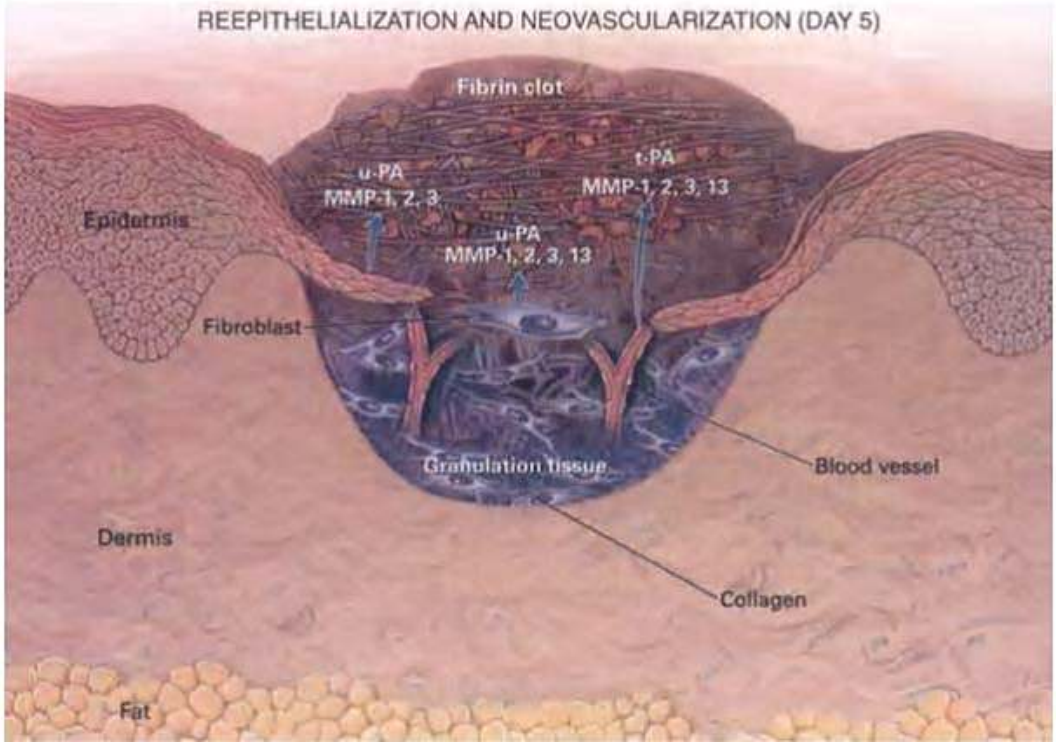


Figure : 8 Process of healing (Day 5)

LYMPHOCYTES:

Around seventh day, Tlymphocytes appear in the wound in significant number. Lymphocytes stimulates production of cytokines due to their effect on fibroblasts.

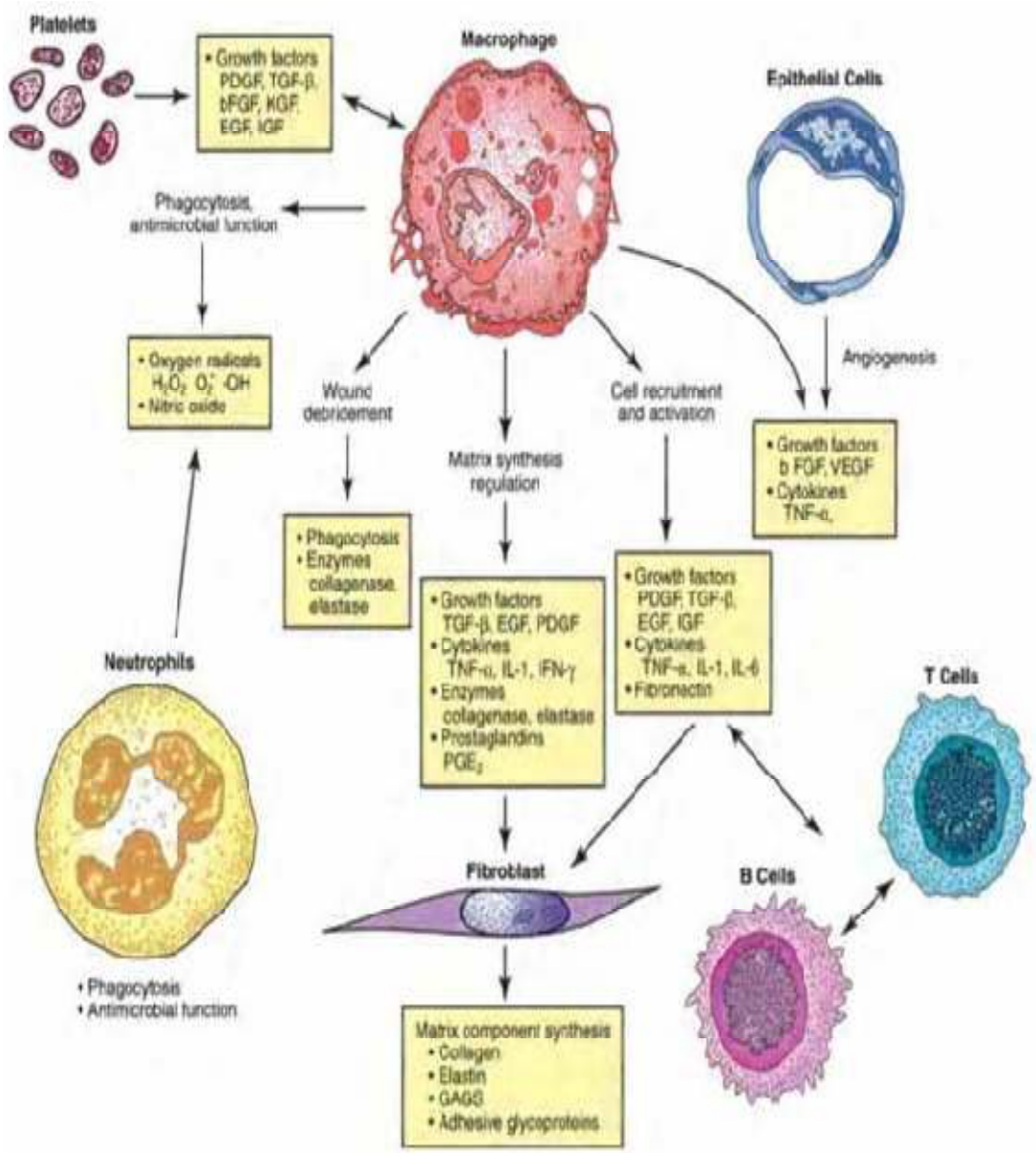


Figure: 9 Functions of Macrophages

PROLIFERATIVE PHASE:

Repair of the wound following inflammatory changes, occurs by angiogenesis, fibroplasiaand epithelialisation.

ANGIOGENESIS:

It is nothing but the process of new blood vessel formation which is needed for supporting the process of wound healing. Following injury, the basement membrane of post capillary venules degraded by activated endothelial cellswhich allows cell migration through this gap. Eventually deposition of the basement membrane occurs which causes capillary maturation.

FIBROPLASIA:

Fibroblasts are specialized cells that are differentiated from connective tissue containing resting mesenchymal cells. The quiescent fibroblasts following injury are attracted towards the site of inflammation site where they produce the components of ECM.

EPITHELIALISATION:

Within hours after injury, reepithelialisation of wound begins. At the initial stage, wound gets sealed by formation of blood clot and then by migration of epithelial cells across the defect. Keratinocytes present at the basal layer of epidermis which migrate to resurface the wound.

EXTRACELLULAR MATRIX:

ECM scaffolds so as to stabilize the physical structure of tissues. It plays an active role by regulation of cell behavior.

Macromolecular components produced by the cells are

1. Glycosaminoglycans,or polysaccharide chains which are found linked to protein by covalently as proteoglycans.
2. Fibrous proteins such as collagen, elastin, fibronectin, and laminin.

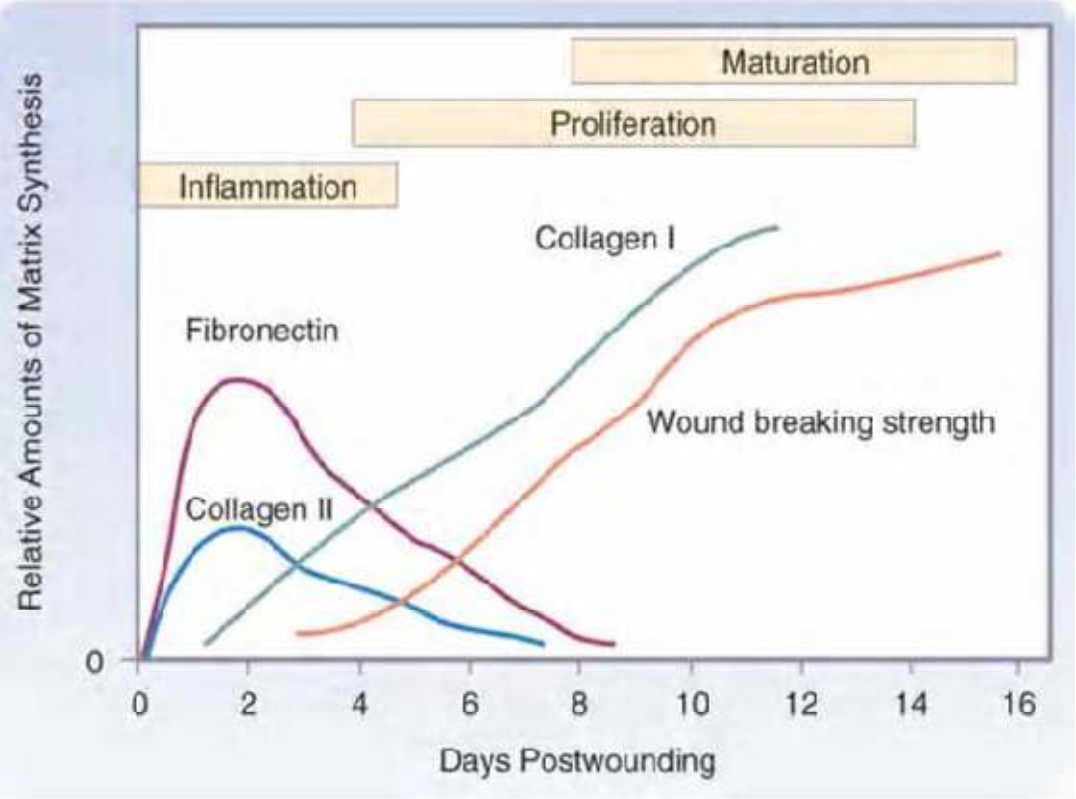


Figure :10 Graph of Healing Phase

MATURATIONAL PHASE:

Contraction of wound occurs in a centripetal manner including the whole thickness of the surrounding skin and reduces the disorganized scar.Contracture of wound is nothing but physical constriction or limitation of function.

REMODELING:

The fibroblast population decreases and dense capillary network regress. Rapid increase in the strength of wound increases by 1-6weeks and then appears to reach the plateauup to 1 year following injury.

Tensile strength of the scar tissue is only 30%. As a result of cross linking of collagen,contraction of wound and an increased tensile strength of the wound occurs. It results in a scar that will be more brittle and reduced elasticity than the normal skin.

The epidermodermal surface of the wound is lack of rete begs, the projections of epidermis that penetrate into the papillary dermis. Loss of the anchoring property of the scar results in increased fragility which results in avulsion even after trivial injury.

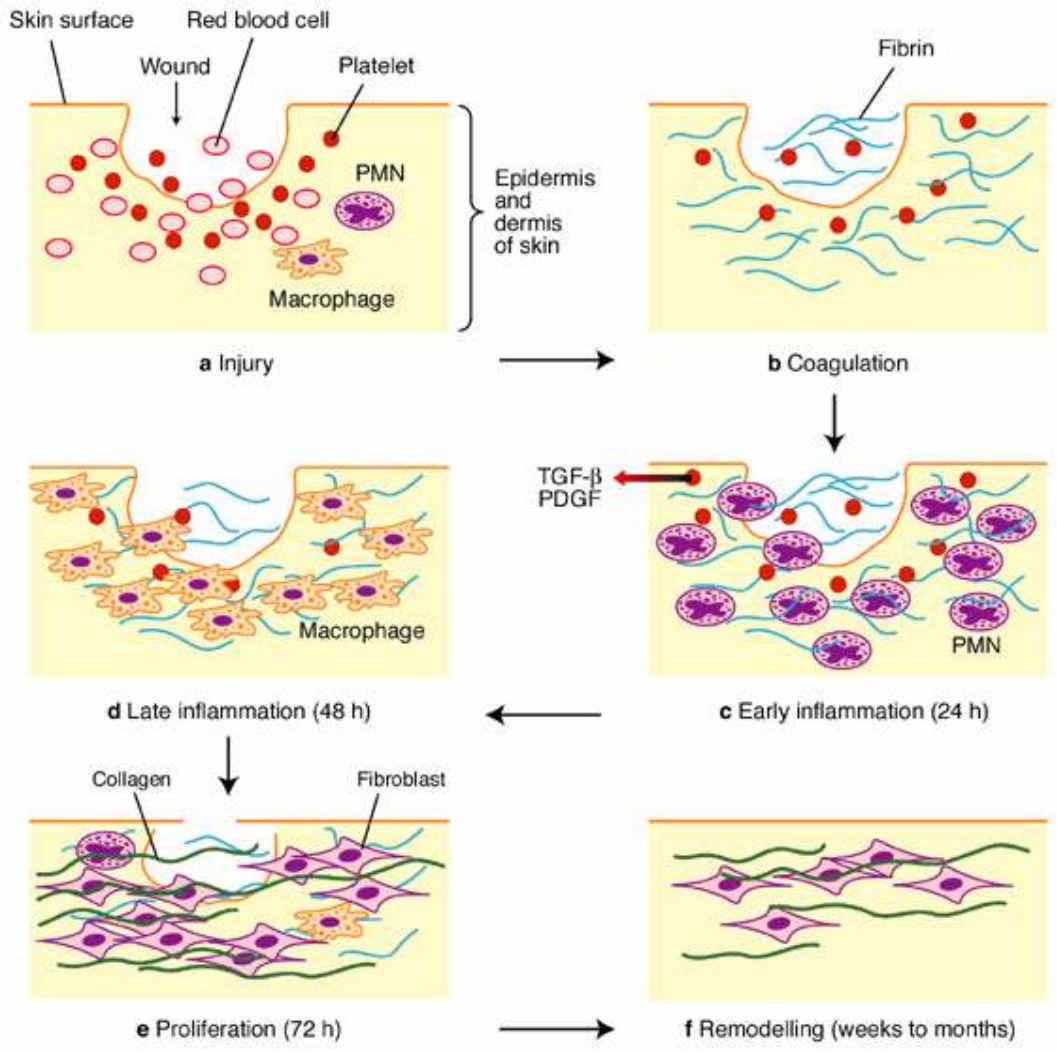


Figure : 11 Phases of wound healing

WOUND CLOSURE ARE OF THREE TYPES:

1. **Primary**: also called first intention , in which the wound is sealed immediately by simple suturing.

