EARLY POST-OPERATIVE WOUND INFECTIONS AT THE KENYATTA NATIONAL HOSPITAL: A PROSPECTIVE STUDY

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By

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"Every operation in surgery is an experiment in bacteriology"

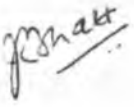
Lord Moynihan

Professor of Clinical Surgery, Leeds

1865 - 1936

DECLARATION

THIS DISSERTATION IS MY ORIGINAL WORK AND HAS NOT BEEN PRESENTED FOR A DEGREE IN ANY OTHER UNIVERSITY.

SIGNED  DATE 25/07/2003.

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DEDICATION

To my loving parents, Rasik and Sudha, for all their sacrifices, patience, hope, understanding and love

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CONTENTS

	PAGE
DECLARATION	i
ACKNOWLEDGEMENT	ii
DEDICATION	iii
CONTENTS	iv
LIST OF TABLES	v
LIST OF FIGURES	vi
ABBREVIATIONS	vii
SUMMARY	1
INTRODUCTION	2
LITERATURE REVIEW	5
STUDY JUSTIFICATION	23
STUDY OBJECTIVES	24
MATERIALS AND METHODS	25
RESULTS	28
DISCUSSION	60
CONCLUSION	66
RECOMMENDATIONS	67
REFERENCES	68
APPENDIX	75

LIST OF TABLES

- Table 1a. Incidence of infection, Foothills Hospital, 1967 14
- Table 1b. Incidence of infection, KNH,1987 15
- Table 1c. Environmental factors in exogenous contamination 16
- Table 1.1. Endogenous contamination v/s infection, KNH 28
- Table 1.2. Endogenous contamination v/s infection, Ward 5A 30
- Table 1.3. Endogenous contamination v/s infection, Ward 5B 31
- Table 1.4. Endogenous contamination v/s infection, Ward 5D 32
- Table 2.1. Preoperative stay v/s infection 34
- Table 2.2. Elective v/s emergency surgery 35
- Table 2.3. Specific theatre incidence of infection 37
- Table 2.4. Subjective hotness / coolness of theatre 39
- Table 2.5. Preoperative shaving v/s infection 39
- Table 2.6. Number of blades used v/s infection 40
- Table 2.7. Seniority of main surgeon v/s infection 41
- Table 2.8. Duration of surgery v/s infection 42
- Table 3.1. Patient age v/s infection 43
- Table 3.2. Gender v/s infection 44
- Table 3.3. Level of Hb / anaemia v/s infection 46
- Table 3.4. Shock v/s infection 47
- Table 3.5. Preoperative fever v/s infection 48
- Table 3.6. Subjective nutritional status v/s infection 49
- Table 3.7. Co-morbidities v/s infection 50

- Table 3.8. Anatomical site v/s infection 52
- Table 3.9. Surgical drains v/s infection 52
- Table 3.10. Pattern of antibiotic use 53
- Table 3.11. Antibiotic use in clean surgery 54
- Table 3.12. Antibiotic use in clean-contaminated surgery 54
- Table 4.1. Infection and post-operative stay 56
- Table 4.2. Infection and in-patient cost 57
- Table 4.3. Microbiology assessment 59

LIST OF FIGURES

- Figure 1.1. Endogenous contamination v/s infection. KNH 29
- Figure 1.2. Comparison between different wards 33
- Figure 2.1. Elective v/s emergency 35
- Figure 2.2. Timing of emergency surgery v/s infection 36
- Figure 2.3. Number of people inside theatre v/s infection 38
- Figure 2.4. Seniority of main surgeon v/s infection 41
- Figure 3.1 Gender v/s infection 44
- Figure 3.2. Level of anaemia v/s infection 45
- Figure 3.3. Serum urea and creatinine v/s infection 46
- Figure 3.4 Dehydration v/s infection 47
- Figure 3.5. Preoperative fever v/s infection 48
- Figure 3.6. Types of comorbidity in infection 50
- Figure 3.7. Blood transfusion v/s infection 51
- Figure 3.8. Comparison between antibiotic use and expected indication 55
- Figure 4.1. Infection v/s postoperative stay 56
- Figure 4.2. Infection v/s cost 58

ABBREVIATIONS

Abx-	Antibiotics
C$-	Canadian Dollars
CME -	Continuing Medical Education
ENT-	Ear Nose Throat
GIT-	GastroIntestinal Tract
Hb-	Haemoglobin
HIV-	Human Immunodeficiency Virus
ICU-	Intensive Care Unit
KShs-	Kenya Shillings
KNH-	Kenyatta National Hospital
Lab-	Laboratory
M.MED-	Master of Medicine
SHO-	Senior House Officer
£-	Sterling Pound
US$-	United States Dollars
UEC-	Urea Electrolyte Creatinine
UGT-	Urogenital Tract
v/s-	versus

SUMMARY

A prospective study of 292 patients undergoing surgical operations in the General Surgical firms at the Kenyatta National Hospital was carried out to assess **early clinical post-operative wound infection**. This outcome was studied in relation to 3 broad variables: Endogenous contamination, exogenous contamination and patient factors.

