
**“COMPARATIVE EVALUATION OF PRE OPERATIVE SKIN
PREPARATION OF 4% CHLORHEXIDINE WITH 5%
POVIDONE IODINE IN PREVENTION OF ABDOMINAL
SURGICAL SITE INFECTIONS – A ONE YEAR RANDOMIZED
CONTROLLED TRIAL AT KLES DR PRABHAKAR KORE
HOSPITALS”**

By

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Dissertation

**Submitted to the
KLE University, Belgaum, Karnataka**

**In Partial Fulfillment
of the requirements for the degree of**

**M. S.
in
GENERAL SURGERY**

**Under the Guidance of
Dr. S. S. SHIMIKORE _{MS}
Professor**

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MAY - 2012

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LIST OF ABBREVIATIONS USED

CA	-	Chronic appendicitis
CDC	-	Centres for Disease Control
CHG	-	Chlorhexidine gluconate
EGF	-	Epidermal growth factor
EH	-	Epigastric hernia
FGF	-	Fibroblast growth factor
GU	-	Genitourinary surgery
IGF	-	Insulin like growth factor
IH	-	Inguinal hernia
IL	-	Interleukin
K.PNEUMONIAE	-	Klebsiella pneumoniae
MRSA	-	Methicillin resistant staphylococcus aureus
Mtb	-	Mycobacterium tuberculosis
NINSS	-	Nosocomial infection national surveillance service
NNIS	-	National nosocomial infections surveillance
P. AERUGINOSA	-	Pseudomonas aeruginosa
PDGF	-	Platelet derived growth factor
PSSI	-	Post surgical site infections
PVP	-	Polyvinyl pyrrolidone
SIRS	-	Systemic inflammatory response syndrome
SSI	-	Surgical site infections
TNF	-	Tumor necrosis factor
UH	-	Umbilical hernia
VISA	-	Vancomycin intermediate staphylococcus aureus
VRE	-	Vancomycin resistant enterococci

ABSTRACT

Background and Objectives

Surgical Site Infections is a dangerous condition, a heavy burden on the patient and social health system. The use of pre operative skin preparation by effective antiseptic plays an important role in reducing postoperative wound infections. Hence the present study was undertaken to compare and evaluate the efficacy of 4% Chlorhexidine versus 5% Povidone Iodine in abdominal surgeries for prevention of SSI.

Methodology

The present one year randomized controlled trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2010 to December 2010 on 120 patients undergoing elective abdominal surgeries. The patients were divided into two groups by computer randomization that is Group A (Chlorhexidine group) and Group B (Povidone Iodine group). Samples from skin were collected and quantitative bacterial cultures were done. The surgical wounds were examined for any infections present.

Results

Most of the patients were males in both the groups (73.33% and 61.67% in group A and B respectively). Half of the of the patients (50%) in both the groups had chronic appendicitis. The mean duration of surgery in group A was 44.66 ± 5.86 minutes and in group B it was 45.00 ± 6.24 minutes. Staphylococcus aureus (1.67% in group A and 10% group B) was the most common organism

isolated after skin preparation. After the application of antiseptic agents there was reduction of bacterial colonization in both the groups, but significant reduction was seen in Chlorhexidine group. In group A two patients had superficial SSIs compared to 14 patients in group B ($p=0.001$). The mean length of hospital stay in group A was significantly less (7.20 ± 1.10 vs. 8.67 ± 3.17).

Conclusion and interpretation

Preoperative skin cleansing with chlorhexidine significantly reduces risk of postoperative SSIs and colonization of bacteria in abdominal surgeries.

Keywords

Antiseptic skin preparation; Chlorhexidine; Lower abdominal surgeries; Povidone iodine; Surgical site infections;

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INTRODUCTION

Surgical Site Infections (SSIs) are infections of tissues, organs, or spaces exposed by surgeons during performance of an invasive procedure.¹ Postoperative SSIs remain a major source of illness and a less frequent cause of death in the surgical patient.² These infections number approximately 500,000 per year, among an estimated 27 million surgical procedures,³ and account for approximately one quarter of the estimated two million nosocomial infections in the United States each year.⁴

Surgical site infections is a dangerous condition, a heavy burden on the patient and social health system. Such infections lengthen bed stay for an average of seven days and results in higher costs.⁵ The incidence of infection varies from surgeon to surgeon, from hospital to hospital, from one surgical procedure to another, and most importantly from one patient to another.⁶

Surgical site infections are among the most common hospital acquired infections comprising 14 to 16% of inpatient infections.⁷ Potential sources of infection are the patient (especially contamination by alimentary tract bacteria), hospital environment, food, other patients, staff, infected surgical instruments, dressings, and even drugs and injections.⁸

The use of pre operative skin preparation by effective antiseptic plays an important role in reducing postoperative wound infections.⁹ There are several kinds of antiseptics available for preoperative skin preparation, however povidone iodine and spirit are commonly used in clinical practice.⁹

Normal flora of the skin is of Gram positive organisms like staphylococcus species, streptococcus species, and Gram negative organisms like *P. aeruginosa*, *K. pneumoniae*, both chlorhexidine and povidone iodine are proved to be effective against most skin commensals.¹⁰

Chlorhexidine is a chemical antiseptic with action against both Gram positive and Gram negative microbes. Chlorhexidine is probably the most widely used biocide in antiseptic products, particular in handwashing and oral products but also as a disinfectant and preservative. Chlorhexidine is a bactericidal agent. The uptake of chlorhexidine by *E.coli* and *S.aureus* was very rapid and depended on the chlorhexidine concentration and pH. It is easily available, cheap and easy to use, no adverse reactions have been reported.¹¹

Chlorhexidine antimicrobial effects are due to the attractions between Chlorhexidine (cation) and negatively charged bacterial cells. After Chlorhexidine is absorbed on to the organisms cell wall, it disrupts the integrity of the cell membrane and causes the leakage of intracellular components of the organisms.¹¹

Povidone iodine (Betadine) is an antiseptic solution used topically on skin. It contains polyvinyl pyrrolidone with water, iodide and one percent available iodine. It has bactericidal ability against a large number of pathogens. Povidone iodine function by release of elemental iodine which binds irreversibly with protein. Although less reactive than chlorine, iodine is rapidly bactericidal, fungicidal, tuberculocidal, virucidal, and sporicidal.¹¹

One study done in Thailand showed that chlorhexidine gluconate was more effective than povidone iodine in preventing SSI and reducing bacterial colonization at abdominal surgical sites.⁹

Several studies have shown the advantages of chlorhexidine in pre operative preparations but so far no studies have been done to compare its efficacy versus povidone iodine for abdominal surgeries in India. Hence the present study was undertaken to compare and evaluate the efficacy of chlorhexidine versus povidone iodine in elective abdominal surgeries for prevention of SSI.

OBJECTIVES

The objectives of the present study were to;

1. To compare and evaluate the efficacy of 4% Chlorhexidine versus 5% Povidone Iodine in elective abdominal surgeries for prevention of SSI.
2. To compare bacterial colonization before and after skin preparation with 4% Chlorhexidine versus 5% Povidone Iodine.

REVIEW OF LITERATURE

Surgical Site Infections continues to be a major source of morbidity following operative procedures. The NNIS report for 1986-1996 described an SSI rate of 2.6% for all operations at the reporting hospitals. It seems likely that overall SSI rates are likely to be greater than reported. All surgical wounds are contaminated by bacteria, but only a minority actually demonstrate clinical infection. The SSI are the biological summation of several factors: the inoculum of bacteria introduced into the wound during the procedure, the unique virulence of contaminants, the microenvironment of each wound, and the integrity of the patients host defense mechanisms. Although an SSI rate of zero may not be achievable, continued progress in understanding the biology of infection at the surgical site and consistent applications of proven methods of prevention will allow to further reduce the frequency, cost, and morbidity associated with SSI.¹²

A. Historical perspective

The ancient Egyptians were the first civilization to have trained clinicians to treat physical ailments. Medical papyri, such as the Edwin Smith papyrus (circa 1600 BC) and the Ebers papyrus (circa 1534 BC), provided detailed information of management of disease, including wound management with the application of various potions and grease to assist healing.^{13,14}

Galen (Roman gladiatorial surgeon, 130-200 AD) was first to recognize that pus from wounds inflicted by the gladiators heralded healing. The link between pus formation and healing was emphasized so strongly that foreign

material was introduced into wounds to promote pus formation-suppurative. The concept of wound healing remained a mystery, as highlighted by the famous saying by Ambroise Paré (French military surgeon, 1510-1590), "I dressed the wound. God healed it."¹⁵

Koch (Professor of Hygiene and Microbiology, Berlin, 1843-1910) first recognized the cause of infective foci as secondary to microbial growth in his 19th century postulates. Semmelweis (Austrian obstetrician, 1818-1865) demonstrated a 5-fold reduction in puerperal sepsis by hand washing between performing postmortem examinations and entering the delivery room. Joseph Lister (Professor of Surgery, London, 1827-1912) and Louis Pasteur (French bacteriologist, 1822-1895) revolutionized the entire concept of wound infection.¹⁶

Antisepsis derived from the Greek “against putrefaction” and its use in modern medicine is most frequently linked to the work of Lister. It refers to the use of solutions for disinfection.¹⁷

In the late eighteenth and early nineteenth centuries operative outcomes were poor. Wounds were allowed to heal by secondary intention and morbidity and mortality were associated largely with surgical-site infections (SSIs). The first use of an antiseptic skin agent in surgery is credited to the English surgeon Joseph Lister (1827- 1912).¹⁷

Before the mid-19th century, surgical patients commonly developed postoperative “irritative fever,” followed by purulent drainage from their incisions, overwhelming sepsis, and often death.¹⁸

Prior to the mid-19th century, limb amputation was associated with an alarming 50% postoperative mortality from sepsis. Following Louis Pasteur's discovery that tissue decay was caused by microscopic organisms, Lister theorized that the spread of these microbes through surgical wounds was responsible for death in the postoperative period.¹⁹

Lister placed carbolic acid into open fractures to sterilize the wound and to prevent sepsis and hence the need for amputation.²⁰ Lister's work radically changed surgery from an activity associated with infection and death to a discipline that could eliminate suffering and prolong life.¹⁸

As early as 1882, Labarraque, a French pharmacist, demonstrated that solutions containing chlorides of lime or soda could eradicate foul odour associated with human corpses and that such solutions could be used as disinfectants and antiseptics.²¹ As late as the 19th century, aseptic surgery was not routine practice. Sterilization of instruments began in the 1880s as did the wearing of gowns, masks, and gloves. Halsted (Professor of Surgery, Johns Hopkins University, United States, 1852-1922) introduced rubber gloves to his scrub nurse (and future wife) because she was developing skin irritation from the chemicals used to disinfect instruments. The routine use of gloves was introduced by Halsted's student J. Bloodgood.²⁰

Alexander Fleming (microbiologist, London, 1881-1955) performed many of his bacteriological studies during World War I and is credited with the discovery of penicillin.²⁰

Penicillin first was used clinically in 1940 by Howard Florey. With the use of antibiotics, a new era in the management of wound infections commenced. Unfortunately, eradication of the infective plague affecting surgical wounds has not ended because of the insurgence of antibiotic-resistant bacterial strains and the nature of more adventurous surgical intervention in immunocompromised patients and in implant surgery.²⁰

B. Definition of Surgical Site Infections²²

Surgical Site Infection is a difficult term to define accurately because it has a wide spectrum of possible clinical features. Surgical-site infection (SSI) is defined by the Centres for Disease Control and Prevention (CDC) as a proliferation of pathogenic micro-organisms which develops in an incision site either within the skin and subcutaneous fat (superficial), musculo-fascial layers (deep), or in an organ or cavity, if opened during surgery.

Since the skin is normally colonized by bacterial flora, an SSI cannot be diagnosed by the microbiological evidence alone but in conjunction with clinical signs which include: redness, heat, pain and swelling, separation of the suture line (dehiscence), or the presence of an abscess in the deeper tissues. Patients may mount a systemic inflammatory response syndrome (SIRS) with an elevated white cell count, body temperature $<35^{\circ}\text{C}$ or $>38^{\circ}\text{C}$, pulse rate $>100/\text{min}$, respiratory rate $>20/\text{min}$, or in severe cases develop signs of sepsis, with an attendant increase in morbidity and mortality.

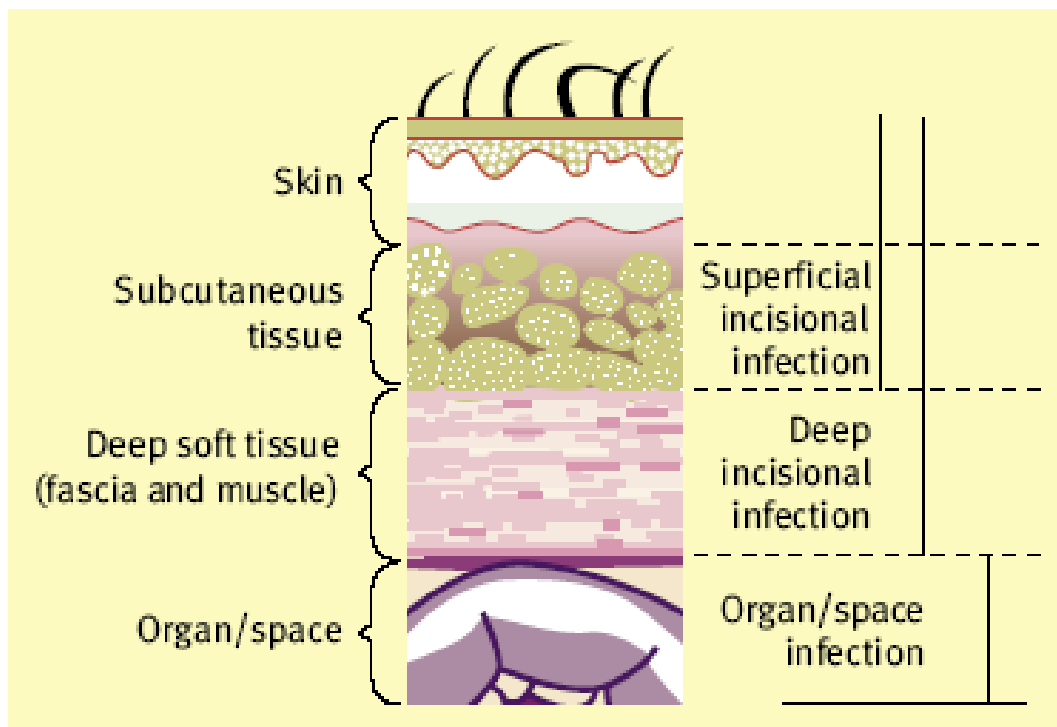


Figure 1. Schematic representation of the anatomical classification of surgical site infections²³

C. Classification of surgical site infection²³

I. Superficial Incisional SSI

Infection involves only skin and subcutaneous tissues of incision.

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

A wound is not considered a superficial site infection if a stitch abscess is present, the infection is at an episiotomy or circumcision site or a burn wound, or the SSI extends into the fascia or muscle.

II, Deep Incisional SSI

Infection involves deep tissues such as fascial and muscle layers. This also includes infection involving both superficial and deep incision sites.

- Occurs within 30 days of operation or within 1 year if an implant is present;
- Involves deep soft tissues (fascia and/or muscle) of the incision; and
- At least 1 of the following:
 - Purulent drainage from the deep incision but without organ/space involvement

- Fascial dehiscence or fascia is deliberately separated by the surgeon due to signs of inflammation
- Deep abscess is identified by direct examination or during reoperation, by histopathology, or by radiologic examination
- Surgeon or attending physician declares that deep incisional infection is present.

III. Organ/Space SSI

Infection involves any part of the anatomy in organs and spaces other than the incision, which was opened or manipulated during operation.

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

D. Epidemiology

Frequency

I. International

Internationally, the frequency of SSI is difficult to monitor because criteria for diagnosis might not be standardized. A survey sponsored by the World Health Organization demonstrated a prevalence of nosocomial infections varying from 3-21%, with wound infections accounting for 5-34% of the total.²⁴ The 2002 survey report by the Nosocomial Infection National Surveillance Service (NINSS), which covers the period between October 1997 and September 2001, indicates that the incidence of hospital acquired infection related to surgical wounds in the United Kingdom is as high as 10% and costs the National Health Service in the United Kingdom approximately 1 billion pounds (1.8 billion dollars) annually.