2. **Secondary:** or spontaneous intention , in which there is no active intention to seal the open wound. Usually this type belongs to highly contaminated wound which close by re-epithelialisation.

3. **Tertiary:** or delayed primary closure, the wound isinitially treated by debriding wound repeatedly, systemic or topical antibiotics , or negative pressure therapy to control wound infection. Once the infection gets controlled, wound closed.

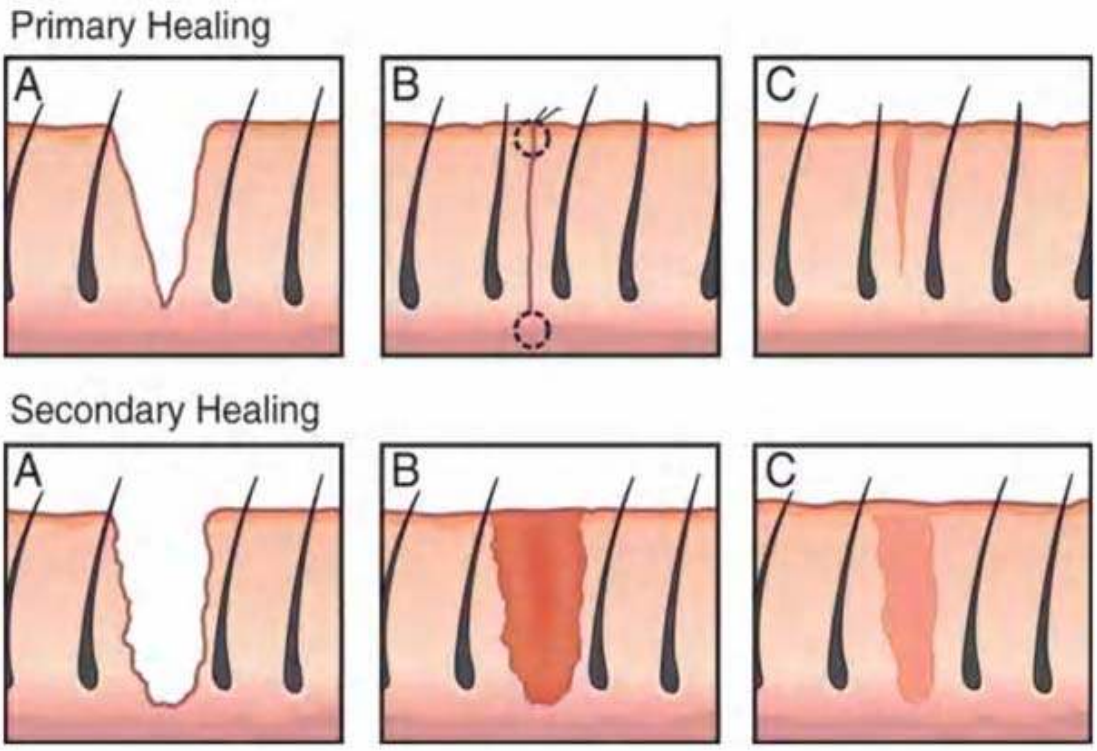


Figure : 12 Types of wound healing

RISK FACTORS FOR THE DEVELOPMENT OF SSIs:

Multiple risk factors are identified and can be compiled within one or more of the major determinants of SSI. Most of the factors have been shown to be associated with the development of SSI. However it is difficult to prove an independent association between every specific risk factor and wound infections.

TABLE 2 :RISK FACTORS FOR DEVELOPMENT OF SSIs:

MICROORGANISM	LOCAL WOUND	PATIENT
Remote site infection	Haematoma	Age
Recent hospitalization	Seroma	Immunosuppression
Duration of surgery	Necrosis	Steroids
Wound class	Sutures	Malignancy
Previous antibiotic therapy	Drains	Obesity
Pre operative shaving	Foreign bodies	Diabetes
Bacterial number		Obesity
Virulence of organism		Transfusions
		Smoking
		Oxygen
		Temperature

Figure :13 Delayed wound healing in a patient taking steroids

PATIENT FACTORS:

- Wound classification
- Age
- Nutritional status
- Altered immune response
- Obesity
- Diabetes
- Smoking
- Remote site infection
- Length of preoperative stay

1.AGE :

Incidence of infection rate increases with in extremes of age because of decreased immunity . It is a modest risk factor and the supportive data are limited.

2.NUTRITIONAL STATUS:

Malnutrition especially protein malnutrition is important in causing wound infections. In surgical patients malnutrition is a common finding. Moreover lose of weight predisposes to decreased host resistance. HabteGabr E et al[22] described malnutrition as a predisposer of SSIs. It is one of the associated factor for postoperative wound infection.

3.DIABETES:

Several studies indicate that diabetes predisposes to wound infection due to impaired healing process. The exact mechanism is not well understood. A study conducted by Cruse and Foord[23] clean wound infection rate in diabetes is 10.7% compared to that in non diabetic is 1.8%.

4.SMOKING:

Smoking found to be a risk factor predisposing to wound infection though supportive data are sparse. In association with malnutrition the rate of SSIs increased. This factor is important because it's a modifiable risk factor. Nagachitnaet al reported higher incidence wound infections in smokers compared to non smokers who underwent cardiac surgeries.[24]

Smoking inhibits wound healing and decreases circulation to the skin due to microvascular obstruction from platelet aggregation and presence of increased non functioninghaemoglobin. Smoking also leads to suppression of immune system and respiratory system. Some studies reveal that only current smoking increases the incidence of SSIs.

A percentage of patients who quit smoking immediately before surgery reveal themselves as non smokers during surgery. Actually the results depend on how distant prior smoking must be before the planned surgery. Atleast one month before surgery, patients are advised to quit smoking. Nutritional status especially vitamins supplementation should be considered before surgery to promote healing process.

5.ALTERED IMMUNE RESPONSE:

Alteration in immune status is also a considerable risk factor for SSIs. Immunosuppression has variety of causes. Even it may be inherited commonly, common variable immunodeficiency in which the patient can't produce antibodies in response to infection. Several studies didn't prove the independent correlation between the two. Wound infection is more in immunocompromisedstate of varied etiology.

There are several drugs which suppress immune system like steroids, methotrexate, cytoxan, remicade, chemotherapy drugs and irradiation. A study proved that in patients with crohn's disease who are on long term steroids develop more infection rate than those not on steroids.

6.OBESITY:

There is only slight increase in theincidence of wound infection in obese individuals compared to non obese patients. The possible reason for increased incidenceof wound infection suggested by the studies conductedbefore is reduced perfusion in fat tissues.

Patients whose BMI > 25 kg/m2 have increased risk for developing incisional hernias because of their susceptibility to acquire wound

infections. Initially obese patients found to have higher complication rate especially in laparoscopic surgeries compared to that in open surgeries.

Later on several studies demonstrated that laparoscopic colorectal surgeries in obese patients found to be feasible and safe hence minimally invasive surgeries are now become preferred method of approach. A study conducted by Cruse and Foord[23] supports this but fails to describe that obesity is either a independent risk factor or not.

7.LENGTH OF PREOPERATIVE STAY IN HOSPITAL:

There is possibility for colonization of multi resistant organisms. A study supporting this was conducted by Cruse and Foord.[23] Though this factor is not an independent risk factor association with other risk factors this is considered as important one.

8.CO – EXISTENT INFECTION:

The presence infection at remote site is gaining importance in predisposition of SSIs. Pre operative treatment of distant site infection is of considerable value in reducing wound infection rate. Remote site infections found to be linked to increase SSI rates three to five fold. Some special surgical cases in which implanted devices are used which demands that the surgery to be postponed until the remote infection is resolved.

TABLE : 3 MEDICAL CONDITIONS CAUSING SSI

Medical conditions causing increased risk of post operative wound infection:
• Extremes of age • Malnutrition • Obesity • Diabetes mellitus • Prior site irradiation • Hypothermia • Hypoxaemia • Coexisting infection • Steroid therapy • Recent operation • Chronic inflammation • Hypocholesterolemia

OPERATIVE FACTORS:

- Preoperative skin preparation
- Duration surgical scrub
- Pre operative shaving
- Duration of surgery

- Anti microbial prophylaxis
- Foreign material in incision site
- Surgical technique
- Use of cautery

1. PRE OPERATIVE SKIN PREPARATION:

Degerming the operative site by washing the site with a germicidal soap solution for 5 – 10 minutes followed by painting the site with antimicrobial solution like povidone iodine. Painting with alcohol solution of povidone iodine is effective in less than 1 minute compared to 5 minute scrub with povidone iodine followed by painting using povidone iodine solution.

Some studies suggest scrubbing for 2 minutes is found to be equally efficaciouscompared to the traditional 10 minutes scrub. Using alcohol found to be cheaper and most effective, rapidly acting skin antiseptic.[25] One potential disadvantage in using it in the operation theatres is its inflammable nature.[25,26]

Few comparative studies reveal chlorhexidine gluconate causes greater reductions in skin flora compared to povidone iodine after a single application.

- **PRE – OPERATIVE SHAVING :**

  Shaving night before operation provides enough time for the microbes to colonise in any cuts or nicksleading to higher rateof infection.[27,28,29,30] If shaving done just before surgery showing reduced infection rate.Use of hair clippers further reduce the rate of incidence of wound infection. A study proved that SSI rate of 5.6% in patients whose hair removal done by razor in comparison with those whose hair removed by depilatory or not getting removed in whom the infection rate was only 0.6%.[29,31]

- **DURATION OF SURGICAL SCRUB:**

  Using soap and antiseptic solution for handwashing removes dirt and desquamated skin which reduces the number of microbes in the skin. Traditionally scrubbing has to be done for 10 minutes.

2. VENTILATION IN OPERATING ROOM:

The number of dust particles available for microbes to adsorb can be reduced by filtering the operating room air. Operative room air should have positive pressure so that unfiltered air from outside cannot enter inside. Special laminar flow further reduces the incidence of air borne infection.

3. PROPHYLACTIC ANTIBIOTICS:

Administration of prophylactic antibiotics reduces the incidence of post operative wound infection rate. The drug should be directed against the organism likely to contaminate the wound. It should have tissue penetration sufficient to reach the whole depth of wound. It should be cost effective and at the sametime it should not disturb intrinsic body flora.

In general prophylactic antibiotics are administered about 30 minutes before surgery. Hence the tissue and blood levels of antibiotics will reach optimal level at the time of skin incision. If the duration of surgery is more than 4 hours the dose has to be repeated.

4. DURATION OF SURGERY:

The duration of surgery has direct impact on incidence of infection. A study by Cruse and Foord implied that roughly the incidence of post operative wound infection is doubled every hour of the procedure. Garibaldi et al revealed an operative duration of more than two hours is associated with wound infection. Hence it is considered as an important risk factor in causing wound infections.

Risk of wound infection is directly proportional to the duration of surgery. Operating duration lasting more than one hour has the infection rate of 1.3% whereas those surgeries lasting 3 hours or more had infection rate of about 4.0%.[32]

5. HYPOTHERMIA:

Randomized control trial conducted by Kurz et al for examining the effects of hypothermia causing SSI. Patients in hypothermia has core temperature of of 34.7°C whereas in control group core temperature is 36.6°C. This 2°C difference in core temperature resulted in 3 fold increase in the incidence of SSIs. Several retrospective studies showed that perioperative hypothermia has also been established as a risk factor for developing SSIs.

Actually hypothermia causes decreased migration of polymorphonuclear cells by suppressing phagocytic activity, which results in reducing superoxide anion production which in turn causes reduced oxidative killing by neutrophils.

6. USE OF ELETROCAUTERY:

As cautery causes more damage to the tissues than scalpel , less numbers of bacteria are required to produce wound infection.

7. TECHNIQUE OF SURGERY:

Factors like tissue handling, hemostasis, presence of dead space and tissue trauma all contribute to increased incidence of wound infection.

8. SURGICAL DRAINS:

Usage of surgical drains provides an opportunity for microbial entry. Drains brought out through operative wound are more prone for wound infection.

TABLE 4 : ADVANCES IN THE CONTROL OF INFECTION IN SURGERY

Advances in the control of infection in surgery
■ Aseptic operating theatre techniques have replaced toxic antiseptic techniques
■ Antibiotics have reduced postoperative infection rates after elective and emergency surgery
■ Delayed primary, or secondary, closure remains useful in contaminated wounds

ASSESSMENT OF RISK:

NNIS system of **CDC** (1996) is the current risk index system serving as a predictive index in finding out risk for developing wound infection. The category of risk index is made by adding the risk factors found during surgery. For every risk factor one point is added and the risk index value

ranges from 0-3. This risk index value is found to be a better inpredicting the development of wound infections than the surgical wound classification.

NNIS RISK INDEX ELEMENTS ARE AS FOLLOWS:

1. **Pre operative physical status** of the patient assessed by anaesthesiologists and classified according to American Society of Anaesthesiologists as greater than three (ASA > 3).
2. **Status of wound**either contaminated / dirty or clean.
3. **Duration of surgery** if prolonged specifically when more than the determined duration called T hours where T represents the 75 th percentile of the duration of surgery performed.