Methodology: Patients were recruited over a two and a half months period, between 12th February 2003 and 23rd April 2003, according to set criteria. Each patient was followed up until discharge, and where necessary in the out-patient clinics. Data was entered into a questionnaire and analysed for statistical differences in the variables mentioned.

Results: Fifty-one out of 292 patients got post-operative wound infection. Endogenous contamination of the wound at the time of surgery was found to be of great significance in predicting wound infection ($p<0.001$). The **clean wound infection rate** of KNH was found to be 3.1 per cent, whereas the overall wound infection rate was 17.4 per cent. There was no significant difference in the clean wound or overall wound infection rates between the individual surgical firms (p value 0.6) Variables in the exogenous contamination and patient host categories that were found to be of significance included prolonged pre-op stay, pre-op shaving, presence of comorbidities, low levels of haemoglobin and blood transfusion, among others. Patients who got infection had a significant increase in their post-op stay and hospitalization costs ($p<0.001$).

Conclusion: Despite marked improvement in rates over the years, post-op wound infection at KNH remains an important cause of morbidity and financial burden. Recommendations have been made on further attempts at reduction of the rates, based on findings of this study.

INTRODUCTION

The ideal surgical operation results in primary healing, an uneventful recovery. and cure of the ailment. In the third millennium. in spite of the tremendous progress made in the science and art of surgery, we still find that surgical infection, notably wound infection, remains a principal cause of suffering, morbidity and great cost in all terms, including economic.

Infection of a wound is the result of a disturbed balance between host defences and infective organisms, mainly bacterial, which may be introduced by either endogenous or exogenous contamination [1]. A wound is a breach in the normal tissue continuum, resulting in a variety of cellular and molecular sequelae. It may be as a result of either planned surgical intervention or trauma [2].

Endogenous contamination reflects the dose of organisms present in the wound at the time of surgery. This is usually from the patient him/herself. This concept has led to the classification of wounds by the American National Research Council in 1964 into **clean, clean-contaminated, contaminated,** and **dirty** [3].

The **clean wound infection rate** is purported to be the most valuable reflection of surgical care in any hospital [4]. It is used for surveillance audit and quality assurance. In such clean wounds, endogenous contamination is at a minimum, and usually there is no need for antibiotic prophylaxis. Hence the other factors, namely exogenous contamination and host resistance, can be accurately assessed. Krizek and Robson found that traumatic wounds were likely to become infected if they contained more than 500,000 organisms per gram of tissue [5].

Exogenous contamination was indeed historically a major contributor to operative mortality and morbidity in the pre-Listerian era, and led to enormous rates of post-operative wound sepsis. The concepts of antisepsis by Lister, asepsis by von Bergmann and gentle operative technique by Halsted have dramatically changed an otherwise grim picture [6]. The operating room environment, preoperative patient skin preparation and sterile surgical technique are perhaps the most varied of the variables, and reflect the quality of surgical care in the hospital.

The discovery and introduction of antibiotics has had a major impact in our lives. However, studies and experience have shown that antibiotics have failed to decrease the overall incidence of surgical infections [6]. In fact, the widespread use and misuse of antibiotic therapy has increased the problems concerned with the prevention of surgical infections. An unwarranted overdependence on these costly drugs has probably led to a relaxation of the stringent "surgical conscience", hence contributing to a rise in exogenous contamination, notwithstanding the establishment of a reservoir of antibiotic-resistant and virulent bacteria in the hospital environment [6].

The concept of assisting the resistance of the patient host is as old as Hippocrates, who advocated assisting the "vis medicatrix naturae" (healing power of nature) in patient management [4]. **Host resistance factors** can be classified as either general, (such as age, sex, and nutritional and immune status) or local wound-related factors. Culbertson et al stated that the risk of wound infection varies according to the following equation [7,8]:

$$\frac{\text{Dose of bacterial contamination} \times \text{Virulence}}{\text{Host Resistance}}$$

Masiira-Mukasa studied postoperative wound sepsis prospectively at KNH in 1981 and found clean wound infection rates of between 9.77 per cent and 16.5 per cent [9]. Another prospective study, also at KNH, by Jani and Kodwavwalla in 1986-1987 found clean wound infection rates of 12 per cent [10]. Peter Cruse established a practice standard during the famous Foothills Hospital wound study between 1967 and 1975 on 100,000 patients: A clean wound infection rate of less than 1 per cent is considered exemplary; 1-2 per cent acceptable; and more than 2 per cent unacceptable and requires an investigation [4,11].

