"A COMPARATIVE STUDY OF INTRA OPERATIVE IRRIGATION OF SUBCUTANEOUS TISSUE WITH POVIDONE IODINE SOLUTION VERSUS SALINE IRRIGATION IN APPENDICECTOMY FOR PREVENTION OF SURGICAL SITE WOUND INFECTION." – A ONE YEAR RANDOMIZED CONTROL TRIAL AT KLES' DR. PRABHAKAR KORE HOSPITAL

By

Dr. SONI CHINTAN SUNIL
(REG. NO. BH0109007)

Dissertation

Submitted to the
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In Partial Fulfillment
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M. S.
in
GENERAL SURGERY

Under the Guidance of

Dr. V. M. UPPIN MS
Professor and Head

DEPARTMENT OF SURGERY,
JAWAHARLAL NEHRU MEDICAL COLLEGE,
BELGAUM, KARNATAKA

MAY - 2012

KLE UNIVERSITY, BELGAUM, KARNATAKA

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Date:

Place:

Dr. SONI CHINTAN SUNIL
REG. NO. BH0109007

KLE UNIVERSITY, BELGAUM, KARNATAKA

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This is to certify that the dissertation entitled **"A COMPARATIVE STUDY OF INTRA OPERATIVE IRRIGATION OF SUBCUTANEOUS TISSUE WITH POVIDONE IODINE SOLUTION VERSUS SALINE IRRIGATION IN APPENDICECTOMY FOR PREVENTION OF SURGICAL SITE WOUND INFECTION." – A ONE YEAR RANDOMIZED CONTROL TRIAL AT KLES' DR. PRABHAKAR KORE HOSPITAL** is a bonafide research work done by **Dr. SONI CHINTAN SUNIL (REG. NO. BH0109007)** in partial fulfillment of the requirement for the degree of **M. S. in GENERAL SURGERY.**

Date:

Place:

Dr. V. M. UPPIN $_{MS}$
Professor and Head,
Department of Surgery,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

KLE UNIVERSITY, BELGAUM, KARNATAKA

ENDORSEMENT BY THE HOD/PRINCIPAL/ HEAD OF THE INSTITUTION

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Dr. V. M. UPPIN $_{MS}$
Professor and Head,
Department of Surgery,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Date:
Place: Belgaum

Dr. V. D. PATIL $_{MD,DCH}$
Principal,
J. N. Medical College,
Nehru Nagar, Belgaum – 10

Date:
Place: Belgaum

KLE UNIVERSITY, BELGAUM, KARNATAKA

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Date :

Place :

Dr. SONI CHINTAN SUNIL
(REG. NO. BH0109007)

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Date:
Place: Belgaum

Dr. SONI CHINTAN SUNIL
REG No. BH0109007

LIST OF ABBREVIATIONS USED

BP	-	Blood pressure
Candida Spp	-	Candida species
C.V.S.	-	Cardiovascular system
CDC	-	Centre for Disease Control
Cm	-	Centimeter
C.N.S.	-	Central nervous system
DM	-	Diabetes mellitus
E.Coli	-	Escherichia coli
F	-	Female
HAI	-	Health care associated infection
HIV	-	Human immunodeficiency virus
HbSAg	-	Hepatitis B virus surface antigen
I.P.	-	In patient
Inj	-	Injection
Intra-op	-	Intra-operative
IV	-	Intravenous
M	-	Male
Mg/dl	-	Miligram per deciliter
mL	-	Millilitre
mm	-	Millimeter
MRSA	-	Methicillin-resistant Staphylococcus aureus
n	-	Number of patients
No.	-	Number
NNIS	-	National nosocomial infection surveillance

Pre – Op	-	Pre operatively
R.S.	-	Respiratory system
Staph aureus	-	Staphylococcus aureus
Strept	-	Streptococcus
Temp	-	Temperature
USG	-	Ultrasonography
WBC	-	White blood cell
x^2	-	Chi square

ABSTRACT

Background and Objectives

Acute appendicitis is the most common surgical emergency in the developed countries that is common in the second decade of life with Surgical Site Infections (SSIs) complicating 1–5% of appendicectomy cases. The present study was undertaken to compare and evaluate the use of povidone iodine solution versus saline irrigation in intraoperative subcutaneous irrigation in appendicectomy for prevention of surgical site infection and also to compare the duration of post-operative hospital stay in each study group.

Methodology

This one year randomized clinical trial was conducted in the Department of General Surgery, KLES Dr. Prabhakar Kore Hospital and Medical Research Centre, Belgaum over a period of January 2010 to December 2010 on 100 patients with non perforated appendicitis. Based on the envelope method, patients were divided into two groups namely group A (Subcutaneous irrigation with 10% Povidone iodine) and group B (Subcutaneous irrigation with normal saline).

Results

In the present study, females outnumbered males (56% vs 44%) in normal saline irrigation group. The mean age in povidone iodine irrigation group was 31.20 ± 12.68 years and in normal saline group it was 29.90 ± 12.05 years. On day seven, none of the patients in povidone iodine irrigation group and 82% in normal saline group had no SSIs. In the remaining patients of normal saline irrigation group 14% of patients had Grade 2 while, 4% had Grade 1 SSIs and

this difference was statistically significant (p=0.003). Mean stay in hospital for povidone iodine group was seven days as compared to 8.4 days in normal saline group.

Conclusion and interpretation

The results of the present study showed that, intraoperative irrigation of subcutaneous tissue with 10% povidine iodine helps in preventing SSIs as compared to normal saline irrigation. It also reduced post operative length of hospital stay significantly.

Keywords

Acute appendicitis; Normal saline; Povidone iodine; Surgical site infections;

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INTRODUCTION

Acute appendicitis is the most common surgical emergency in the developed countries that is common in the second decade of life. The incidence of acute appendicitis is 1.5/1000 in males and 1.9/1000 in females with an overall lifetime risk of 6 to 20%. It is uncommon before two years of age.[1]

Appendicectomy is one of the commonest operations in abdominal surgeries. The most common method of appendicectomy is to crush and ligate the stump and then invaginate into caecal wall by means of purse string suture. However some surgeons prefer to omit the step of invagination.[2]

In recent years, the incidence of appendicitis has markedly decreased. Nevertheless, appendicitis remains one of the more common surgical emergencies, and appendicectomy remains the treatment of choice in noncomplicated appendicitis.

Complications may occur in patents with appendicitis, accounting for an average morbidity of around 10%. Death is rare but can occur in patients who have profound peritonitis and sepsis. If a complication occurs, following appendicectomy further diagnostic and therapeutic procedures may be required, which may lead to further prolonged hospitalization and additional cost.

Severe infection may result in adynamic ileus. Postoperatively, wound infection or dehiscence may occur, especially in patients with gangrenous or perforated appendicitis, persistent ileus, caecal fistulas, and pelvic or abdominal abscess. Patients with these conditions present with wound tenderness or

soreness, drainage of fluid from the incision, or swelling and redness at the incision site.

Surgical site infections (SSIs) are the most common complications seen after appendicectomy. About 5 – 10% patients with uncomplicated appendicitis develop wound infections after open appendicectomy.[2]

Surgical site infection is an infrequent but at times serious complication of surgery. Postoperative infection often requires repeat surgery and prolonged hospitalization. It leads to an increase in cost of medical services, compromises the ultimate surgical outcome.

Despite the widespread use of prophylactic antibiotics, surgical site infection continues to occur and is devastating for patients. Many different wound irrigation solutions, including soaps, antibiotics and antiseptics, have been used to reduce surgical site infection.[1] Wound irrigation with povidone-iodine, an antiseptic solution, may be useful for reducing infection, but it is of uncertain efficacy and risk.

Povidone iodine is an antiseptic solution, which consists of polyvinylpyrrolidone with water, iodide and 1% available iodine; it has bactericidal ability against a large array of pathogens.[3]

Povidone iodine acts by release of elemental iodine which binds irreversibly with protein. It has been used topically as skin antiseptic with good results. It has been also reported as an effective, non toxic, topical antiseptic agent in surgical wounds.[4]

In view of the above context, the present study was undertaken to compare and evaluate the use of povidone iodine solution versus saline irrigation in intraoperative subcutaneous irrigation in appendicectomy for prevention of surgical site infection and also to compare the duration of post-operative hospital stay in each study group.

OBJECTIVES

The objectives of the present study were;

Primary

To compare and evaluate the use of povidone iodine solution versus normal saline irrigation in intraoperative subcutaneous irrigation in appendicectomy for prevention of SSI.

Secondary

To compare the duration of post-operative hospital stay in each study group.

REVIEW OF LITERATURE

SURGICAL SITE INFECTIONS

Definition

Surgical site infections are infections present in any location along the surgical tract after a surgical procedure. SSIs involve postoperative infections occurring at any level (incisional or deep) of a specific procedure. SSI represents a significant burden in terms of patient morbidity and mortality, and cost to health services around the world. A multitude of risk factors influence the development of SSIs and awareness of these will help to promote effective preventive strategies. Assessment tools such as the Centers for Disease Control (CDC) definitions, ASEPSIS and the Southampton Wound Assessment Scale are needed to accurately identify and classify SSIs.[5]

Over the past 50 years, increased interest in the discipline of surgical infection has resulted in advances in post-surgical infection control. Early investigations focused on the importance of anaerobic microflora to postoperative infection and paved the way for significant improvements in prophylactic and therapeutic antibiotic treatment of surgical patients. Later research centered on the identification of risk factors to better predict postoperative infection rates.[6]

Historical perspectives

Before the mid-19th century, surgical patients commonly developed postoperative "irritative fever," followed by purulent drainage from their

incisions, overwhelming sepsis, and often death. It was not until the late 1860s, after Joseph Lister introduced the principles of antisepsis that postoperative infectious morbidity decreased substantially. Lister's work radically changed surgery from an activity associated with infection and death to a discipline that could eliminate suffering and prolong life.[7]

Until the middle of the 19th century, when Ignaz Semmelweis and Joseph Lister became the pioneers of infection control by introducing antiseptic surgery, most wounds became infected. Mortality rate in cases of the deep or extensive infection was around 70 to 80%.[8] Since then a number of significant developments, particularly in the field of microbiology, have made surgery safer. However, the overall incidence of healthcare associated infections (HAIs) remains high and represents a substantial burden of disease.

In 1992, the US CDC revised its definition of 'wound infection', creating the definition 'surgical site infection' (SSI)[9] to prevent confusion between the infection of a surgical incision and the infection of a traumatic wound. Most SSIs are superficial, but even so they contribute greatly to the morbidity and mortality associated with surgery.[10,11] Estimating the cost of SSIs has proved to be difficult but many studies agree that additional bed occupancy is the most significant factor. A review of the incidence and economic burden of SSIs in Europe estimated that the mean length of extended stay attributable to SSIs was 9.8 days, at an average cost per day of €325.[11]

In 1980, Cruse estimated that a SSI increased a patient's hospital stay by approximately 10 days and cost an additional $2,000.[12,13] A 1992 analysis

showed that, each SSI resulted in 7.3 additional postoperative hospital days, adding $3,152 in extra charges.[14] Other studies corroborate that increased length of hospital stay and cost are associated with SSIs.[15,16] Deep SSIs involving organs or spaces, as compared to SSIs confined to the incision, are associated with even greater increases in hospital stays and costs.[17,18]

Surgical wounds may heal by primary intention, delayed primary intention or by secondary intention. Most heal by primary intention, where the wound edges are brought together (apposed) and then held in place by mechanical means (adhesive strips, staples or sutures), allowing the wound time to heal and develop enough strength to withstand stress without support. The goal of surgery is to achieve healing by such means with minimal oedema, no serous discharge or infection, without separation of the wound edges and with minimal scar formation. On occasion, surgical incisions are allowed to heal by delayed primary intention where non-viable tissue is removed and the wound is initially left open. Wound edges are brought together at about 4-6 days, before granulation tissue is visible.[19] This method is often used after traumatic injury or dirty surgery.

Healing by secondary intention occurs when the wound is left open, because of the presence of infection, excessive trauma or skin loss, and the wound edges come together naturally by means of granulation and contraction.[20]

Experimentally as well as clinically it has been shown that a delay in wound closure of four to five days increases the tensile strength of the wound as well as resistance to infection. The overall rate of SSIs in traumatic war wounds

using delayed principles was 3-4%, compared with more than 20% after primary closure.[21] In civilian practice, delayed healing has been used successfully in cases of severe incisional abscesses, mainly after laparotomy. Another benefit of delayed closure is the cosmetic result after healing. The appearance of a wound after a delay of four to five days is comparable to that of primary closure. A wider scar follows late closure (after 10-14 days), although this is cosmetically much better than the result obtained after the healing of an open granulating wound.

Table 1. Classification

Classification of operative wounds based on degree of microbial contamination[9]

Classification	Criteria
Clean	Elective, not emergency, non-traumatic, primarily closed; no acute inflammation; no break in technique; respiratory, gastrointestinal, biliary and genitourinary tracts not entered.
Clean-contaminated	Urgent or emergency case that is otherwise clean; elective opening of respiratory, gastrointestinal, biliary or genitourinary tract with minimal spillage (appendicectomy) not encountering infected urine or bile; minor technique break.
Contaminated	Non-purulent inflammation; gross spillage from gastrointestinal tract; entry into biliary or genitourinary tract in the presence of infected bile or urine; major break in technique; penetrating trauma <4 hours old; chronic open wounds to be grafted or covered.
Dirty	Purulent inflammation (abscess); preoperative perforation of respiratory, gastrointestinal, biliary or genitourinary tract; penetrating trauma >4 hours old.

Classification of operative wounds based on CDC guidelines[9]

Superficial incisional SSI

- Infection involves only skin and subcutaneous tissue of incision.
- Superficial incisional SSI
    - Occurs within 30 days after the operation
    - Involves only the skin or subcutaneous tissue
    - At least 1 of the following:

        - Purulent drainage is present (culture documentation not required).
        - Organisms are isolated from fluid/tissue of the superficial incision.
        - At least 1 sign of inflammation (eg, pain or tenderness, induration, erythema, local warmth of the wound) is present.
        - The wound is deliberately opened by the surgeon.
        - The surgeon or clinician declares the wound infected.
    - Note: A wound is not considered a superficial incisional SSI if a stitch abscess is present; if the infection is at an episiotomy, a circumcision site, or a burn wound; or if the SSI extends into fascia or muscle.

Deep incisional SSI

- Infection involves deep tissues, such as fascial and muscle layers. This also includes infection involving both superficial and deep incision sites and organ/space SSI draining through incision.
    - Occurs within 30 days of the operation or within 1 year if an implant is present
    - Involves deep soft tissues (eg, fascia and/or muscle) of the incision
    - At least 1 of the following:
        - Purulent drainage is present from the deep incision but without organ/space involvement.