TABLE NO .5

American Society of Anaesthesiologists (ASA) classification of physical status of patient:

ASA SCORE	CHARACTERISTICS
1	Normal healthy individual
2	Patient with mild systemic disease
3	Patient with severe systemic disease that limits activity but is not incapacitating
4	Patient with incapacitating systemic disease which is a constant threat to life
5	Moribund patient not expected to survive 24 hours with or withoutsurgery

Predictive percentage of occurrence of wound infection by wound type and risk index:

By using NNIS risk index system pre operatively we can predict the possibility of the wound to get infected which is used as a guide to administer antibiotic prophylactically. The predictive percentage of SSI based on NNIS risk grading is given in the following table:

TABLE NO:6

Predictive percentage of SSI occurrence by wound type and risk index:

AT RISK INDEX	PREDICTIVE % OF SSI
0	1.5
1	2.9
2	6.8
3	13.0

CLASSIFICATION OF SURGICAL WOUNDS:

In 1964 , National Research Council put forth a set of definitions which is useful in predicting the probability of wound infection. These informations had found to be strongly associated with post operative wound infections. Four categories of wound infections are described as follows:

TABLE NO: 7

Wound Classification and Subsequent possibility for risk of wound infection (without use of antibiotics):

Classification	Description	Infective risk %
Class 1 - Clean	Uninfected operative wound, no acute inflammation, closed primarily. Respiratory, gastrointestinal, biliary, urinary tract not entered. No break in aseptic technique, closed drainage used if necessary.	< 2
Class2-Clean-contaminated	Elective entry into respiratory, biliary, gastrointestinal, urinary tract and with minimal spillage. No evidence of infection or major break in aseptic technique. Ex : appendisectomy	<10
Class 3-Contaminated	Presence of non purulent inflammation. Spillage of GI contents. Penetrating wound < 4hours. Lack ofaseptic technique.	About 20
Class 4-Dirty / infected	Pus discharge from wound.Presence of visceral perforation during preoperative period. Penetrating injuries lasting longer than4 hours.	About 40

Accurate surveillance can only be achieved using trained, unbiased and blinded assessors. Usually the surveillance includes upto 30-day postoperative period. There are scoring systems for the severity of wound infection useful in surveillance and research like Southampton and ASEPSIS systems.

TABLE 8 : ASEPSIS WOUND SCORE:

CRITERION	POINTS
Additional treatment Antibiotics for wound infection Drainage of pus under local anaesthesia Debridement of wound under general anaesthesia	0 10 5 10
Serous discharge	Daily (0-5)
Erythema	Daily (0-5)
Purulent exudates	Daily (0-10)
Separation of deep tissues	Daily (0-10)
Isolation of bacteria from wound	10
Stay as inpatient for > 14 days as a result of wound infection	5

(scored for 5 of the first 7 days only, the remainder being scored if present in the first two months)

TABLE 9 : SOUTHAMPTON WOUND GRADING SYSTEM:

GRADE	APPEARANCE
0	Normal healing
I	Normal healing with mild bruising or erythema
Ia	Some bruising
Ib	Considerable bruising
Ic	Mild erythema
II	Erythema + other inflammatory signs
IIa	At one point
IIb	Around sutures
IIc	Along wound
IId	Around wound
III	Clear or hemoserous discharge
IIIa	At one point only < 2 cm
IIIb	Along wound > 2 cm
IIIc	Large volume
IIId	Prolonged > 3 days
MAJOR COMPICATIONS	
IV	Pus
Iva	At one point only < 2 cm
IVb	Along wound > 2 cm
V	Deep or severe wound infection with or without tissue breakdown; haematoma requiring aspiration

INVESTIGATIONS:

LAB STUDIES:

The method of collecting specimen: Purulent fluidor exudate is collected on a swab for culture.The swab tends to trap microbes which are not released on culture plate. Specimen collected are submitted in a screw capped bottle, firmly stoppered tube or syringe, or a capillary tube which is sealed. Two swabs are necessary one for smear preparation and the other for culture.

STAINING METHODS:

The quickest and simplest method is gram staining for infective organisms. Based on the ability to retain the primary crystal violet dye , the organisms are classified as gram positive and gram negative. As gram positive bacteriae retain the primary dye they appear as blue or purple. Gram negative bacteria loose the primary stain and take up counter stain hence appear red or pink. The spectrum of staining is wide which includes many fungi, parasites and even includes protozoan cysts. Gram staining is also useful in differentiating epithelial and inflammatory cells.

CULTURE TECHNIQUE

Both aerobic and anaerobic organisms are cultured routinely. A combination of enriched, non selective, selective and differentiated media used for isolation of both aerobic and anaerobic bacteriae from the

clinical specimen. There is also possibility of subcultures for identifying the specific organisms. Testing sensitivity for routine antibiotics is used for mainly aerobic organisms.

IMAGING STUDIES

Ultrasonogram is used in cases of wound infection to assess any underlying collection.

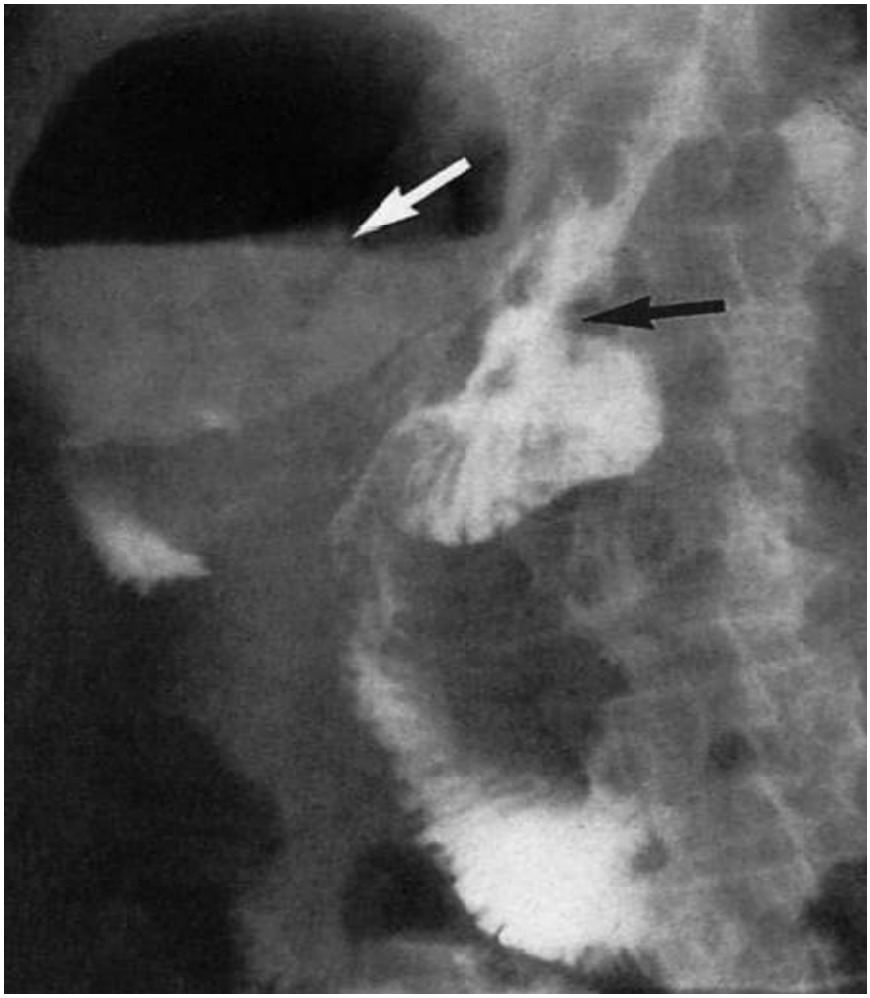


Figure : 14 Plain radiograph showing subphrenic abscess

PREVENTION OF SSI:

The milestone in preventing SSI starts with the use of antibiotics. The concept of prophylactic antibiotics is based on the level of antibiotic dose in blood level during the time of making skin incision. It is generally agreed that antibiotics given prophylactically are indicatedfor clean contaminated and contaminated wounds.

Antimicrobials used for dirty wounds works in treating as infection was already established. Prophylactic antibiotic is indicated in clean surgeries in which there is an indication for the use of prosthetic devices because infection if occurs in these cases will lead to bad surgical outcome for the patient.

However, other clean procedures like breast surgeries may be a matter of contention.

The quality of prophylactic antibiotics depends mainly on the ability of the antibiotic to cover predicted microorganisms likely to cause infection, should have good tissue penetration to reach the involved wound.

Cost effectiveness of the drug needs to be considered. It should cause only minimal disturbance to commensals.

Timing of administration of antibiotic prophylaxis is very important as the concentration of the antibiotic used should reach therapeutic levels at the time when skin incision is made and which should be ideally at the same concentration for few hours post operatively (CDC 1996).

It is the current recommendation to administer antibiotic through intravenous route ½ hour before making skin incision. If antibiotics is administered 2 hours prior to surgery is usually ineffective. In colorectal surgeries bowel clearance in the form of enemas and oral antimicrobial prophylaxis is required inaddition to routine antibiotic prophylaxis.

TABLE 10 : SURGICAL INCISIONS THROUGH INFECTED OR CONTAMINATED TISSUES

Surgical incisions through infected or contaminated tissues
■ When possible, tissue or pus for culture should be taken before antibiotic cover is started ■ The choice of antibiotics is empirical until sensitivities are available ■ Wounds are best managed by delayed primary or secondary closure

TABLE 11 : PREVENTIVE MEASURES FOR SURGICAL SITE INFECTIONS:

Timing	Micro Organism	Local	Patient
Pre operative	1. Shorten preop stay 2. Antiseptic shower pre operatively, 3. Appropriate or no hair removal. 4. Avoid or treating remote infections. 5.Antibiotic prophylaxis	Appropriate preop hair removal or no hair removal	Optimize nutrition, Preoperative warming, Tight glucose control, Stop smoking
Intra operative	1. Asepsis and antisepsis. 2. Avoid of spillage of GI contents	Haematoma/seroma Good perfusion, Complete debridement, Deadspaces, Monofilament sutures, Justified use of drains	Supplemental oxygen, Intra operative warming, Adequate fluid resuscitation, Tight glucose control
Post operative	1. Protect wound site for 48-72 hrs 2. Remove drains as soon as possible 3. Avoid post operative bacteremia	Post operative dressing for 48-72 hrs	Early enteral feeding, Supplemental oxygen, Tight glucose control, Surveillance programs

RECOMMENDATIONS FOR PROPHYLACTIC ANTIBIOTIC:

Several studies have shown that prophylactic use of antibiotics helpful in reducing the incidence of wound infections. The drug used for prophylaxis should be directed against the bacteria likely to contaminate the wound. In clean wounds usual organisms causing wound infection are staphylococcusaureus, staphylococcus epidermidis and gram negative bacteria.

In cases of gastroduodenal and biliary tract surgeries, colorectal surgeries and gynecological surgeries gram negative enteric bacteria will likely to cause wound infection. Atleast 30 minutes before making skin incision antibiotic has to beadministered.

If the duration of surgery is more than 4 hours or twice the half life of antibiotic used the dose of antibiotic has to be repeated. According to Woods R K current recommended guidelines for antibiotic prophylaxis is as follows:

Prophylactic use of systemic antibiotics are beneficial in the following situations:

1. High risk gastroduodenal procedures including surgeries done for gastric carcinoma, ulcer, bleeding etc.
2. High risk biliary procedures including CBD stones, jaundice and in patients with previous endoscopic biliary manipulation.
3. Resection and anastomosis of bowel
4. Vascular surgeries involving lower extremities and aorta
5. Craniotomy
6. Cardiac surgeries
7. Primary caesarean section
8. Implantation of any prosthetic material
9. Abdominal or vaginal hystrectomy
10. Any wound with gross bacterial contamination
11. Accidental wounds with heavy contamination
12. Injuries prone for any clostridial infection.

The use of prophylactic antibiotics in clean wounds in which no prosthetic material is implanted is controversial. A well designed trial has demonstrated that there is significant reduction in the incidence of SSI in breast and groin hernia repairs with prophylactic antibiotic use than those received placebo.

Several reports demonstrated a reduced incidence of wound infections in those combined use of oral non absorbable and intravenous antibiotics used.

For most patients undergoing elective surgery, the first dose of prophylacticantibiotics are given at the time of induction of anaesthesia. A single dose may be sufficient depending on the drug used and length of the procedure.

Prophylactic antibiotic coverage of more than 12 hours for a planned surgery is never indicated. In addition, for obese patients there are studies suggesting benefit of using higher initial doses and more frequently for repeated doses to achieve appropriate tissue levels throughout the operation.

No antibiotic is found to be superior than the other when each possessed a similar and appropriate antibacterial spectrum. The most important determinant in selecting an antibiotic is whether the planned procedure is expected to enter the parts of the body containing bacterial colonization.

Four principles guide the administration of antimicrobial agent for prophylaxis:

1. Safety
2. An appropriate narrow spectrum of coverage of relevant pathogens
3. Little or no reliance on the agent for therapy of infection
4. Administration within one hour before surgery and for a defined brief period thereafter

NON DRUG BASED RECOMMENDATIONS FOR PREVENTION SSI, APRIL 1999:

Preparation of patient :

1. Hair need not be removed unless it interferes with operating field. If it is required it has to be done just prior to surgery and preferably with electric clippers.
2. Tobacco consumption should be stopped at least one month before surgery.
3. All remote site infections has to be treated before the proposed surgery.
4. Blood glucose level is to be optimized before surgery.
5. Blood products necessary to correct co morbid conditions has to be given well before surgery.
6. Patient has to take antiseptic bath atleast the night before surgery.

7. Nutritional intake has to be enhanced.
8. Discontinuation of steroid use is advised.
9. Prophylactic antibiotic use is recommended.
10. Measures to enhance wound space oxygenation.

SURGICAL TEAM MEMBERS

- Use a cap or hood to cover the hair on face and head.
- Masks should be worn which covers both mouth and also nose .
- Scrub hands and forearms above elbow for atleast 3 – 5 minutes using an appropriate antibiotic.
- Keep the fingernails short.
- Clean under the fingernails just before first scrub of the day.
- After scrubbing the hands should be kept facing up with elbows in flexed position and also away from the body ;sterile towel used to dry hands before wearing aprons andgloves.
- Liquid resistant sterile surgical gowns and sterile gloves are to be used.
- Visibly soiled gowns has to be changed.
- Personnel with skin lesions with discharge has to be given exemption from duty until he gets cured of the illness.
- Shoe covers are not considered necessary.