LITERATURE REVIEW

HISTORICAL OVERVIEW:

A little over 150 years ago, most – if not all – wounds became infected, and the resultant mortality approached levels of 70 – 90% [6]. Operating rooms were more of amphitheaters with eminent surgeons of the day facing patients and their diseases with the tenacity and bravado of ancient gladiators – with their scalpels and bare hands! Although the advent of anaesthesia in 1846 by Morton (who cunningly took the credit for this wonderful discovery by his friend Wells in 1845) changed the world of surgery, there were still lots of myths surrounding wound infection.

The Crimean War from 1853 – 1856 proved that wound infections were deadlier than the weapons of war themselves. Of the French army of about 300,000, approximately 10,000 soldiers were killed on the battlefield, but more than eight times that number, 85,375, died as a result of wound infections and febrile illnesses. Amputations had a mortality of more than 92% [6].

In 1848, a young Austrian obstetrician in Vienna called Ignaz Semmelweis started a difficult journey of change, against the tide and tirade of his seniors, by suggesting that puerperal sepsis, which carried a high mortality, was propagated from patient to patient by the doctors' unwashed hands, which happened to be the practice vogue then. His suggestion of washing hands with chlorinated water was met with stiff resistance from other doctors, students and nurses. Despite showing evidence of reduced mortality rates, his theories of "contact infection" were watered down by professors such as Virchow amongst others. He died a frustrated man in 1865, that too of septicaemia.

Just 38 years before the inception of Kenyatta National Hospital, in 1863, a French chemist, Louis Pasteur published his experimental findings in a French periodical entitled "Recherches sur la Putre'faction", in which he demonstrated putrefaction as a result of fermentation by microbes [6, 12, 13]. Joseph Lister, a surgeon in Glasgow cleverly drew a parallel between Pasteur's experiments and the clinical scenario of gangrene and pyaemia in septic wounds. He further applied the use of a coal-tar derivative – carbolic acid in dressing wounds, which had previously been used by a certain Dr Crooks in eliminating the stench of putrefaction in drainage sewers. This marked the dawn of "Antiseptic Surgery" [6, 12, 14].

Lister's findings, like Semmelweis', were also met with scorn by the prominent persons of his day. His wards, however, had amazingly low rates of sepsis. It was in 1877 that the discovery and isolation of micro-organisms and their association as causation of human disease by Robert Koch, then an obscure country doctor in the small German town of Wollstein, put weight on Pasteur's and Lister's works [12].

In the 1880's, another wave of enthusiasm led to the concept of "Aseptic Surgery" as propagated by German surgeons von Bergmann and Schimmelbusch [6, 15, 16]. In that era, a surgeon's prowess was measured by the stiffness of his black coat from the patient's dried blood splashed during operations! Von Bergmann insisted on the change of colour of uniform of medical personnel in hospitals and operating rooms from black, which masked any dirt or blood, to white, as still used today. Schimmelbusch came up with steam sterilisation of instruments [16].

Mikulicz was the first to try sterilised knitted gloves, but discarded the idea due to constant soakage. We owe the discovery of the rubber glove to one Miss Caroline

Hampton, later Mrs William Halsted, who was chief operating nurse in Halsted's theatre in Baltimore, USA and who reacted to the sublimate hand wash, hence prompting the famous surgeon to think of this ingenious solution in 1890, which later took root in operating rooms worldwide.

The discovery of Penicillin by Fleming in 1928 marked a new dawn of hope in the battle against infection. It was, however, only after 1939 that antimicrobials were used clinically [17]. Operative mortality dropped even more, but sadly the euphoria and overuse associated with it has led to resistance and other problems, such as a relaxation of strict aseptic techniques.

DEFINITIONS AND CLASSIFICATIONS:

A wound is defined as a breach in normal tissue continuum, resulting in a variety of cellular and molecular sequelae [2]. It has also been defined as a breach in an epithelial surface which may be surgical or accidental and which includes drain sites but not burns, ulcers, or pressure sores [6].

A wound infection is most commonly defined as the discharge of pus from the surgical incision or wound [18]. All wound infections must therefore either have a purulent discharge in, or exuding from, the wound, or there should be a painful, spreading erythema indicative of cellulitis around the wound [6]. The presence of a few drops of clear fluid from a wound should not be regarded as signifying infection unless it becomes purulent or is accompanied by cellulitis [6].

A wound infection is defined as early if it presents within 30 days of operation; intermediate if between one and three months of operation; and late if presenting more than three months after surgery [6].