- Fascial dehiscence or fascia is deliberately separated by the surgeon because of signs of inflammation.
- A deep abscess is identified by direct examination or during reoperation, by histopathology, or by radiologic examination.
- The surgeon or clinician declares that a deep incisional infection is present.

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 the operation or within 1 year if an implant is present
- Involves anatomical structures not opened or manipulated during the operation
- At least 1 of the following:
    - Purulent drainage is present from a drain placed by a stab wound into the organ/space.
    - Organisms are isolated from the organ/space by aseptic culturing technique.
    - An abscess in the organ/space is identified by direct examination, during reoperation, or by histopathologic or radiologic examination.
    - A diagnosis of organ/space SSI is made by the surgeon or clinician.

Prevalence of SSIs

Infection rates in the four surgical classifications (clean, clean-contaminated, contaminated and dirty wounds) have been published in many studies but most literature refers as a benchmark for infection rates.[13,22] Before the routine use of prophylactic antibiotics infection rates were 1-2% or less for clean wounds, 6-9% for clean-contaminated wounds, 13-20% for contaminated wounds and about 40% for dirty wounds.[13,22] Since the introduction of routine prophylactic antibiotic use, infection rates in the most contaminated groups have reduced drastically. Infection rates in United States National Nosocomial Infection Surveillance (NNIS) system hospitals were reported to be: clean 2.1%, clean-contaminated 3.3%, contaminated 6.4% and dirty 7.1%.[23] There is, however, considerable variation in each class according to the type of surgery being performed.[24,25]

An Indian study[26] was conducted at Himalayan Institute of Medical Sciences, Dehradun, India from November 2008 to October 2009 to determine the incidence of SSI in elective abdominal surgeries; to correlate the SSI with the nature of elective surgical procedure; to study the profile of bacterial isolates obtained from cases of SSI. The patients who underwent elective abdominal surgery were included in the study group. These patients were followed up for superficial incisional SSIs until complete wound healing occurred or on their discharge from the hospital. The incidence of SSI in elective surgeries was found to be five percent. E. coli was the most common organism isolated followed by Staphylococcus aureus. Risk factors like diabetes mellitus, smoking and duration of surgery play a significant role in causing SSI. The study concluded that, an

effective surveillance programme for SSIs should be a critical component of any hospital infection control programme to reduce the rate of infection.

Risk factors

Table 2. Risk factors associated with SSIs[27]

	Risk factors	
	Host related	**Procedure related**
Definite	Age	Pre-operative hair removal
	Obesity	Type of procedure
	Disease severity	Antibiotic prophylaxis
	Nasal carriage of Staph aureus	Duration of surgery
	Remote infection	
	Duration of pre-op hospitalization	
Likely	Malnutrition and low serum albumin	Multiple procedures
	Diabetes mellitus	Tissue trauma
		Foreign material
		Blood transfusion
Possible	Malignancy	Pre-op showers
	Immunosuppressive therapy	Emergency surgery
		Drains

Risk factors related to appendicectomy[27]

Patient factors

These include, extreme age, obesity, malnutrition, certain concurrent disease or conditions that is, diabetes, malignancy, chronic chest or heart disease and immunosuppression. Patients with pre-existing skin lesions or infection in another site, and treatment with steroid and immunosuppressive drugs are more prone to get surgical wound infection due to impaired host defense mechanisms.

Surgical technique

The skill of the surgeon has a central role in minimizing surgical wound infection. Bad surgical practice must not be covered up with antibiotics. Expeditious surgery, gentle handling of tissue, reduction of blood loss or hematoma formation, elimination of dead tissue, debridement of devitalized tissue, removal of all foreign body materials from the wound are essential to minimize surgical wound infections in all patients.

Duration of operation

There is a direct link between the length of the operation and the infection rate with a clean wound which doubles every hour. This is because bacterial contamination increases over time and the operative tissue are damaged by drying and other surgical manipulations that is use of refractor, diathermy etc.

Pathogenesis

Microbial contamination of the surgical site is a necessary precursor of SSI. The risk of SSI can be conceptualized according to the following relationship:[28,29]

Dose of bacterial contamination X virulence = Risk of SSI.

Resistance of the host patient Quantitatively has shown that if a surgical site is contaminated with >105 microorganisms per gram of tissue, the risk of SSI is markedly increased. However, the dose of contaminating microorganisms required to produce infection may be much lower when foreign material is present at the site (100 staphylococci per gram of tissue introduced on silk sutures).[30-32]

Microorganisms may contain or produce toxins and other substances that increase their ability to invade a host, produce damage within the host, or survive on or in host tissue. For example, many gram-negative bacteria produce endotoxin, which stimulates cytokine production. In turn, cytokines can trigger the systemic inflammatory response syndrome that sometimes leads to multiple system organ failure.[33-35] One of the most common causes of multiple system organ failure in modern surgical care is intraabdominal infection.[36,37] Some bacterial surface components, notably polysaccharide capsules, inhibit phagocytosis,[38] a critical and early host defense response to microbial contamination. Certain strains of clostridia and streptococci produce potent exotoxins that disrupt cell membranes or alter cellular metabolism.[39] A variety of microorganisms, including gram-positive bacteria such as coagulase negative

staphylococci, produce glycocalyx and an associated component called "slime,"[40-45] which physically shields bacteria from phagocytes or inhibits the binding or penetration of antimicrobial agents.[46] Although these and other virulence factors are well defined, their mechanistic relationship to SSI development has not been fully determined.

For most SSIs, the source of pathogens is the endogenous flora of the patient's skin, mucous membranes, or hollow viscera.[47] When mucous membranes or skin is incised, the exposed tissues are at risk for contamination with endogenous flora.[48] These organisms are usually aerobic gram-positive cocci (staphylococci), but may include fecal flora (anaerobic bacteria and gramnegative aerobes) when incisions are made near the perineum or groin. When a gastrointestinal organ is opened during an operation and is the source of pathogens, gramnegative bacilli (*E. coli),* gram-positive organisms (enterococci), and sometimes anaerobes (*Bacillus fragilis)* are the typical SSI isolates.

Seeding of the operative site from a distant focus of infection can be another source of SSI pathogens,[49-58] particularly in patients who have a prosthesis or other implant placed during the operation. Such devices provide a nidus for attachment of the organism.[40,59-63]

Exogenous sources of SSI pathogens include surgical personnel (especially members of the surgical team),[64-68] the operating room environment (including air), and all tools, instruments, and materials brought to the sterile field during an operation. Exogenous flora are primarily aerobes, especially gram-positive organisms (staphylococci and streptococci). Fungi from endogenous and

exogenous sources rarely cause SSIs, and their pathogenesis is not well understood.[69]

Microbiology

According to data from the NNIS system, the distribution of pathogens isolated from SSIs has not changed markedly during the last decade.[70,71]

Staphylococcus aureus, coagulase-negative staphylococci, *Enterococcus* spp., and *Escherichia coli* remain the most frequently isolated pathogens. An increasing proportion of SSIs are caused by antimicrobial-resistant pathogens, such as methicillin-resistant *S. aureus* (MRSA),[72,73] or by *Candida albicans.*[74] From 1991 to 1995, the incidence of fungal SSIs among patients at NNIS hospitals increased from 0.1 to 0.3 per 1,000 discharges.[74] The increased proportion of SSIs caused by resistant pathogens and *Candida* spp. may reflect increasing numbers of severely ill and immunocompromised surgical patients and the impact of widespread use of broad-spectrum antimicrobial agents.

Outbreaks or clusters of SSIs have also been caused by unusual pathogens, such as Rhizopus oryzae, Clostridium perfringens, Rhodococcus bronchialis, Nocardia farcinica, Legionella pneumophila and Legionella dumoffii, and Pseudomonas multivorans. These rare outbreaks have been traced to contaminated adhesive dressings,[75] elastic bandages,[76] colonized surgical personnel,[77,78] tap water,[79] or contaminated disinfectant solutions.[80] When a cluster of SSIs involves an unusual organism, a formal epidemiologic investigation should be conducted.

Preventive techniques

The surgical technique used can affect the infection rate in various ways, for example in relation to skin preparation, shaving and wound closure.

Skin preparation

The skin is colonised by various types of bacteria, but up to 50% of these are *Staphylococcus aureus*.[5] In analyses of contamination rates after cholecystectomy, the main source of wound contamination was found to be the skin of the patient.[5] For this reason, preoperative preparation should be performed. Evidence has shown that the use of a preoperative wash containing chlorhexidine decreases the bacterial count on skin by 80-90%, resulting in a decrease in preoperative wound contamination.[5] The effect on SSI incidence has, however, been more difficult to demonstrate and it is possible that prolonged washing releases organisms from deeper layers of the skin.

Shaving

It is now recognized that shaving damages the skin and that the risk of infection increases with the length of time between shaving and surgery.[5] In one study, if the patient had been shaved more than two hours before surgery the clean wound infection rate was found to be 2.3%.[5] However, if patients had not been shaved but their body hair had been clipped the rate was 1.7%, and if they had not been shaved or clipped the rate dropped to 0.9%.[5] If shaving is essential, it should be performed as close to the time of surgery as possible.

Wound closure

The healing of closed surgical wounds depends on many factors, one of the most complex of which is the influence of technique and expertise.[5] The incidence of SSIs in relation to the different types of closure techniques used is shown in Table.

Table 3. Incidence of SSIs following closure/delayed closure of an infected wound[5]

Opening and re-closure times	Reinfection rate
Opening and re-closure at once	50%
Opening and re-closure after two days	20%
Opening and re-closure after four days	5%
Opening and re-closure after nine days	10%

Once wounding has occurred, the surgeon has control over several factors concerning the wound itself that may reduce susceptibility to infection. The duration of surgery is one factor that influences the wound infection rate. Procedures that take longer than two hours are associated with higher infection rates.[5] This may be related to desiccation or maceration of the wound edges, an increase in the number of bacteria that accumulate within the wound, and decreased temperature and hypovolaemia leading to peripheral vasoconstriction and therefore poorly perfused skin. Fewer bacteria are required to produce an infection in the presence of necrotic tissue, foreign bodies, haematomas, seromas and poor tissue perfusion.[5]

Although infection cannot occur without any bacterial burden or contamination, the presence of bacteria in a wound does not inevitably result in an infection. Many different factors determine the potential for and incidence of infection.[5]

Identifying surgical site infections

The most widely recognised definition of infection, which is used throughout the United States of America and Europe, is that devised by Horan and colleagues and adopted by the CDC.[5] This splits SSIs into three groups - superficial and deep incisional SSIs and organ-space SSIs - depending on the site and the extent of infection. The CDC definition states that only infections occurring within 30 days of surgery (or within a year in the case of implants) should be classified as SSIs.[5]

In addition to sterile procedures and patient warming, prophylactic antibiotics have been shown to reduce SSI.[81] Despite the widespread use of prophylactic antibiotics, however, SSI continues to occur and is devastating for patients. Many different wound irrigation solutions, including soaps, antibiotics and antiseptics, have been used to reduce SSI.[81]

Povidine iodine

Iodine is a rapidly acting broad spectrum (bacteria. Viruses and fungi) germicide. It has variable action against bacterial spores and tubercle bacilli. Its I : 20,000 solution has the capability to kill most vegetative forms of bacteria within one minute. Thus iodine makes a nearly ideal disinfectant / antiseptic. It

was originally used as tincture iodine wherein elemental iodine was mixed with potassium iodide (KI) to increase its solubility in aqueous-alcoholic solution. However, it had the disadvantages of discolouring skin and other material, having an odour and being painful on skin abrasions and open wounds.

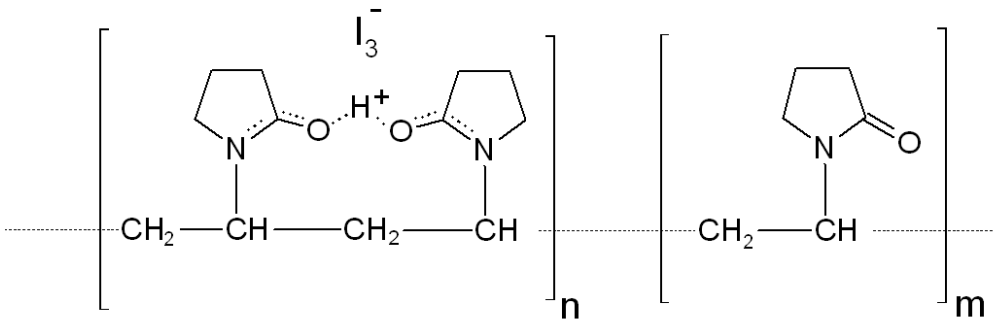


Figure 1. Chemical structure of povidone iodine

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 extema, 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.[82]

Povidone iodine is an antiseptic solution consisting of polyvinylpyrrolidone with water, iodide and 1% available iodine; it has bactericidal ability against a large array of pathogens.[3] Povidone iodine functions by release of elemental iodine which binds irreversibly with protein. Although a vast amount of literature exists regarding its use as a topical antibacterical agent in surgery, its use as a prophylactic irrigation solution against SSI has been examined to a lesser degree.[81]

In the clinical environment, there is no general agreement regarding the 'best' antiseptic and the practice varies widely. Although there is a distinct lack of well-designed, randomised controlled trials evaluating antiseptic efficacy, selection should be based on the next best available evidence. This evidence suggests that the use of povidone-iodine as an agent of choice is dependent on the clinical need but is also likely to be influenced by personal preference.[83]

A review[85] reported that, an exponential increase in the number of published prospective studies reflects both a continuing interest in, and a lack of consensus on, the optimal prophylaxis of wound sepsis after appendicectomy. Antibiotics reduce the frequency of wound sepsis and although low wound sepsis rates have been reported with systemic antibiotics active against only anaerobes, the cumulative evidence favours a spectrum of antibacterial activity against both aerobic and anaerobic organisms. Topical antiseptics have no significant effect but topical antibiotics are beneficial.

A randomized control trial[85] studied 187 patients undergoing surgical treatment. Patients were divided into two group depending on the type of

subcutaneous irrigation used. The study concluded that, the patient who underwent saline and Povidone iodine irrigation showed a lower infection rate of 4.6% compared to control group who underwent only normal saline irrigation in with infection rate of 10.9%.

In a prospective comparative study,[86] authors examined 90 patients undergoing clean-contaminated operations who were divided into three equal groups. Group A patients received irrigation of the operative wound with 5% povidone-iodine. Group B patients received irrigation with 5% povidone-iodine and 5 mg/mL of metronidazole. Group C patients received irrigation with sterile normal saline. The infection rate was 30% in Group C and 10% in Group A and Group B ($p = 0.056$). No antibiotics were used in this study. Participants' age and adverse effects were not mentioned.