- Surgical personnel has to be educated regarding reporting of illness which are of transmissible in nature.
- Do not wear arm or hand jewellery.
- Restriction of scrub suits inside the operation theatre.
- How and where launder scrub suits should be instructed.

PRE AND POST OPERATIVE WOUND CARE:

- Duringindwelling catheters like intravenous, spinal, epidural catheters are inserted and infusion of drugs through them should be done in strict aseptic condition.
- Class 3 and 4 wounds to be managed by delayed closure or healing by secondary intention.
- Gentle handling of tissues is important. Good hemostasis to be achieved.
- Minimize the presence of devitalized tissues
- Dead space has to be obliterated.
- If the wound requires drain it has to come out via a separate incision apart from main wound. The drain has to be removed once the drainage purpose is over to limit the possibility of acquiring wound infection via this.
- Hands need to be washed before and after handling the wound.

- After closing wound it has to be protected using sterile dressings for atleast 24 – 48 hours.
- Wound dressings to be done in sterile manner.
- The patient and relatives to be educated regarding the symptoms of SSIs so that early diagnosis is possible to treat.

THEATRE ENVIRONMENT AND INSTRUMENTS MAINTAINENCE

- Atleast 15 air changes has to be maintained out of which 3 being fresh air.
- Positive pressure has to be maintained inside operation theatre compared to the surrounding.
- Air has to enter through the ceiling and exit via floor.
- Appropriate air filters to be used.
- Operating room doors should be closed unless indicated otherwise.
- The use of ultraviolet lights found to be no way superior in SSI prevention.
- Before each procedure soiled surfaces needs to be cleaned with disinfectants approved by Environmental Protection Agency (**EPA**).

- Use of a tacky mat at the entrance is not necessary.
- Each surgical instrument has to be sterilized according to standard guidelines. Flash sterilization is permitted only if it is required for immediate patient use.
- Just prior to use all the required surgical instruments and solutes has to be assembled.
- Limit the number of persons entering into operation theatre.
- The floor of operating room has to be sterilized using **EPA** – approved agents at the end of day / night.

TABLE 12 : CLASSIFICATION OF SOURCES OF INFECTION

Classification of sources of infection
■ **Primary:** acquired from a community or endogenous source (such as that following a perforated peptic ulcer) ■ **Secondary or exogenous (HAI):** acquired from the operating theatre (such as inadequate air filtration) or the ward (e.g. poor hand-washing compliance) or from contamination at or after surgery (such as an anastomotic leak

SPECIAL SITUATIONS:

- **Colon surgery** :

Handling of bowel during surgery leads to breakdown of intestinal mucous membrane which in turn causes release of facultative anaerobes and anaerobes from distal small intestine and large intestine. Eradication of these microbesshould be done to reduce infection. Mechanical cleansing of bowel and prophylactic antibiotics could achieve this.

For colonic surgeries cleansing by mechanical means should be started with dietary restrictions , whole gut lavage using solutions like mannitol 10% or polyethylene glycol usually done on the day of surgery. Using oral neomycin and erythromycin eradication of intrinsic bowel flora has to be done. This is the commonly used regime in United States. Other neomycin combinations are metronidazole and tetracycline. Parenteral antibiotics also used prophylactically.

- **Intravascular device related infections:**

Intravascular catheters used for the parenteral administration of antibiotics, other medications, fluids, blood products, access to hemodialysis and also useful in monitoring of critically ill patients. As it is used in invasive procedures it may lead to infective complications. Recommendations for prevention and treatment of such infections by Pearson , 1995 : Mermel , 2001.

SURGICAL CARE:

The surgeons should aim at preventing wound infections. Treatment should be individualized to the patient, wound class, and the nature of the infection. The surgeon who is going to do the surgery should aware of the possibility of infection in the wound. During surgery the surgeon plays a major role in minimizing the possibility of developing wound infection.

Following steps have positive impact on outcome:

1) Careful handling of tissues.
2) Meticulous dissection, hemostasis and debridement of devitalized tissues.
3) Control of intraluminal contents from spilling into abdominal cavity.
4) Preservation of blood supply of the operated organs.
5) Elimination of foreign body.
6) Maintaining strict asepsis by the operating team.
7) Thorough drainage and irrigation of pus from the wound using warm saline.
8) Maintaining the patient in euthermic state.
9) Proper decision regarding closing the wound either primarily or secondarily.

Treatment involves opening the wound,draining pus and cleaning of wound. Deep tissues has to be checked for the presence of deep space infection or source.

Changing the dressings allow tissue granulation and the wound will heal by means of secondary intention over weeks. Changing the dressings should be done by aseptic and non touch technique.

After 48hours of surgery, saline dressing can be done and patient allowed to take bath. Topical use of antimicrobials is not advised for surgical wounds healing by primary intention.

Identification of surgical site infections:

1. Hyperpyrexia
2. Wound edema
3. Purulent discharge from the wound
4. Redness around the wound site

TABLE : 13 BACTERAEMIA AND SEPSIS

Bacteraemia and sepsis
■ Sepsis is common after anastomotic breakdown
■ Bacteraemia is dangerous if the patient has a prosthesis
■ Sepsis may be associated with MODS

SUTURE MATERIAL

Monofilament suture materials are preferred for deep closure and skin closure. Wound closure should not be excessively tight and to allow wound edema.

Inpatient care

- Due to SSI increased hospital stay is estimated to be 7-10 days. The cost of increased hospitalization is about 20% (Haley, 1981).
- Interventions like wound debridement and routine dressing is found to important allowing the wound to heal by secondary intention.

Outpatient care

- Most of wound infections if occurs after discharge are managed in the community. Managing wound infection mainly includes changing the dressing regularly helps in wound healing which is usually by secondary intention.

MANAGEMENT OF WOUND INFECTION:

Wound infection can be predicted to some extent. Haley and colleagues first published about the importance of identifying high risk patients for SSIs.

Important risk factors causing wound infections are analysed by multiple logistic regression techniques , and amodel was put forth containing following four risk factors

1. Abdominal surgeries
2. Duration of surgery lasting more than 2 hours
3. Contaminated or dirty wounds
4. Patients having three or more differential diagnosis

Figure: 15 Faecal peritonitis in which wound left open to granulate

They have concluded that when compared to routine system of wound classification this simplified index predicts risk of SSI approximately twice than that done by routine methods.

The overall surgical site infection rate increases progressively from clean(2.9%), to clean-contaminated(3.9%), to contaminated (8.5%), to dirty- infected (12.6%).

The risk of infection in each category was found to be in wide range in clean operations from 1.1% to 15.8%; in clean contaminated wounds 4.5% to 23.9%; in dirty wounds 6.7% to 27.4%. In patients with contaminated and dirty wounds there is no low risk category identified.

Following this work ,investigators at centres for disease control (CDC) reported composite risk index used in the National Nosocomial Infection Surveillance system.

NNIS risk index is based on the modification of the study on the Efficacy of Nosocomial Infection Control (SENIC) project. Though NNIS risk index uses the routine system of wound classification but itimproved it by several ways.

It utilizes three various diagnoses to identifyfactors as a risk of infection in host. Secondly, it gave some cut off point specific to a procedure to indicate prolonged duration of surgery for everyprocedure.

TABLE 14 : RISK FACTORS FOR DEVELOPMENT OF SURGICAL SITE INFECTIONS:

Patient factors:
Ascites
Chronic inflammation
Steroid use
Obesity
Diabetes
Extremes of age
Hypoxaemia
Peripheral vascular disease
Post operative anemia
Prior site irradiation
Recent operation
Remote infection
Skin disease in the site of incision
Undernutrition
Environmental factors:
Contaminated medications
Inadequate disinfection
Inadequate ventilation
Treatment factors:
Drains
Emergency procedure
Hypothermia
Inadequate antibiotic prophylaxis
Oxygenation
Prolonged pre operative hospitalization
Prolonged operative time

Surgical patients are prone to develop a wide variety of nosocomial infections during post operative period, which include SSIs, UTIs, pneumonia and bacteremic episodes. These are possibly iatrogenic.

Hence prolonged use of indwelling catheters and tubes for the purpose of urinary drainage, ventilation, venous and arterial access should be taken care of to prevent sepsis.

NNIS SCORE AND RISK FOR SSI:

Risk factors:

1. Procedure time > 75th percentile
2. Contaminated or dirty wound
3. ASA III,IV,V

TABLE 15 : NNIS SCORE AND RISK FOR SSI

NUMBER OF POSITIVE RISK FACTORS	RISK FOR SSI
0	1.5%
1	2.9%
2	6.8%
3	13%

Comparison of NNIS score and Wound Classification for predicting risk for SSI:

TABLE 16 : NNIS RISK SCORE

Wound class	**0**	**1**	**2**	**3**	**ALL**
Clean	1.0	2.3	5.4	-	2.1
Clean-contaminated	2.1	4.0	9.5	-	3.3
Contaminated	-	3.4	6.8	13.2	6.4
Dirty	-	3.1	8.1	12.8	7.1
All	1.5	2.9	6.8	13.0	-

MANAGEMENT:

Treatment of wound infections mainly depends on the depth of infection. For both superficial and deep wound infections sutures or skin staples are removed over the area of infection.A cotton tipped applicator is introduced into the wound and purulent material are cleared out. The wound is to be explored to confirm the depth of infection.

If fascia is found to be intact, debridement of non viable tissues performed. The wound is irrigated with normal saline solution and packed with saline - moistened gauze to allow wound healing.

If widespread infection in the form of cellulitis noted, then administration intravenous antibiotics should be considered. Empirical antibiotic therapy is started and may be tailored according to culture and sensitivity data.

If the fascia has separated or purulent material coming from deeper aspect of wound, there is possibility of dehiscence or an intra-abdominal abscess that requires drainage.

TABLE 17 : ABSCESSES

Abscesses
■ Abscesses need drainage with curettage.
■ Modern imaging techniques may allow guided aspiration.
■ Antibiotics are indicated if the abscess is not localised (e.g. evidence of cellulitis).
■ Healing by secondary intention is encouraged.

Controversy exists in doing wound cultures in small and superficial wounds. If wound dehiscence or complex infection is present then wound culture is indicated.

Thepresence of grayish or dishwater coloured fluid raises the suspicion for the possibility of necrotizing fasciitis. The presence of crepitus in any surgical wound suggests the possibility of clostridium perfringens infection. In these type of wound infections immediate and effective wound debridement is indicated.

Most of the post operative wound infections are treated with healing by secondary infection. This allows the wound heal from the base anteriorly, with epithelialisation at the end. Delayed primary closure may be considered according to the amount of contamination.

Use of topical antibiotics for the wound that heals by primary intention has to be avoided. Do not use eusol for wounds that are intended to heal by secondary intention.

In earlier times, the presence of intraabdominal abscess mandated surgical exploration. Now a days, because the availability of various imaging techniques, the abscess drained percutaneouly with image guidance.

Surgical intervention is reserved for those containing multiple abscesses, those abscesses in close proximity to vital structures so that percutaneous drainage would be hazardous.

Surgical intervention is necessary for those in whoman ongoing source of contamination like enteric leak is identified.

Methodology

METHODOLOGY

A Prospective study of 100 patients admitted in Coimbatore Medical College Hospital from August 2013 to August 2014 in the Department of General Surgery who underwent elective abdominal surgeries.

- Thorough physical examination would be done for all patients underwent thisstudy.
- Patients would be evaluated with routine clinical examination and biochemical investigations.
- All patients with are carefully monitored for the presence of pain,redness, induration, wound discharge and fever.
-Pus culture and sensitivity from wound discharge done to find out common organism causing SSIs.
-Guidelines for prevention of SSIs are followed strictly.

Inclusion criteria

- Adult male and female patients
- Patients undergoingelective abdominal surgical procedure
- Patients with comorbid conditions like diabetes, hypetension.

Exclusion criteria

- Immunocompromised individuals

- Children

Method of collection of data:

PRE OPERATIVE EVALUATION CHART:

Age / sex	POH	Diagnosis	BMI	Co-morbid conditions

OPERATIVE FACTORS EVALUATION:

Type of Anaesthesia	Wound class	Surgery	Use of drain or mesh

POST OPERATIVE EVALUATION CHART:

Sign of SSI	Day of presentation	POH	Cultured micro organisms

Prophylactic antibiotics:

Third generation cephalosporin cefotaxime is routinely given to all patients underwent this study 30 minutes before surgery.

Pre operative preparation:

Shaving the operative area the night before surgery. All patients were advised to take bath with soap on the day of surgery.

Aseptic precautions in the operation theatre:

Routine aseptic precautions are followed like autoclaved gowns, sterile drapes, gloves and instruments used. Standard surgical scrub was done for 4 minutes before performing the surgery.

Operative Care:

Operative area was painted routinely using povidone iodine and spirit. Tissue handling was kept minimum and complete hemostasis secured for all surgeries.

Closed suction drain was used whenever necessary. Skin was closed using either using suture material or stapler. Povidone iodine ointment was used for local application and wound covered using adhesive dressings.

Post operative care:

Injection cefotaxime was continued in the postoperative period. The wound was inspected for the signs of inflammation after 48hrs till the day of discharge.

The criteria for SSI was based on CDC definition. Daily dressing done under strict aseptic precautions. Wound swab from infected wounds were taken and sent to microbiological laboratory for culture. The incidence rate were calculated separately for each wound class.

Figure 16 : Irreducible Incisional Hernia

Figure 17 : Post Operative Wound Status on Day 5

Figure 18 : Umbilical Hernia

Figure 19 : Wound Status on Post Operative Day 6

Results

RESULTS

This study includes 100 elective abdominal surgical patients out of which 11 patients were found to have SSIs.