The accurate assessment of the severity of a wound infection is important [19,20]. It is classified as minor if there is a discharge of pus from the wound without cellulitis, lymphangitis, deep tissue destruction, or systemic disturbance. A major wound infection is defined as the discharge of pus associated with breakdown, partial or complete, and dehiscence of the deep fascial layers of the wound, or when there is evidence of systemic illness accompanying a spreading cellulitis or lymphangitis [6].

A wound infection is defined as superficial if it occurs above the fascia and deep if it occurs below the fascia [21]. The American National Research Council Study of 1964 has classified wounds according to the theoretical number of bacteria that contaminate it into 4 classes:

- **Clean-** These are elective operation wounds that are closed primarily. They are non-traumatic and uninfected without any apparent inflammation encountered. There should be no break in aseptic technique. The respiratory, alimentary, genitourinary, or oropharyngeal tracts are not entered.
- **Clean – Contaminated-** These are from clean operations in which the alimentary, respiratory, or genitourinary tracts are entered without significant spillage and under controlled conditions. There is a minor break in technique.
- **Contaminated -** These are from operations in which acute inflammation without pus formation is encountered, or in which there is gross spillage from a hollow viscus. Fresh traumatic wounds and wounds which in which a major break in aseptic technique occurs are also included here.

- **Dirty -** These are created by operations in which pus is encountered, or a perforated viscus is found. Traumatic wounds more than 4 hours old or with retained devitalised tissue or foreign bodies are included here.

The **'clean wound infection rate'** is defined as the rate at which a wound classified as clean complicates with post-operative wound sepsis. It is worked out as a percentage of the ratio of clean wounds that get infected over the total number of clean wounds.

INCIDENCE AND COST OF POST-OPERATIVE WOUND INFECTIONS:

The true incidence of wound infections following surgeries in Kenya is not known. Studies done previously at KNH yielded clean wound infection rates as high as 16.5 per cent and 12 per cent [9,10]. As long back as 1967, Altemeier reported estimated incidence of post-operative wound infections for all types of operations in the United States to be 7.4 per cent [22]. This estimate was based on data from 1,118 hospitals in the USA, and applied to the entire USA where the estimated numbers of surgical procedures were 18,800,000, with overall wound infection numbers estimated at 1,391,200 [22]. The clean wound infection rate in the Foothills Hospital study was found to be 1.4 per cent and the total wound infection rate for all types of wounds was 4.4 per cent [4].

Within Africa, the incidence of wound infections has varied. A prospective study in a teaching hospital in Gondar, Ethiopia in 1988 yielded an overall wound infection rate of 21 per cent on clinical grounds alone [23]. A study of 3000 surgical wounds in Tunisia in November 2000 found the overall wound infection rate to be an impressive 3.53 per cent[24]. However, this study was retrospective. A prospective study in University College Hospital in Ibadan, Nigeria in 1978-1979 reported a clean wound infection rate as low as

1.9 – 2.1 per cent [25]. However, one of the biggest shortfalls noted in this study is that it only regarded infection as being present from positive bacteriological culture results. It is an undisputed fact that wound discharges may be sterile – even from infected wounds [4].

The incidence of wound infections depends largely on two main factors: the dose of bacterial contamination introduced at operation, (be it by endogenous or exogenous means) and the patient's ability to resist that infection. The overriding importance of endogenous contamination which proves to be more important than all the exogenous factors combined will be demonstrated in the detailed review of these factors later [4]. All studies have shown an increase in the incidence of wound infection rate with advancing age [26]. There is no difference in the incidence of wound infections between males and females [4].

The cost of wound infections is indeed phenomenal. This has been calculated in actual figures in countries where taxpayers are respectfully regarded as the employers of governments and policy-makers. Sadly, we don't know the economic impact of wound infections in Kenya. In 1970, Lawrence Swartz of the University of Virginia, USA reported one of the most comprehensive studies on application of economic analysis to the problem of wound infections. He accounted for indirect costs (e.g. loss of man-hours at work), intangible costs (e.g. cost of pain and discomfort) and direct costs (e.g. cost of bed, treatment, physician's fees, dressing, nursing etc.). Patients with infection had a mean length of stay of 35.48 days, compared to patients without infection who had a stay of only 11.61 days. The total per-patient cost for those with infection was worked out to between US$ 6,700 and US$ 9,477 [27].

It has been estimated that the hospital bed occupancy resulting from postoperative wound infection in England and Wales in 1973 cost £ 20 million [28]. In 1986, the cost of

postoperative infections in the UK was estimated at £ 111 million [29]. Another study done by Zoutman et al in 1998 at the Kingston General Hospital and Queen's University, Ontario, Canada, found hospital costs for inpatient care attributable to wound infections to be C$ 321,533 in total for 108 cases. This was worked out as C$ 3,937 per infection[30].