A randomized controlled trial[87] enrolled 131 patients ranging in age from 3.5 to 74 years who underwent appendectomies at Limerick Regional Hospital. Antibiotics were used in 53 of the 131 patients distributed evenly across 3 study groups. The first group ($n = 49$) received irrigation with 1% povidone iodine solution (150 mL intraperitoneally and 50 mL on the wound following closure of the peritoneum). The second group ($n = 31$) received irrigation with sterile water. The third group ($n = 51$) received no irrigation. Infection was defined as the presence of pus with or without probing. Overall, 17 wound infections, or a 12.97% infection rate, occurred. There were no significant differences between the 3 groups; however, the authors did not supply the p value, nor did they provide enough data to calculate it. The authors did not identify any risks.

Another randomized controlled trial[4,88] conducted at the University of Maryland Hospital where patients ranged in age from 9 to 80 years who underwent general (abdominal and gastrointestinal) and urologic (genitourinary) procedures. Of the 500 patients enrolled, 242 were randomly allocated to 10% povidone-iodine (1% available iodine) irrigation of the subcutaneous tissue for 60 seconds at operation, and 258 were randomly allocated to an equivalent amount of saline irrigation. Patients were classified as clean, potentially contaminated, contaminated or dirty. Patients in the latter 3 groups received combined clindamycin and gentamicin as antibiotics preoperatively to 48 hours postoperatively. Infection was defined as pus from the incision site within 12 weeks after surgery along with bacteria recovered from a wound culture. The infection rate was 2.9% in the treatment group and 15.1% in the control group ($p < 0.001$). The treatment group did not experience any interference with wound healing or adverse reactions.

A meta-analysis[89] was performed to assess the effect of intraoperative povidone iodine application compared with no antiseptic solution (saline or nothing) on the SSI rate. The meta-analysis included randomized controlled trials that compared intraoperative povidone iodine lavage with no povidone iodine in patients undergoing surgery with SSI as the primary outcome. Twenty-four randomized controlled trials totalling 5004 patients (2465 patients with povidone iodine and 2539 patients without) were included: 15 in the main analysis and nine in the sensitivity analysis. The rate of SSI was eight percent in the povidone iodine group and 13.4% in the control group. Intraoperative povidone iodine application significantly decreased the SSI rate (relative risk 0.58, 95%

confidence interval 0.40 to 0.83; p=0.003) and consistent results were observed in subgroup analyses according to the method of povidone iodine administration, its timing and the type of surgery. The meta-analysis results suggested that the use of intraoperative povidone iodine reduced rates of SSI.

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 100 patients with non perforated appendicitis.

Study design

The study design was one year randomized clinical trial.

Study period and duration

The present one year study was conducted during the period of 1st January 2010 to 31st December 2010.

Place

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

Source of Data

Patients diagnosed with acute or chronic appendicitis undergoing open appendicectomy during the period of one year.

Sample size

A total of 100 patients diagnosed with acute or chronic appendicitis undergoing appendicectomy were studied.

Sampling procedure

The sample size was calculated considering the literature review[86] of wound infection rate as 30% in operative wound irrigated with povidone iodine in comparison with 10% in operative wound irrigated with sterile normal saline using the formula as mentioned below.

$$n = \frac{2(z\alpha + z\beta)^2 \times p(1-p)}{(p_o - p_1)^2}$$

$P_o = 30\%$

$p_1 = 10\%$

$Z\alpha = 1.65$

$Z\beta = 0.84$

$P = p_o + p_1 \div 2 = 20$

Substituting these values to the above equation sample size i.e., n = 100.

Selection criteria

Inclusion

- All the patients with Appendicitis (Acute, Chronic, Recurrent).

Exclusion

- Patients with;
    - Impaired renal function.
    - Thyroid disorders.
    - Appendicitis secondary to ileal/caecal pathology.
    - Laparoscopic appendicectomy.
    - Perforated appendix.
    - Appendicular abscess.
    - Non perforated gangrenous appendicitis.
    - Patient already taking antibiotics.
    - Any other incision other than Grid Iron Incision.
    - Appendicectomy done in addition to other intra operative procedure.

Randomization

Two groups were divided by envelope method. 100 envelopes were made and divided into 50:50 each. Fifty envelopes contained a card mentioning Group A and other mentioning Group B. Envelope were sealed and patients were asked to pick up one envelope and depending upon groups mentioned in the envelope they were allocated as;

- Group A – Subcutaneous irrigation with 10% povidone iodine.
- Group B – Subcutaneous irrigation with normal saline.

Procedure

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 diagnosed to have appendicitis and undergoing open appendicectomy were evaluated based on selection criteria. The patients were selected by detailed medical history, physical examination and investigations. The selected patients were briefed about the nature of the study, the interventions used and a written informed consent was obtained (Annexure I).

Demographic data like gender and age were collected along with relevant history and recorded on predesigned and pretested performa (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 and special investigation such as ultrasound of abdomen was done. Patients were randomized according to the randomization procedure.

Pre operative

Shaving of the abdomen from nipple to mid-thigh a day prior to surgery. On the operation table the abdomen was cleaned with 10% povidone iodine and then re cleaning with spirit was done under all aseptic precautions. Injection Ceftriaxone 1 gm IV and Inj. Metronidazole 100 ml IV were given prior to skin incision.

Intra Operative

Group A: Subcutaneous tissues of patients in this group was irrigated for 60 seconds after closure of fascia with 20ml of 10% povidone iodine.

Group B: Saline irrigation was done in this group. Subcutaneous tissue was irrigated for 60 seconds with 20 ml of normal saline.

Appendix specimen was sent for histopathological examination. The suture material used during the procedure included;

- Stump ligation by Silk (2,0)
- Purse string suture by Silk (2,0)
- Closure of External Oblique by Absorbable suture (Vicryl 2,0)
- Skin closed by mattress sutures with Silk (2,0)

Post operative

The patients were postoperatively also medicated with Inj. ceftriaxone 1 gm IV twice daily for one day and Inj. metronidazole 100 ml thrice daily for one day.

Wound inspection was done on day three, five and seven post operatively. Sutures were removed on day seven post operatively and wound was inspected. In case of infection, wound culture was sent for microbiological examination.

Grading of wound infection

Grade 0: Wound undergoes normal healing without any infection.

Grade1: Redness of wound: minimal wound infection.

Grade2: Frank Suppuration.[90]

Wound Infection Definition[9]

A wound infection was defined as:

Superficial Incisional SSI - Infection involves only skin and subcutaneous tissue of incision.

Deep Incisional SSI - Infection involves deep tissues, such as facial and muscle layers.

Organ/space SSI - Infection involves any part of the anatomy (organs and spaces) other than the incision, which was opened or manipulated during the operation.

Statistical analysis

The data obtained was tabulated and expressed as rates, ratios and percentages for different parameters. The comparison for the demographic characteristics was done using chi-square test and infection rates were compared using Fisher's exact test. The mean duration of hospital stay was compared using un-paired "t" test.

RESULTS

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 100 patients with non perforated appendicitis. Based on the envelope method patients were divided into two groups namely;

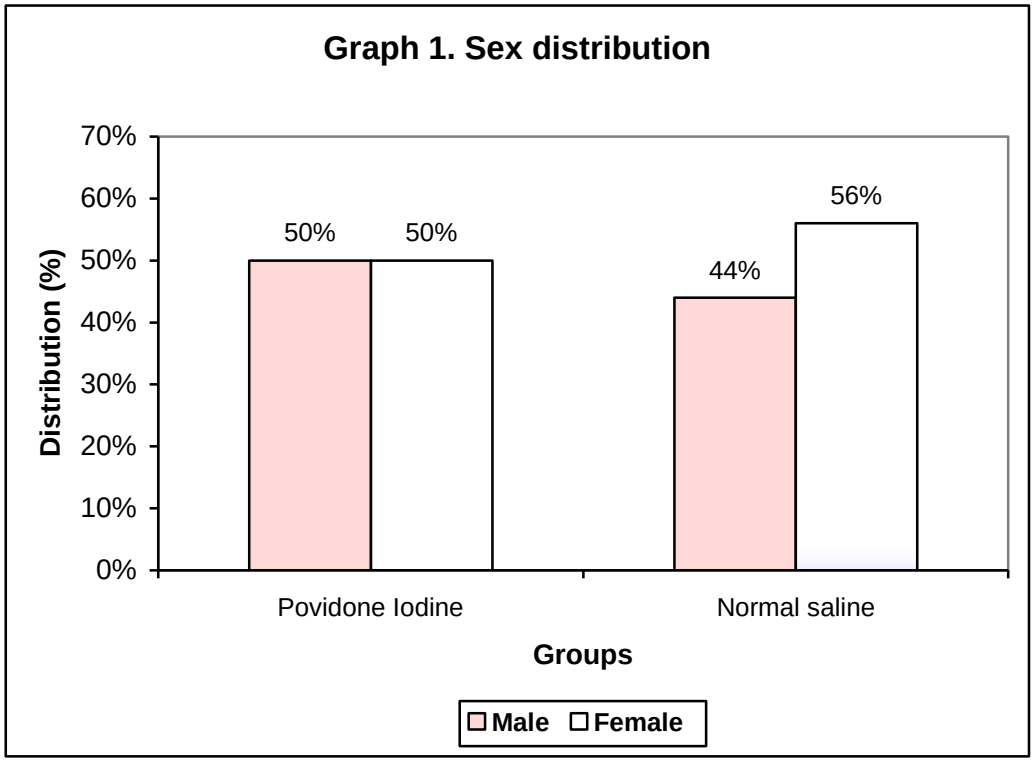
- Group A – Subcutaneous irrigation with 10% povidone iodine.
- Group B – Subcutaneous irrigation with normal saline.

The data obtained was tabulated and expressed as rates, ratios and percentages for different parameters. Demographic data was compared with chi-square test. The comparison for infection rates was done using Fishers exact test and mean duration of hospital stay was compared using un-paired “t” test and analysis was done as below.

Table 4. Sex distribution

Sex	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
Male	25	50.00	22	44.00
Female	25	50.00	28	56.00
Total	50	100	50	100

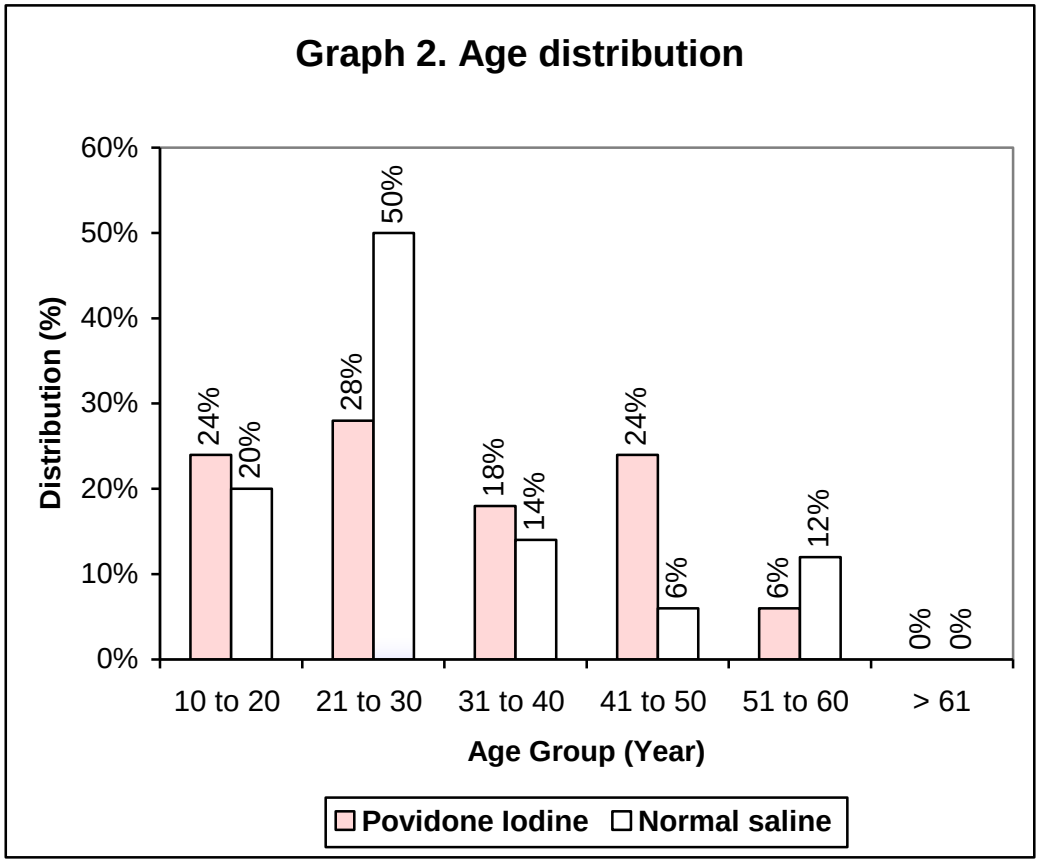
x^2=0.361 DF=1 p=0.548



In the present study 44% were males and 56% were females in normal saline irrigation group whereas in povidone iodine irrigation group, males and females were equally distributed. The comparison of both the groups showed equal distribution (p=0.548).

Table 5. Age distribution

Age groups (Year)	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
10 to 20	12	24.00	10	20.00
21 to 30	14	28.00	25	50.00
31 to 40	9	18.00	7	14.00
41 to 50	12	24.00	3	6.00
51 to 60	3	6.00	6	12.00
>61	0	0.00	0	0.00
Total	**50**	**100**	**50**	**100**



In this study, among the patients undergoing irrigation with povidine iodine and normal saline, majority of the patients had age between 21 – 30 years.