II. United States

Surgical site infections (SSIs) are not an extinct entity; they account for 14-16% of the estimated two million nosocomial infections affecting hospitalized patients in the United States.²⁵

III. Indian scenario

The surgical site infection rate reports by different workers have differed considerably. A study²⁶ done in India reported overall infection rate as 8.95% and

number of studies carried out in India indicate an overall infection rate of 4.04 to 30% for clean surgeries and 10.06 to 45% for clean-contaminated surgeries.^{27,28,29}

Collated data on the incidence of wound infections probably underestimate true incidence because most wound infections occur when the patient is discharged, and these infections may be treated in the community without hospital notification.²⁴

Incidence of SSIs with regard to abdominal surgical sites and operating conditions⁵ are as shown in the table number 1.

IV. Mortality/Morbidity

Surgical site infections are associated not only with increased morbidity but also with mortality. Seventy-seven percent of the deaths of surgical patients were related to surgical wound infection.¹⁸ Kirkland et al calculated a relative risk of death of 2.2 attributable to SSIs, compared to matched surgical patients without infection.³⁰

E. Pathogenesis of SSIs³¹

- *The Human Inflammatory Response*

With the creation of the surgical incision through the skin and in to subcutaneous tissues, 5 critical initiators of the human inflammatory response are activated (Figure 2).

Table 1. Incidence of SSIs with regard to abdominal surgical sites and operating conditions⁵

Clean wounds	1.5 to 3.7%
Clean -contaminated wounds	3 to 4%
Contaminated wounds	8.5%
Dirty	
Infected wounds	28 to 40%
Laparoscopy	10%
Umbilical hernia	2 to 5%
Cancer of the colon	
Without taking antimicrobial drugs	30 to 60%
With antibiotic and proper intestine wash	10%
Colostomy -	above 50%
Colon perforation	20%
Stomach cancer and surgery	20%
Hernia	50%
Adult appendectomy	10 to 20%
Children's appendicitis	2 to 5%
Aged appendicitis and in pregnant women	10 to 50%
AIDS victims	above 50%
Liver abscess	20%
Hydatid cyst	2 to 5%
Acute and chronic cholecystectomy without stones	10%
Acute septic cholangitis	10 to 20%
Laparoscopic cholecystectomy	2 to 5%
Splenectomy	2 to 5%

Coagulation proteins and platelets are initially activated as part of the human hemostatic mechanism, but they also herald the onset of inflammation. Mast cells and complement proteins are activated, and bradykinin is produced from its ubiquitous protein precursors. The net effect of these 5 factors is vasodilation and increased local blood flow at the site of the surgical incision. While bulk flow is increased, flow velocity is reduced in preparation for margination of phagocytes.

The simultaneous occurrence of increased vascular permeability and local vasodilation facilitates the formation of edema fluid, resulting in increased space between endothelial cells. The increased vascular permeability provides phagocytic access to the injured soft tissue, while edema provides aqueous conduits for the navigation of these phagocytes through the normally condensed extracellular tissues. Activation products from the 5 initiator events described above result in the production of nonspecific chemoattractant signals, while mast cells produce specific chemokine signals that "draw" specific neutrophil, monocyte, and other leukocyte populations into the area of the surgical site.

The important point of this discussion about inflammation is that tissue injury from the incision initiates the mobilization of phagocytes into the wound before bacterial contamination actually occurs from the procedure itself. This mobilization of the innate host defenses before significant intraoperative contamination occurs undoubtedly gives the patient an advantage against infection as an outcome.

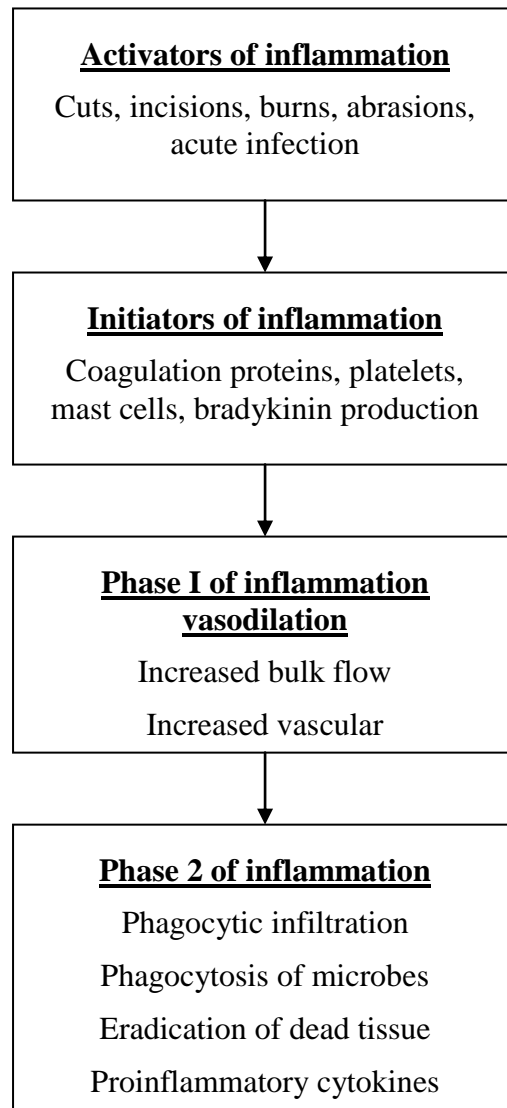


Figure 2. The consequences of inflammation³¹

The abundant release of chemoattractant signals, products of tissue injury, orchestrates the movement of phagocytes into the wound. Chemoattractant signaling proteins bind to local vascular endothelial cells and upregulate selectin proteins on the endothelial surface of these cells, which results in neutrophil "rolling" on the endothelial surface within the post-capillary venule. Further interaction between neutrophil and endothelial cell adhesion proteins anchor the neutrophil to the surface of the endothelial cell, and the chemoattractant gradient

then acts as a biological "beacon" to direct neutrophil movement toward the site of injury. Neutrophil presence at the surgical site allows systematic ingestion and digestion of any microbial contaminants from the operation.

By about 24 hours after creation of the surgical wound, monocytes enter the surgical site and initiate 1 of 2 different scenarios. When microbial contamination has been minimal and the early arriving neutrophils have been able to adequately control the bacteria that are present, then monocytes produce local chemical signals to regulate the wound-healing process. Myofibrocytes migrate into the fibrin matrix of the wound, and collagen deposition displaces its fibrin latticework. However, if microbial contamination and proliferation overwhelm the initial neutrophil infiltration, the monocyte assumes the role of a proinflammatory cell with the release of potent cytokines.

Tumor necrosis factor (TNF)-alpha is produced and released by the monocytes and serves numerous functions; notably, it becomes a potent paracrine signal to upregulate vigorous neutrophil activity within the wound. TNF-alpha-stimulated neutrophils consume microbes, and lysosomal vacuoles may release reactive oxygen intermediates and acid hydrolases into the extracellular space from its lysosomal vacuoles. The extracellular release of reactive oxygen intermediates and the acid hydrolases results in lipid peroxidation of the local environment, with further tissue injury and further activation of the initiator signals. In this way, the entire inflammatory response is further intensified. Interleukin (IL)-1, IL-6, and other proinflammatory signals are released by the activated monocyte and serve as endocrine signals responsible for fever, stimulation of acute phase reactants, and other responses.

The net effect of vigorous neutrophilic stimulation, tissue autolysis, and sustained stimulation of inflammatory initiation is the creation of a wound space that is a host-pathogen battlefield. Ultimately, the wound space is filled with necrotic tissue, neutrophils, bacteria, and proteinaceous fluid that together constitute pus. The viable tissues around the infected wound typically exhibit the classic signs of inflammation. Wound *rubor* reflects local vasodilation. *Calor* is the warmth of the vasodilated tissues resulting in increased heat conduction. *Tumor* reflects the presence of edema fluid about the wound. *Dolor* occurs from stimulation of nerve nociceptors by the numerous products of the inflammatory cascade and tissue injury. The discharge of pus from the wound interface via the incision completes the natural history of SSI.

F. Pathophysiology of wound healing²⁰

Wound healing is a continuum of complex interrelated biological processes at the molecular level. Healing is divided into the following phases for descriptive purposes: inflammatory phase, proliferative phase, and maturation phase.

The inflammatory phase commences as soon as tissue integrity is disrupted by injury; this begins the coagulation cascade to limit bleeding. Platelets are the first of the cellular components that aggregate to the wound, and, as a result of their degranulation (platelet reaction), they release several cytokines (or paracrine growth factors). These cytokines include platelet derived growth factor (PDGF), insulinlike growth factor-1 (IGF-1), epidermal growth factor (EGF), and fibroblast growth factor (FGF). Serotonin is also released, which,

together with histamine (released by mast cells), induces a reversible opening of the junctions between the endothelial cells, allowing the passage of neutrophils and monocytes (which become macrophages) to the site of injury.

This large cellular movement to the injury site is induced by cytokines secreted by the platelets (chemotaxis) and by further chemotactic cytokines secreted by the macrophages themselves once at the site of injury. These include transforming growth factor alpha (TGF-alpha) and transforming growth factor beta (TGF-beta). Consequently, an inflammatory exudate that contains red blood cells, neutrophils, macrophages, and plasma proteins, including coagulation cascade proteins and fibrin strands, fills the wound in a matter of hours. Macrophages not only scavenge but they also are central to the wound healing process because of their cytokine secretion.

The proliferative phase begins as the cells that migrate to the site of injury, such as fibroblasts, epithelial cells, and vascular endothelial cells, start to proliferate and the cellularity of the wound increases. The cytokines involved in this phase include FGFs, particularly FGF-2, which stimulates angiogenesis and epithelial cell and fibroblast proliferation. The marginal basal cells at the edge of the wound migrate across the wound, and, within 48 hours, the entire wound is epithelialized. In the depth of the wound, the number of inflammatory cells decreases with the increase in stromal cells, such as fibroblasts and endothelial cells, which, in turn, continue to secrete cytokines. Cellular proliferation continues with the formation of extracellular matrix proteins, including collagen and new capillaries (angiogenesis). This process is variable in length and may last several weeks.

In the maturation phase, the dominant feature is collagen. The dense bundle of fibers, characteristic of collagen, is the predominant constituent of the scar. Wound contraction occurs to some degree in primary closed wounds but is a pronounced feature in wounds left to close by secondary intention. The cells responsible for wound contraction are called myofibroblasts, which resemble fibroblasts but have cytoplasmic actin filaments responsible for contraction.

The wound continuously undergoes remodeling and try to achieve a state similar to that prior to injury. The wound has 70-80% of its original tensile strength at 3-4 months postoperative.

G. Causes

All surgical wounds are contaminated by microbes, but in most cases, infection does not develop because innate host defenses are quite efficient in the elimination of contaminants. A complex interplay between host, microbial, and surgical factors ultimately determines the prevention or establishment of a wound infection.³²

- Factors that affect surgical wound healing

I. Microbiology

Microbial factors that influence the establishment of a wound infection are the bacterial inoculum, virulence, and the effect of the microenvironment. When these microbial factors are conducive, impaired host defenses set the stage for enacting the chain of events that produce wound infection.³²

Most SSIs are contaminated by the patient's own endogenous flora, which are present on the skin, mucous membranes, or hollow viscera. The traditional microbial concentration quoted as being highly associated with SSIs is that of bacterial counts higher than 10,000 organisms per gram of tissue (or in the case of burned sites, organisms per cm² of wound).³²

Organisms associated with SSIs vary with type of procedure and anatomic location of the operation. The usual pathogens on skin and mucosal surfaces are gram-positive cocci (notably staphylococci, streptococci) account for most exogenous flora involved in SSIs. The most common group of bacteria responsible for SSIs are *Staphylococcus aureus*. The emergence of resistant strains has considerably increased the burden of morbidity and mortality associated with wound infections. However, gram-negative aerobes and anaerobic bacteria contaminate skin in the groin/perineal areas. The contaminating pathogens in gastrointestinal surgery are the multitude of intrinsic bowel flora, which include gram-negative bacilli (eg, *Escherichia coli*) and gram-positive microbes, including enterococci and anaerobic organisms. Sources of such pathogens include surgical/hospital personnel and intraoperative circumstances, including surgical instruments, articles brought into the operative field, and the operating room air.³²

Methicillin resistant *Staphylococcus aureus* (MRSA) is proving to be the scourge of modern day surgery. Like other strains of *S aureus*, MRSA can colonize the skin and body of an individual without causing sickness, and, in this way, it can be passed on to other individuals unknowingly. Problems arise in the treatment of overt infections with MRSA because antibiotic choice is very

limited. MRSA infections appear to be increasing in frequency and are displaying resistance to a wider range of antibiotics.³²

Of particular concern are the vancomycin intermediate *Staphylococcus aureus* (VISA) strains of MRSA. These strains are beginning to develop resistance to vancomycin, which is currently the most effective antibiotic against MRSA.³²

Table 2. Pathogens Commonly Associated with Wound Infections and Frequency of Occurrence³³

Pathogen	Frequency (%)
<i>Staphylococcus aureus</i>	20
Coagulase-negative staphylococci	14
Enterococci	12
<i>Escherichia coli</i>	8
<i>Pseudomonas aeruginosa</i>	8
<i>Enterobacter</i> species	7
<i>Proteus mirabilis</i>	3
<i>Klebsiella pneumoniae</i>	3
Other streptococci	3
<i>Candida albicans</i>	3
Group D streptococci	2
Other gram-positive aerobes	2
<i>Bacteroides fragilis</i>	2

In clean surgical procedures, in which the gastrointestinal, gynaecologic, and respiratory tracts have not been entered, *Staphylococcus aureus* from the exogenous environment or the patient's skin flora is the usual cause of infection. In other categories of surgical procedures, including clean-contaminated, contaminated, and dirty, the polymicrobial aerobic and anaerobic flora closely resembling the normal endogenous microflora of the surgically resected organ are the most frequently isolated pathogens.³⁴

- *Others risk factors*

II. Patient Factors³⁵

Obesity increases risk substantially when the subcutaneous abdominal fat layer exceeds 3 cm (1.5 inches) (Nyström et al 1987). The risk is increased by the need for a larger incision, decreased circulation to the fat tissue or the technical difficulty of operating through a large fat layer.

Infection at another site may increase the risk of spreading infection through the bloodstream.

Immunocompromised patients (those with HIV/AIDS, those with chronic corticosteroid use such as occurs with asthma and heavy smokers or users of other tobacco products) are at significantly greater risk of SSIs.

Malnutrition may or may not be a contributing factor. Unfortunately, most studies have not been conducted in developing countries where severe malnutrition is more common.

Age, race, socioeconomic status and chronic diseases, such as diabetes and malignancy, are difficult to assess because they are frequently associated with other factors that independently contribute to risk. For example, age over 70 may be accompanied by decreased defense mechanisms, poor nutrition and anemia.²⁰

Wound characteristics include nonviable tissue in wound; hematoma; foreign material, including drains and sutures; dead space; poor skin preparation, including shaving; and pre-existent sepsis (local or distant).²⁰

Operative characteristics include poor surgical technique; lengthy operation (>2 h); intraoperative contamination, including infected theater staff and instruments and inadequate theater ventilation; prolonged preoperative stay in the hospital; and hypothermia.²⁰

The type of procedure is a risk factor. Certain procedures are associated with a higher risk of wound contamination than others. Surgical wounds have been classified as clean, clean-contaminated, contaminated, and dirty-infected as shown in table number 3.