BIOLOGY OF WOUND INFECTIONS:

The development of a wound infection is the result of a number of predisposing risk factors – the presence of bacterial contamination in the wound, the local tissue features of the wound itself, and the overall host resistance provided by the physiologic state of the patient [31]. The interplay between these factors dictates whether a wound will get infected or not.

The bacterial element depends on the dose of the contaminant bacteria, as well as the virulence of the particular micro-organism [7]. The pathogenic potential of bacteria depends upon their ability to invade, survive, and multiply within host tissues; inhibit host defence mechanisms; and cause overt damage to the host by destroying tissues [6]. Regardless of their origin, be it via endogenous or exogenous contamination, when bacteria gain a foothold at a point within the body where their numbers and virulence exceed the capacity of the local tissue defences, they may multiply and destroy tissues unless contained by the immunological and inflammatory responses [6].

Traditionally, it has been held that wound infection will occur if the dose of bacteria is greater than 100,000 per gram of tissue [6]. However, the exact number of bacteria needed to create suppurative lesion also varies according to the physiologic state of the tissue [32,33]. Therefore inaccurate haemostasis, retained blood clots, foreign bodies, and necrotic or traumatised tissue can allow small numbers of bacteria to create a

suppurative wound. This point is further demonstrated by the findings of experiments done in 1957 by Elek and Conen, who measured the deleterious effects of foreign bodies on local resistance by injecting the forearms of British medical students at St. George's Hospital with measured numbers of staphylococci. A dose of 6.5 million staphylococci was required to produce a subcuticular abscess, whereas only 100 organisms were necessary if they injected into the area of a previously placed subcutaneous silk suture [34].

The surgical incision is in itself a breach of the body's non-specific defence when the skin barrier is cut. The specific host defences to sepsis include humoral and cell-mediated immunity. Other non-specific mechanisms include phagocytes and complement. All these are interdependent during the host's inflammatory response to any assault, and is also known as the 'acute phase response' [35]. Alteration or suppression of a normal acute phase response by factors such as debilitation due to age, disease, drugs or trauma may be a key process by which infections become established in the surgical patient [36].

Systemic resistance must also be continued through the maintenance or reestablishment of normal physiology. Low cardiac output and systemic hypoperfusion, as in shock states, seriously weaken the patient's local and systemic antibacterial mechanisms. This loss of host resistance is particularly detrimental to the contaminated wound [31]. Prevention or immediate correction of local or systemic circulatory failure is essential to the prevention of wound infection.

Normal respiratory function, adequate gas exchange, acid-base equilibrium, electrolyte balance, and overall hydration status must also be maintained if the leukocytes are to function normally [31]. These cells are hampered in hyperosmolar environments during dehydration, and low intracellular potassium levels reduce their mobility.

Other factors include pre-existing disease states such as diabetes. Hyperglycaemia and excess steroids (endogenous or exogenous) inhibit leukocyte migration.

Malnutrition can also predispose to infection. Protein depletion can have serious manifestations. Vitamins too play a role, notably vitamin A – a component of inflammation and an adjuvant in antibody formation [31], and vitamin C – probably important in superoxide formation in the oxidative killing mechanism of white cells.

ENDOGENOUS CONTAMINATION:

This occurs when the contamination of a wound originates from the patient's own sources. Based on this, the American National Research Council has classified wounds into the following four categories: clean, clean-contaminated, contaminated and dirty[3]. These categories have already been defined earlier. The overriding importance of endogenous contamination, which proves to be more important than all the exogenous factors combined, can be reproducibly demonstrated in all studies, whereby the risk of subsequent infection can be predicted according to the level of endogenous contamination.

In 1967, the Foothills Hospital began a prospective audit of all surgical wounds. The results of the first 100,000 wounds analysed are shown in Table 1a. This shows the influence of contamination on the infection rates for various types of wounds. The overall infection rate of 4.4% was not regarded to be of epidemiological value [4], as this can vary depending on the predominant type of surgery done in a given institution. Therefore, if mostly clean operations are performed in an institution (e.g. hernia repairs) then the overall infection rate will be lower than the hospital where much bowel surgery is done.

Table 1 a - Incidence of infection, Foothills Hospital (1967) [4]

Category	No. of patients	No. infected	Percentage
Clean	73 589	1002	1.4
Clean contaminated	14 018	879	6.3
Contaminated	9 085	1211	13.3
Dirty	3 308	1310	39.9
Total	100 000	4412	4.4

The rate of infections for clean wounds was 1.4 per cent. For dirty wounds, where pus was found at operation, the rate was 39.9 per cent. This striking difference in the rates is a reminder that endogenous contamination at operation is the single most important factor in the production of subsequent wound infection. Another study, this time at our own KNH, by P. G. Jani and Kodwavwala between 1986 and 1987 also demonstrates the marked difference between clean and dirty wound infection rates, as shown in Table 1b, though the wound infection rates between the afore-mentioned two studies are significantly different.