TABLE 18 : INCIDENCE OF SSI

SSI	No of patients	Percentage
Not present	89	89
Present	11	11
Total	100	100

Figure 20 : INCIDENCE OF SSI

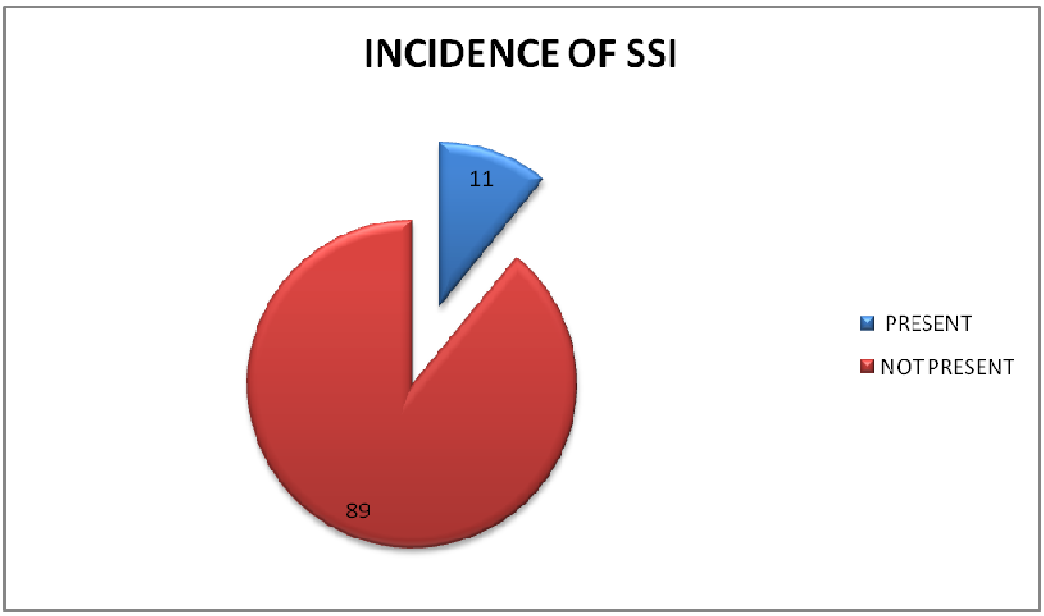
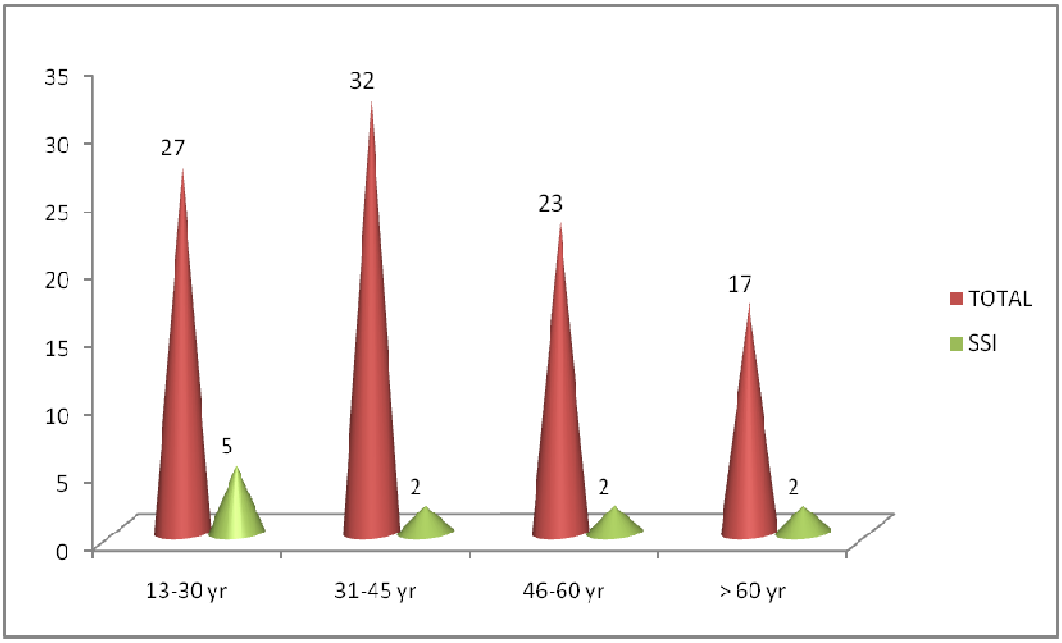


TABLE 19: INCIDENCE IN RELATION TO AGE GROUP

AGE	INFECTION		TOTAL NO OF PATIENTS
	Not present / Percentage	Present / Percentage	
13-30	22 81.48%	5 18.51%	27
31-45	30 93.75%	2 6.25%	32
46-60	22 91.66%	2 8.33%	24
➢ **60**	15 88.23%	2 11.76%	17
TOTAL	89 89%	11 11%	100

FIGURE 21: INCIDENCE IN RELATION TO AGE GROUP



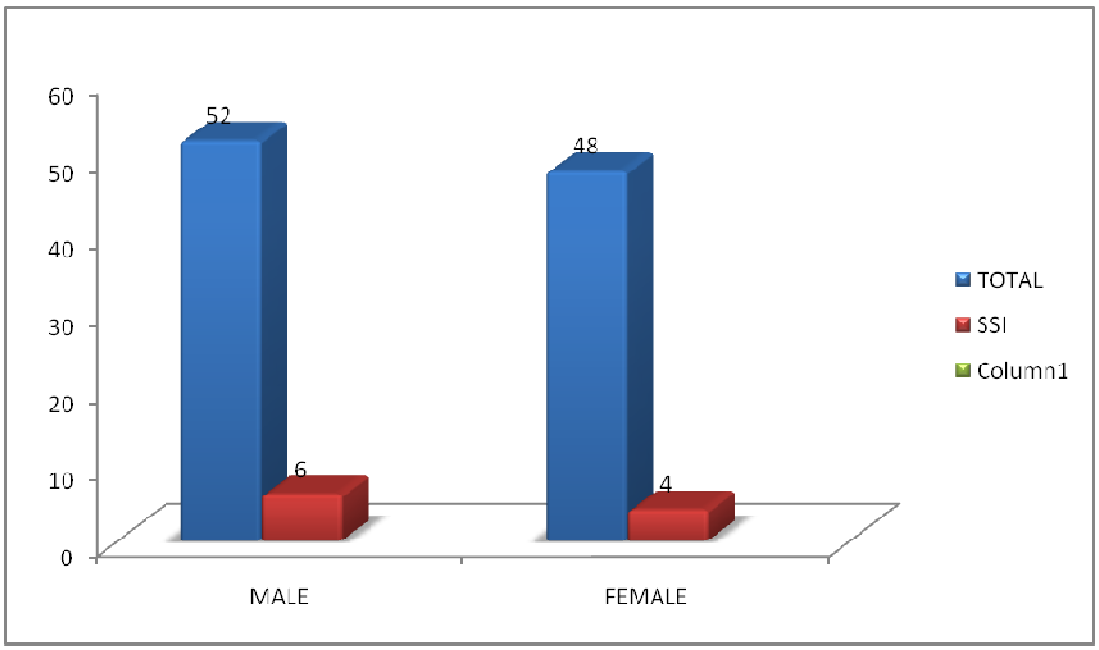
In this study, out of 27 patients in age group 13-30year, 5 patients developed SSI; 2 patients out of 33 in 31-45 year age group developed wound infection; 2 patients out of 23 developed SSI in 46-60 year age group; out of 17 patients in the age group of above 60 year 2 patients developed SSI.

On analyzing the incidence of SSI according to the data obtained from this study, it was found that the incidence is more in the age group of 13-30 year who are all coming under class II wound classification followed by increased incidence among age group of more than 60 years.

TABLE 20: INCIDENCE IN RELATION TO SEX

SEX	INFECTION		TOTAL
	Not present	Present	
MALE	46 (88.46%)	6 (11.53%)	52
FEMALE	43 (89.58%)	5 (10.41%)	48
TOTAL	89	11	100

FIGURE 22 : INCIDENCE IN RELATION TO SEX

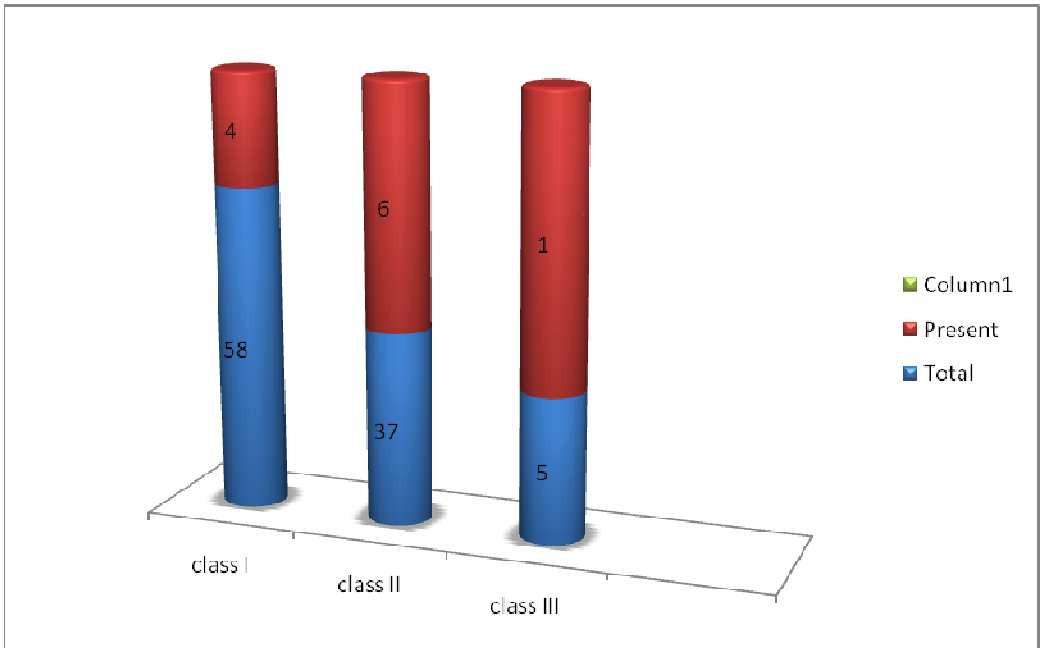


In this study it was found that there is male preponderance for post operative wound infections which is statistically significant.

TABLE 21: INCIDENCE IN RELATION TO WOUND CLASS

WOUND CLASS	INFECTION		TOTAL NO OF CASES
	Not present	Present	
I	54 (93.10%)	4(6.89%)	58
II	31 (83.78%)	6(16.21%)	37
III	4(80%)	1 (20%)	5
TOTAL	89	11	100

FIGURE 23 : INCIDENCE IN RELATION TO WOUND CLASS

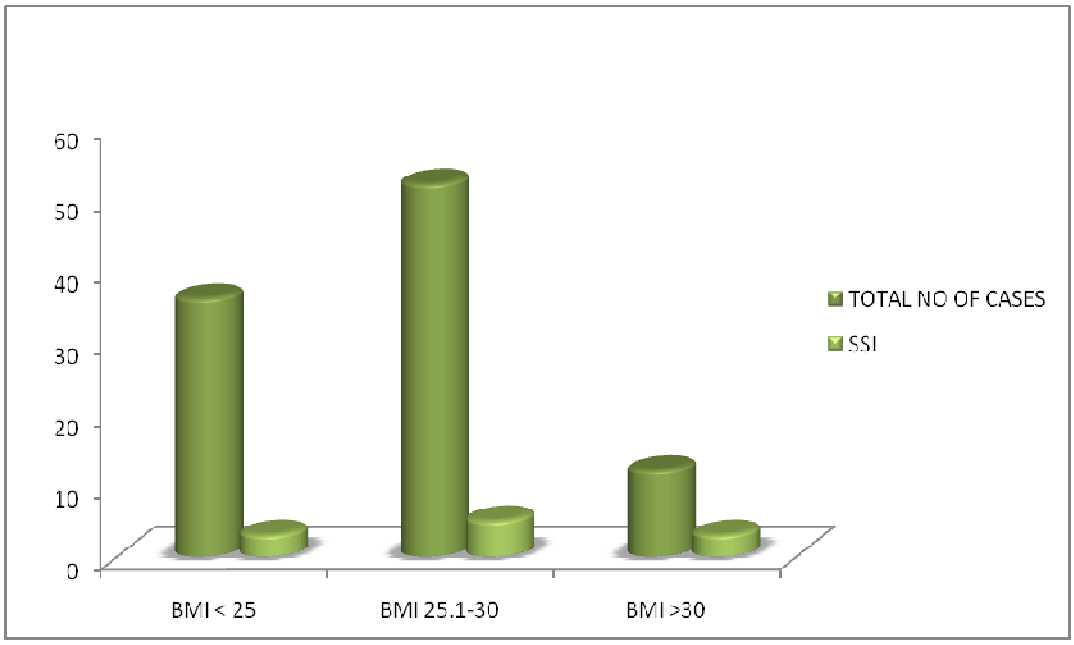


In this study we had 58 patients in class I,37 in class II and 5 in classIII. Class IV patients are not coming under this study. About 6.89% of class I, 16.21% of class II & 20% of class III are found to develop post operative wound infection.