Table 6. Mean Age

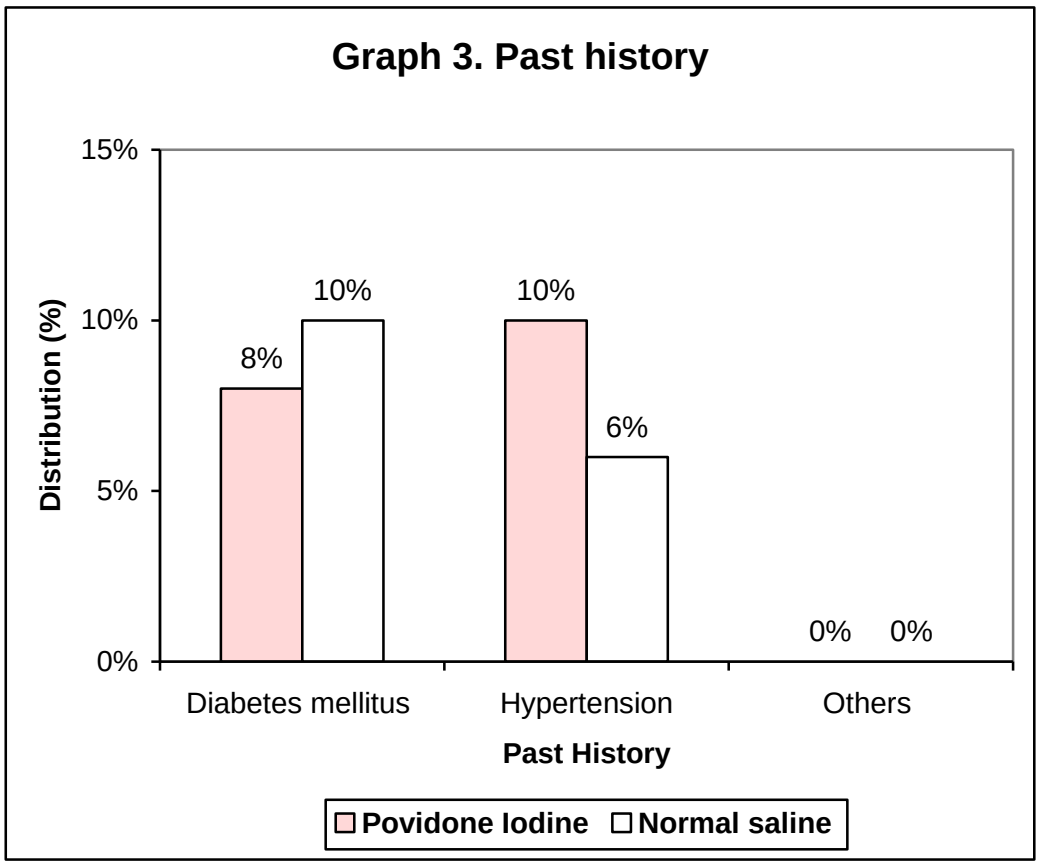
	Group A (n=50) (Povidone Iodine)		**Group B (n=50) (Normal Saline)**	
	Mean	**SD**	**Mean**	**SD**
Mean age	31.20	12.68	29.90	12.05

x^2=0.525 DF=98 p=0.601

The mean age in povidone iodine irrigation group was 31.20 ± 12.68 years and in normal saline group it was 29.90 ± 12.05 years suggesting the age was comparable in both the groups (p=0.601).

Table 7. Past history

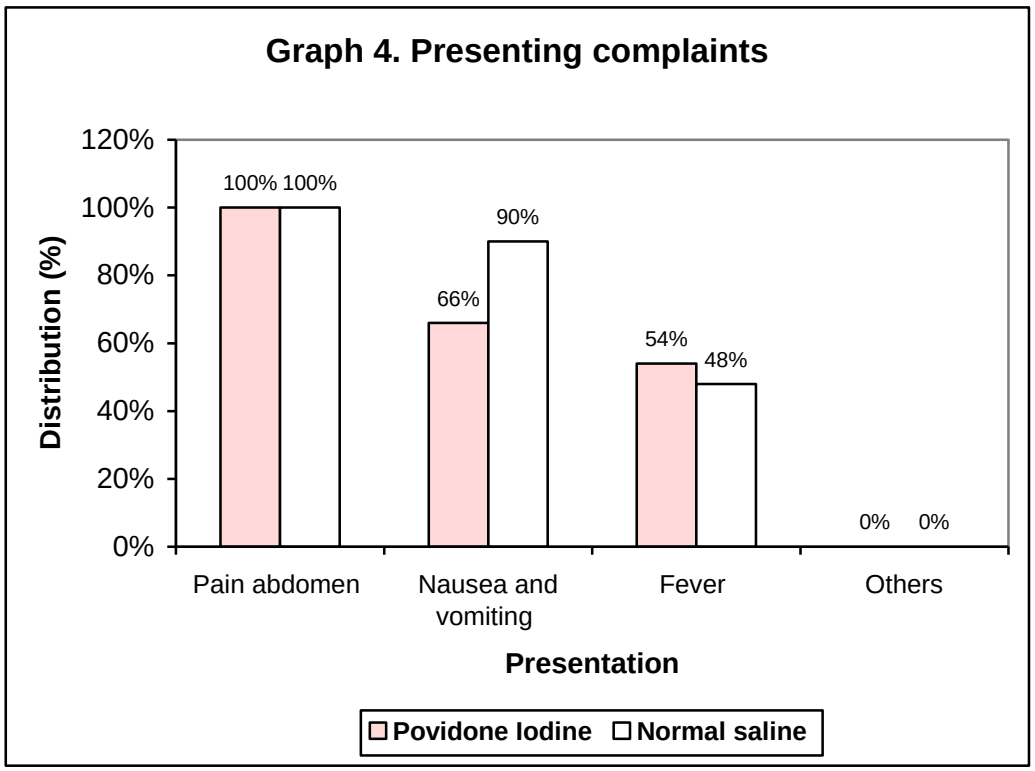
History	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
Diabetes	4	8.00	5	10.00
Hypertension	3	10.00	3	6.00
Others	0	0.00	0	0.00



In the present study, 8% of patients had diabetes mellitus and 10% had hypertension in povidone iodine irrigation group whereas 10% of the patients had diabetes mellitus and 6% of patients had hypertension in normal saline irrigation group.

Table 8. Presenting complaints

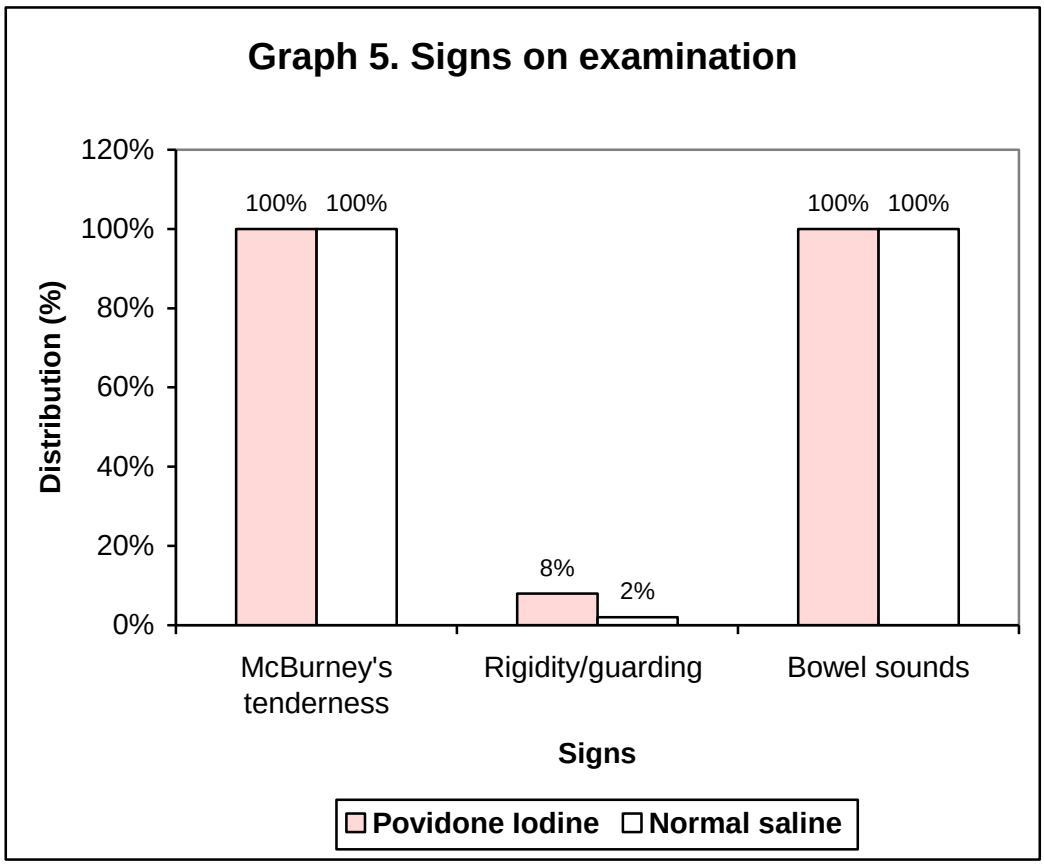
Presentation	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
Pain abdomen	50	100.00	50	100.00
Nausea / Vomiting	33	66.00	45	90.00
Fever	27	54.00	24	48.00
Others	0	0.00	0	0.00



In this study all the patients (100%) in both the groups presented with pain in abdomen (Rt lower abdomen). Nausea and vomiting were the next presenting complaint in 66% patients followed by fever among 54% patients in povidone iodine group while 90% patients in normal saline group had nausea and vomiting and 48% had fever.

Table 9. Signs on examination

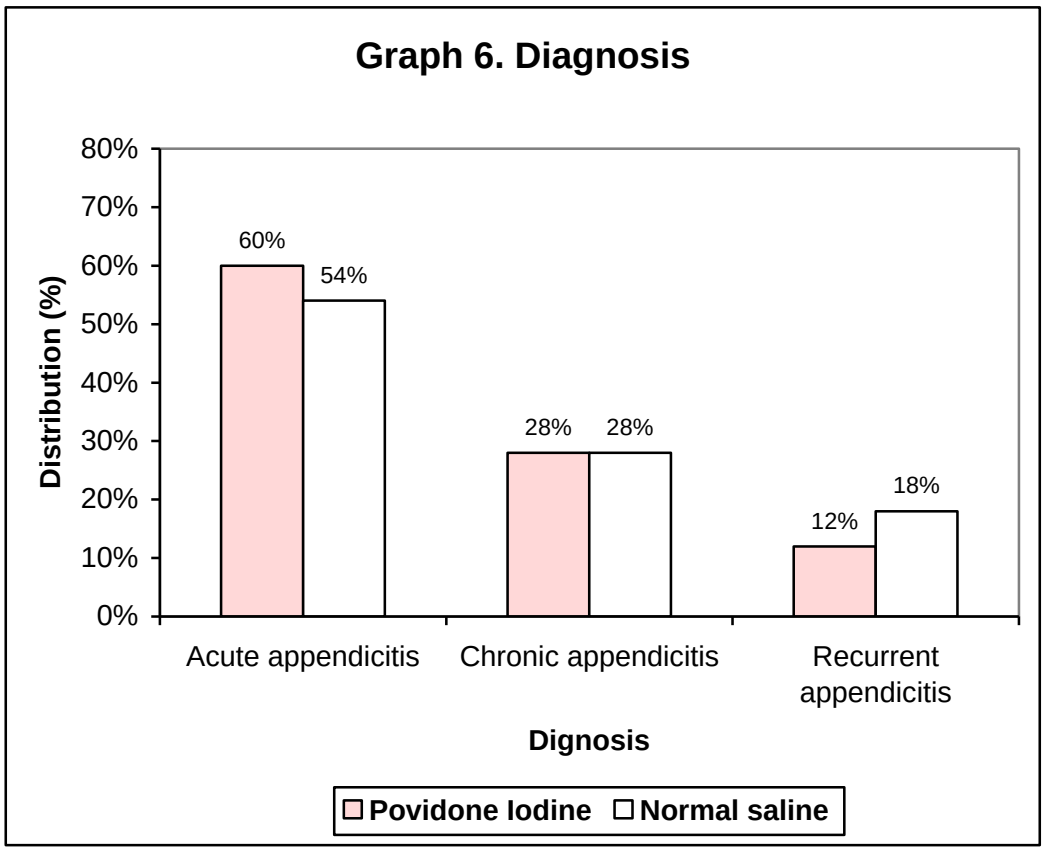
Signs	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percent	Number	Percent
McBurney's Tenderness	50	100.00	50	100.00
Rigidity / guarding	4	8.00	1	2.00
Bowel sounds	50	100.00	50	100.00



In this study, tenderness at McBurney's point was present in all the patients (100%) in both the groups while guarding and rigidity were present in eight percent patients in povidone iodine group and two percent patients in normal saline group. Bowel sounds were present in all the patients (100%).

Table 10. Diagnosis

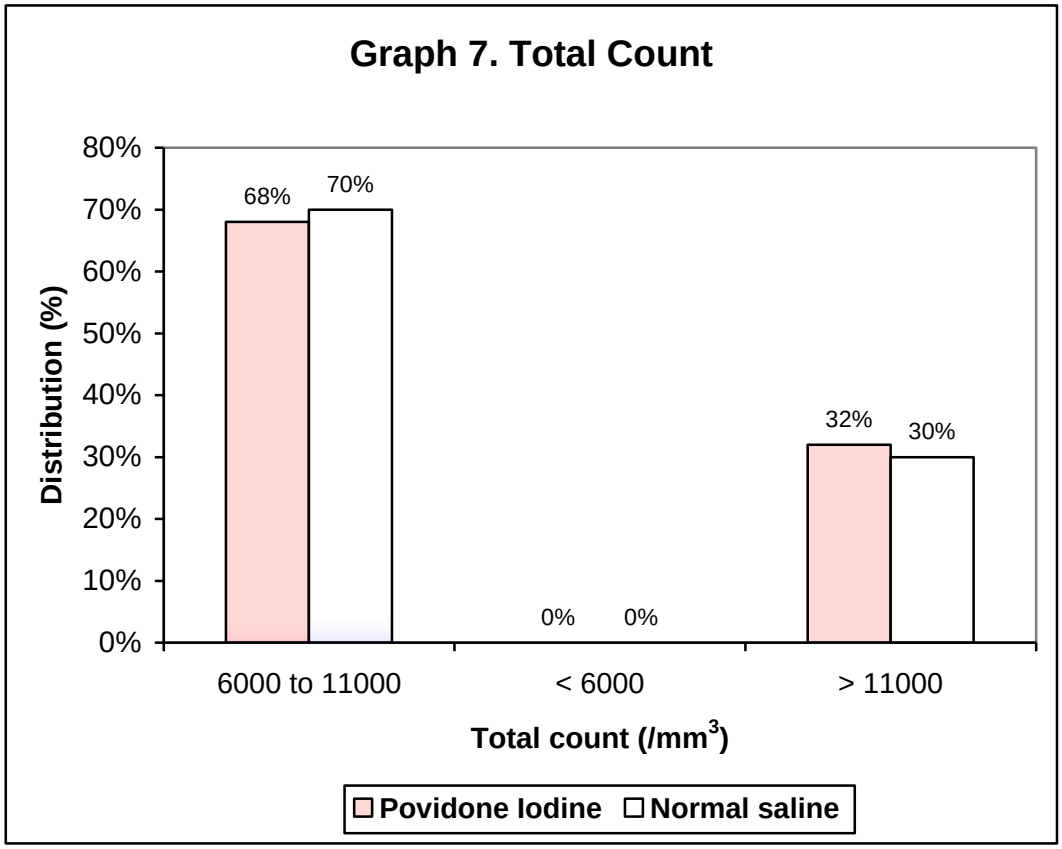
Diagnosis	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	**Percentage**	**Number**	**Percentage**
Acute appendicitis	30	60.00	27	54.00
Chronic appendicitis	14	28.00	14	28.00
Recurrent appendicitis	6	12.00	9	18.00
Total	**50**	**100**	**50**	**100**



In this study, 60% of patients had acute appendicitis in povidone iodine group as compared to 54% in normal saline group. 28% patients had chronic appendicitis in both the groups. Recurrent appendicitis was seen in 12% of patients in povidone iodine group and 18% patients in normal saline group.