Table 1b - Incidence of infection, Kenyatta National Hospital (1987) [10]

Category	No. of patients	No. infected	Percentage
Clean	57	7	12
Clean contaminated	11	3	27
Contaminated	22	7	32
Dirty	10	8	80
Total	100	25	25

One can clearly appreciate the difference in the various rates as predicted by the type of wound. One can also see the difference in the "Clean wound infection rate" between the Foothills Hospital and KNH. According to Peter Cruse, the "Clean wound infection rate" is the most valuable reflection of surgical care in any hospital [4]. Endogenous bacterial contamination in these clean wounds is at a minimum, and the influence of the other factors such as exogenous factors (hand scrubs, sterile surgical technique, operating room environment, and preoperative preparation) and patient factors (general or local) can be accurately assessed.

EXOGENOUS CONTAMINATION:

This occurs when contamination occurs from extraneous sources other than the patient. The incriminating factors can be broadly classed into two groups: environmental factors and surgical factors.

Environmental Factors

These have been listed in Table 1c. They include factors that determine the level of contamination from the environment to the specific operative field on the patient. The contamination from the environment can occur in the preoperative period, intraoperative or rarely postoperative periods.

Table 1c: Environmental Factors:

Patient' s skin preparation:	*Theatre Ventilation:*
Preoperative shower	Air movement
Hair removal	Air temperature
Skin preparation	Air humidity
Draping	*Theatre environment:*
Theatre personnel attire:	Number of people
Gowns and Gloves	Cleaning between cases
Masks and caps	*Other factors:*
Footwear	Preoperative stay

In the early part of the Foothills study, it appeared that a shower using hexachlorophene soap was of value in reducing infection [37]. This study comparing three groups – those who had no preoperative shower, those who showered with ordinary bath soap, and those who showered with hexachlorophene soap – revealed infection rates of 2.3, 2.1, and 1.3 per cent respectively. However, Ayliffe and co-workers [38] found that preoperative washing with an antiseptic did not reduce the infection rate in Birmingham.

Cruse showed that in patients who were shaved more than 2 hours before operation, the clean wound rate infection was 2.3 per cent. In those who only had clipping of hair done, the rate fell to 1.7 per cent, whereas in those who had neither shaving nor clipping done, the rate was 0.9 per cent [39]. Seropian and Reynolds [40] also reported on the deleterious effects of body shaving in the wards. Altemeier et al [6] showed the importance of shaving immediately before an operation to prevent bacterial multiplication in the serum oozing from razor nicks.

Degerming the patient's skin with alcohol-based antiseptic solutions has been used widely in the past, with very good result [41]. However, due to fire accidents related to their inflammability with electrocautery, they have largely been replaced by povidone-iodine. To date, there has been no increase in the clean-wound infection rate [4]. Draping with cotton drapes produces less infection rates (1.5 %) than plastic adhesive drapes (2.3%), due to sweating and proliferation of bacteria beneath the plastic [42,43,44].

The supply of air to an operating room should have three functions: To control the movement of air to minimise it's flow from less clean to cleaner areas; to reduce air-borne bacterial contamination; and to control temperature and humidity [45]. Plenum ventilation is when filtered air is maintained under positive pressure. Portable fans are prohibited as these promote blowing bacteria into the operative field [45]. A further reduction of air-borne contamination can be achieved by using high efficiency particulate air (HEPA) filters, and by increasing the air-change turnover rates, as well as maintaining a unidirectional flow of ultra-clean air (UCA) [45].

'A surgeon who is comfortably dressed in light cool theatre clothing is less likely to make an error of judgement than one who is perspiring in a heavy, airless gown' [46]. The type of fabric used in the gown dictates differential dispersal of bacteria, being less

with non-woven fabric [45,46]. In the Foothills study, 11.6 per cent of gloves were found to be punctured. However, not a single wound infection developed [4,42]. Whereas it is imperative to cover all scalp hair of theatre personnel with caps, studies have shown no difference in infection rates between groups wearing masks and those who don't [47,48,49]. Nevertheless, it is agreed that high efficiency filtration masks must be worn during implant surgery [45]. In general surgical operations, they should thus be worn more for protecting the surgeon from being splashed by operative fluids.

There is little evidence to show that the floor or footwear plays a significant role in spread of infection. However, cleanliness should still be adhered to with clean, comfortable, antislip and antistatic shoes [45]. Bacterial contamination is directly proportional to the number of staff in the operating room. There is no evidence to suggest that there is an increased risk of infection when a clean operation follows a dirty case [45].