TABLE 22: INCIDENCE OF SSI IN RELATION TO BMI

BMI	NO OF CASES	INFECTED	PERCENTAGE
<25	36	3	8.33%
25- 30	52	5	9.61%
> 30	12	3	25%
TOTAL	100	11	

FIGURE 24: INCIDENCE OF SSI IN RELATION TO BMI:

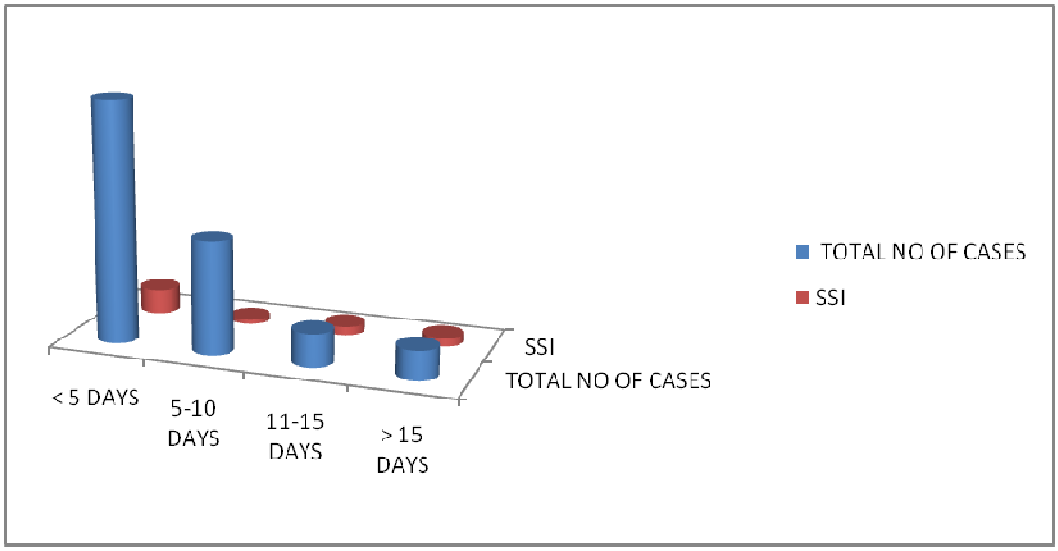


According to the data obtained in this study most people belong to the category with BMI of 25-30. SSI is more common among people having BMI more than 30.

TABLE : 23 INCIDENCE IN RELATION TO PREOP HOSPITALISATION

NO OF DAYS	NO OF CASES	SSI	PERCENTAGE
< 5	58	6	10.34%
5-10	27	1	3.70%
11-15	8	2	25%
> 15	7	2	28.57%
TOTAL	100	11	

FIGURE 25: INCIDENCE IN RELATION TO PREOP HOSPITALISATION

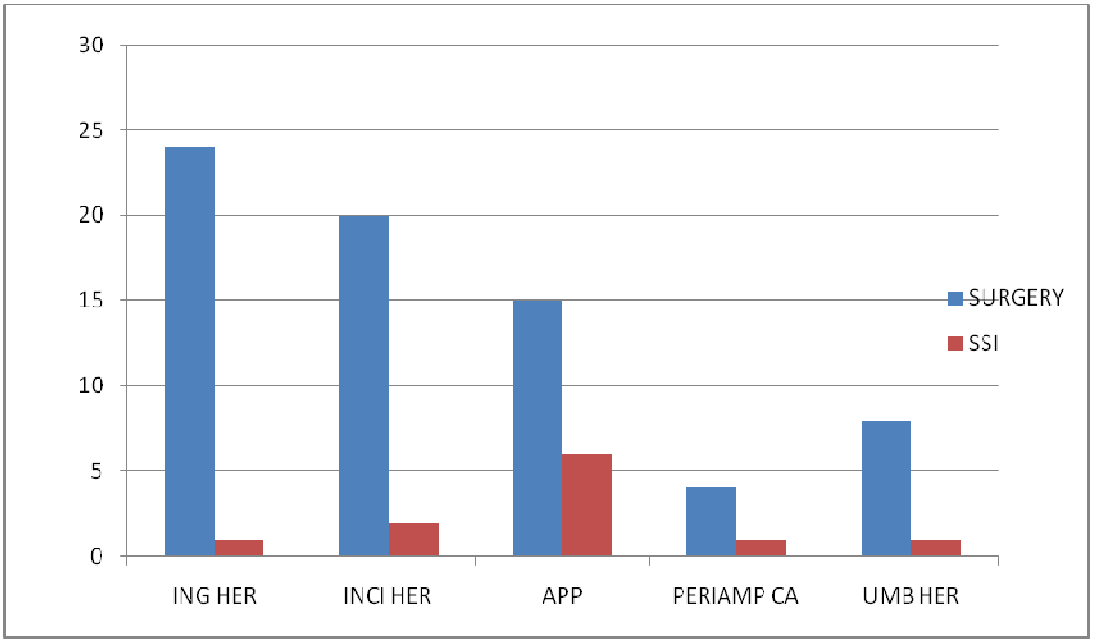


Among 11 patients who developed wound infection, incidence is 10.34% if pre operative hospitalization is less than 5 days; 3.7% if POH is 5-10 days; 25% if POH is 11-15 days and in cases with POH if more than 15 days incidence is 28.57%.

TABLE 24: INCIDENCE IN RELATION TO DIAGNOSIS

SURGERY DONE	NO OF CASES	INCIDENCE	PERCENTAGE
INGUINAL HERNIOPLASTY DONE	24	1	4.16%
INCISIONAL HERNIA REPAIR DONE	20	2	10%
ELECTIVE APPENDISECTOMY	15	6	40%
PERIAMPULLARY CARCINOMA TRIPLE ANASTOMOSIS DONE	4	1	25%
UMBILICAL HERNIA REPAIR DONE	8	1	12.5%

FIGURE 26: INCIDENCE IN RELATION TO DIAGNOSIS

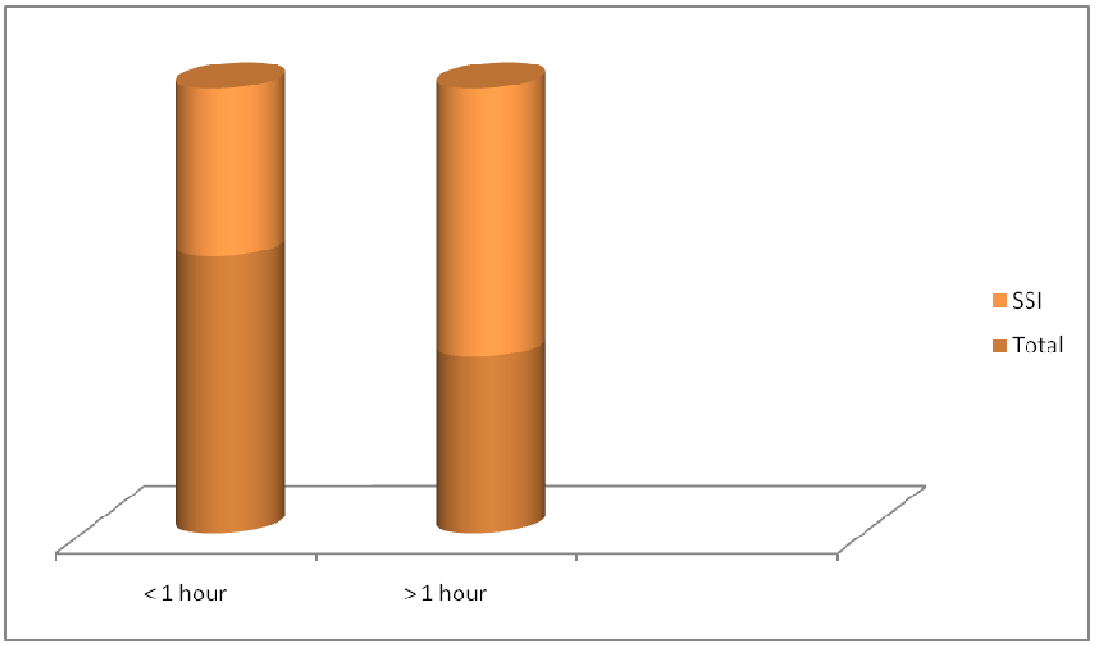


In this study, SSI is found to be in 1 out of 24 cases of Inguinal Hernioplasty; 2 out of 20 cases of incisional hernia repair ;6 out of 15 cases of appendisectomy; 1 out of 4 in periampullary carcinoma patients and 1 out of 8 cases of umbilical hernia repair.

TABLE 25 : INCIDENCE IN RELATION TO DURATION OF SURGERY

DURATION OF SURGERY	NO OF CASES	INCIDENCE	PERCENTAGE
< 1 hour	49	4	8.16%
> 1 hour	51	7	13.72%
TOTAL	100	11	

FIGURE 27: INCIDENCE IN RELATION TO DURATION OF SURGERY

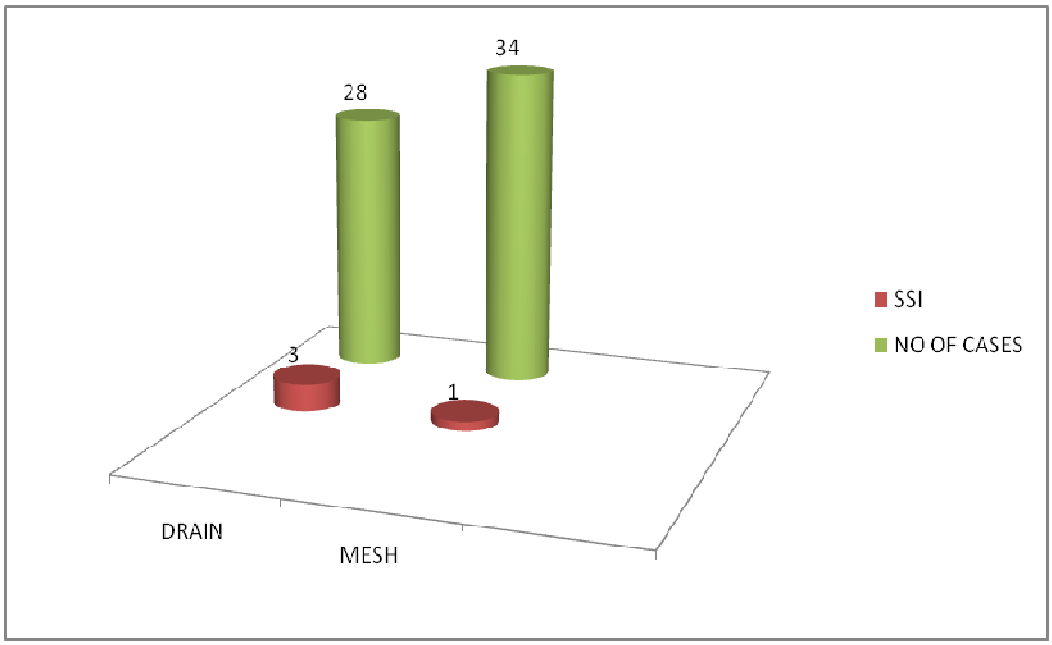


The incidence of wound infections is 8.16% if duration of surgery is less than 1 hour whereas incidence is increased to 13.72% if duration of surgery exceeds 1 hour.

TABLE 26 : INCIDENCE IN RELATION TO USE OF DRAIN AND MESH

	NO OF CASES	INFECTION	PERCENTAGE
DRAIN	28	3	10.71%
MESH	24	1	4.16%

FIGURE 28 : INCIDENCE IN RELATION TO USE OF DRAIN AND MESH

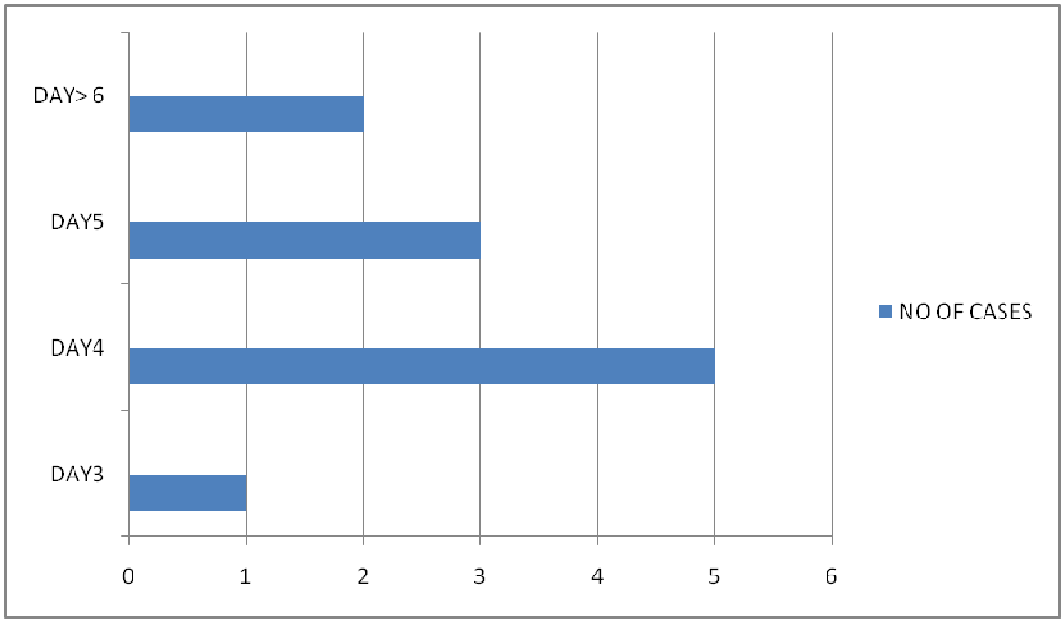


In patients in whom drain is used, the incidence of SSI found to be 10.71%; if mesh is used incidence is 4.16%. This incidence accounts to increased tissue handling by the trainees.

TABLE 27: INCIDENCE OF INFECTION NOTED ON POSTOPERATIVE DAY

DAY	NO OF CASES	PERCENTAGE
II DAY	0	
IIIDAY	1	9.09%
IV DAY	5	45.45%
V DAY	3	27.27%
> VI DAY	2	18.18%
TOTAL	11	

FIGURE 29: INCIDENCE OF INFECTION NOTED ON POSTOPERATIVE DAY

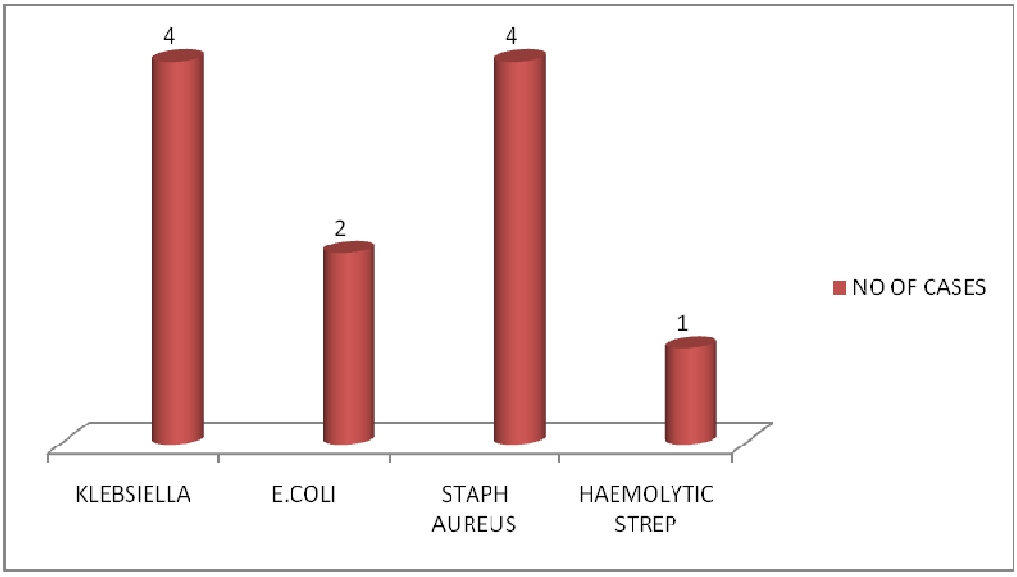


Wound infection presented on day 3 is 9.09%; day 4 is 45.45%; day 5 is 27.27% and after 5 days is 18.18%. None of them were presented on day 2 because of the effective pre operative prophylactic care.