Table 11. Total Count

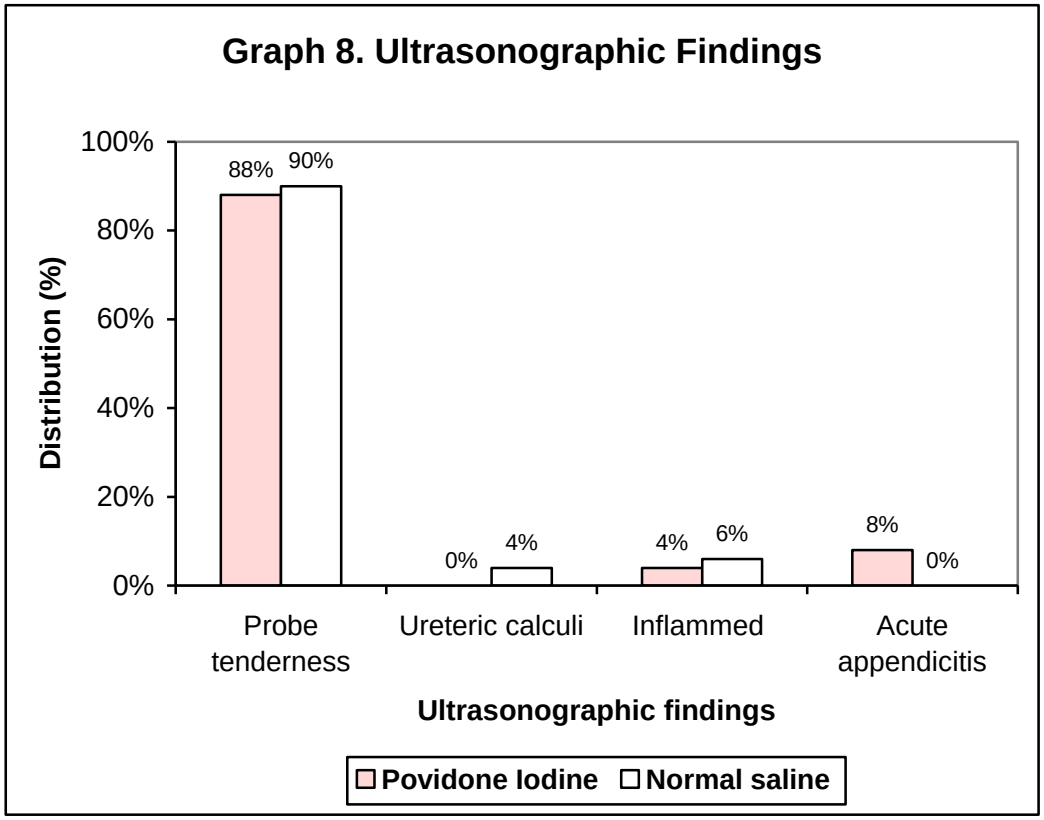
Total count (/mm^3)	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	**Percentage**	**Number**	**Percentage**
6000 to 11000	34	68.00	35	70.00
< 6000	0	0.00	0	0.00
> 11000	16	32.00	15	30.00
Total	**50**	**100**	**50**	**100**



In the present study 68% and 70% patients in povidone iodine and normal saline group had a normal total leucocyte count respectively whereas, 32% patients in povidone iodine and 30% patients in normal saline group had leucocytosis.

Table 12. Ultrasonographic Findings

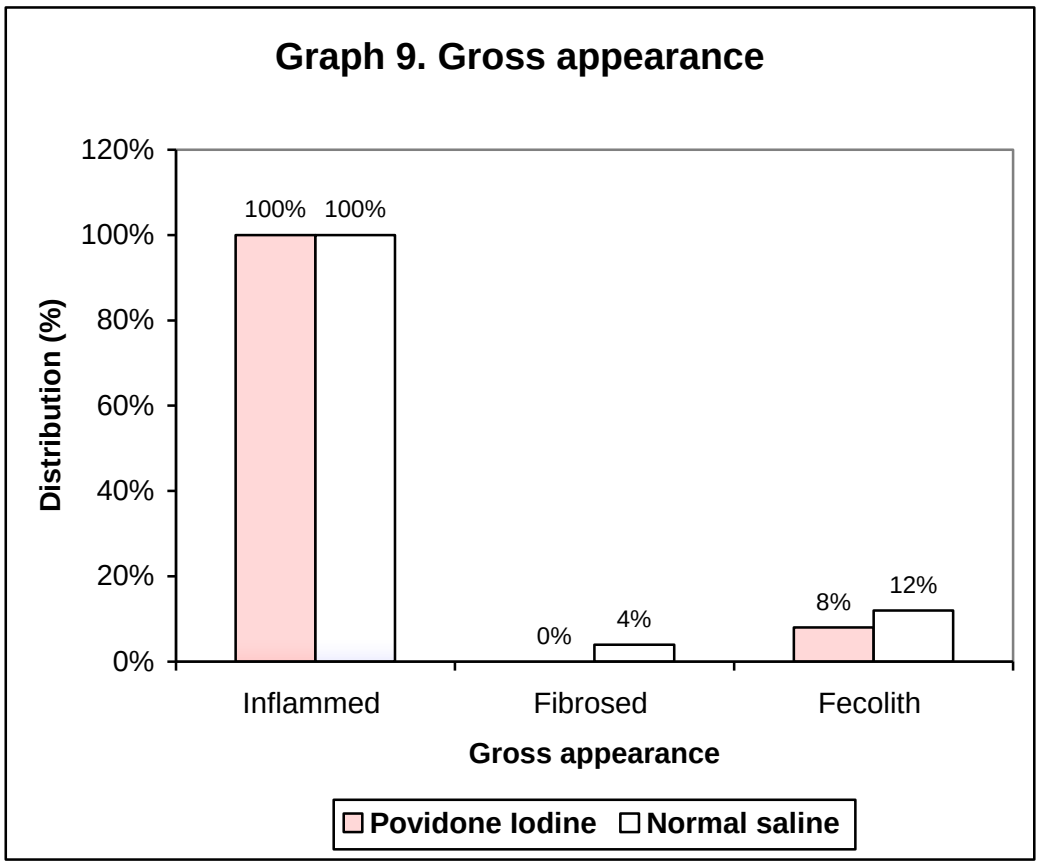
USG findings	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
Probe tenderness	44	88.00	45	90.00
Ureteric calculi	0	0.00	2	4.00
INF	2	4.00	3	6.00
Acute appendicitis	4	8.00	0	0.00



In this study majority (88% in povidone iodine and 90% in normal saline group) had probe tenderness present on USG examination. Incidental findings like, ureteric calculi was found in 4% patients in normal saline group. Inflamed appendix was seen in 4% of patients in povidone iodine group and 6% patients in normal saline group.

Table 13. Gross appearance

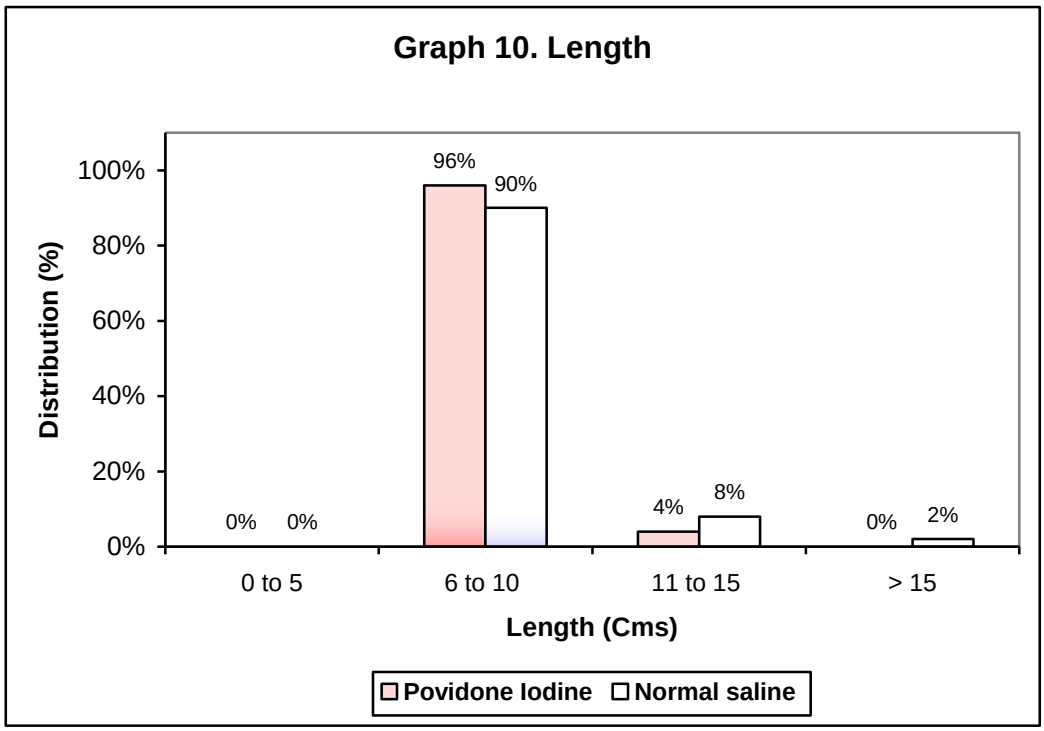
Gross appearance	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
Inflammed	50	100.00	50	100.00
Fibrosed	0	0.00	0	0.00
Fecolith	4	8.00	6	12.00



All the patients in this study had an inflamed appendix intraoperatively (100%). Fecolith was seen in eight percent patients in povidone iodine group and six percent patients in normal saline group.

Table 14. Length

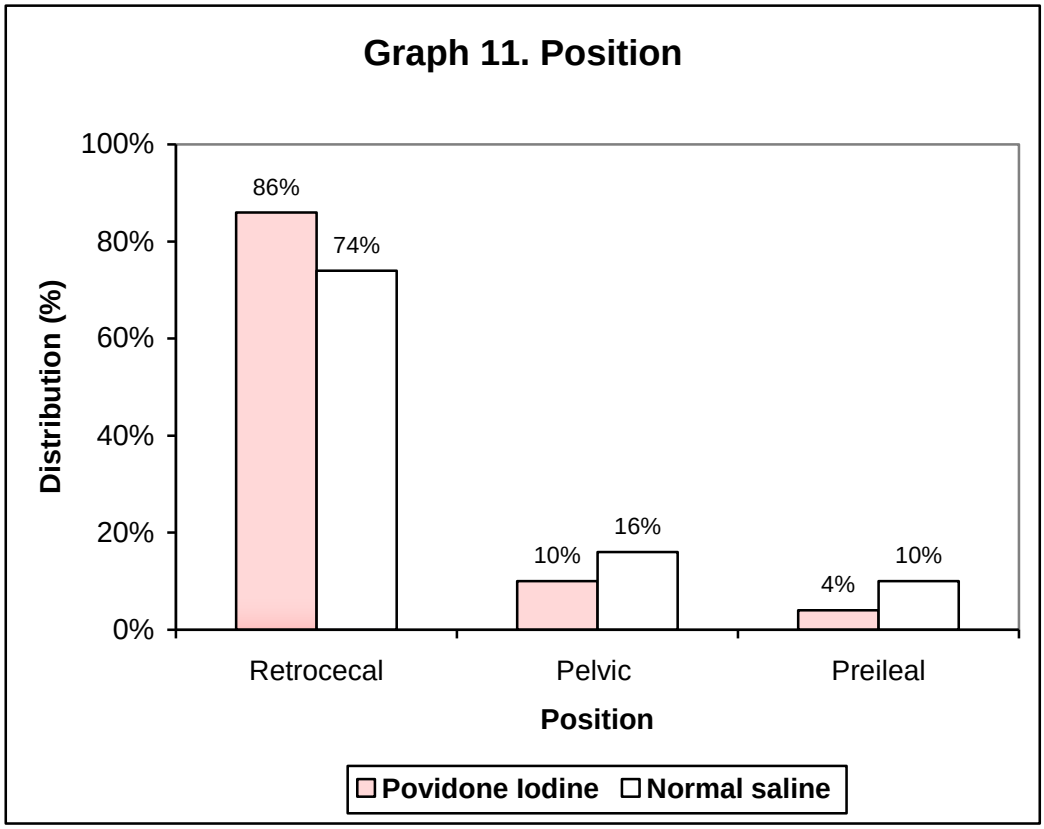
Length (Cms)	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
0 to 5	0	0.00	0	0.00
6 to 10	48	96.00	45	90.00
11 to 15	2	4.00	4	8.00
> 15	0	0.00	1	2.00
Total	**50**	**100**	**50**	**100**



In the present study majority of patients (96% in povidone iodine group and 90% in normal saline group) had length between 6 to 10 cm followed by four percent and eight percent patients having in between 11 to 15 cm in povidone iodine group and normal saline group respectively. Two percent patients in normal saline group had length 7.5 cm.

Table 15. Position

Length	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	**Percentage**	**Number**	**Percentage**
Retrocecal	43	86.00	37	74.00
Pelvic	5	10.00	8	16.00
Preileal	2	4.00	5	10.00
Total	**50**	**100**	**50**	**100**

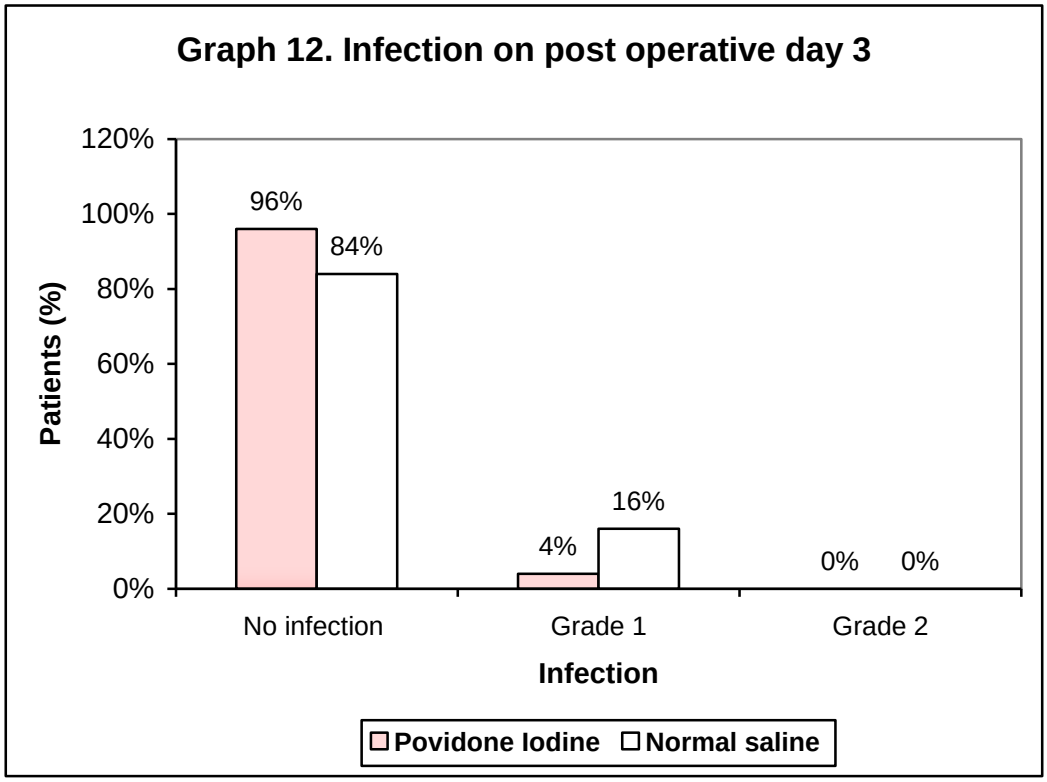


In the present study majority of patients (86% in povidone iodine group and 74% in normal saline group) had retrocaecal appendix followed by 16% and 10% pelvic appendix respectively. 10% patients in normal saline group had preileal appendix as compared to four percent in patients with povidone iodine group.