The longer the patient stays in hospital before an operation, the higher the risk of developing wound infection. With a one-day preoperative stay the infection rate is 1.1 per cent; with a one-week preop stay 2.1 per cent; and if the preop stay exceeds two weeks, the rate increases to 3.4 per cent [42]. The post-operative ward care of wounds played an insignificant part in the development of wound infections, according to the Foothills study [4,42]. Clean operation wounds should be left exposed 48 hours after surgery.

Surgical Factors

The ritual of the surgical hand scrub has varied from place to place. In the Foothills study, the clean wound infection rate was not affected by the type of scrub antiseptic used. The change from a full ten minute scrub to the present two to three

minute scrub has only gained credence after studies have not shown any increase in infection rates, hence saving time, water and hand epithelium [4].

Previously, it was taught that the blade used for making the initial skin incision should not be re-used in deepening the incision. However, there is no evidence to show any increase in infection rates with the use of a single blade through and through [4,11,26]. The use of diathermy in incisions does not alter the infection rates either.

There is a direct relation between the length of an operation and the infection rate [3,50]. The clean wound infection rate roughly doubles with every hour [4]. This is because bacterial contamination increases with time. Also, the tissues in the operative area are damaged by drying and retractors. There is also an increased use of sutures and electrocoagulation, as well as more blood loss, hence reducing the local and general resistance of the patient.

Surgical dressings provide a moist environment that improves epithelialization. They also retain heat and the antimicrobial effect of wound exudate [51,52]. However, a wound that is kept open and allowed to dry forms a coagulum, which resists secondary infection. Hence, clean operation wounds should be left exposed after 48 hours postoperatively.

HOST DEFENCE MECHANISMS:

The concept by Culbertson et al [7,8] in which the risk of wound infection varies according to the dose of bacterial contamination, virulence and the host resistance. explains why a heavily contaminated wound will often heal without infection in a patient with normal host defence mechanisms. Host resistance can be classified into general and local factors.

General Factors

All studies have shown an increase in the wound infection rate with advancing age [26]. This can be explained by reduced general and local resistance with increasing age. There is no significant difference in infection rates between male and female patients. Patients with altered physiology are more prone to developing infection. Hence, dehydration, shock, anaemia, uraemia, trauma all contribute to increased rates of wound infection [6].

In the collaborative five university Ultraviolet study, the incidence of infection in diabetic patients was 10.4 per cent, significantly higher than the overall infection rate of 7.4 per cent [8]. In the same study, patients on steroid therapy had a rate of 16 per cent, whereas severely obese patients had a rate of 18.1 per cent. Severe malnutrition yielded rates as high as 22 per cent.

Patients who harbour infection remote from the operative incision have been found to be at higher risk for the development of wound infection. In the Ultraviolet Collaborative Study, there was a wound infection rate of 18.4 per cent in this group, compared with 6.7 per cent in those without remote infection [6,8].

It has been suggested that healing is impaired after major surgery in AIDS patients. This has not been substantiated, and outcome appears to be related more to the CD4 T-cell count, nutritional status and haemoglobin level than any single hallmark of HIV infection [53,54]. A study done by Chuwanga [55] in 1999 on HIV seroprevalence among 145 patients admitted for elective surgery in KNH showed a rate of 29% of cases as being HIV positive. Of these, only 4 cases out of total of 42 patients who tested positive for HIV developed post-op wound infection. Thus only 9.5% of HIV positive patients developed post-op wound sepsis. Other factors reducing host resistance include malignancy, cirrhosis, leukopaenia, cytotoxic agents and blood transfusion.

Local Factors

The local resistance of the wound far exceeds in importance the general resistance of the patient. In 1537, Ambroise Pare' found that gunshot wounds healed better when treated with bland irrigations rather than with boiling oil. In the 1890s Kocher demonstrated the low infection rate attainable by gentle operative technique and meticulous haemostasis [4]. Halsted extolled Kocher's technique and proclaimed the principles of wound care: complete haemostasis, adequate blood supply, removal of all devitalized tissue, obliteration of dead space, use of appropriate sutures, and wound closure without tension [4].

The presence of foreign bodies is inevitable with the use of sutures. The type of suture used has been incriminated in increased infection rates, as shown by Elek and Conen with the use of silk suture [34]. Halsted recommended use of fine non-absorbable sutures, which are removed as soon as the wound has healed. If unnecessary tissue, which

will eventually necrose, is included with a ligated blood vessel, then the infective dose of bacteria is further reduced [56].

Haematoma in the surgical wound is, however, the single most important factor in reducing local resistance [4]. Blood is a very good medium for bacteria to flourish in. Hence, meticulous haemostasis is of great importance. Electrocautery, if used with precision and hence minimal necrotic tissue, does not adversely affect the infection rate; it actually reduces the duration of surgery.