TABLE 28 : INCIDENCE IN RELATION TO MICROORGANISMS ISOLATED

ORGANISMS	NO OF CASES	PERCENT
KLEBSIELLA	4	36.36%
E.COLI	2	18.18%
STAPH. AUREUS	4	36.36%
β-HAEMOLYTIC STREPTOCOCCI	1	9.09%
TOTAL	11	

FIGURE 30 : INCIDENCE IN RELATION TO MICROORGANISMS ISOLATED



In this study, common micro organisms isolated from culture of the wound are Klebsiella and Staphylococcus aureus followed by E.Coli and β- hemolytic streptococci.

Discussion

DISCUSSION

In developing countries, no proper study, surveillance or feedback available regarding the incidence of SSIs. Most of the studies are conducted in isolation and the rate of SSIs varyfrom institution to institution, which warrants a united approach to develop and adopt certain strategies to overcome this ever menacing problem.

In this study out of 100 patients,SSI occurs in 11 patients. This incidence is found to be higher than that in western countries such as United Kingdom (3.1%), Holland (4.3%), etc.

Age related incidence of SSI in this study shows higher in the 13-30 year age group followed by more than 60 year age group. The increased incidence among those in the age group of 13-30 year accounts to their presence in the wound class II in which SSI is more. But the overall incidence of SSI does not differ significantly in each age group. Hence according to this study age of the patient does not affect the incidence of SSIs significantly.

In sexwise incidence, there is higher incidence in seen in males. This is because of the presence of additive risk factors like smoking, systemic illness more among males.

The incidence of SSI in our study is 11% whichfavourably compares with studies of Raka et al (12%) and Razavi et al (17.4).

INCIDENCE IN RELATION TO OTHER STUDIES

	Present study	**Raka et al**	**Razavi et al**
No of cases	100	225	802
No of cases infected	11	27	139
Incidence	11%	12%	17.4%

The rate of SSI incidence differed by wound classification in our study. The maximum number of incidence of SSI noted in class II followed by class III wounds. We had no class IV wound included in this study as this study involves only elective abdominal surgeries. Because of the need of more tissue handling in class I wound ,there is relative increased incidence of wound infection seen in these cases.

In this study, obese individuals with BMI > 30 have increased incidence compared to those with less BMI. Similar results were obtained in Hoer Jet al study. This is mainly due to the decrease in blood circulation in fat tissues.

According to this study, the incidence of wound infections is significantly higher in those with pre operative hospitalisation of more than 10days. This is attributed to the possibility of colonization of patients with nosocomial strains during the hospital stay. There is possibility of having reduced nutritional food intake which is an additive factor for development of SSIs in those cases.

Antibiotic prophylaxis reduces the rate of SSIs significantly in this study. It reduces the microbial burden of the intra operative contamination to a level that can be handled by host defence mechanisms. In this study we found that prophylactic administration of antibiotics half an hour before the surgery wound bring best results in reducing the incidence of SSIs.

However there is significant correlation observed from this study between duration of surgery and the incidence of SSIs. The risk of SSI increases when the duration of surgery is more than 60 minutes. This is attributable to the explanation that prolonged exposure of tissues and prolonged tissue handling make the tissues more vulnerable to the incidence of wound infection.

The presentation of SSI at the earliest time according to this study is on 3rd post operative day. Most cases of wound infection presented on day 5 because of the prophylactic measures used.

In this study the bacteriological profile showed that the commonest organisms isolated from the culture are klebsiella and staphylococcus aureus. It also showed that commonly there is single organism involved in causing SSIs.

Conclusion

CONCLUSION

1. Incidence of SSIs in elective abdominal surgeries in our hospital is found to be 11%.

2. Age group of 45year and above are found to be more susceptible in developing wound infections.

3. Patients with BMI > 30 have increased incidence of SSIs in this study.

4. In prolonged pre operative hospitalization there is increased occurrence of SSI in this study.

5. This study does not reveal any statistically significant correlation between sex and the type

6. If the duration of surgery is prolonged, the incidence of wound infections were found to be higher.

7. There is increased incidence of wound infection if drain is used.

Bibliography

BIBLIOGRAPHY

1. David J. Leaper. 2004. “Surgical infection.” Bailey & Love’s short practice ofsurgery, 25th edition, p 32-48.

2. Breasted D: The Edwin Smith Surgical papyrus. University of Chicago: University of Chicago press; 1930(as quoted by Singhal H: wound infection. E-medicine)

3. Bryan PW: The Papyrus Ebers. London/Washington DC: Government Printing Office; 1883. (as quoted by Singhal H: wound infection. E-medicine)

4. Cohen IK: A brief history of wound healing Ist ed. Yardly , Pa: Oxford clinical communications Inc ; 1998

5. Helling TS, Daon E : In Flanders fields : the Great war , Antoine Depage, and the resurgence of debridement. Ann Surg 1998 Aug ; 228 (2): 173-81

6. Ad hHoc committee on Trauma, Division of Medical Sciences, National Academy of sciences, National Research Council 'Post operative wound infections. The influence of ultraviolet irradiation of the operating room and of various other factors'. Ann surg 1964; 160 (Supp 13); 1-32.

7. Williams. R.E.O., McDonald. J.C., Blowers. R. 'Incidence of surgical wound infection in England and Wales; a report of the Public Health Laboratory Service', The Lancet 1960; 2: 659-63.

8. Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. *Arch Surg*1973; 107:206-10.

9. Olson M.M., James. T.Lee 'Continuous, 10-year wound Infection Surveillance; results, advantages and unanswered questions' Arch Surg. 1990: 794-803.

10. Anvikar. A.R., Deshmukh A.B. et al, 'A one year prospective study of 3280 surgical wounds' I.J.M.M. 1999; 17 (3) 129-32.

11. Hernandez K, Ramos E, Seas C, Henostroza G, Gotuzzo E. Incidence and risk factors for surgical-site infections in a Peruvian hospital. Infect Control HospEpidemiol. 2005 May; 26(5):473-7.

12. Iñigo JJ, Bermejo B, Oronoz B, Herrera J, Tarifa A, Pérez F, et al. Surgical site infection in general surgery: 5-year analysis and assessment of the National Nosocomial Infection Surveillance (NNIS) index. Cir Esp. 2006 Apr; 79(4):199-201

13. Emori TG, Gaynes RP: An overview of nosocomial infections , including the role of microbiology laboratory. ClinMicrobiol Rev 1993 Oct; 6(4): 428-42

14. Mayon-White RT, Ducel G, Kereselidze T : An international survey of prevalence of hospital-acquired infection. J Hosp Infect 1988 Feb; 11 suppl A: 43-8

15. National Nosocomial Infections Surveillance (NNIS) report, data summary from October 1986-April 1996, issued May 1996. A report from the NNIS system Am J Infect Control 1996 Oct; 24(5): 380-8

16. Di Leo A, Piffer S, Ricci F , et al. Surgical site infections in an Italian surgical ward : a prospective study . Surg Infect (Lachmt). Aug 18 , 2009 [Medline]

17. Margram AJ, Horan TC, Pearson ML: Guideline for prevention surgical site infection , 1999. Hospital infection control practices Advisory Committee. Infect Control HospEpidemiol 1999 Apr; 20(4) : 250-78 ; quiz 279-80

18. Mahmoud, N.Kulaylat, merrilT.Dayton. Surgical complications. In Townsend CM, Sabiston Textbook of Surgery Book I Eighteenth edition. Saunder; 2008: 328-370

19. National Nosocomial Infections Surveillance (NNIS) System. NNIS report, data summary from January 1992 to June 2002, issued August 2002. Am J Infect Control Dec 2002 ; 30(8): 458-75. [Medline]

20. Krizek TJ, Robson MC: Evolution of quantitative bacteriology in wound management . Am J Surg 1975 Nov; 130(5): 579-84

21. Weiss CA, Statz CI, Dahms RA et al . Six year of surgical wound surveillance at a tertiary care centre . Arch Surg 134: 1041-1048, 1999

22. HabteGabr E, Gedeben M, Kronvall G. Hospital acquired infections among surgical patients in TikurAnbersahospital, Addis Ababa, Ethiopia Am J Infect Control 1988; 7-13

23. Cruse PJE, Foord R: A five year Prospective Study of 23649 Surgical wounds Arch Surg 107: 206, 1973.

24.Nagachinta T, Stephans M, Reitz b : Risk factors for Surgical wound infection following Cardiac Surgery . J Infect Dis 156: 967, 1987.

25. Larson E. Guideline for use of topical antimicrobial agents. Am J Infect Control1988; 16:253-66

26.Ritter MA, French ML, Eitzen HE, Gioe TJ. The antimicrobial effectiveness ofoperative-site preparative agents: a microbiological and clinical study. J Bone Joint Surg Am 1980; 62(5):826-8.

27. Cruse PJ, Foord R. The epidemiology of wound infection: a 10-year prospectivestudy of 62,939 wounds. SurgClin North Am 1980; 60(1): 27-40.

28. Mishriki SF, Law DJ, Jeffery PJ. Factors affecting the incidence of postoperative wound infection. J Hosp Infect 1990; 16:223-30.

29.Seropian R, Reynolds BM. Wound infections after preoperative depilatory versus razor preparation. Am J Surg 1971; 121:251-4.

30. Mehta G, Prakash B, Karmoker S. Computer assisted analysis of wound infection in neurosurgery. J Hosp Infect 1988; 11:244-52

31.Hamilton HW, Hamilton KR, Lone FJ. Preoperative hair removal. Can J Surg1977; 20:269-71, 274-5.

32. Cruse PJ, Foord R. The epidemiology of wound infection: a 10-year prospectivestudy of 62,939 wounds. SurgClin North Am 1980; 60(1): 27-40.

Annexures

PROFORMA

Name: DOA:

Age/ Sex: DOS:

Occupation: DOD:

Address:

CHIEF COMPLANTS:

1.Pain and swelling over the wound site

2.wound discharge

3.fever

PAST HISTORY:

1. H/O DM/ HTN/ Asthma/ TB/ Epilepsy
2. H/O previous surgery
3. H/O drug intake

PERSONAL HISTORY:

Smoker/ Alcoholic.

Bowel and bladder habits, sleep pattern.

GENERAL PHYSICAL EXAMINATION:

1. Hydration
2. Nutritional status
3. Pallor
4. Icterus
5. Cyanosis/ clubbing/ edema
6. Generalized/ regional lymphadenopathy
7. Pulse rate
8. Blood pressure.

SYSTEMIC EXAMINATION:

- PER ABDOMEN:

  Inspection

  Palpation

  Percussion

  Auscultation

- RESPIRATORY SYSTEM:

  Inspection

  Percussion

  Auscultation

- CARDIOVASCULAR SYSTEM:

  Inspection

  Palpation

  Auscultation

- CENTRAL NERVOUS SYSTEM:

  Consciousness

  Orientation

  Higher mental functions.

DIAGNOSIS

INVESTIGATIONS:

-Complete haemogram,

-Random blood sugar, blood urea, serum creatinine

- Pus culture and sensitvity

MANAGEMENT**:**

- Routine wound care
- Appropriate antibiotics

CONSENT FORM

It has been explained to me in my mother tongue and I completely understand my condition, its related complications and the treatment options available. I have been explained in detail regarding this study **"Study on surgical site infections in elective abdominal surgeries".** I hereby give my consent to participate in the above mentioned study.

DATE: SIGNATURE OF THE PATIENT

PLACE:

<u>ஒப்புதல் படிவம்</u>

பெயர் :

பாலினம் : வயது :

முகவரி :

அரசு கோவை மருத்துவக் கல்லூரியில் பொது அறுவை சிகிச்சை துறையில் பட்ட மேற்படிப்பு பயிலும் மாணவி மேற்கொள்ளும் "**வயிற்றுப் பகுதியில் அறுவை சிகிச்சைக்குப் பின் கிருமி தாக்கு ஏற்படுதல்**" குறித்த ஆய்வில் செய்முறை மற்றும் அனைத்து விவரங்களையும் கேட்டுக் கொண்டு எனது சந்தேகங்களை தெளிவுப்படுத்திக் கொண்டேன் என்பதை தெரிவித்துக் கொள்கிறேன்.

நான் இந்த ஆய்வில் முழு சம்மதத்துடனும், சுய சிந்தனையுடனும் கலந்து கொள்ள சம்மதிக்கிறேன்.

இந்த ஆய்வில் என்னுடைய அனைத்து விபரங்கள் பாதுகாக்கப்படுவதுடன் இதன் முடிவுகள் ஆய்விதழில் வெளியிடப்படுவதில் ஆட்சேபனை இல்லை என்பதை தெரிவித்துக் கொள்கிறேன். எந்த நேரத்திலும் இந்த ஆய்விலிருந்து நான் விலகிக் கொள்ள எனக்கு உரிமை உண்டு என்பதையும் அறிவேன்.