H. Role of skin preparation in prevention of SSIs

The use of pre operative skin preparation by effective antiseptic plays an important role in reducing postoperative wound infections. Recognizing the substantial morbidity and economic burden, in 1999 the Centers for Disease Control (CDC) issued standardized guidelines for the prevention of surgical infections.¹⁹

Table 3. Surgical Wound Classification and Subsequent Risk of Infection^{33,36}

Classification	Description	Infective Risk (%)
Clean (Class I)	<p>Uninfected operative wound</p> <p>No acute inflammation</p> <p>Closed primarily</p> <p>Respiratory, gastrointestinal, biliary, and urinary tracts not entered</p> <p>No break in aseptic technique</p> <p>Closed drainage used if necessary</p>	< 2
Clean-contaminated (Class II)	<p>Elective entry into respiratory, biliary, gastrointestinal, urinary tracts and with minimal spillage</p> <p>No evidence of infection or major break in aseptic technique</p> <p>Example: appendectomy</p>	< 10
Contaminated (Class III)	<p>Nonpurulent inflammation present</p> <p>Gross spillage from gastrointestinal tract</p> <p>Penetrating traumatic wounds < 4 hours</p> <p>Major break in aseptic technique</p>	About 20
Dirty-infected (Class IV)	<p>Purulent inflammation present</p> <p>Preoperative perforation of viscera</p> <p>Penetrating traumatic wounds >4 hours</p>	About 40

These included making specific evidence-based recommendations for modifying patient factors that may predispose to infection, for the use of antimicrobial prophylaxis, for optimizing sterility in the operating room, and for the use of antiseptic agents for skin preparation.¹⁹

The goal of preoperative skin preparation is to reduce the incidence of SSI in a safe, user-friendly, and cost effective manner. Because surgeons perform a breadth of different operations accessing numerous surgical sites, a standard antiseptic agent is unlikely to be uniformly optimal.¹⁹

The choice of which specific agent to use for skin preparation was not addressed due to the diversity of sites and approaches in surgery, as well as the absence of data on SSI risk in well-controlled, operation-specific studies. Therefore, the choice of agent should be based primarily on the surgeon's knowledge of the product's efficacy, cost, and ease of use.¹⁸

I. Modern Surgical Skin Preparation

The most common skin preparation agents used today include products containing iodophors or chlorhexidine gluconate (CHG). Agents are further classified by whether they are aqueous or alcohol-based solutions as shown in table number 4.¹⁸

I. Aqueous-Based Solutions

Aqueous-based iodophors such as povidone-iodine (PVP-I) contain iodine complexed with a solubilizing agent that allows for the release of free iodine when in solution.¹⁹

Table 4. Characteristics of antiseptic solutions¹⁹

	Aqueous iodophor	Aqueous CHG	Alcohol iodophor	Alcohol CHG
Mechanism of action	Free iodine – Protein DNA damage	Disrupts membranes	Denatures protein, free iodine- protein DNA damage	Denatures protein, disrupts membranes
Antimicrobial coverage	Excellent for gram bacteria, good for gram – ve fungi, virus Mtb	Excellent for gram +ve good for gram – and virus, fair for fungus poor for Mtb	Improved gram – ve, Mtb activity	Improved gram – ve, Mtb fungal activity
Onset	Intermediate	Intermediate	Rapid	Rapid
Duration	2 Hours	6 hours	48 hours (Dura pep) 96 hours (Prevail FX)	48 hours
Application	2 step scrub and paint	2 step scrub and dry repeat	1 step paint dry time minimum of 3 minutes on hairless surface	Dry site 30 sec scrub, Moist site 2 min scrub Dry time minimum of 3 min on hairless surface
Examples	Betadine Scrub care	Hibiclens	Dura pep solution Prevail FX	Chlorapep

Iodine acts in an antiseptic fashion by destroying microbial proteins and DNA. Iodophor containing products enjoy widespread use because of their broad-spectrum antimicrobial properties, efficacy, and safety on nearly all skin surfaces in patients regardless of age. In the aqueous form, most commercially available

iodophors require a 2-step application in a scrub-and-paint technique, and their activity is limited by the amount of time the agent is in contact with the skin.³⁷

II. Aqueous-based chlorhexidine gluconate

A second product, aqueous-based chlorhexidine gluconate (CHG), works by disrupting bacterial cell membranes. CHG has more sustained antimicrobial activity and is more resistant to neutralization by blood products than the iodophors. CHG is applied in a similar manner to PVP-I, but should not be used in the genital region. This agent has gained popularity as a hand-scrubbing and showering antiseptic prior to surgery, but also continues to be used as a patient skin preparation agent.³⁸

III. Alcohol-Based Solutions

Combination solutions with alcohol and CHG or iodophors have gained popularity among general, cardiac, and orthopedic surgeons and may have additional utility in certain urologic procedures. Recent studies suggest that these products may have greater efficacy, easier application, improved durability, and a superior cost profile when compared with traditional aqueous-based solutions.¹⁹

Ethyl and isopropyl alcohol are 2 of the most effective antiseptic agents available. When used alone, alcohol is fast and short acting, has broad-spectrum antimicrobial activity, and is relatively inexpensive.¹⁸

Alcohol-based solutions that contain CHG or iodophors have sustained durable antimicrobial activity that lasts long after alcohol evaporation.³⁹ Because

alcohol dries on exposed skin within moments of application, these can be applied with a 1-step preparation as opposed to a scrub-and-paint technique.

There have been a few reports of operating room fires originating from alcohol-based skin preparation resulting in significant injury to patients and staff.⁴⁰ Flammability can be avoided by allowing skin to completely dry and avoiding preparation of areas with excessive body hair that can delay alcohol vaporization.

Additionally, alcohol-based solutions should not be applied to mucous membranes and therefore have limited utility as antiseptic agents prior to transurethral or transvaginal surgery.

Studies have demonstrated that DuraPrep solution is effective against a broad range of microorganisms, including those most commonly encountered in genitourinary (GU) surgery, including gram-negative rods, *Staphylococcus* species, and *Enterococcus*, as well as multi drug resistant organisms such as methicillin resistant *Staphylococcus aureus* (MRSA), methicillin-resistant *Staphylococcus epidermidis* (MRSE), and vancomycin-resistant enterococci (VRE). Furthermore, DuraPrep solution accomplishes a six fold bacterial log reduction within 1 minute of contact with a greater percentage release of free iodine when compared with the leading aqueous iodophors.¹⁹

Another potential advantage of this product is its durability in the surgical environment. In a prospective, randomized surgical simulation study, DuraPrep solution demonstrated better antimicrobial activity after saline soak when

compared with the leading CHG alcohol-based solution, suggesting that it is particularly suitable for use in “wet” surgical environments.⁴¹

Another unique feature of DuraPrep solution is that it enhances adhesion between surgical drapes and the prepared skin surface, theoretically limiting the spread of organisms on to the surgical field. In a randomized, prospective study comparing drape adhesion in patients undergoing total joint replacement, patients prepared with DuraPrep solution had significantly less area of drape lift than those prepared with PVP-I, 1.5 cm² versus 9.9 cm², respectively (p=0.0001).⁴²

In a prospective, randomized study of general surgery patients undergoing operations 3 hours or longer, the use of DuraPrep solution resulted in a 3-fold decrease in SSI when compared with tincture of iodine.⁴³

Another study⁴⁴ of 3209 general surgical procedures compared the use of 3 skin preparations: a povidone-iodine scrub-paint combination (with an isopropyl alcohol application between the steps), ChloroPrep, and DuraPrep solution. This study employed a sequential implementation design, and each agent was used for a 6-month period for all general surgery cases. PSSIs were tracked for 30 days. DuraPrep solution was associated with the lowest infection rate (3.9%, compared with 6.4% for Betadine and 7.1% for ChloroPrep [p=0.002]).

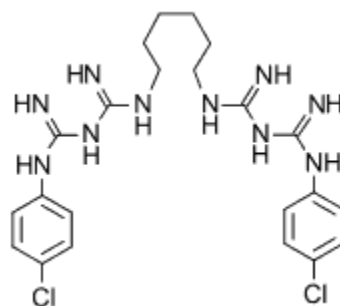
In addition to an analysis of efficacy, ease of use, cost, and user satisfaction are important considerations when choosing a skin preparation agent. In a prospective comparison of alcohol-based iodophors with traditional PVP-I preparation, the alcohol-based solutions had shorter application and drying times.

Taking into consideration operating room time and product expenses, the alcohol-containing products had lower overall costs.⁴⁵

With safe use and proper instruction, alcohol-based antiseptics may save valuable time and operating room resources.¹⁹

J. Chlorhexidine

Chlorhexidine is a chemical antiseptic.⁴⁶ It is effective on both Gram-positive and Gram-negative bacteria, although it is less effective with some Gram-negative bacteria.⁴⁷ It has both bactericidal and bacteriostatic mechanisms of action, the mechanism of action being membrane disruption, not ATPase inactivation as previously thought.⁴⁸ It is also useful against fungi and enveloped viruses, though this has not been extensively investigated. Chlorhexidine is harmful in high concentrations, but is used safely in low concentrations in many products, such as mouthwash and contact lens solutions.



Chlorhexidine is present in oral rinses and skin cleansers, and in small quantities it is used as a preservative. It is easily available, cheap and easy to use, no adverse reactions have been reported.

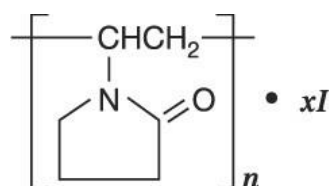
Chlorhexidine was discovered in 1946 and introduced into clinical practice in 1954.⁴⁹ It is widely used as an antiseptic in handwashing, and as a surgical scrub, but in wounds its application has been limited largely to irrigation.

Chlorhexidine is available as diacetate, digluconate and dihydrochloride; the digluconate is most frequently used in wound management. It has rapid, bactericidal activity against a wide spectrum of non-sporing bacteria by damaging outer cell layers and the semi-permeable cytoplasmic membrane to allow leakage of cellular components. It also causes coagulation of intracellular constituents, depending on concentration.¹¹ Antibacterial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and a range of clinical isolates has been documented,⁵⁰ however in MRSA, resistance has been observed.⁵¹

Chlorhexidine acts on the wall of microorganisms. It is absorbed immediately (in vitro) when added to a bacterial suspension. Its effect on cells depends on chlorhexidine concentration, number and type of microorganisms. Chlorhexidine action is partially inhibited by organic material (serum, blood,) and phospholipids. Its action is potentiated by alcohol (excipient).

K. Povidone Iodine

Povidone-Iodine is a broad-spectrum microbicide. The structural formula is as follows:



Povidone iodine (Betadine) is an antiseptic solution used topically on skin. It contains polyvinyl pyrrolidone with water, iodide and one percent available iodine. It has bactericidal ability against a large number of pathogens. Povidone iodine function by release of elemental iodine which binds irreversibly with protein.

Iodine and its antibacterial properties have been used for the prevention and management of wound infections for over 150 years. The resultant broad spectrum of antimicrobial activity is well documented and its efficacy, particularly in relation to resistant micro-organisms such as methicillin-resistant *Staphylococcus aureus*, has been shown.⁵²

The development of iodophores has led to a wider acceptance of iodine as a disinfectant. Iodophores are the soluble complexes of iodine with large molecular natural polymers such as polyvinyl pyrrolidone or polyethyl glycols from which free iodine is released slowly. Iodophores have little or no odour, reduce discolouration of surfaces and serve as a reservoir for sustained release of free iodine to react with the susceptible microorganisms. The most popular iodophore is povidone iodine, which is a polyvinyl pyrrolidone complexed with iodine. In higher concentration (5%) it is used on boils, burns, otitis externa, ulcers, monilial/trichomonal/nonspecific vaginitis, furunculosis and tinea infections. A 10% solution can be used to disinfect endoscopes and surgical instruments. Lower concentrations (1%) can be used in mouth wash. Povidone iodine (5%) when used with spray-wipe-spray technique is an effective surface disinfectant.⁵³

Several studies have shown the advantages of chlorhexidine in pre operative preparations but so far no studies have been done to compare its efficacy versus povidone iodine for abdominal surgeries in India.

A study⁵⁴ was carried out in 45 adult and old-age patients undergoing surgery (average age 62 years). 10% povidone-iodine solution was effective for skin antiseptics. The study concluded that, the antiseptic efficacy immediately after application of 10% povidone-iodine solution was evidenced in surgical patients with class II wounds. The solution was also effective for the prevention of postoperative skin wound infection.

A study⁵⁵ hypothesized that preoperative skin cleansing with chlorhexidine–alcohol is more protective against infection than povidone–iodine. Patients undergoing clean-contaminated surgery were randomly assigned in six hospitals to preoperative skin preparation with either chlorhexidine–alcohol scrub or povidone–iodine scrub and paint. The primary outcome was any surgical-site infection within 30 days after surgery. Secondary outcomes included individual types of surgical-site infections. A total of 849 subjects (409 in the chlorhexidine–alcohol group and 440 in the povidone–iodine group) qualified for the intention-to-treat analysis. The overall rate of surgical-site infection was significantly lower in the chlorhexidine–alcohol group than in the povidone–iodine group (9.5% vs. 16.1%; $P=0.004$; relative risk, 0.59; 95% confidence interval, 0.41 to 0.85). Chlorhexidine–alcohol was significantly more protective than povidone–iodine against both superficial incisional infections (4.2% vs. 8.6%, $P=0.008$) and deep incisional infections (1% vs. 3%, $P=0.05$) but not against organ-space infections (4.4% vs. 4.5%). Adverse events were similar in

the two study groups. The study concluded that, preoperative cleansing of the patient's skin with chlorhexidine–alcohol is superior to cleansing with povidone–iodine for preventing surgical-site infection after clean-contaminated surgery.

In a randomized study⁵⁶ the application of chlorhexidine alcohol reduced the risk of surgical-site infection by 41% as compared with the most common practice in the United States of using aqueous povidone–iodine.

One study⁹ done in Thailand showed that chlorhexidine gluconate was more effective than povidone iodine in preventing SSI and reducing bacterial colonization at abdominal surgical sites. In this study, 500 patients were randomly divided into two groups that is group 1 (n=250) and group 2 (n=250). For group 1 Povidine iodine was used for skin preparation and in group 2 Chlorhexidine was used. Postoperative SSI and colonization of bacteria were significantly reduced in Chlorhexidine group. The efficacy of chlorhexidine in post operative surgical wound infection was proved.

Another study⁵⁷ was conducted to compare the efficacy of chlorhexidine and povidine iodine among the patients with vaginal hysterectomy. The study showed that, among the first set of intraoperative specimens 63% of the cultures (17/27) from the Povidone Iodine group and 22% of the cultures (5/23) from the chlorhexidine group were classified as contaminated. Thus efficacy of chlorhexidine versus povidone iodine as antiseptics for vaginal hysterectomies was proved.

Another study⁵⁸ conducted to determine effects of alcoholic chlorhexidine with aqueous povidone iodine for the collection of blood cultures concluded that,

alcoholic chlorhexidine skin preparation was more efficacious compared to aqueous povidine iodine.

A prospective randomized study⁵⁹ conducted to assess superiority of chlorhexidine in skin decontamination among the foot and ankle surgeries indicated that chlorhexidine and alcohol provide better reduction in bacterial carriage than povidone iodine.

Both the antiseptic preparations possess broad-spectrum antimicrobial activity.¹⁸ the superior clinical protection provided by chlorhexidine–alcohol is probably related to its more rapid action, persistent activity despite exposure to bodily fluids, and residual effect.⁶⁰

Because antiseptics act only against organism that reside on the patient's integument, the overall superior protection afforded by chlorhexidine alcohol is attributed primarily to a reduction in the rates of superficial and deep incisional infections that were caused mostly by gram-positive skin flora. Since two thirds of surgical-site infections are confined to the incision,^{18,61} optimizing skin antisepsis before surgery could result in a significant clinical benefit.⁵⁵

METHODOLOGY

The present study was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2010 to December 2010 on 120 patients.

Study design

The study design was one year randomized controlled trial.

Study period and duration

The present one year study was conducted during the period of January 2010 to December 2010.

Place

Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, and Department of Microbiology, Jawaharlal Nehru Medical College, Belgaum.

Source of Data

Patients undergoing abdominal surgeries in KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum were included in the group.

Sample size

A total of 120 patients undergoing abdominal surgeries were studied.

Sampling procedure

Effect size of chlorhexidine versus povidone iodine is not available. Hence with thumb rule a total of 120 cases divided into two groups that is, 60 each in chlorhexidine and povidone iodine were studied.