Table 16. Infection on post operative day 3

Infection	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
No infection	48	96.00	42	84.00
Grade 1	2	4.00	8	16.00
Grade 2	0	0.00	0	0.00
Total	50	100	50	100

p=0.046 (Fisher's Exact Test)

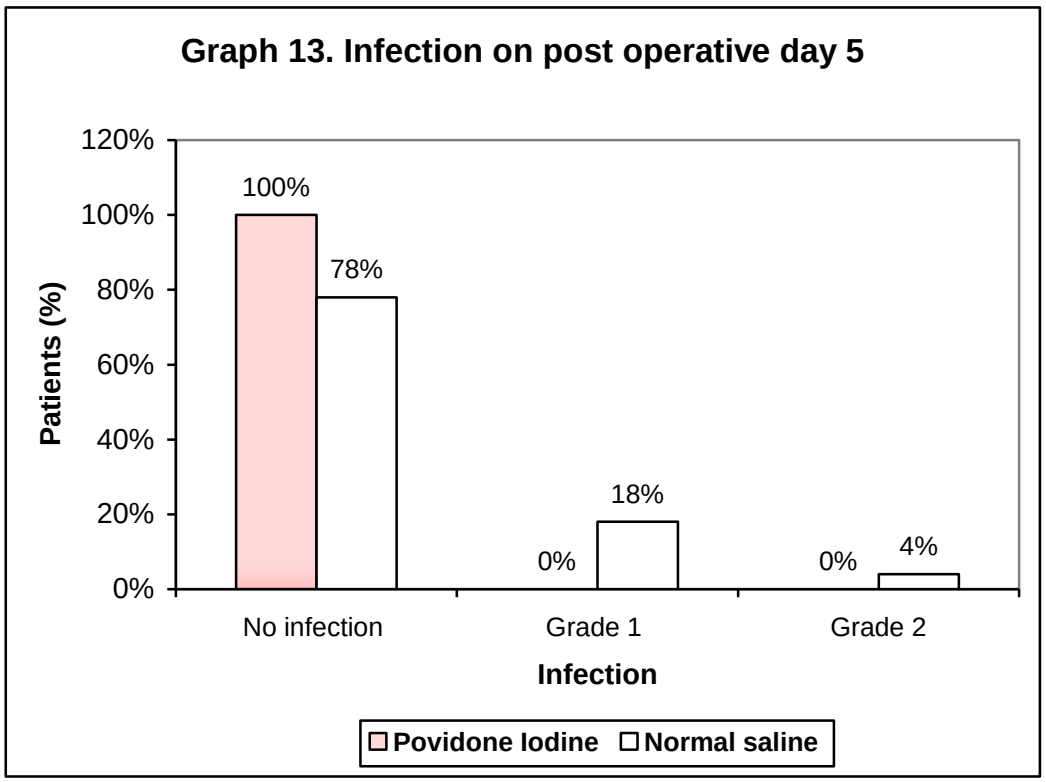


In this study on post operative day three, 16% patients in normal saline group and 4% of patients in povidone iodine group had surgical site infection (Grade 1) and this difference between the two groups was statistical significant (p=0.046).

Table 17. Infection on post operative day 5

Infection	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
No infection	50	100.00	39	78.00
Grade 1	00	0.00	09	18.00
Grade 2	00	0.00	02	4.00
Total	50	100	50	100

p=0.001 (Fisher's Exact Test)

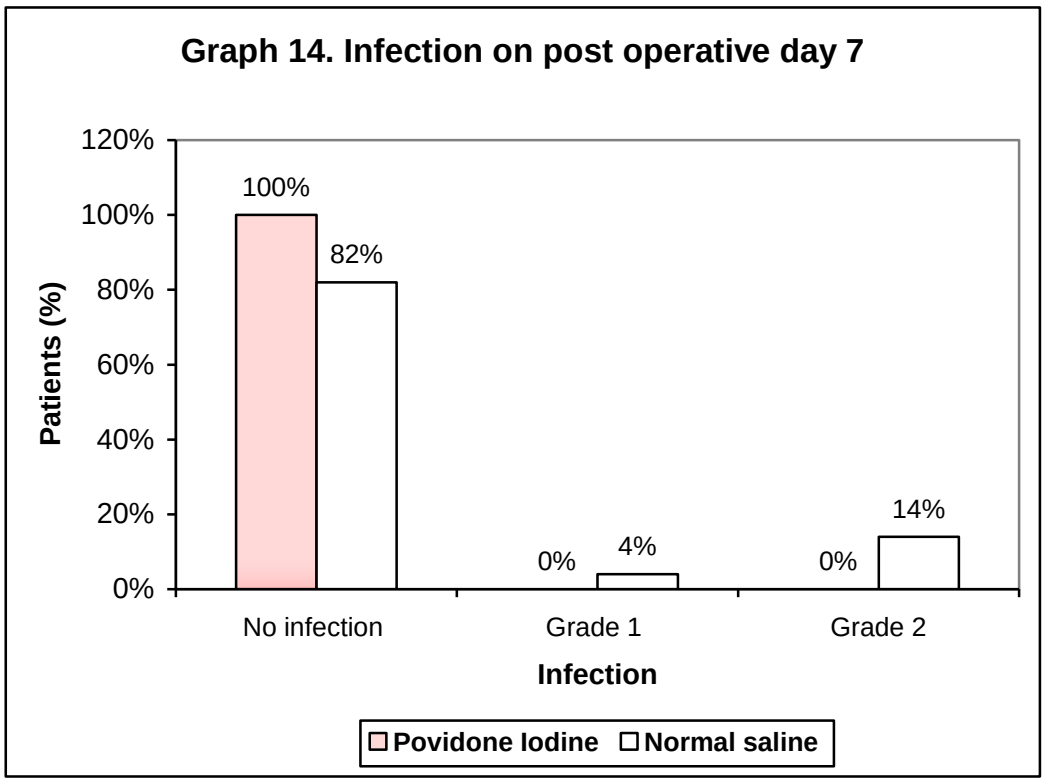


On post operative day 5 none of the patients in povidone iodine group had infection compared to 18% patients had Grade 1 and four percent patients had Grade 2 infection in normal saline normal saline group and this difference was statistically significant (p=0.001).

Table 18. Infection on post operative day 7

Infection	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
No infection	50	100.00	41	82.00
Grade 1	00	0.00	02	4.00
Grade 2	00	0.00	07	14.00
Total	50	100	50	100

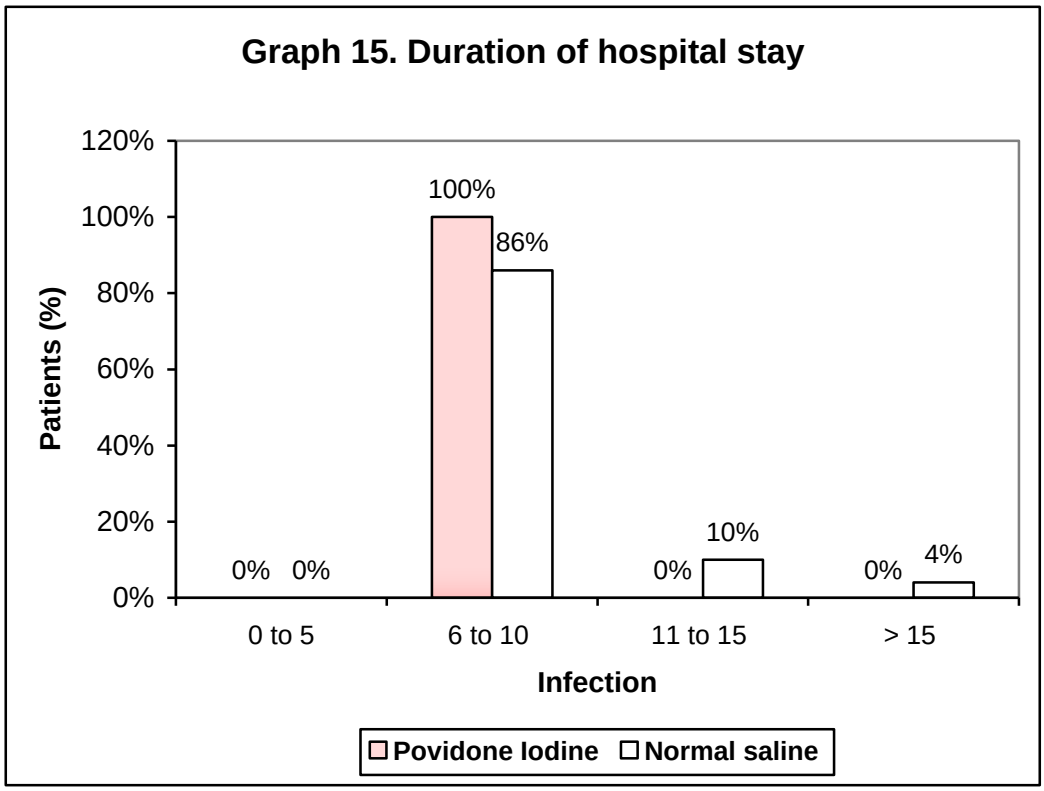
p=0.003 (Fisher's Exact Test)



On post operative day 7 none of the patients in povidone iodine group had infection as compared to 82% in normal saline group. In remaining patients of normal saline group 14% of patients had Grade 2 while four percent of patients had Grade 1 infection and this difference was statistically significant (p=0.003).

Table 19. Duration of hospital stay

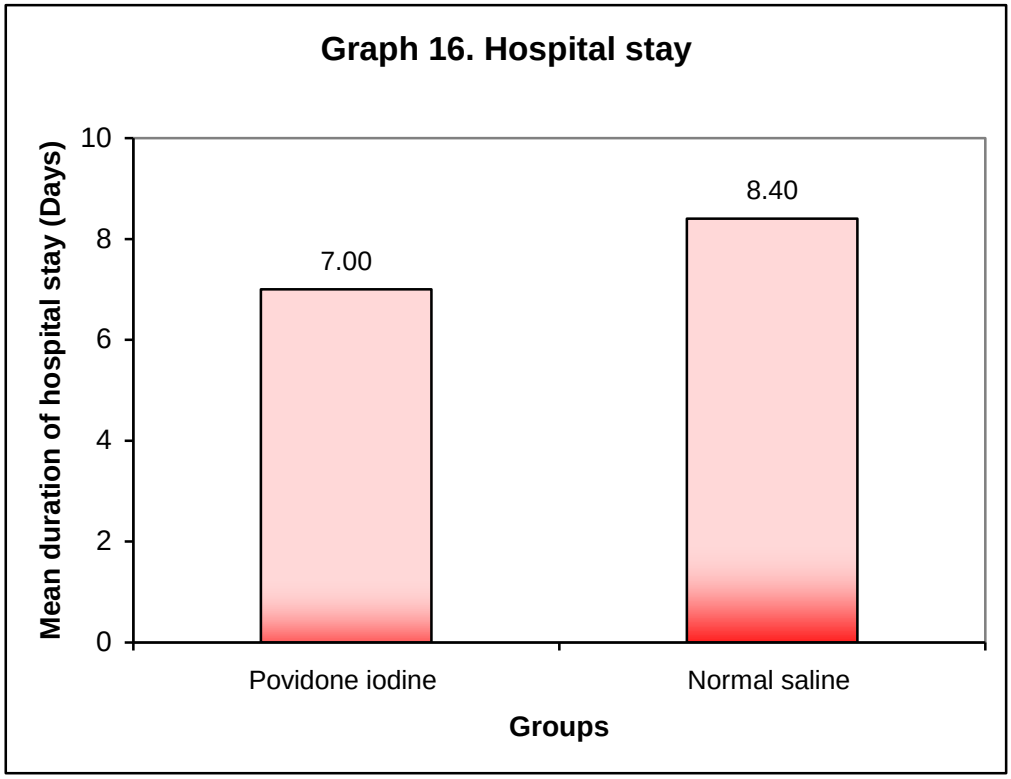
Duration (Days)	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
0 to 5	0	0.00	0	0.00
6 to 10	50	100.00	43	86.00
11 to 15	0	0.00	5	10.00
> 15	0	0.00	2	4.00
Total	**50**	**100**	**50**	**100**



In the this study the length of hospital stay was between six to ten days in all the patients with povidone iodine group compared to 86% in normal saline group. 10% of patients in normal saline group stayed between 11 to 15 days and in four percent patients it was more than 15 days.