இடம் : கையொப்பம் / ரேகை

நாள் :

MASTER CHART

S.NO	NAME	AGE	SEX	IP NO	POH	POS	DIAGNOSIS	SURGERY	ANAES	BMI	DOPS	WC	POS	upto 48 hrs	3rd day	4 th day	5 th day	6th day	7th day	CMO	
1	thilagavathy	46	f	45755	3	5	incisional hernia	open onlay mesh repair	SA	29	40min	I	5days								
2	jothilakshmi	46	f	44241	3	5	subacute appendicitis	Open appendisectomy	GA	30	50min	II	4 days			discharge				β hemo strep	
3	Ranganathan	33	m	42207	3	8	Incisional hernia	open onlay mesh repair	SA	30	60min	I	9days								
4	maindhan	22	m	52079	3	3	subacute appendicitis	lap appendisectomy	GA	25	45min	II	4days								
5	antony	21	m	52046	5	5	undescended testis	lap orchidopexy	GA	18	40min	I	6days								
6	murugan	44	m	54902	3	4	b/l inguinal hernia	stoppa's procedure	SA	28	1hr35min	I	5days								
7	mani	75	m	53724	9	2	lt inguinal hernia	lt inguinal hernioplasty	SA	24	60 min	I	2days								
8	kaliveeran	77	m	48847	29	10	carcinoma stomach	distal gastrectomy	GA	20	1hr25min	II	11days								
9	bangaru	50	m	58851	10	3	umblical hernia	lap mesh repair	SA	34	40 min	I	4days								
10	duraisamy	61	m	58212	13	3	b/l inguinal hernia	b/l inguinal hernioplasty	SA	24	1hr 30min	I	3days								
11	mithun	13	m	69114	4	4	subacute appendicitis	open appendisectomy	GA	19	60min	II	4days						pus	klebsiella	
12	arun prakash	35	m	75913	13	6	pseudocyst of pancreas	cystogasrostomy done	GA	21	50min	III	4days								
13	venkatachalam	65	m	1512	3	3	left inguinal hernia	lt inguinal hernioplasty	SA	25	45min	I	6days								
14	krishnakumar	42	m	6568	2	5	rt inguinal hernia	rt inguinal hernioplasty	SA	30	1hr	I	3days								
15	ramesh	23	m	8945	6	1	rt inguinal hernia	rt inguinal hernioplasty	SA	19	50min	I	5days								
16	subash	51	m	10494	2	3	lt inguinal hernia	lt inguinal hernioplasty	SA	25	1hr	I	3days								
17	feroz khan	54	m	16651	3	3	lt inguinal hernia	lt inguinal hernioplasty	SA	29	1hr 10min	I	3days								
18	kumar	34	m	17279	2	3	lt inguinal hernia	lt inguinal hernioplasty	SA	27	1hr 15 min	I	3days								
19	ravi kumar	35	m	19685	5	4	rt inguinal hernia	rt inguinal hernioplasty	SA	27	50min	I	4days								
20	chinnasamy	67	m	22817	15	4	b/l inguinal hernia	b/l inguinal hernioplasty	SA	24	1hr 30min	I	4days								
21	stephen	65	m	27434	2	6	umblical hernia	lap mesh repair	GA	32	45min	I	6days								
22	vellingiri	52	m	32008	12	10	duodenal growth	anterior gastrojejunostomy	GA	26	50min	II	10days								
23	siva kumar	28	m	37007	12	10	rt sliding hernia	rt inguinal hernioplasty	SA	24	1hr	I	10days								
24	Ranganathan	55	m	41857	2	4	incisional hernia	open onlay mesh repair	SA	30	1hr 10min	I	7days								
25	chinnagurusam	55	m	41885	2	4	rt inguinal hernia	rt inguinal hernioplasty	SA	28	1hr 20min	I	4days								
							with incisional hernia	with open onlay mesh repair				I									

26	rangasamy	49	m	40145	12	4	umblical hernia	open onlay mesh repair	SA	27	50min	I	4days									
27	ayyavu	70	m	43502	4	5	rt inguinal hernia	rt inguinal hernioplasty	SA	23	1hr	I	5days									
28	kaliappan	36	m	43517	2	4	subacute appendicitis	lap appendisectomy	GA	29	1hr 15 min	II	4days									
29	prabu	15	m	43801	4	4	subacute appendicitis	lap appendisectomy	GA	17	1hr	II	4days									
30	marudhachalar	72	m	45081	5	3	lt sliding hernia	lt inguinal hernioplasty	SA	31	1hr 10min	I	16days			discharge				staph aureus		
31	ravikumar	24	m	45094	5	3	subacute appendicitis	lap appendisectomy	GA	27	1hr 15min	II	3days									
32	jeyaraman	45	m	45123	5	4	rt inguinal hernia	rt inguinal hernioplasty	SA	30	50min	I	4days									
33	jeyakumar	36	m	45071	9	3	lipoma epigastric region	enucleation	LA	28	30min	I	3days									
34	solairaj	32	m	48145	9	3	epigastric hernia	open onlay mesh repair	SA	24	45min	I	3days									
35	chandrasekar	75	m	43495	23	6	periampullary carcinoma	triple bypass	GA	27	1hr 30 min	III	16 days				discharge			E.Coli		
36	ammasai	55	m	49509	2	3	b/l inguinal hernia	b/l inguinal hernioplasty	SA	30	1hr 45 min	I	3days									
37	murugaperuma	33	m	52707	2	2	subacute appendicitis	open appendisectomy	GA	31	1hr 20min	II	5 days				discharge			E.Coli		
38	kanmayan	62	m	51131	1	3	umblical hernia	open onlay mesh repair	SA	32	55min	I	3days									
39	sethyeacelen	33	m	52342	2	3	paraumbilical hernia	open onlay mesh repair	SA	29	45min	I	4days									
40	rajasekar	28	m	54132	2	6	umblical hernia	open onlay mesh repair	SA	29	40min	I	7days									
41	murugesan	44	m	53445	2	6	rt inguinal hernia	rt inguinal hernioplasty	SA	30	1hr	I	7days									
42	dharaniya	16	f	49073	2	2	subacute appendicitis	lap appendisectomy	GA	17	1hr 10min	II	2days									
43	nageshwari	40	f	50413	10	7	calculous cholecystitis	lap cholecystectomy	GA	32	1hr 20min	II	7days									
44	yaseema	50	f	13489	1	7	acute cholecytitis	lap cholecystectomy	GA	34	1hr 15min	II	7days									
45	alageshwari	28	f	67588	4	8	umblical hernia	open onlay mesh repair	SA	30	45min	I	8days									
46	fathima	30	f	68945	2	15	incisional hernia	open onlay mesh repair	SA	32	1hr	I	15days									
47	shanthi	39	f	73841	5	12	paraumbilical hernia	open onlay mesh repair	SA	20	50min	I	12days									
48	mariyayee	57	f	69022	12	19	periampullary carcinoma	triple bypass	GA	28	1hr40min	II	19days									
49	shanthi	40	f	5919	5	3	calculous cholecystitis	lap cholecystectomy	GA	32	1hr 10min	II	3days									
50	selvi	37	f	5895	8	6	umblical hernia	open onlay mesh repair	SA	31	45min	I	3days									
51	saroja	65	f	8761	3	8	incisional hernia	open onlay mesh repair	SA	30	1hr	I	4days									
52	joice	36	f	8919	2	4	subacute appendicitis	lap appendisectomy	GA	25	1hr 10 min	II	4days									

53	annai	15	f	12194	1	4	subacute appendicitis	open appendisectomy	GA	18	1hr	II	4days			discharge				klebsiella	
54	baby	50	f	12097	9	4	recurrent sub acute	lap adhesiolysis	GA	32	1hr	I	4days								
							intestinal obstruction														
55	vasantha	65	f	11935	12	26	carcinoma stomach	distal gastrectomy with billro	GA	35	1hr 40min	III	26days								
56	lakshmi	54	f	15137	9	3	calculous cholecystitis	lap cholecystectomy	GA	30	1hr 15min	II	3days								
57	jothimani	26	f	16627	5	3	epigastric hernia	open onlay mesh repair	SA	23	40min	I	3days								
58	femina	30	f	17427	2	5	calculous cholecystitis	lap cholecystectomy	GA	27	1hr 10min	II	3days								
59	rajeshwari	30	f	18445	10	5	incisional hernia	open onlay mesh repair	SA	29	50min	I	5days								
60	sabeena	14	f	19700	5	2	acute appendicitis	lap appendisectomy	GA	19	1hr 10min	II	2days								
61	nancy	26	f	21288	4	11	calculous cholecystitis	lap cholecystectomy	GA	28	1hr 15min	II	11days								
62	muthulakshmi	29	f	20141	15	8	incisional hernia	open onlay mesh repair	SA	22	1hr	I	4days								
63	eswari	45	f	19704	19	16	carcinoma stomach	distal gastrectomy with billro	GA	26	1hr 20min	III	16days								
64	lakshmi	60	f	24372	9	6	gall bladder polyp	lap cholecystectomy	GA	28	1hr 10min	II	6days								
65	kalpana	25	f	24352	9	5	calculous cholecystitis	lap cholecystectomy	GA	25	1hr 10min	II	3days								
66	valliyammal	70	f	25933	7	18	periampullary carcinoma	triple bypass	GA	25	1hr 30min	III	18days								
67	lakshmi	45	f	30563	1	14	port site incisional hernia	open onlay mesh repair	SA	34	1hr 10 min	I	14days								
68	jaibunisha	55	f	20547	1	7	recurrent incisional herni	open onlay mesh repair	SA	22	1hr 10min	I	7days								
69	ayyammal	49	f	28930	19	7	incisional hernia	open onlay mesh repair	SA	27	1hr 15min	I	3days								
70	rajeshwari	32	f	38538	1	4	post operative adhesive	lap adhesiolysis	GA	28	1hr	I	4days								
							intestinal obstruction														
71	malar kodi	45	f	40210	5	8	incisional hernia	open onlay mesh repair	SA	30	1hr 10min	I	4days								
72	manickam	52	f	41876	5	7	calculous cholecystitis	lap cholecystectomy	GA	28	1hr 15min	II	4days								
73	padmavathy	15	f	45090	2	5	subacute appendicitis	lap appendisectomy	GA	19	1hr 10min	II	4days								
74	sasikala	26	f	46607	2	6	incisional hernia	open onlay mesh repair	SA	29	1hr 15min	I	6days								
75	kaliammal	48	f	46611	2	8	calculous cholecystitis	lap cholecystectomy	GA	26	1hr 10min	II	8days								
76	kasthuri	15	f	47971	2	2	acute appendicitis	open appendisectomy	SA	21	1hr	II	2days			edema				klebsiella	
77	renuka	56	f	48073	2	8	incisional hernia	open onlay mesh repair	SA	29	1hr	I	3days								

78	vanpriya	24	f	49514	8	1	chlelithiasis	lap cholecystectomy	GA	27	1hr 15min	II	1day								
79	siva gamy	60	f	51176	5	8	incisional hernia	open onlay mesh repair	SA	30	1hr 10min	I	4days								
80	kamalam	72	f	56063	1	7	incisional hernia	open onlay mesh repair	SA	29	1hr	I	3days								
81	velayudam	65	m	42249	13	17	duodenal growth	triple bypass	GA	24	1hr 45min	III	16days								
82	mohammed ge	55	m	56134	5	9	rt inguinal hernia	rt inguinal hernioplasty	SA	27	1hr	I	10days								
83	manickam	59	m	6713	2	5	carcinoma oesophagus	feeding jejunostomy	SA	19	45min	II	4days								
84	kanagaraj	56	m	26743	12	15	recurrent incisional herni	open onlay mesh repair	SA	34	1hr 10min	I	12 days		discharge					staph aureus	
85	manikandan	48	m	43500	7	14	pseudocyst of pancreas	cystogasrostomy done	GA	23	1hr 10min	II	14days								
86	murugan	48	m	54342	2	3	lt inguinal hernia	lt inguinal hernioplasty	SA	27	1hr 10min	I	3days								
87	devaraj	70	m	55782	2	3	rt inguinal hernia	rt inguinal hernioplasty	SA	27	50min	I	4days								
88	nagammal	76	f	52001	8	5	carcinoma anal canal	sigmoid loop colostomy	SA	17	45min	II	5days								
89	kanaga	26	f	23145	12	5	incisional hernia	open onlay mesh repair	SA	29	1hr 10min	I	3days			redness				klebsiella	
90	mangalam	40	f	46534	9	6	port site incisional hernia	open onlay mesh repair	SA	30	1hr 15min	I	4days								
91	mehrol	33	m	53477	5	5	b/l inguinal hernia	b/l inguinal hernioplasty	SA	26	1hr 40min	I	4 days								
92	mariammal	25	f	50213	2	5	cholelithiasis	lap cholecystectomy	GA	29	1hr 20min	II	3 days								
93	thangaraj	41	m	44534	5	4	carcinoma oesophagus	feeding jejunostomy	SA	20	50min	II	4days								
94	mani	36	m	43201	5	4	rt inguinal hernia	rt inguinal hernioplasty	SA	25	1hr 10min	I	4days								
95	poomani	15	m	50412	5	5	subacute appendicitis	lap appendisectomy	GA	20	1hr	II	6days								
96	biju	20	m	51443	4	3	subacute appendicitis	open appendisectomy	GA	25	1hr 15min	II	2 days					discharge		staph aureus	
97	packiam	42	f	40213	3	9	incisional hernia	open onlay mesh repair	SA	29	1hr 10min	I	9days								
98	panneerselvam	37	m	42312	5	5	rt sliding hernia	rt inguinal hernioplasty	SA	24	1hr	I	5days								
99	parvathy	33	f	43032	1	17	incisional hernia	open onlay mesh repair	SA	27	50min	I	11 days				pus			staph aureus	
100	puniyakodi	60	m	29651	5	6	b/l inguinal hernia	b/l inguinal hernioplasty	SA	29	1hr 30min	I	4 days								

KEY TO MASTER CHART

DOA	→	Date of admission
DOS	→	Date of surgery
DOD	→	Date of discharge
POH	→	Pre operativehospitalisation
ANAES	→	Anesthesia
BMI	→	Body mass index
DOFS	→	Duration of surgery
WC	→	Wound classification
POS	→	Post operative stay
CMO	→	Cultured micro organisms