Selection criteria

Inclusion

- All patients undergoing abdominal surgeries irrespective of age and sex.
- All elective abdominal surgeries.
- Duration of surgery 30 to 60 minutes.

Exclusion

- Immunocompromised patients (HIV I and II, HbSAg).
- Diabetes mellitus.
- History of allergy to study agents.
- Local skin infections.
- Patient refusal.

Randomization

The patients were divided into two groups by computer randomization that is;

- Group A - Chlorhexidine group.
- Group B - Povidone Iodine group.

The study was approved by the Ethical and Research Committee of Ethics Committee, Jawaharlal Nehru Medical College, Belgaum. Patients admitted in the wards of Department of General Surgery at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum undergoing elective abdominal surgeries were evaluated based on selection criteria. The selected patients were briefed about the nature of the study and a written informed consent was obtained (Annexure I).

Demographic data like sex and age were collected along with relevant history and recorded on predesigned and pretested proforma (Annexure II). A thorough clinical examination was conducted and the findings were also recorded.

Routine investigations such as complete blood count, blood urea, serum creatinine, chest X-ray and echocardiography were done. Patients were randomized according to the randomization procedure.

Sample collection⁹

1. Prior to the application of the antiseptic agent one cotton swab was swabbed at pretended incision site.

2. The antiseptic agents (chlorhexidine or povidone iodine) were applied to the skin by sterile gauze piece under aseptic precautions.
3. The antiseptic agents were left on the skin for about three to four minutes.
4. The second cotton swab was swabbed at pretended incision site after application of antiseptic agent.
5. These cotton swabs were transferred to the laboratory for culture and sensitivity.

Sample processing

Out of the two swabs one was used for making the smear on the glass slide and was subjected to grams staining and the results were noted down. Another swab was used to inoculate on to blood agar and MacConkey agar plates (Full plate streaking) and incubated at 37⁰ C for 18 hours.

Identification of isolates was done using standard microbiological techniques and various biochemical reactions.^{62,63} Semiquantitation of the isolates was done for both pre and post application of antiseptic solutions. Results of the number and type of isolates were noted.

The surgical wounds were examined on post operative day three, five and seven for any infections present. An incisional surgical site infection was considered to be positive if surgical wound drained purulent material or if the surgeon judges it to be infected and opens it. The surgical wound infection was classified according to US Centre for Disease Control and Prevention (CDC) as SSI.²³ This is further classified as:

- *Superficial Incisional SSI* – Infection involves only skin and subcutaneous tissue of incision.
- *Deep Incisional SSI* – Infection involves deep tissues, such as fascial and muscle layers.
- *Organ/space SSI* – Infection involves any part of the anatomy in organs and spaces other than the incision, which was opened or manipulated during the operation.

Follow-up

The patients were followed up for SSIs at an interval of once in a week upto three months.

Statistical analysis

The data was tabulated on Microsoft excel spread sheet and analysed by rates, ratios and percentages. SSI infections and post operative hospital stay among the two groups was compared using Chi-square test and bacterial colonization was compared by using paired 't' test.

RESULTS

The present one year randomized controlled trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2010 to December 2010 on 120 patients undergoing abdominal surgeries. The patients were divided into two groups by computer randomization that is;

- Group A - Chlorhexidine group.
- Group B - Povidone Iodine group.

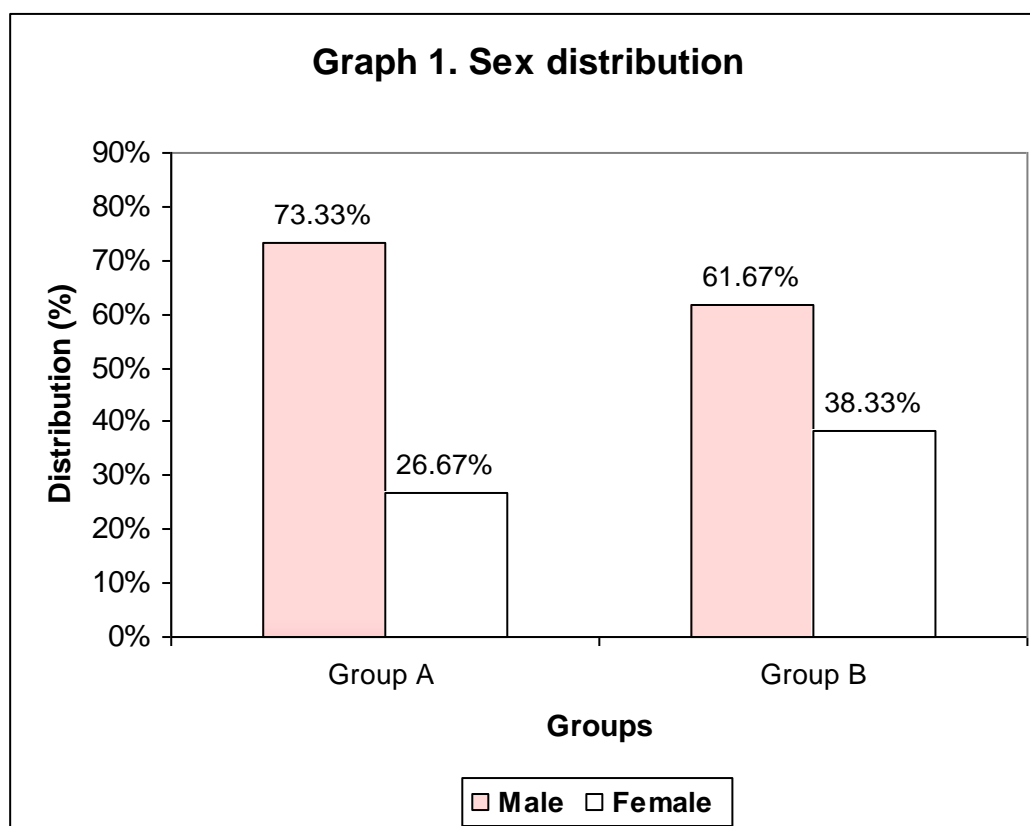
The data obtained was tabulated on Microsoft excel spread sheet and analysed by rates, ratios and percentages.

Table 5. Sex distribution

Sex	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Male	44	73.33	37	61.67
Female	16	26.67	23	38.33
Total	60	100.00	60	100.00

$$\chi^2=1.861$$

$$p=0.172$$



In the present study most of the patients were males in both the groups (73.33% in group A and 61.67% in group B). The male to female ratio in group A was 2.75:1 and in group B it was 1.60:1 suggesting both the groups were comparable.

Table 6. Age distribution

Age groups (Year)	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
10 to 20	6	10.00	9	15.00
21 to 30	18	30.00	13	21.67
31 to 40	10	16.67	14	23.33
41 to 50	9	15.00	8	13.33
51 to 60	8	13.33	10	16.67
>61	9	15.00	6	10.00
Total	60	100.00	60	100.00

$$\chi^2=2.954$$

$$p=0.707$$

In this study the most common age group among patients in group A was 21 to 30 years (30%) and in group B it was 31 to 40 years (23.33%). The mean age in group A was 39.88 ± 18.53 years with range being 11 to 92 years and in group B mean age was 39.15 ± 16.39 years with range being 10 to 77 years suggesting that in both the groups the age was comparable.

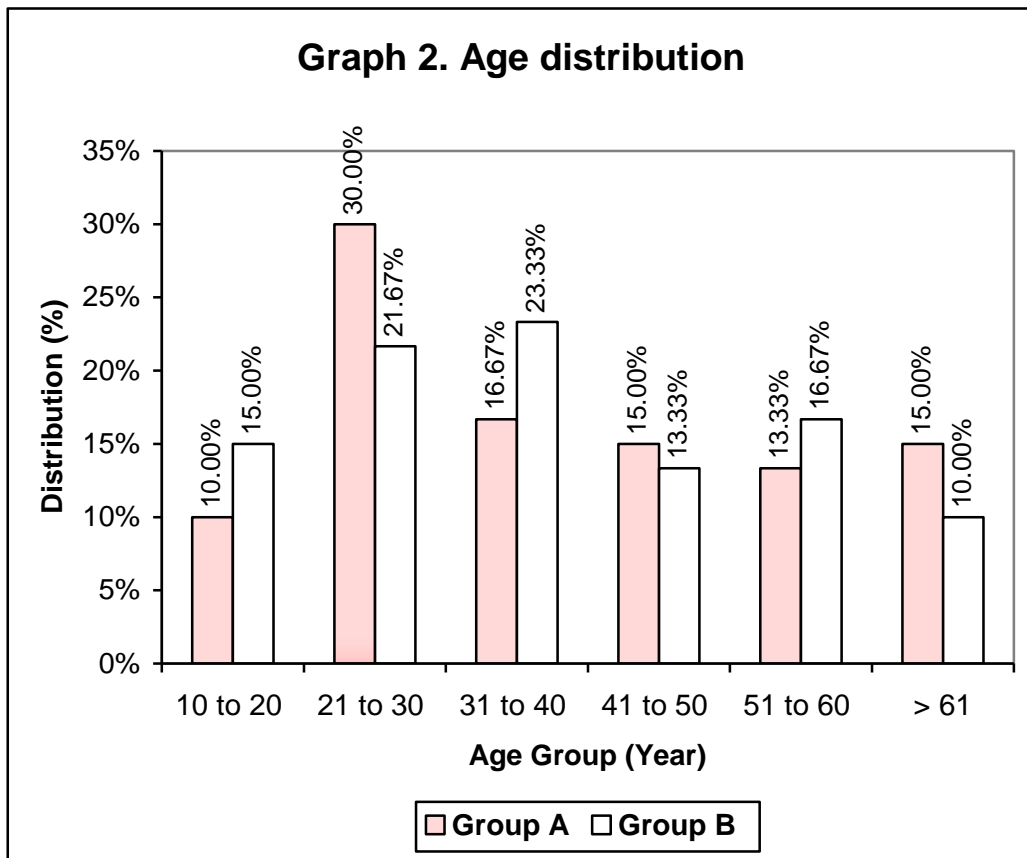


Table 7. Diagnosis

Diagnosis	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Chronic appendicitis	30	50.00	30	50.00
Inguinal hernia	29	48.33	24	40.00
Umbilical hernia	0	0.00	6	10.00
Epigastric hernia	1	1.67	0	0.00
Total	60	100.00	60	100.00

$$x^2=4.043$$

$$p=0.132$$

In the present study 50% of the patients in both the groups had chronic appendicitis. Inguinal hernia was diagnosed in 48.33% of patients in group A and 40% in group B and umbilical hernia was diagnosed in 10% of patients in group B. The epigastric hernia was diagnosed in 1.67% in group A.

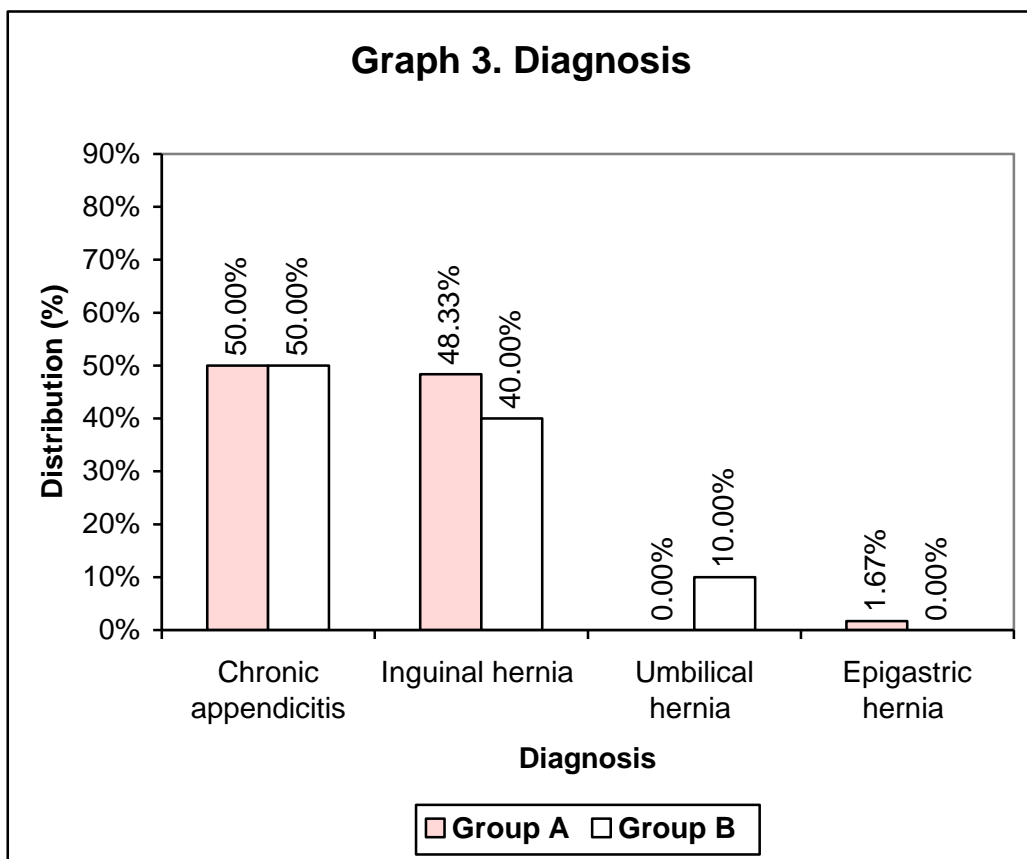
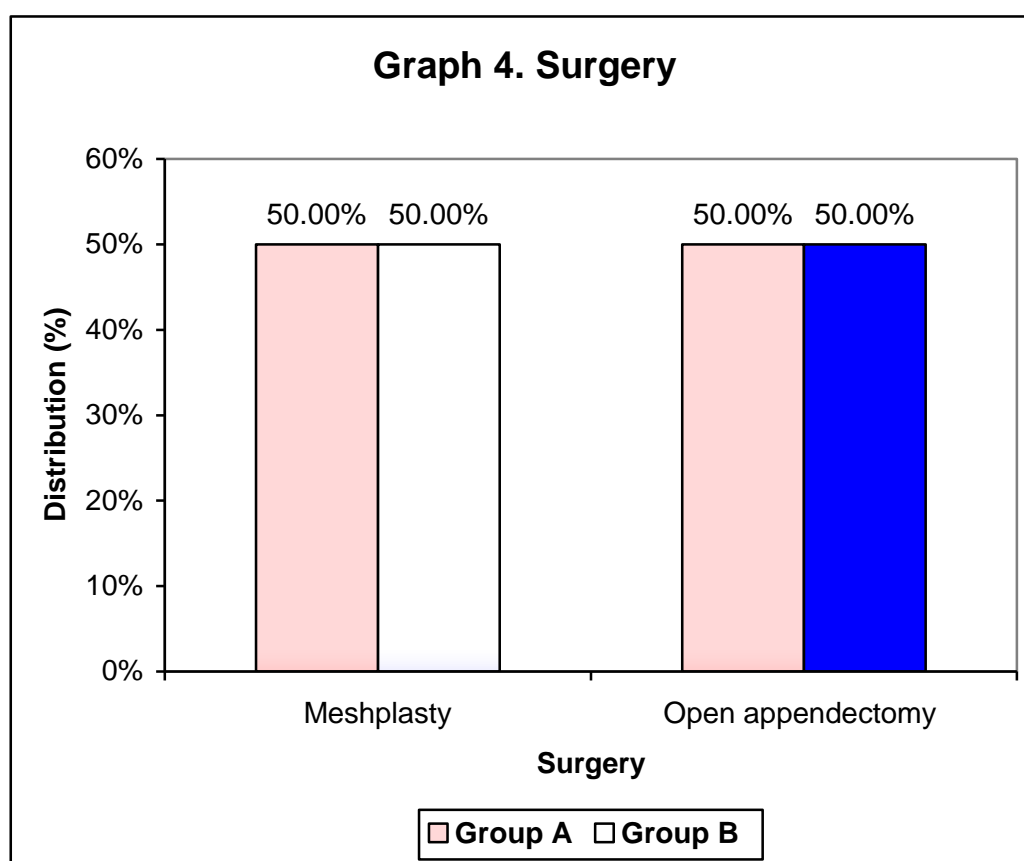