Table 20. Hospital Stay

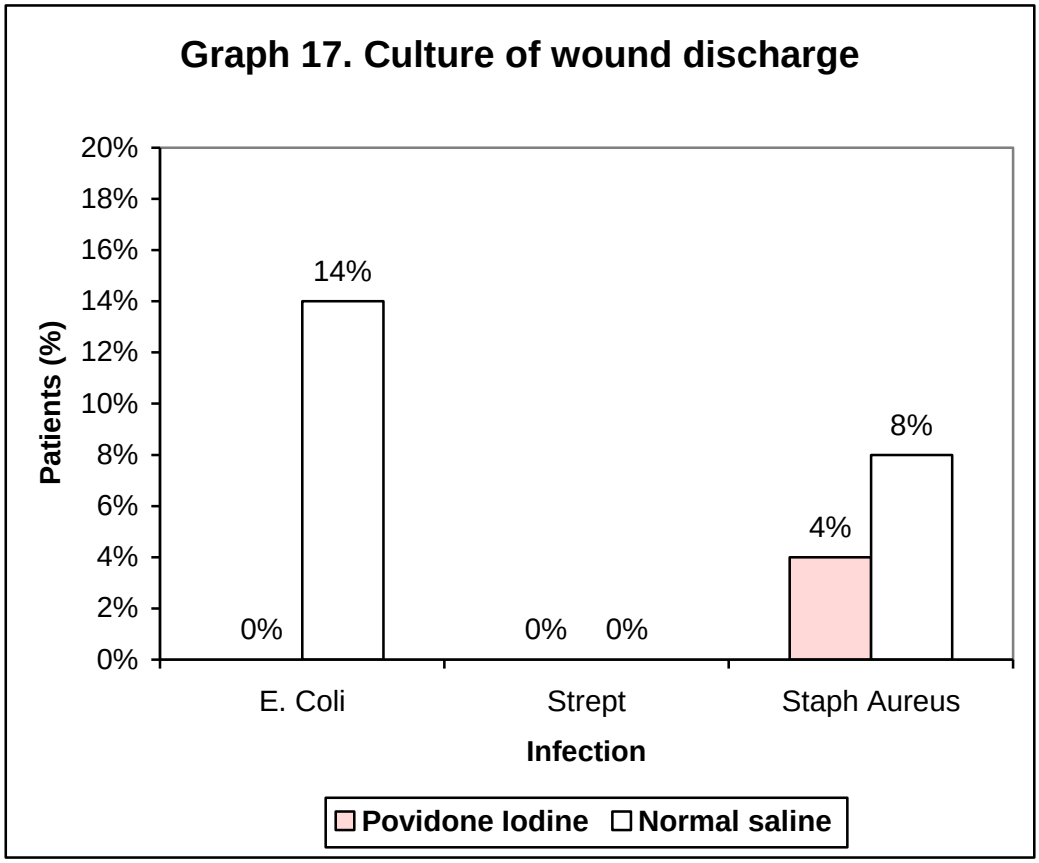
Groups	Mean (Days)	SD	Median (Days)	Range (Days)
Group A (n=50) (Povidone Iodine)	7	0.14	7-8	7
Group B (n=50) (Normal Saline)	8.4	2.68	7-16	7
t=3.523		df=98		p=0.001



In this study as all the patients in povidone iodine group had a hospital stay of 6 – 10 days as compared to normal saline group in which 86% had a hospital stay of 6 – 10 days. 10% patients and 4% patients in normal saline group had a hospital stay of 10 – 15 days and > 15 days respectively. Mean stay in hospital for povidone iodine group was 7 days as compared to 8.4 days in normal saline group.

Table 21. Culture of wound discharge

Culture	Group A (n=50) (Povidone Iodine)		Group B (n=50) (Normal Saline)	
	Number	Percentage	Number	Percentage
E. Coli	0	0.00	7	14.00
Strept	0	0.00	0	0.00
Staph Aureus	2	4.00	4	8.00



In this study among the patients with infection the microbiological examination revealed E. coli as the commonest (14%) organism in normal saline group followed by staph aureus (8%). In povidone iodine group four percent of patients had infection due to staph aureus.

DISCUSSION

Appendicectomy is one of the most common surgical procedures[91] with SSI complicating 1–5% of appendicectomy cases.[92-94] The lifetime rate of appendicetomy is 12% for men and 25% for women, with approximately 7% of all people undergoing appendicectomy for acute appendicitis during their life time. Over the past 10 years the rate of appendicectomy for appendicitis has remained constant at 10 per 10,000 per year.[96]

Earlier studies have reported increasing age,[97] and emergency surgery[98] as risk factors of SSI. A prolonged duration of operation has been reported as a risk factor for SSI in other studies.[99-101] The effectiveness of the inflammatory response to mobilize patient defense mechanisms, such as, activation of various types of white blood cells that contain and destroy the bacteria, before infection can occur depends to large extent on the patient's general health, age, obesity, smoking, some chronic diseases and the status of the immune system.

In 1999, CDC issued guidelines[7] for reducing the risk of SSIs, based on existing scientific data, theoretical rationale and applicability. These guidelines include, handling of the tissues gently, maintain effective hemostasis, minimize devitalized tissue and foreign bodies (sutures, charred tissues, necrotic debris), and eradicate dead space at the surgical site.

The present study was undertaken to compare and evaluate the use of 10% povidone iodine solution versus saline irrigation in intraoperative subcutaneous irrigation in appendicectomy, for prevention of surgical site

infection and also to compare the duration of post-operative hospital stay in each study group.

This 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 100 patients with non perforated appendicitis. Based on the envelope method, patients were divided into two groups namely group A (Subcutaneous irrigation with 10% Povidone iodine) and group B (Subcutaneous irrigation with normal saline).

In the present study, females outnumbered males (56% vs 44%) in normal saline irrigation group whereas in povidone iodine irrigation group equal distribution was seen (p=0.548). Among the patients undergoing irrigation with povidone iodine and normal saline, majority of the patients had age between 21 – 30 years. The mean age in povidone iodine irrigation group was 31.20 ± 12.68 years and in normal saline group it was 29.90 ± 12.05 years suggesting the age was comparable in both the groups (p=0.601).

These findings were consistent with literature showing, appendicitis is most frequently seen in patients in their second through fourth decades of life with a mean age 31.3 years and a median age of 22 years. There is a slight male:female predominance (1.2 to 1.3:1).[101,102]

In this study, eight percent of patients had diabetes mellitus and 10% had hypertension in povidone iodine irrigation group whereas 10% of the patients had diabetes mellitus and six percent of patients had hypertension in normal saline irrigation group. All the patients (100%) in both the groups presented with pain in

right iliac fossa. Nausea and vomiting were the next presenting complaint in 66% patients followed by fever among 54% patients in povidone iodine group while 90% patients in normal saline group had nausea and vomiting and 48% had fever.

The tenderness at McBurney's point was present in all the patients (100%) in both the groups while guarding and rigidity were noted in eight percent patients in povidone iodine group and two percent patients in normal saline group. A study reported that, the classic right lower quadrant physical signs are present when the inflamed appendix lies in the anterior position. Tenderness often is maximal at or near the McBurney point.[103]

In the present study, 60% of patients had acute appendicitis in povidone iodine group as compared to 54% in normal saline group. 28% patients had chronic appendicitis in both the groups. Recurrent appendicitis was seen in 12% of patients in povidone iodine group and 18% patients in normal saline group.

In the present study 68% and 70% patients in povidone iodine and normal saline group had a normal total leucocyte count respectively whereas, 32% patients in povidone iodine and 30% patients in normal saline group had leucocytosis. Mild leukocytosis, ranging from 10,000 to 18,000 cells/mm^3, usually is present in patients with acute, uncomplicated appendicitis and often is accompanied by a moderate polymorphonuclear predominance. White blood cell counts are variable, however.[104]

In this study majority of patients (88% in povidone iodine and 90% in normal saline group) had probe tenderness present on USG examination. Incidental findings like, ureteric calculi was found in four percent patients in

normal saline group. Inflamed appendix was seen in four percent of patients in povidone iodine group and six percent patients in normal saline group.

In this study, all the patients had an inflamed appendix intraoperatively (100%). Fecolith was seen in eight percent patients in povidone iodine group and six percent patients in normal saline group.

In the present study majority of patients (86% in povidone iodine group and 74% in normal saline group) had retrocaecal appendix followed by 16% and 10% pelvic appendix respectively. The relationship of the base of the appendix to the cecum remains constant, whereas the tip can be found in a retrocecal, pelvic, subcecal, preileal, or right pericolic position.[105]

Most of the serious early complications are septic and 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.

In this study on post operative day three, significantly high rate of surgical site infection (Grade 1) in patients with normal saline irrigation group (16%) was noted as compared to four percent of patients in povidone iodine irrigation group (p=0.046). On day five none of the patients in povidone iodine irrigation group had SSIs compared to 18% patients who had Grade 1 and 4% patients had Grade 2 infection in normal saline irrigation group. This difference was statistically significant (p=0.001). On day seven, none of the patients in povidone iodine irrigation group and 82% in normal saline group had no SSIs. In the remaining

patients of normal saline irrigation group 14% of patients had Grade 2 while, 4% had Grade 1 SSIs and this difference was statistically significant (p=0.003).

In the patients having Grade 2 SSIs, the wound was laid open and culture was sent from the wound. Secondary suturing was undertaken subsequently once the wound was clean.

In patients with suspected SSIs antibiotics were started. Grade 1 infection was seen in two patients in povidone iodine group which resolved with the antibiotic therapy. Patients with Grade 2 infection were also started with antiobiotics and the wound was laid open to facilitate the drainage of the collection. Inspite of antibiotic therapy in the normal saline group six patients having Grade 1 infection on post operative day three subsequently ended up with Grade 2 infection on post operative day seven, whereas remaining two patients responded to the antibiotic therapy and did not show infection on post operative day seven. On post operative day five three new patients were found to be having Grade 1 infection in normal saline group out of which one patient ended up with Grade 2 infection on post operative day seven whereas the remaining two patients continued to have Grade 1 infection on post operative day seven and were treated with antibiotics by which the infection resolved later on.

In this study among the four patients with diabetes mellitus in group A, one had SSI and in group B out of five patients with diabetes mellitus four had SSIs. Hypertension was noted in three patients each in both the groups, of them in group A no SSI was seen as compared to one patient in group B.

A randomized controlled trial[87] on 131 patients between the age from 3.5 to 74 years undergoing appendectomies at Limerick Regional Hospital reported 12.97% infection rate.

Another study[86] summarized wound infection rate to be 10% in operative wound irrigated with povidone iodine in comparison with 30% in operative wound irrigated with sterile normal saline.

The pathologic state of the appendix is the most important determinant of postoperative infection.[106,107] Wound infection after appendicectomy, for perforative or gangrenous appendicitis is four to five times higher than for early disease. Because the pathologic state of the appendix often cannot be determined before or during operation, a parenteral antibiotic agent is recommended as prophylaxis in all patients.

In the present study rate of SSIs between day three to seven varied between 16 to 22% in normal saline irrigation group whereas it was 4% in povidone iodine irrigation group. This rate was comparable with a study conducted in India.[86]

However a recent meta-analysis[89] provided useful information on the overall protective effect of intraoperative povidone iodine application in the prevention of SSI. The pooled results from all trials that assessed the effect of intraoperative application *versus* no antiseptic showed a statistically significant reduction in SSI rates. These results accord with a previous literature review which assessed povidone iodine irrigation only, using both randomized and non-randomized trials, but without quantifying this effect. This analysis quantified the

effect of povidone iodine on the rate of postoperative SSI through a meta-analysis that took into account a large number of randomized controlled trials. Among the 24 studies included, six showed a significant reduction in SSI rate when intraoperative povidone iodine was used. The 18 other studies did not show any significant differences between the two groups, although for most the observed SSI rate was lower in the povidone iodine group than in the control group. For five studies, however, SSIs were more common in the povidone iodine group, although this was not significant statistically.

The variation in outcomes of the literature as well as the present study could be attributable to the surgical procedures which have changed over time and design of the trials as most of the studies were published before 1990.[89]

In this study, the duration of hospital stay was between six to ten days in all the patients (100%) with povidone iodine group, compared to 86% in normal saline group. 10% of patients in normal saline group stayed between 11 to 15 days and in 4% patients it was more than 15 days. Mean stay in hospital for povidone iodine group was 7 days as compared to 8.4 days in normal saline group and this difference was statistically significant suggesting prolonged hospital stay in patients with group B ($p=0.001$). Though the patients 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.

A study reported that, post operative SSIs require prolonged hospital stay and in turn it has adverse effect on the patients economy and also the hospital resources in the form of reduced availability of beds and man power.[81]

In this study among the patients with infection the microbiological examination revealed E. coli as the commonest (14%) organism in normal saline group followed by staph aureus (8%). In povidone iodine group 4% of patients had infection due to staph aureus.

Appendicitis is a polymicrobial infection, with some series reporting the culture of up to 14 different organisms in patients with perforation. The principal organisms seen in the normal appendix, in acute appendicitis, and in perforated appendicitis are *Escherichia coli* and *Bacteroides fragilis.*[108-111] However, a wide variety of both facultative and anaerobic bacteria and mycobacteria may be present.[108]

Overall the results of this study suggest that, the use of intraoperative irrigation of subcutaneous tissue with povidone iodine significantly reduced the rate of SSIs in patients. However, these findings are limited to a single procedure that is open appendicectomy. Further studies on large sample with various abdominal surgeries could focus the beneficial effect of intraoperative irrigation of subcutaneous tissue with povidone iodine.

CONCLUSION

The results of the present study showed that, intraoperative irrigation of subcutaneous tissue with povidine iodine helps in preventing SSIs as compared to normal saline irrigation. It also reduced post operative length of hospital stay significantly.

SUMMARY

Acute appendicitis is the most common surgical emergency in the developed countries that is common in the second decade of life with SSI complicating 1–5% of appendicectomy cases. The present study was undertaken to compare and evaluate the use of povidone iodine solution versus saline irrigation in intraoperative subcutaneous irrigation in Appendicectomy for prevention of surgical site infection and also to compare the duration of post-operative hospital stay in each study group.

This one year randomized clinical 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 100 patients with non perforated appendicitis. Based on the envelope method, patients were divided into two groups namely group A (Subcutaneous irrigation with 10% Povidone iodine) and group B (Subcutaneous irrigation with normal saline).

In the present study, females outnumbered males (56% vs 44%) in normal saline irrigation group. The mean age in povidone iodine irrigation group was 31.20 ± 12.68 years and in normal saline group it was 29.90 ± 12.05 years.

In this study on post operative day three, significantly high rate of surgical site infection (Grade 1) in patients with normal saline irrigation group (16%) was noted as compared to 4% of patients in povidone iodine irrigation group (p=0.046). On day five none of the patients in povidone iodine irrigation group had SSIs compared to 18% patients who had Grade 1 and 4% patients had

Grade 2 infection in normal saline irrigation group. This difference was statistically significant (p=0.001). On day seven, none of the patients in povidone iodine irrigation group and 82% in normal saline group had no SSIs. In the remaining patients of normal saline irrigation group 14% of patients had Grade 2 while, 4% had Grade 1 SSIs and this difference was statistically significant (p=0.003). Mean stay in hospital for povidone iodine group was 7 days as compared to 8.4 days in normal saline group

The results of the present study showed that, intraoperative irrigation of subcutaneous tissue with 10% povidine iodine helps in preventing SSIs as compared to normal saline irrigation. It also reduced post operative length of hospital stay.

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ANNEXURE I – CONSENT FORM

Mr. /Mrs. _____ are requested to enroll yourself in study titled **"A comparative study of intra operative irrigation of subcutaneous tissue with Povidone Iodine Solution versus Saline irrigation in Appendicectomy for prevention of surgical site wound infection." – A One year Randomized Control Trial at KLES' Dr. Prabhakar Kore Hospital** conducted by **Dr.Chintan Soni** Postgraduate student in M.S (Gen. Surgery) under guidance of **Dr. V.M. Uppin(MS)** at J.N.M.C, Belgaum.