Table 8. Surgery

Surgery	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Meshplasty	30	50.00	30	50.00
Open appendectomy	30	50.00	30	50.00
Total	60	100.00	60	100.00



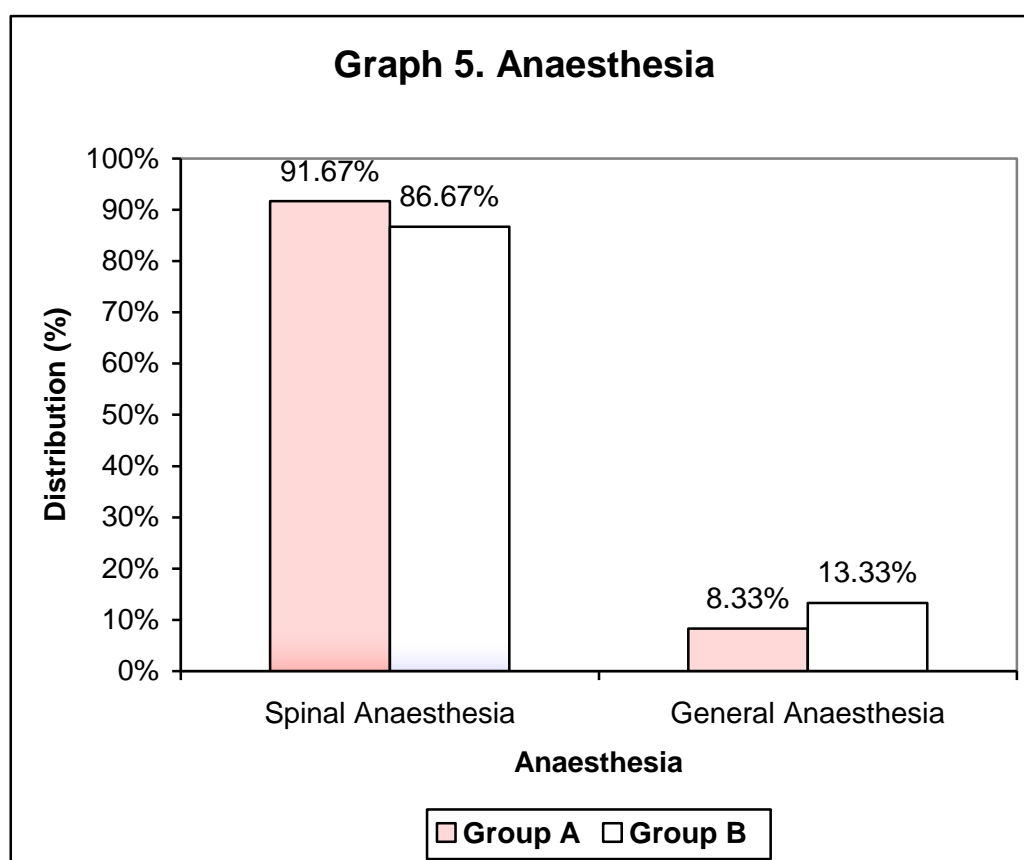
In this study each 50% of patients in both the groups underwent meshplasty and open appendectomy.

Table 9. Anaesthesia

Anaesthesia	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Spinal anaesthesia	55	91.67	52	86.67
General anaesthesia	5	8.33	8	13.33
Total	60	100.00	60	100.00

$$\chi^2=0.776$$

$$p=0.378$$



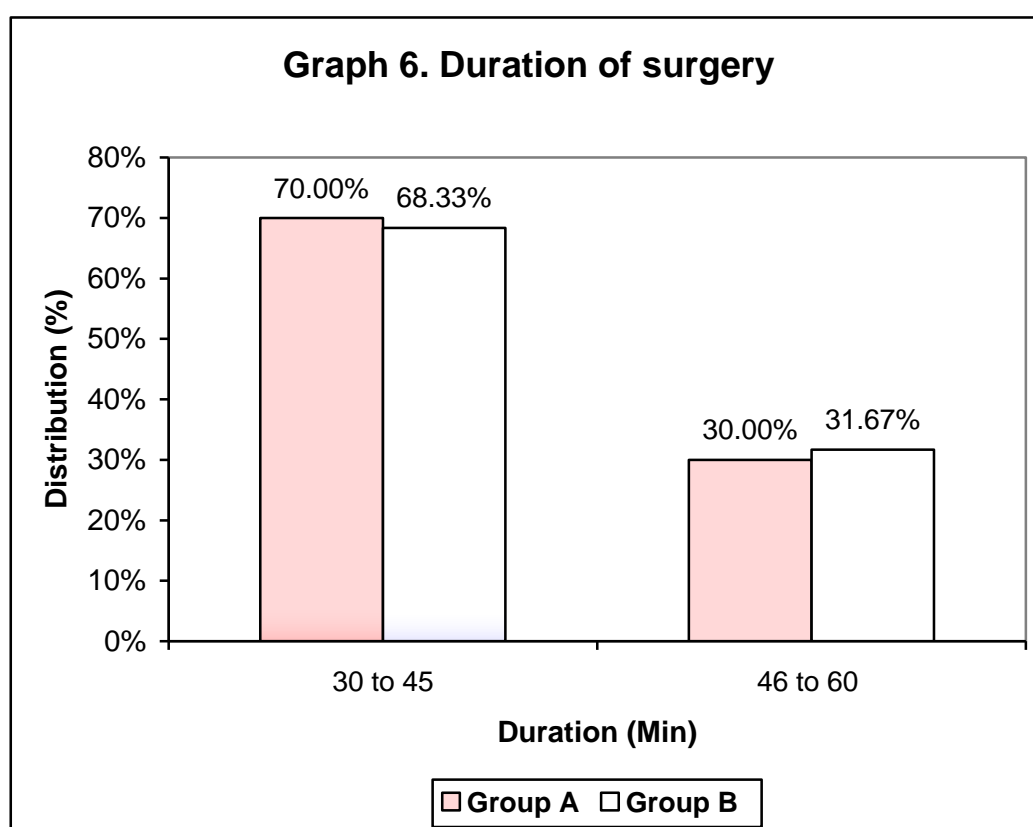
In this study majority of the patients in both the groups (91.67% in group A; 86.67% in group B) had spinal anaesthesia.

Table 10. Duration of surgery

Duration (Minutes)	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
30 to 45	42	70.00	41	68.33
46 to 60	18	30.00	19	31.67
Total	60	100.00	60	100.00

$$\chi^2=0.039$$

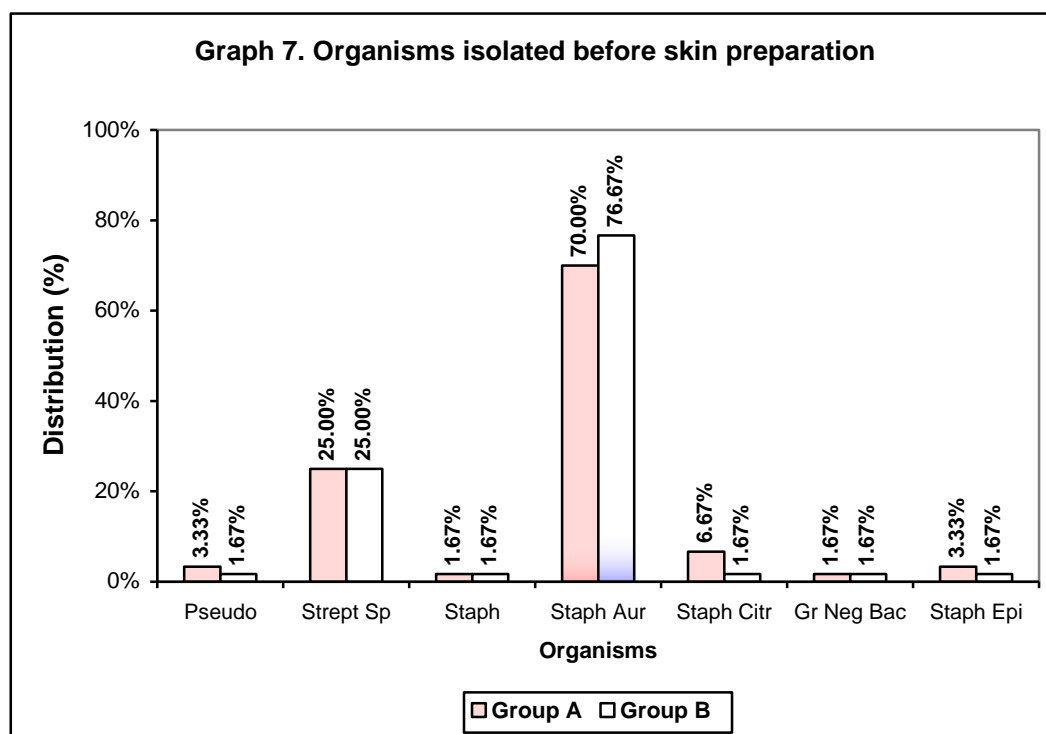
$$p=0.843$$



In this study, the duration of surgery was between 30 to 45 minutes in 70% of patients in group A and 68.33% in group B. In the remaining patients (30% in group A; 31.67% in group B) had duration of surgery between 46 to 60 minutes. The mean duration of surgery in group A was 44.66 ± 5.86 minutes and in group B it was 45.00 ± 6.24 minutes.

Table 11. Organisms isolated before skin preparation

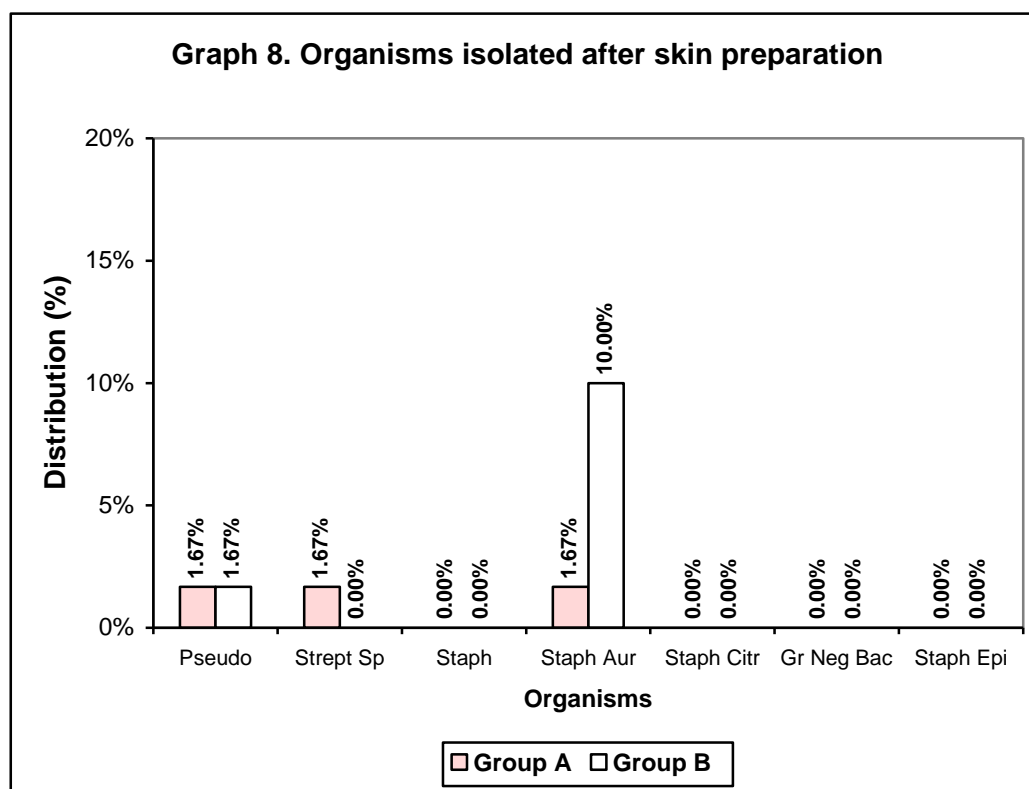
Organisms	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Pseudomonas aeruginosa	2	3.33	1	1.67
Streptococcus species	15	25.00	15	25.00
Staphylococcus	1	1.67	1	1.67
Staphylococcus Aureus	42	70.00	46	76.67
Staphylococcus Citreus	4	6.67	1	1.67
Gram negative bacilli	1	1.67	1	1.67
Staphylococcus epidermis	2	3.33	1	1.67



In this study, staphylococcus aureus (70% in group A and 76.67% in group B) and streptococcus species (25% each) were the commonest organisms isolated before the antiseptic skin preparation.

Table 12. Organisms isolated after skin preparation

Organisms	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Pseudomonas aeruginosa	1	1.67	1	1.67
Streptococcus species	1	1.67	0	0.00
Staphylococcus	0	0.00	0	0.00
Staphylococcus Aureus	1	1.67	6	10.00
Staphylococcus Citreus	0	0.00	0	0.00
Gram negative bacilli	0	0.00	0	0.00
Staphylococcus epidermis	0	0.00	0	0.00



Staphylococcus aureus (1.67% in group A and 10% in group B) were the commonest organisms isolated after the antiseptic skin preparation.

Table 13. Comparison of bacterial colonization

Groups	Paired 't' value	'p' value
Group A	31.298	< 0.001
Group B	2.593	0.012

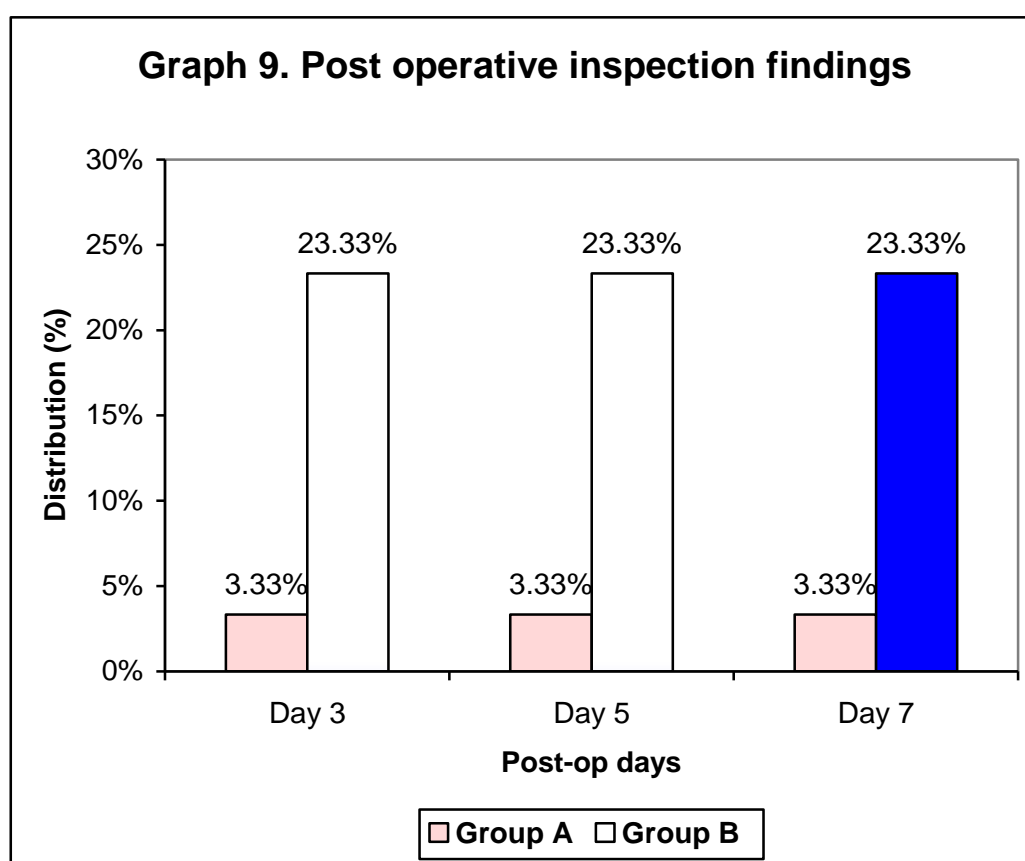
In the present study, after the application of antiseptic agents (Chlorhexidine and povidone iodine) there was reduction of bacterial colonization in both the groups but significant reduction was seen in chlorhexidine group.

Table 14. Post operative inspection findings

Interval	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Day 3*	2	3.33	14	23.33
Day 5*	2	3.33	14	23.33
Day 7*	2	3.33	14	23.33

* $\chi^2=10.385$

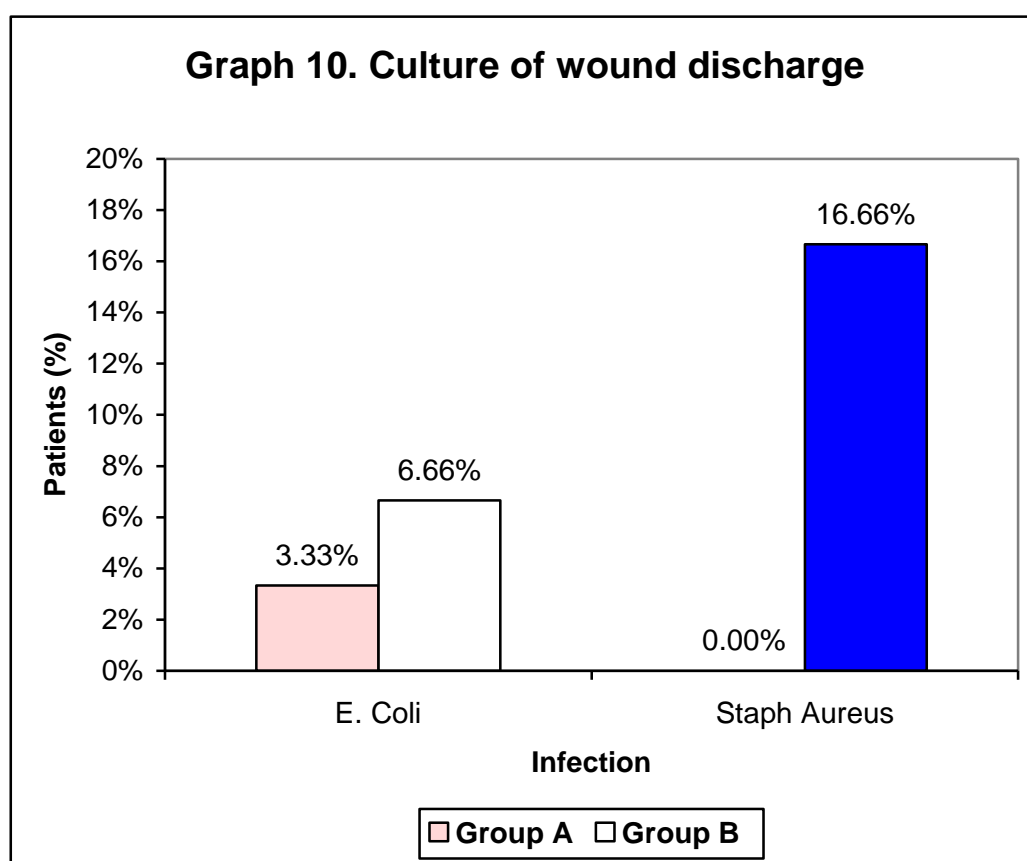
p=0.001



In the present study on post operative day three, five and seven inspection findings revealed significantly high rate of infection in group B (23.33%) compared to group A (3.33%) (p=0.001).

Table 15. Culture of wound discharge

Culture	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
E. Coli	2	3.33	4	6.66
Staph Aureus	0	0.00	10	16.66



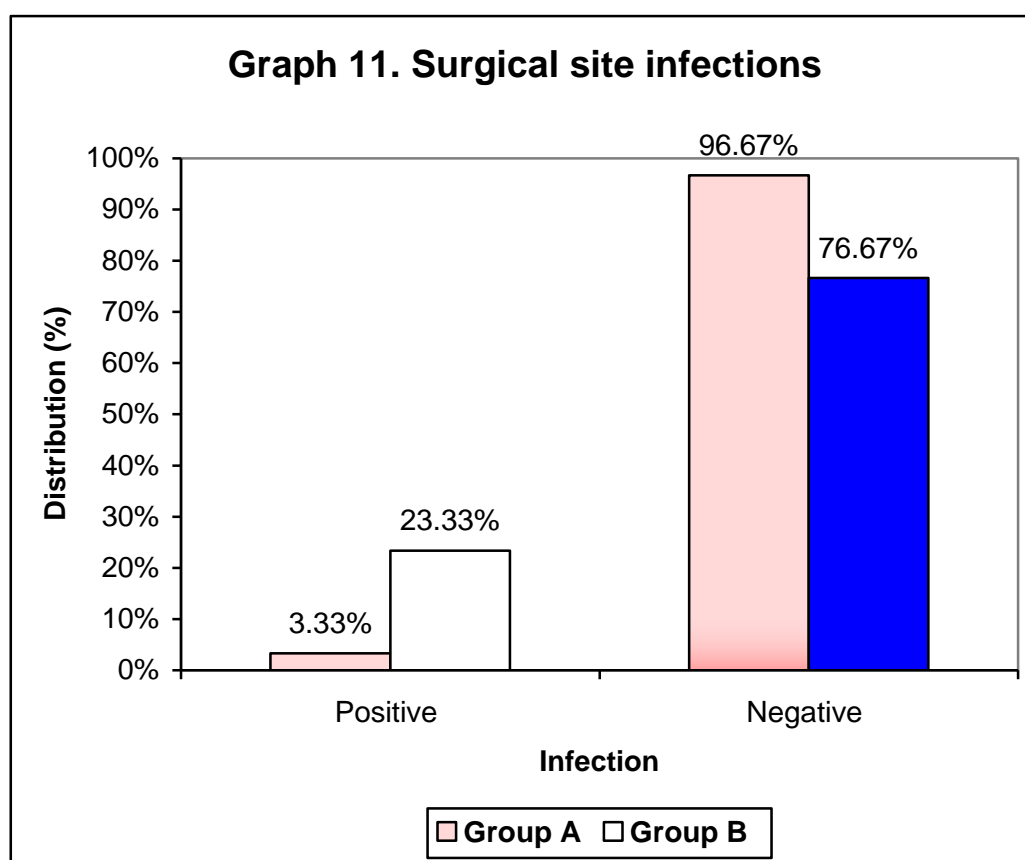
In this study among the patients who had SSIs the microbiological examination revealed E coli as the organism (3.33%) present in chlorhexidine group. In povidone iodine group 16.66% of the patients had infection due to staph aureus followed by E coli 6.6%

Table 16. Surgical site infections

Infection	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Positive	2	3.33	14	23.33
Negative	58	96.67	46	76.67
Total	60	100.00	60	100.00

* $\chi^2=10.385$

p=0.001



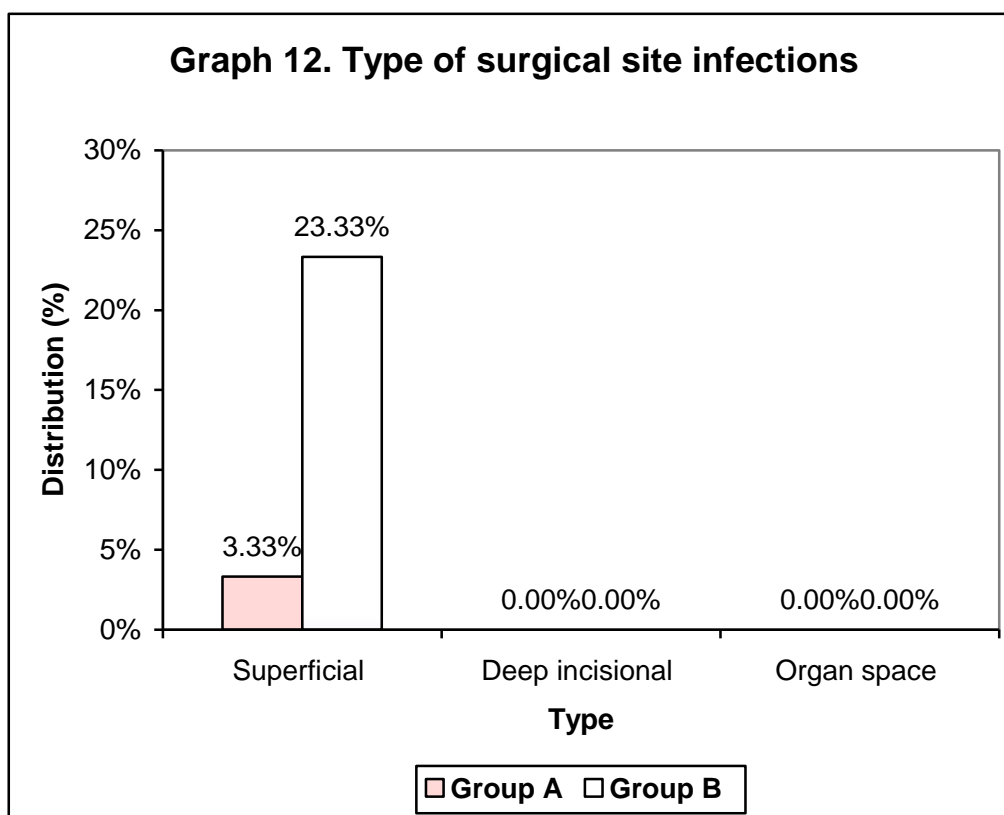
In the present study in group A, 3.33% patients had SSIs compared to 23.33% in group B and this difference was statistically significant (p=0.001).

Table 17. Type of surgical site infections

Surgical site infection	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Superficial	2	3.33	14	23.33
Deep incisional	0	0.00	0	0.00
Organ space	0	0.00	0	0.00

$$*\chi^2=10.385$$

$$p=0.001$$



In the present study in group A, 3.33% patients had superficial SSIs compared to 23.33% in group B and this difference was statistically significant ($p=0.001$).

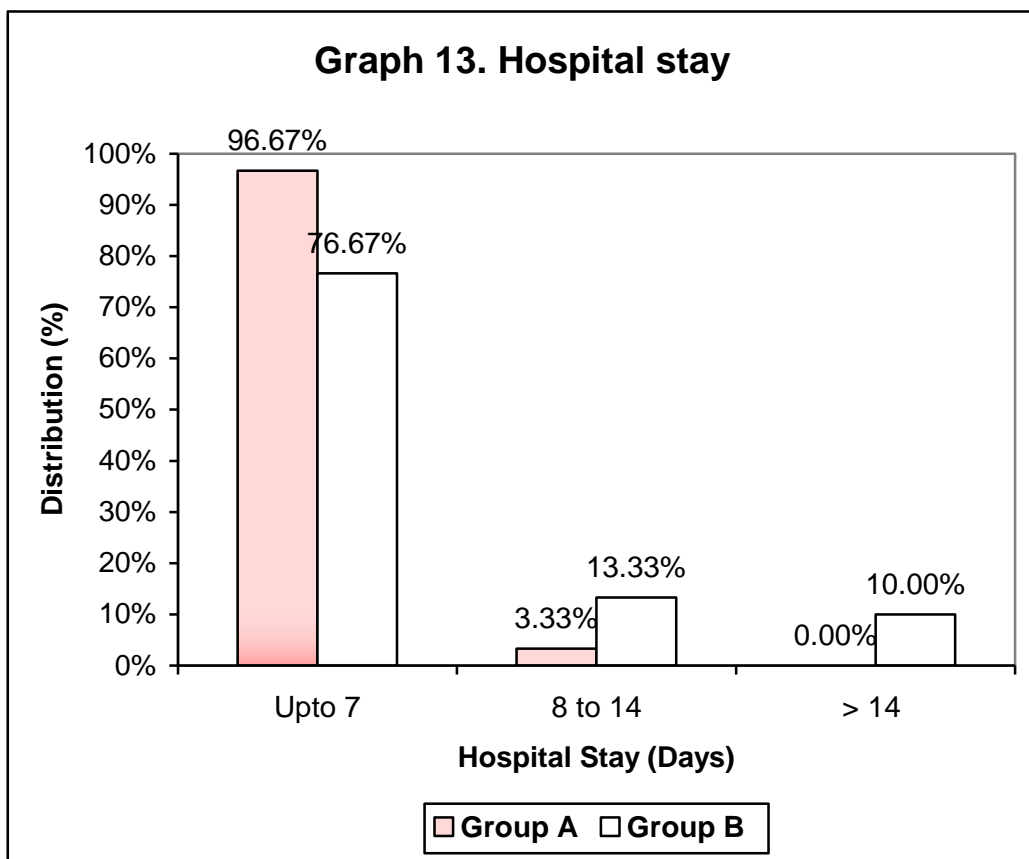
Table 18. Hospital stay

Stay (Days)	Group A (n=60)		Group B (n=60)	
	Number	Percentage	Number	Percentage
Upto 7	58	96.67	46	76.67
8 to 14	2	3.33	8	13.33
> 14	0	0.00	6	10.00
Total	60	100.00	60	100.00

$$*\chi^2=10.385$$

$$p=0.001$$

In this study majority (96.67%) of the patients in group A had hospital stay upto seven days and 3.33% patients required hospital stay between 8 to 14 days. In group B, 76.67% patients had hospital stay upto seven days followed by 13.33% of patients between 8 to 14 days and 10% of patients more than 14 days. This difference was statistically significant ($p=0.001$). The mean length of hospital stay in group A was 7.20 ± 1.10 days whereas in group B it was 8.67 ± 3.17 days.



DISCUSSION

Although considerable progress has been made in understanding the cause and prevention of Surgical Site Infections during the past 100 years, postoperative wound infections (incisional and deep) remain a leading cause of infections, especially in developing countries.⁶⁴

Most SSIs are potentially preventable as their occurrence usually depends on contamination of an incision during surgery with the patient's own endogenous organisms. Later contamination with exogenous organisms is less common. In both cases however the establishment of an infection relates to the amount and pathogenicity of the microorganisms present and the adequacy of the patient's host response, in turn related to their comorbidity.⁶⁵

Among surgical patients, SSIs are the most common nosocomial infection, accounting for about a third of all such infections. In most studies about two thirds of these can be classified as superficial incisional, while the remaining involve either organs or spaces entered during surgery or deep incisional SSIs. On average, having an SSI increases a patient's hospital stay by 7–10 days, with organ/space and deep incisional SSIs accounting for the longest stays and highest costs.³⁵

In the present study most of the patients were males in both the groups (73.33% in group A and 61.67% in group B). The male to female ratio in group A was 2.75:1 and in group B it was 1.60:1. The most common age group among patients in group A was 21 to 30 years (30%) and in group B it was 31 to 40

years (23.33%). The mean age in group A was 39.88 ± 18.53 years and in group B it was 39.15 ± 16.39 years. These findings suggest both the groups were comparable in demographic characteristics.

A similar study⁹ was done to compare the efficacy of the reduction of bacterial colonization and surgical wound infection using chlorhexidine and povidone iodine antiseptic skin preparations in general surgery patients. The patients were divided into two groups. Group 1, included 250 patients (122 females, 138 males), was the povidone iodine group and group 2 (250 patients, 91 females and 159 males) was the chlorhexidine group. The mean age was 56.2 years (20-79) in group 1 and 50.5 years (18-78) in group 2. There was no significant statistical difference of the age between the two groups (p-value = 0.27).

In the present study, half of the of the patients (50%) in both the groups had chronic appendicitis whereas inguinal hernia was diagnosed in 48.33% of patients in group A and 40% in group B. Cases of umbilical hernia were diagnosed in 10% of patients in group B only and epigastric hernia was diagnosed in 1.67% in group A only. Majority of the patients in both the groups (91.67% in group A; 86.67% in group B) had spinal anaesthesia. Based on the diagnosis, half of the patients in both the groups (50%) underwent meshplasty and open appendectomy.

Overall the duration of surgery ranged between 30 to 60 minutes and it was between 30 to 45 minutes in 70% of patients in group A and 68.33% in group B. However 30% in group A and 31.67% in group B had duration of

surgery between 46 to 60 minutes. The mean duration of surgery in group A was 44.66 ± 5.86 minutes and in group B it was 45.00 ± 6.24 minutes.