OBJECTIVE/ PURPOSE OF THIS 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 two methods of intra operative irrigation of the subcutaneous tissue wound with 1) 10% Povidone Iodine (Betadine) and (2) Saline, and learn their post operative outcomes in terms of Surgical Site Wound Infection (SSI) for Open Appendicectomy.

PROCEDURE INVOLVED:

In Open Appendicectomy after closure of the subcutaneous tissue, just before the closure of skin, subcutaneous tissue wound will be irrigated either with

Povidone Iodine or Saline according to the Randomization and the results will be compared.

RISKS & 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 identify the incidence of post operative surgical site wound infection with the above two mentioned wound irrigation methods. The results obtained at the end of study will help other similar patients who get admitted in the hospital.

PRIVACY & 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 KLE's 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, you can contact the following:

Dr. V.D.Patil (M.D.,D.C.H.)
Chairman, College Ethical Dissertation
And Research Committee,
J. N. Medical College,
KLE University, Belgaum – 10.
Phone : 0831-2473777

Dr. V.M.Uppin (MS)
Professor,
Department of Surgery,
J. N. Medical College,
KLE University, Belgaum-10
Phone : +91-9845273505

Dr. Chintan Soni (PG Gen. Surgery)
Post graduate student,
Department of Surgery
J. N. Medical College,
KLE University, Belgaum – 10.
Phone : +91-9164246247

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.

Participants name : _____ Signature : _____

Witness name : _____ Signature : _____

Researchers name: _____ Signature : _____

Place : _____ Date : _____

ANNEXURE II – PROFORMA

For Study Purposes	
Record no:	
Study Group:	A / B

Patient Details

Name : Age :

Sex : IP No :

Date of Admission :

Date of Discharge :

Address :

History

Chief Complaints

1)

2)

3)

Other history :

Signs and symptoms related to thyroid disorder :

Examination

General Examination : Vitals :

Pulse Rate

B.P.

Temp

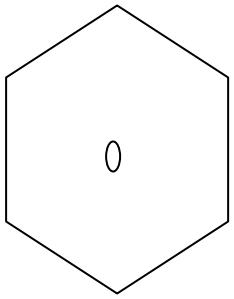
Respiratory Rate

Systemic Examination :

Per Abdomen :

Mc Burney's point tenderness :

Guarding/Rigidity :



CVS :

RS :

CNS :

Provisional Diagnosis :

INVESTIGATIONS

Haemoglobin

Total Leucocyte count

Differential count

Red Blood Cell count

Platelet Count

Blood Urea

Serum Creatinine

HIV

HbSAg

USG Abdomen

OPERATION DETAILS

Name of Surgery : Open Appendicectomy

Date of surgery :

Anaesthesia :

Intra operative findings :

- ➔ Gross appearance
- ➔ Position of appendix
- ➔ Length of appendix

Intra operative irrigation :

- ➔ Povidone iodine (Betadine)
- ➔ Saline

Post Operative :

- ➔ Passage of flatus
- ➔ Bowel sounds
- ➔ Oral feeds

Post Operative Day 3 inspection :

Post Operative Day 5 inspection :

Post Operative Day 7 inspection :

Suture removed on :

Wound Infection :

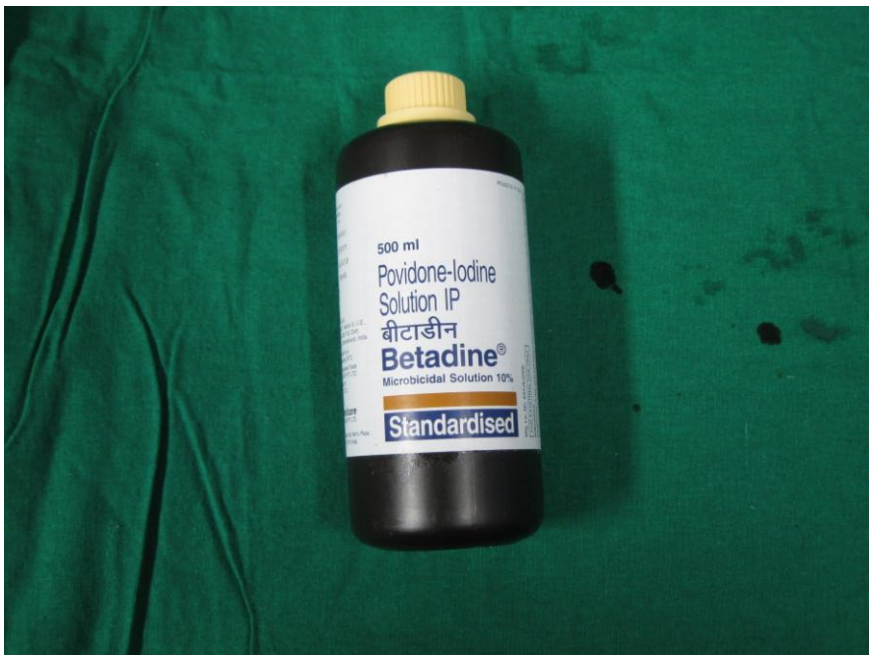
- ➔ Present ( )
  - A) Grade I
  - B) Grade II
- ➔ Absent ( )

Culture sensitivity report :

Histopathological report :

Duration of Hospital stay :

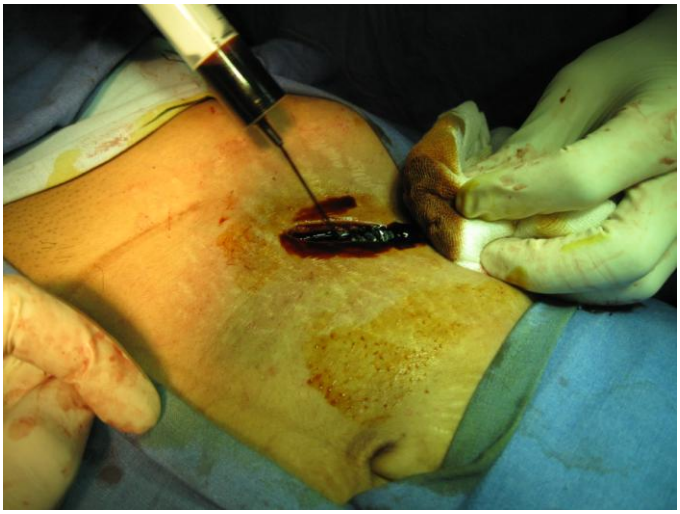
ANNEXURE III – PHOTOGRAPHS



Photograph 1. Povidone iodine

Photograph 2. Normal saline

Photograph 3. Surgical site infection



Photograph 4. Irrigation of subcutaneous tissue with povidone iodine

Photograph 5. Irrigation of subcutaneous tissue with normal saline

ANNEXURE IV – KEY TO MASTER CHART

-	-	Absent
+	-	Present
AA	-	Acute appendicitis
CA	-	Chronic appendicitis
Cm	-	Centimeter
DM	-	Diabetes mellitus
E. Coli	-	Escherichia coli
F	-	Female
FEC	-	Fecolith
GR1	-	Grade 1
GR2	-	Grade 2
INF	-	Inflammed
IP. No.	-	In patient number
Lt	-	Left
M	-	Male
mm	-	Millimeter
PEL	-	Pelvic
PI	-	Preileal
POD	-	Post operative day
PT	-	Probe tenderness
RC	-	Retrocaecal
Rt	-	Right
RA	-	Recurrent appendicits

Staph	-	Staphylococcus aureus
Strept	-	Streptococcus
UC	-	Ureteric calculi

MASTER CHART - GROUP A

Sl. No.	I.P. No.	Age (Years)	Sex	Past History	Symptoms			Signs			Diagnosis	Investigations		Intraop findings			Postop findings					Hospital stay (Days)
					Pain	Vomiting/nausea	Fever	Mc Burney's tenderness	Rigidity/Guarding	Bowel sounds		Total count (/mm^3)	Ultrasonography	Gross appearance	Length (Cms)	Position	Wound infection POD 3	Wound infection POD 5	Wound infection POD 7	Culture of wound discharg	Histopathology report	
A1	4E+05	38	F	-	+	-	+	+	-	+	AA	8800	AA	INF	14	PEL	-	-	-	-	AA	7
A2	4E+05	38	M	-	+	-	+	+	-	+	CA	11900	PT	INF	7	RC	-	-	-	-	CA	7
A3	4E+05	30	F	-	+	+	+	+	+	+	AA	14500	PT	INF	12	RC	-	-	-	-	CA	7
A4	4E+05	25	M	-	+	+	+	+	+	+	RA	10850	PT	INF	6.5	RC	-	-	-	-	CA	7
A5	4E+05	45	F	DM	+	+	+	+	-	+	AA	8720	AA	INF	6.5	RC	-	-	-	-	AA	7
A6	4E+05	42	F	-	+	-	+	+	-	+	CA	11000	PT	INF	8	RC	-	-	-	-	CA	7
A7	4E+05	21	F	-	+	-	+	+	-	+	CA	9400	PT	INF	8	RC	-	-	-	-	CA	7
A8	4E+05	15	M	-	+	+	-	+	+	+	AA	10800	AA	INF	9	RC	-	-	-	-	AA	7
A9	4E+05	28	M	-	+	-	+	+	-	+	CA	15000	PT	INF,FEC	10	RC	-	-	-	-	CA	7
A10	4E+05	46	M	DM	+	+	-	+	-	+	AA	11800	PT	INF	7	RC	-	-	-	-	AA	7
A11	4E+05	11	F	-	+	+	+	+	+	+	AA	11700	AA	INF, FEC	9	PEL	-	-	-	-	AA	7
A12	4E+05	15	M	-	+	+	+	+	-	+	AA	11600	PT	INF	9	RC	-	-	-	-	AA	7
A13	4E+05	36	F	-	+	+	+	+	-	+	CA	10500	PT	INF	10	RC	-	-	-	-	CA	7
A14	4E+05	22	F	-	+	+	-	+	-	+	AA	9400	PT	INF	7	RC	-	-	-	-	AA	7
A15	4E+05	20	F	-	+	+	-	+	-	+	AA	11020	PT	INF	7.5	RC	-	-	-	-	AA	7
A16	4E+05	20	F	-	+	+	-	+	-	+	CA	9400	PT	INF	7	RC	-	-	-	-	CA	7
A17	4E+05	48	M	HTN	+	-	+	+	-	+	RA	8880	PT	INF, FEC	7	RC	-	-	-	-	CA	7
A18	4E+05	42	M	-	+	+	+	+	-	+	CA	11400	PT	INF	7	RC	-	-	-	-	CA	7
A19	4E+05	25	M	-	+	+	+	+	-	+	AA	9200	INF	INF	8	RC	-	-	-	-	AA	7
A20	4E+05	22	F	-	+	+	-	+	-	+	AA	10100	PT	INF	7	RC	-	-	-	-	AA	7
A21	4E+05	30	M	-	+	+	-	+	-	+	AA	9800	PT	INF	6.5	RC	-	-	-	-	AA	7
A22	4E+05	32	F	-	+	-	+	+	-	+	AA	8850	PT	INF	7	RC	-	-	-	-	AA	7
A23	4E+05	43	M	HTN	+	-	+	+	-	+	RA	11200	PT	INF	6.5	RC	-	-	-	-	CA	7
A24	4E+05	16	M	-	+	+	-	+	-	+	AA	8500	PT	INF	7	RC	-	-	-	-	AA	7
A25	4E+05	26	F	-	+	+	+	+	-	+	CA	8100	PT	INF	7	RC	-	-	-	-	CA	7
A26	4E+05	32	F	-	+	-	+	+	-	+	CA	7650	PT	INF	6	RC	-	-	-	-	CA	7
A27	4E+05	36	F	-	+	+	+	+	-	+	AA	7850	PT	INF	6.5	RC	-	-	-	-	CA	7
A28	4E+05	43	M	DM	+	+	-	+	-	+	AA	12550	PT	INF	7	PI	Gr I	-	-	Staph	AA	8
A29	4E+05	17	F	-	+	+	-	+	-	+	AA	12000	PT	INF	6	PEL	-	-	-	-	AA	7
A30	4E+05	12	M	-	+	-	-	+	-	+	AA	7500	PT	INF	9	RC	-	-	-	-	AA	7
A31	4E+05	35	F	-	+	+	-	+	-	+	AA	12100	PT	INF	8	RC	Gr I	-	-	Staph	AA	7
A32	3E+05	14	M	-	+	+	+	+	-	+	AA	9400	PT	INF	6	RC	-	-	-	-	AA	7
A33	4E+05	48	F	-	+	+	-	+	-	+	CA	6500	PT	INF	7	RC	-	-	-	-	CA	7
A34	4E+05	22	F	-	+	+	-	+	-	+	AA	7300	PT	INF	9.5	RC	-	-	-	-	CA	7
A35	4E+05	32	F	-	+	+	+	+	-	+	RA	9250	PT	INF	6.5	RC	-	-	-	-	CA	7
A36	4E+05	12	F	-	+	+	-	+	-	+	CA	9500	PT	INF	7	RC	-	-	-	-	A-C	7
A37	4E+05	52	F	-	+	-	+	+	-	+	RA	8880	PT	INF, FEC	7	RC	-	-	-	-	CA	7
A38	4E+05	48	F	HTN	+	-	+	+	-	+	CA	6400	PT	INF	7	RC	-	-	-	-	AA	7
A39	4E+05	25	M	-	+	-	-	+	-	+	AA	#####	INF	INF	8	RC	-	-	-	-	CA	7
A40	4E+05	22	M	-	+	+	+	+	-	+	AA	8600	PT	INF	7	RC	-	-	-	-	A-C	7
A41	4E+05	22	M	-	+	+	-	+	-	+	AA	10500	PT	INF	6.5	RC	-	-	-	-	AA	7
A42	4E+05	18	F	-	+	-	+	+	-	+	AA	7650	PT	INF	6	RC	-	-	-	-	AA	7
A43	4E+05	43	F	-	+	-	-	+	-	+	CA	8950	PT	INF	7	RC	-	-	-	-	A-C	7
A44	4E+05	46	M	-	+	+	+	+	-	+	AA	6500	PT	INF	7	RC	-	-	-	-	A-C	7
A45	4E+05	34	M	-	+	-	+	+	-	+	AA	8900	PT	INF	6	RC	-	-	-	-	AA	7
A46	3E+05	30	M	-	+	+	-	+	-	+	AA	11200	PT	INF	6	PEL	-	-	-	-	AA	7
A47	4E+05	59	M	-	+	+	-	+	-	+	RA	8600	PT	INF	6.5	RC	-	-	-	-	CA	7
A48	3E+05	45	M	-	+	+	-	+	-	+	AA	8400	PT	INF	7	PI	-	-	-	-	AA	7
A49	4E+05	55	M	DM	+	-	-	+	-	+	AA	12000	PT	INF	8	PEL	-	-	-	-	AA	7
A50	4E+05	20	M	-	+	+	-	+	-	+	CA	11800	PT	INF	9	RC	-	-	-	-	CA	7