A similar study⁹ had reported the average operation time as 1.43 hours (40 min to 3 hours) in povidone iodine and 1.45 hours (45 min to 3 hours) in chlorhexidine group ($p=0.93$).

In the present study risk factors for development of surgical site infection except preoperative skin preparation using two different antiseptic agents was controlled. There was no significant statistical difference of the risk factors between the two groups of the sample patients such as age, operative time, wound classification, or underlying host factors. Surgeries were performed in both the groups under the same standard guidelines.

Most of the serious early complications are septic which include abscess and wound infection. Wound infection is common but is nearly always confined to the subcutaneous tissues and responds promptly to wound drainage, which is accomplished by reopening the skin incision. Wound infection predisposes the patient to wound dehiscence.

The most common organism isolated before antiseptic skin preparation was staphylococcus aureus 70% in group A and 76.67% in group B, streptococcus species in both the groups (25% each). After skin preparation staphylococcus aureus (1.67% in group A and 10% group B) was the commonest organisms isolated. After the application of antiseptic agents there was reduction of bacterial colonization in both the groups, but significant reduction was seen in Chlorhexidine group ($p < .001$). In the present study on post operative day three,

five and seven inspection findings revealed significantly high rate of infection in group B (23.33% versus 3.33%; $p=0.001$). In the present study in group A two patients of inguinal hernia had superficial SSIs compared to 14 patients in group B.(seven patients=inguinal hernia, seven patients=chronic appendicitis) and this difference was statistically significant ($p=0.001$). In the patients having SSIs, the wound was laid open and secondary suturing was undertaken subsequently once the wound was clean.

These findings were similar to the results of a study⁹ done in Thailand. The study reported that, wound infection decreased from 3.2% to 2% after chlorhexidine skin preparation and the organisms found in the culture specimen included *Streptococcus epidermidis*, *Staphylococcus aureus*, *Streptococcus* species and *Enterococcus* species. The bacterial colonizations reduced significantly after skin preparations in all types of organisms. The authors also suggested other disadvantages of using povidone iodine are hypersensitivity and colour staining. The study recommended, chlorhexidine antiseptic should be the first consideration for preoperative skin preparation.

Another randomized controlled trial was conducted on patients undergoing clean-contaminated surgery in six hospitals to preoperative skin preparation with either chlorhexidine–alcohol scrub or povidone–iodine scrub and paint. The primary outcome was any surgical-site infection within 30 days after surgery. Secondary outcomes included individual types of surgical-site infections. A total of 849 subjects (409 in the chlorhexidine–alcohol group and 440 in the povidone–iodine group) qualified for the intention-to-treat analysis. The overall rate of surgical-site infection was significantly lower in the

chlorhexidine–alcohol group than in the povidone–iodine group (9.5% vs. 16.1%; $p=0.004$; relative risk, 0.59; 95% confidence interval, 0.41 to 0.85). Chlorhexidine–alcohol was significantly more protective than povidone–iodine against both superficial incisional infections (4.2% vs. 8.6%, $P = 0.008$) and deep incisional infections (1% vs. 3%, $p=0.05$) but not against organ-space infections (4.4% vs. 4.5%). The study concluded that, preoperative cleansing of the patient’s skin with chlorhexidine–alcohol is superior to cleansing with povidone–iodine for preventing surgical-site infection after cleancontaminated surgery.⁵⁵

In a randomized study,⁵⁶ the application of chlorhexidine–alcohol reduced the risk of surgical-site infection by 41% as compared with the most common practice in the United States of using aqueous povidone–iodine.

In this study among the patients with who has SSIs the microbiological examination revealed E coli as the organism (3.33%) present in chlorhexidine group. In povidone iodine group (16.66%) of the patients had infection due to staph aureus followed by E coli (6.6%).

In the present study majority (96.67%) of the patients in group A had duration of hospital stay upto seven days and 3.33% patients required hospital stay between 8 to 14 days. In group B, 76.67% patients had hospital stay upto seven days followed by 13.33% of patients between 8 to 14 days and 10% of patients more than 14 days suggesting significantly prolonged length of hospital stay in group B. ($p=0.001$). The mean length of hospital stay in group A was 7.20 ± 1.10 days whereas in group B it was 8.67 ± 3.17 days and this difference was statistically significant. Though the patients who had no SSIs were fit for

discharge on third or fourth postoperative day, they insisted to stay in hospital till suture removal which was undertaken on post operative day seven as they were coming from far off places and remote villages.

Overall the present study showed that preoperative skin cleansing with chlorhexidine significantly reduced the rate of postoperative SSIs. However, the choice of preoperative surgical-site antisepsis remains controversial and surgeons have long debated the choice of skin preparation.

The limitations of the present study were smaller sample size and risk factors for SSIs in abdominal surgeries such as age, obesity, associated comorbid conditions such as diabetes mellitus, hypertension and immunocompromised patients were not taken into consideration. Hence further studies with larger sample considering these risk factors would explore outcomes of SSIs using skin antisepsis with chlorhexidine.

CONCLUSION

Overall, the results of present study showed that, antisepsis with 4% Chlorhexidine significantly reduces the risk of post operative SSIs, colonization of bacteria and duration of hospital stay in elective abdominal surgeries compared to 5% Povidone Iodine.

SUMMARY

Surgical Site Infections is a dangerous condition, a heavy burden on the patient and social health system. Such infections lengthen bed stay for an average of seven days and results in higher costs. The use of pre operative skin preparation by effective antiseptic plays an important role in reducing postoperative wound infections. Several studies have shown the advantages of Chlorhexidine in pre operative preparations but so far no studies have been done to compare its efficacy versus Povidone Iodine for elective abdominal surgeries in India. Hence the present study was undertaken to compare and evaluate the efficacy of chlorhexidine versus povidone iodine in abdominal surgeries for prevention of SSI.

The present one year randomized controlled trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period from January 2010 to December 2010 on 120 patients undergoing abdominal surgeries. The patients were divided into two groups by computer randomization that is Group A (Chlorhexidine group) and Group B (Povidone Iodine group). Prior to the application of the antiseptic agent one cotton swab was swabbed at pretended incision site. The antiseptic agents (chlorhexidine or povidone iodine) were applied to the skin by sterile gauze piece under aseptic precautions. The antiseptic agents were left on the skin for about three to four minutes. The second cotton swab was swabbed at pretended incision site after application of antiseptic agent. These cotton swabs were transferred to the laboratory for culture and sensitivity. The surgical wounds

were examined on post operative day three, five and seven for any infections present. The surgical wound infection was classified according to US Centre for Disease Control and Prevention (CDC) as SSI.

In the present study most of the patients were males in both the groups (73.33% and 61.67% in group A and B respectively). The male to female ratio in group A was 2.75:1 and in group B it was 1.60:1. The mean age in group A was 39.88 ± 18.53 years and in group B it was 39.15 ± 16.39 years. Half of the of the patients (50%) in both the groups had chronic appendicitis. Inguinal hernia was diagnosed in 48.33% of patients in group A and 40% in group B and umbilical hernia was diagnosed in 10% of patients in group B. The epigastric hernia was diagnosed in 1.67% in group A. Each 50% of patients in both the groups underwent meshplasty and open appendectomy.

Majority of the patients in both the groups (91.67% in group A; 86.67% in group B) had spinal anaesthesia. The mean duration of surgery in group A was 44.66 ± 5.86 minutes and in group B it was 45.00 ± 6.24 minutes. There was no significant statistical difference of the risk factors between the two groups of the sample patients such as age, operative time, wound classification, or underlying host factors. Surgeries were performed in both the groups under the same standard guidelines.

The most common organism isolated before antiseptic skin preparation was staphylococcus aureus 70% in group A and 76.67% in group B, streptococcus species in both the groups (25% each). After skin preparation staphylococcus aureus (1.67% in group A and 10% group B) was the commonest

organism isolated. After the application of antiseptic agents there was reduction of bacterial colonization in both the groups, but significant reduction was seen in Chlorhexidine group ($p < 0.001$). On post operative day three, five and seven inspection findings revealed significantly high rate of infection in group B (23.33% versus 3.33%; $p = 0.001$). In the present study in group A two patients of inguinal hernia had superficial SSIs compared to 14 patients in group B. (seven patients=inguinal hernia, seven patients=chronic appendicitis) and this difference was statistically significant ($p = 0.001$).

In the patients having SSIs, the wound was laid open and secondary suturing was undertaken subsequently once the wound was clean. Among the patients who had SSIs the microbiological examination revealed E coli as the organism (3.33%) present in chlorhexidine group. In povidone iodine group 16.66% of the patients had infection due to staph aureus followed by E coli 6.6%. The mean length of hospital stay in group A was 7.20 ± 1.10 days whereas in group B it was 8.67 ± 3.17 days and this difference was statistically significant.

Overall the present study showed that preoperative skin cleansing with 4% Chlorhexidine significantly reduced the risk of postoperative SSIs and colonization of bacteria in elective abdominal surgeries.

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ANNEXURE I – CONSENT FORM

CONSENT FOR PARTICIPATION IN RESEARCH

Mr. /Mrs. _____ are requested to enroll yourself in study titled “**COMPARATIVE EVALUATION OF PRE OPERATIVE SKIN PREPARATION OF 4% CHLORHEXIDINE WITH 5% POVIDONE IODINE IN PREVENTION OF ABDOMINAL SURGICAL SITE INFECTIONS – A ONE YEAR RANDOMIZED CONTROLLED TRIAL AT KLES DR PRABHAKAR KORE HOSPITALS**” conducted by Dr. Rohit Muvva Postgraduate student in M.S (Gen. Surgery) under guidance of Dr. S. Shimikore_{MS} at Jawaharlal Nehru Medical College, Belgaum.

Objective / Purpose of the study.

You have been requested to participate in research because you are fitting into the study group. Your participation in research is voluntary. Your decision whether to or not to participate, will not affect your relationship with the J.N.M.C. If you decide not to participate, you are free to withdraw at any time.

Purpose of research is to compare SSI after pre-op skin preparation with 4% chlorhexidine versus povidone iodine.

Procedure involved

During abdominal surgeries abdomen is scrubbed either with 4% chlorhexidine or povidone iodine and then two swabs will be taken for culture sensitivity as; first will taken before application of study agent (chlorhexidine or povidone iodine) and other will be taken after application of study agent

(chlorhexidine or povidone iodine) and post operative SSI will be observed on third, fifth and seventh day and after that once a week upto 30 days. Further the data will be tabulated and results will be compared.

Risks and benefits

There are no extra risks involved in this study. Complications, if at occur are those which are normally anticipated. This study will help to prevent the SSI and reduction of bacterial colonisation in normal flora of the skin. The results obtained at the end of study will help other similar patients who get admitted in the hospital.

Privacy and Confidentiality

The only people who will know that you are a research subject are members of the research team. No information about you or provided by you during research will be disclosed to others without your written permission except in emergency to protect your rights and welfare and if required by law.

Authorization to publish results

When the results of research are published or discussed, in conference, no information will be displaced that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed with your permission.

Withdrawal/removal from the study

Participant has full freedom to withdraw from the study whenever he wishes and without prior notice. Even if he declines to participate, there will not be any change in the line of your management or the relationship with your doctor. You will be told about all the new information that may affect your decision to participate in the study. The investigator can also remove the participant from the study.

Institutional policy

If any foreseen complications or injury occurs during the period of study, treatment will be given to the participant within the limitations of KLES Prabhakar Kore Hospital General Ward, Belgaum. No reimbursement, compensation or free medical care will be given. Participant will not be paid/offered any free gifts for participating in the research By Law.

Contact details

In case of any queries or doubts regarding the study you can contact the following.

Dr. Rohit Muvva
Post Graduate Student,
Department of Surgery,
J. N. Medical College,
KLE University, Belgaum – 10.
10
Phone No.: +91-9164007655

Dr. S. S. Shimikore MS
Professor,
Department of Surgery,
J. N. Medical College,
KLE University, Belgaum-
10
Phone No: +91-9448112522

In case of any problem during the study you can contact;

Dr. V. D. Patil MD, DCH
Chairman, College Ethical Dissertation
And Research Committee,
J. N. Medical College,
KLE University, Belgaum – 10.

Financial incentives for participation

You will not be paid / offered any free gifts for participating in the research. You will not be reimbursed for expenses.

Consent statement

I, the undersigned, have been explained in my own vernacular language about the study and my participation in the study is voluntary. If I want, I can withdraw at any time. Also I have been given enough time to clear my doubts about the study and my rights as a study patient.

Participant's name : _____ Signature: _____

Witness name : _____ Signature: _____

Researchers name : _____ Signature: _____

Place : _____ Date: _____

ANNEXURE II – PROFORMA

“COMPARATIVE EVALUATION OF PRE OPERATIVE SKIN PREPARATION OF 4% CHLORHEXIDINE WITH 5% POVIDONE IODINE IN PREVENTION OF ABDOMINAL SURGICAL SITE INFECTIONS – A ONE YEAR RANDOMIZED CONTROLLED TRIAL AT KLES DR PRABHAKAR KORE HOSPITALS”

PATIENT DETAILS

Name : IP No :
Sex : Age :
Date of Admission : Date of Discharge :
Address :

HISTORY

Chief Complaints :

Other history :

EXAMINATION

General Examination

Vitals

Pulse Rate : /Min B.P. : mm Hg
Temperature : °F R. R. : /Min

Systemic Examination

Per Abdomen :

Bowel Sounds :

Provisional Diagnosis :

INVESTIGATIONS

HIV :

HbSAg :

OPERATION DETAILS

Date of surgery :

Name of Surgery :

Anaesthesia :

Duration of the surgery :

Culture sensitivity report :

Post Operative Day 3 inspection :

Post Operative Day 5 inspection :

Post Operative Day 7 Inspection :

Wound Infection

Present

Superficial incisional SSI :

Deep incisional SSI :

Organ/space SSI :

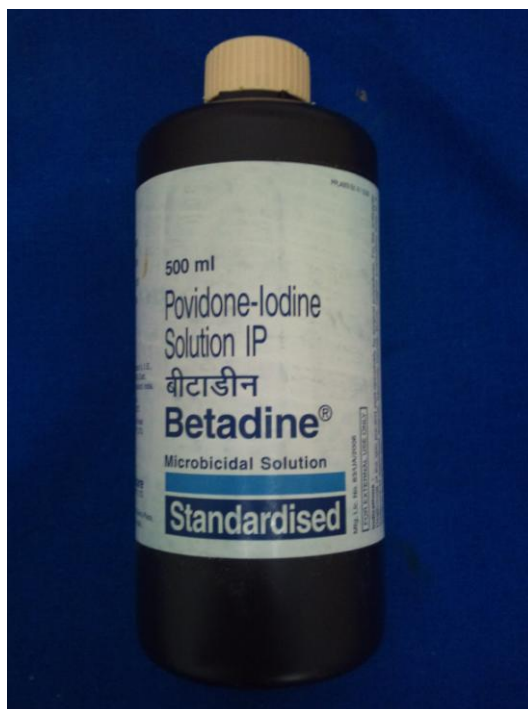
Absent

Duration of Hospital stay :

ANNEXURE III – PHOTOGRAPHS



Photograph 1. 4% Chlorhexidine



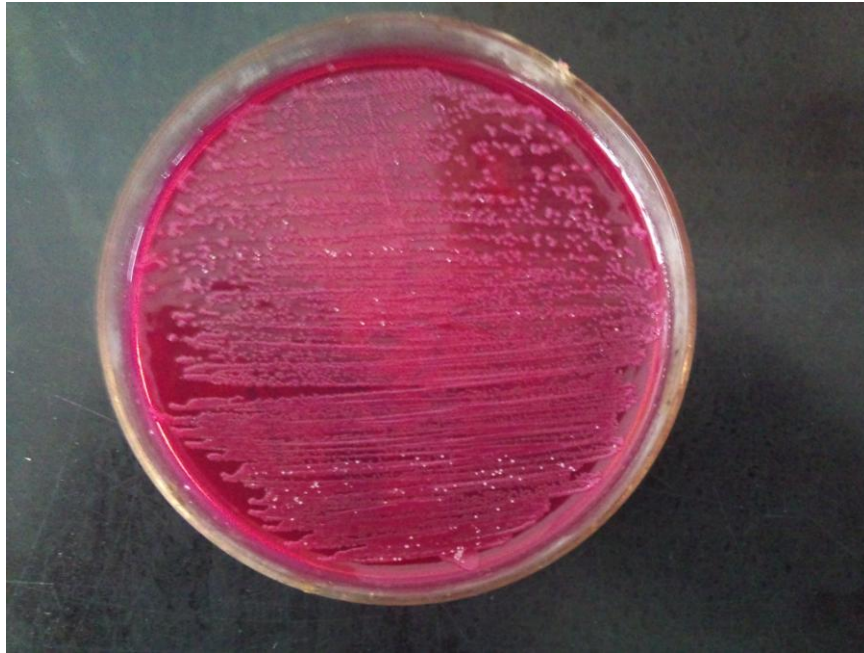
Photograph 2. 5% Povidone Iodine



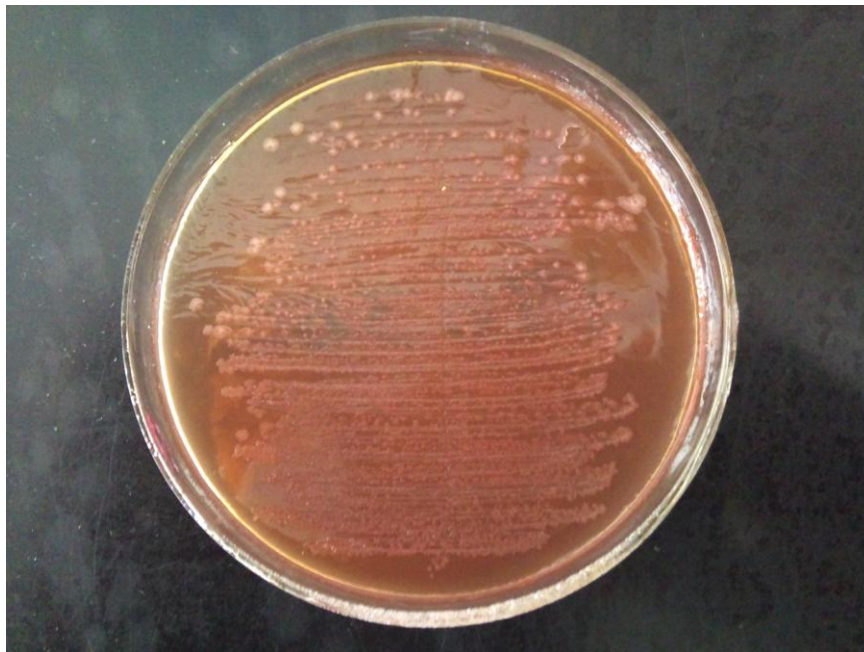
Photograph 3. Prior to the application of antiseptic agent cotton swab was swabbed over pretended incision site



Photograph 4. After the application of antiseptic agent second cotton swab was swabbed at pretended incision site



Photograph 5. McConkey agar plate showing the growth from the skin swabs (lactose fermenting colonies)



Photograph 6. McConkey agar plate showing the growth from the skin swabs (non-lactose fermenting colonies)



Photograph 7. Superficial Surgical Site Infection

MASTER CHART - GROUP B POVIDONE IODINE

Serial Number	In Patient Number	Sex	Age (Years)	Date of admission	Date of Discharge	Diagnosis	Surgery			Post-op inspection			Wound Infection			Culture sensitivity				Hospital Stay (Days)		
							Date	Name of surgery	Anesthesia	Duration (Min)	Day 3	Day 5	Day 7	Surgical site infection	Superficial incisional	Deep Incisional	Organ Space	Before			After	
																		Organism	Colony Count		Organism	Colony Count
1	381663	M	32	28.08.10	04.09.10	CA	28.08.10	OA	SA	40	-	-	-	-	-	-	Sa Au	10	-	-	7	
2	384368	F	30	16.09.10	24.09.10	IH	17.09.10	M	GA	55	-	-	-	-	-	-	Sa Au	10 ⁵	-	-	7	
3	384443	M	45	19.09.10	27.09.10	IH	20.09.10	M	SA	40	-	-	-	-	-	-	Sa Au	10 ⁵	-	-	7	
4	372879	M	14	02.07.10	10.07.10	CA	03.07.10	OA	SA	45	-	-	-	-	-	-	Str	10 ²	-	-	7	
5	372242	F	35	29.06.10	07.07.10	UH	30.06.10	M	GA	55	-	-	-	-	-	-	Sa Au, Str	10 ⁴ , 10 ³	-	-	7	
6	372303	F	28	29.06.10	07.07.10	CA	30.06.10	OA	SA	40	-	-	-	-	-	-	Sa Au	2 X 10 ⁴	-	-	7	
7	369270	F	30	10.06.10	18.06.10	CA	11.06.10	OA	SA	40	-	-	-	-	-	-	Sa Au	2 X 10 ⁴	-	-	7	
8	368200	M	20	01.06.10	09.06.10	IH	02.06.10	M	SA	40	-	-	-	-	-	-	Sa Au	2 X 10 ⁴	-	-	7	
9	369680	M	54	10.06.10	18.06.10	IH	11.06.10	M	SA	55	-	-	-	-	-	-	Sa Au	2 X 10 ⁴	-	-	7	
10	371163	M	28	08.08.10	16.07.10	UH	09.07.10	M	SA	50	-	-	-	-	-	-	Sa Au	15 X 10 ⁴	-	-	7	
11	401486	M	67	11.03.11	19.03.11	IH	12.03.11	M	SA	40	+	+	+	+	+	-	Sa Au, Str	2 X 10 ⁴ , 2 X 10 ⁴	-	-	12	
12	401455	F	18	20.01.11	28.01.11	CA	21.01.11	OA	SA	35	-	-	-	-	-	-	Sa Au	10 ⁴	-	-	7	
13	401994	M	42	24.01.11	31.01.11	UH	25.01.11	M	GA	55	-	-	-	-	-	-	Sa Au, Str	10 ⁵ , 10 ⁵	-	-	7	
14	404328	M	50	11.02.11	19.02.11	CA	12.02.11	OA	SA	40	+	+	+	+	+	-	Sa Au	7.5 X 10 ⁴	-	-	14	
15	404247	F	59	19.02.11	27.02.11	IH	19.02.11	M	GA	50	-	-	-	-	-	-	Sa Au	5 X 10 ⁴	-	-	7	
16	406720	M	62	27.02.11	07.03.11	IH	28.02.11	M	GA	55	+	+	+	+	+	-	Sa Au	10 ⁵	-	-	16	
17	407070	F	20	03.03.11	11.03.11	CA	04.03.11	OA	SA	40	-	-	-	-	-	-	Sa Au	10 ⁵	-	-	7	
18	409415	M	32	21.03.11	29.03.11	IH	22.03.11	M	SA	50	-	-	-	-	-	-	Sa Au	10 ⁵	-	-	7	
19	406114	M	48	04.03.11	12.03.11	IH	05.03.11	M	SA	55	-	-	-	-	-	-	Sa Au, Str	2 X 10 ⁴ , 2 X 10 ⁴	-	-	7	
20	399931	M	27	06.01.11	13.01.11	IH	07.01.11	M	SA	40	-	-	-	-	-	-	Sa Au, Str	5 X 10 ⁴ , 2 X 10 ⁴	-	-	7	
21	399519	M	58	07.01.11	15.01.11	IH	08.01.11	M	SA	45	-	-	-	-	-	-	Sa Au	2 X 10 ⁴	-	-	7	

MASTER CHART - GROUP B POVIDONE IODINE

Serial Number	In Patient Number	Sex	Age (Years)	Date of admission	Date of Discharge	Diagnosis	Surgery			Post-op inspection			Wound Infection			Culture sensitivity				Hospital Stay (Days)		
							Date	Name of surgery	Anesthesia	Duration (Min)	Day 3	Day 5	Day 7	Surgical site infection	Superficial incisional	Deep Incisional	Organ Space	Before			After	
																		Organism	Colony Count		Organism	Colony Count
22	398968	F	40	02.01.11	10.01.11	UH	03.01.11	M	SA	55	-	-	-	-	-	-	-	-	-	-	7	
23	407462	M	58	05.03.11	12.03.11	IH	05.03.11	M	SA	40	+	+	+	+	+	-	-	Sa Au	50 X 10 ³	Sa Au	50 X 10 ²	12
24	370710	M	16	17.06.10	25.06.10	CA	18.06.10	OA	SA	40	-	-	-	-	-	-	-	Sa Au	10 ⁶	-	-	7
25	399711	M	37	07.01.11	15.01.11	IH	08.01.11	M	SA	45	-	-	-	-	-	-	-	Sa Au	-	-	-	7
26	402481	M	77	28.01.11	05.02.11	IH	29.01.11	M	SA	40	+	+	+	+	+	-	-	Sa Au, Str	10 X 10 ³ , 5 X 10 ³	-	-	16
27	403482	F	21	07.02.11	15.02.11	CA	08.02.11	OA	SA	40	-	-	-	-	-	-	-	Sa Au	10 X 10 ³	-	-	7
28	402825	F	24	31.01.11	08.02.11	CA	01.02.11	OA	SA	40	-	-	-	-	-	-	-	Sa Au	15 X 10 ³	-	-	7
29	403215	M	18	02.02.11	10.02.11	CA	03.02.11	OA	SA	40	-	-	-	-	-	-	-	-	-	-	-	7
30	406497	F	36	25.02.11	05.03.11	CA	26.02.11	OA	SA	45	-	-	-	-	-	-	-	Sa Au	5 X 10 ³	-	-	7
31	410897	F	26	29.03.11	06.04.11	CA	30.03.11	OA	SA	35	-	-	-	-	-	-	-	Sa Au, Str	10 ² , 10 ³	-	-	7
32	408812	F	40	15.03.11	23.03.11	CA	16.03.11	OA	SA	55	-	-	-	-	-	-	-	Sa Au	3 X 10 ⁴	-	-	7
33	406132	F	28	24.02.11	04.03.11	CA	25.02.11	OA	SA	40	+	+	+	+	+	-	-	Str	5 X 10 ⁴	Sa Au	2 X 10 ⁴	14
34	403880	M	65	08.02.11	16.02.11	IH	09.02.11	M	SA	55	+	+	+	+	+	-	-	Str	10 ⁵	Sa Au	10 ²	12
35	402061	M	30	24.01.11	01.02.11	CA	25.01.11	OA	SA	35	-	-	-	-	-	-	-	Sa Au	10 ⁵	-	-	7
36	401981	M	10	28.01.11	05.02.11	CA	29.01.11	OA	GA	40	-	-	-	-	-	-	-	Sa Au, Str	10 ³ , 10 ⁵	-	-	7
37	399301	M	48	04.01.11	12.01.11	CA	05.01.11	OA	SA	40	+	+	+	+	+	-	-	Sa Au	10 ⁵	-	-	16
38	399113	M	17	03.01.11	11.01.11	IH	04.01.11	M	SA	50	+	+	+	+	+	-	-	PA	10 ⁵	PA	10 ²	16
39	410994	M	59	28.03.11	05.04.11	IH	29.03.11	M	SA	50	-	-	-	-	-	-	-	Sa Au	-	-	-	7
40	410012	F	16	18.03.11	26.03.11	CA	19.03.11	OA	SA	40	-	-	-	-	-	-	-	Sa Au	10	-	-	7
41	407104	F	30	03.03.11	11.03.11	CA	04.03.11	OA	SA	40	-	-	-	-	-	-	-	Str	4 X 10 ³	-	-	7
42	407350	M	33	05.03.11	12.03.11	IH	05.03.11	M	SA	50	-	-	-	-	-	-	-	Sa Au, Str	2 X 10 ³ , 4 X 10 ³	-	-	7

MASTER CHART - GROUP B POVIDONE IODINE

Serial Number	In Patient Number	Sex	Age (Years)	Date of admission	Date of Discharge	Diagnosis	Surgery			Post-op inspection			Wound Infection			Culture sensitivity				Hospital Stay (Days)		
							Date	Name of surgery	Anesthesia	Duration (Min)	Day 3	Day 5	Day 7	Surgical site infection	Superficial incisional	Deep Incisional	Organ Space	Before			After	
																		Organism	Colony Count		Organism	Colony Count
43	407475	M	35	07.03.11	15.03.11	IH	08.03.11	M	SA	40	-	-	-	-	-	-	-	-	-	-	7	
44	407642	M	31	07.03.11	15.03.11	IH	08.03.11	M	SA	45	-	-	-	-	-	-	-	-	-	-	7	
45	400886	M	54	16.01.11	24.01.11	UH	17.01.11	M	GA	55	-	-	-	-	-	-	-	-	-	-	7	
46	401887	F	40	24.01.11	01.02.11	CA	25.01.11	OA	SA	40	-	-	-	-	-	-	Sa Au	20 X 10 ³	-	-	7	
47	403077	F	38	02.02.11	10.02.11	CA	03.02.11	OA	SA	45	+	+	+	+	+	-	Sa Au	20 X 10 ³	Sa Au	10 X 10 ³	14	
48	405541	F	52	21.02.11	01.03.11	UH	22.02.11	M	GA	55	-	-	-	-	-	-	Str, Sa Au	5 X 10 ³ , 4 X 10 ³	-	-	7	
49	404673	M	42	14.02.11	22.02.11	IH	15.02.11	M	SA	45	-	-	-	-	-	-	Sa Au, Str	8 X 10 ³ , 3 X 10 ³	-	-	7	
50	412521	F	32	11.04.11	19.04.11	CA	12.04.11	OA	SA	45	-	-	-	-	-	-	Sa Au	6 X 10 ³	-	-	7	
51	400978	M	43	19.01.11	27.01.11	CA	20.01.11	OA	SA	45	-	-	-	-	-	-	Sa Au	2.5 X 10 ³	-	-	7	
52	404053	F	30	08.02.11	16.02.11	CA	09.02.11	OA	SA	40	-	-	-	-	-	-	Sa Au	1.5 X 10 ³	-	-	7	
53	404852	M	59	15.02.11	23.02.11	IH	16.02.11	M	SA	45	-	-	-	-	-	-	St Cr	8 X 10 ³	-	-	7	
54	406709	M	57	28.02.11	08.03.11	IH	01.03.11	M	SA	45	-	-	-	-	-	-	Sa Au	8 X 10 ³	-	-	7	
55	410873	F	55	01.04.11	08.04.11	CA	02.04.11	OA	SA	40	+	+	+	+	+	-	St Epi, Gr N B	60, 10	-	-	16	
56	407370	M	40	04.03.11	12.03.11	CA	05.03.11	OA	SA	45	-	-	-	-	-	-	ST	2 X 10 ³	-	-	7	
57	410166	F	69	24.03.11	01.04.11	CA	25.03.11	OA	SA	50	+	+	+	+	+	-	-	-	-	-	12	
58	411398	M	22	01.04.11	09.04.11	CA	02.04.11	OA	SA	40	-	-	-	-	-	-	Sa Au	200	-	-	7	
59	411399	M	50	31.03.11	08.04.11	CA	01.04.11	OA	SA	55	+	+	+	+	+	-	Sa Au	80	Sa Au	1	16	
60	410572	M	72	12.04.11	20.04.11	IH	13.04.11	M	SA	45	+	+	+	+	+	-	Sa Au	100	Sa Au	2	12	

ANNEXURE IV - KEY TO MASTER CHART

-	-	Absent
+	-	Present
CA	-	Chronic appendicitis
EH	-	Epigastric hernia
F	-	Female
GA	-	General anaesthesia
Gn	-	Gram negative bacilli
IH	-	Inguinal hernia
M	-	Male
M	-	Meshplasty
OA	-	Open appendectomy
PA	-	Pseudomonas aeruginosa
Post-op	-	Post operative
Sa Au	-	Staphylococcus Aureus
SA	-	Spinal anaesthesia
St Cr	-	Staphylococcus Citreus
St Epi	-	Staphylococcus epidermidis
ST	-	Staphylococcus
Str	-	Streptococcus species
UH	-	Umbilical hernia