The use of drains also affects the local resistance. Closed suction drains are valuable in wounds in which haematoma formation is likely [4]. Stagnant wound fluid, deficient in opsonin, is evacuated allowing fresh fluid with opsonin to enter the wound [57]. Open drains, such as corrugated rubber or Penrose drains have been found to be harmful: they allow a direct route of contamination, and are foreign bodies, hence reducing the local resistance [4,58].

STUDY JUSTIFICATION

In its 101 years of existence, Kenyatta National Hospital has grown and matured into a quality health care institution. As a teaching hospital of the University of Nairobi, it has played a most vital role in training over 3000 doctors, and over 200 surgeons to date. The latter have researched in various important areas and written informative dissertations, as a University requirement for their training and hence an important justification in itself.

Post-operative wound infections have always been of great importance to the surgical fraternity, as they often reflect the quality of care to the surgical patient. Whereas it should be a recommended standard practice to have ongoing surveillance on the rates of infection in any hospital, post-operative wound infections have only been studied twice before at KNH [9,10], that too a long while ago. There are no recent studies on this topic for the last fifteen to twenty years. Hence there is a great need to update ourselves on the current status.

STUDY OBJECTIVES

Broad Objective:

To study post-operative wound infections prospectively as seen at the general surgical firms of Kenyatta National Hospital.

Specific Objectives:

- To study post-op wound infection in relation to endogenous contamination of the wound.
- To determine the clean wound infection rate as well as the overall wound infection rate of Kenyatta National Hospital, and to compare these between individual surgical firms.
- To study the outcome in relation to variables of exogenous contamination, such as pre-op stay, duration of surgery, type (elective versus emergency), specific theatre, environment of theatre, shaving and level of surgeon, among others.
- To study the outcome in relation to patient host factors, both general and local.
- To study what proportion of infected wounds are actually investigated for microbiology, culture and sensitivity.
- To assess the effects of wound infection on post-operative patient stay and hospital costs.

MATERIALS AND METHODS

STUDY DESIGN:

This was a descriptive prospective study of post-operative wound infections in patients undergoing surgery at the KNH over a period of two and a half months, between 12th February 2003 and 23rd April 2003.

STUDY AREA:

The study was conducted at the Kenyatta National Hospital, the national referral and teaching hospital of the University of Nairobi. Specifically, it encompassed all the three firms of General Surgery, with their respective wards and theatres, as well as out-patient clinics.

SAMPLING TECHNIQUE AND SAMPLE SIZE:

All patients admitted to the three general surgical firms for elective or emergency operation in the study period were included if they fulfilled the inclusion criteria. Elective cases were those which were operated in the designated elective theatre lists for the relevant firms. Emergency cases were those admitted through casualty and who underwent surgery in the emergency theatres. The final sample size obtained was thus 292 subjects.

INCLUSION CRITERIA:

- All patients going for emergency general surgery (including trauma), in whom a wound is either surgically created or existing by virtue of trauma, and in whom the wound is closed primarily at the end of the operation.
- All patients going for elective general surgical procedures, except those outlined below, in whom the wound is closed at the end of the operation.

EXCLUSION CRITERIA:

- Patients with burns.
- Patients undergoing oral, vaginal or rectal operations.
- Patients undergoing circumcision.
- Patients undergoing cystoscopic or endoscopic surgery.
- All ENT, Ophthalmologic and Obstetric / Gynaecologic procedures.
- All Orthopaedic, Neurosurgical, Cardiothoracic and Paediatric surgical procedures.
- Patients who are lost to follow up
- Early post-operative mortality (< 5 days from surgery)

DATA COLLECTION:

Data was collected on a pre-designed data collection form (Appendix I). Post-operative wound evaluation and recording was carried out by the researcher, and was compared with independent assessment by the ward staff, as reflected in the patient files. The files were also be scrutinised on and after discharge for feedback on microbiology laboratory results for all those who developed wound infection as well as for any other information.

DATA ANALYSIS:

The data was analysed using the SPSS version 9.0 data analysis package. Statistical significance was determined using the Pearson Chi- square test, and a p-value of < 0.05 was considered to be significant. Results have been presented in tabular and graphic forms.

ETHICAL CONSIDERATIONS AND CONFIDENTIALITY:

The research proposal was submitted to the KNH Ethical and Research Committee for approval before embarking on the study. Patients were recruited after signing an informed consent form (Appendix II). This was signed after the patient had read and understood the Patient Information form (Appendix III). All patient information was treated with strict confidentiality and used only for the intended purpose.

RESULTS

Out of a total of 314 patients initially recruited for this study, 22 were excluded for reasons all affecting assessment in the follow-up period. Thus the final study sample size was 292 patients. Of these, fifty-one patients developed post-operative wound infection, giving an overall wound infection rate of 17.4 per cent.

1. ENDOGENOUS CONTAMINATION

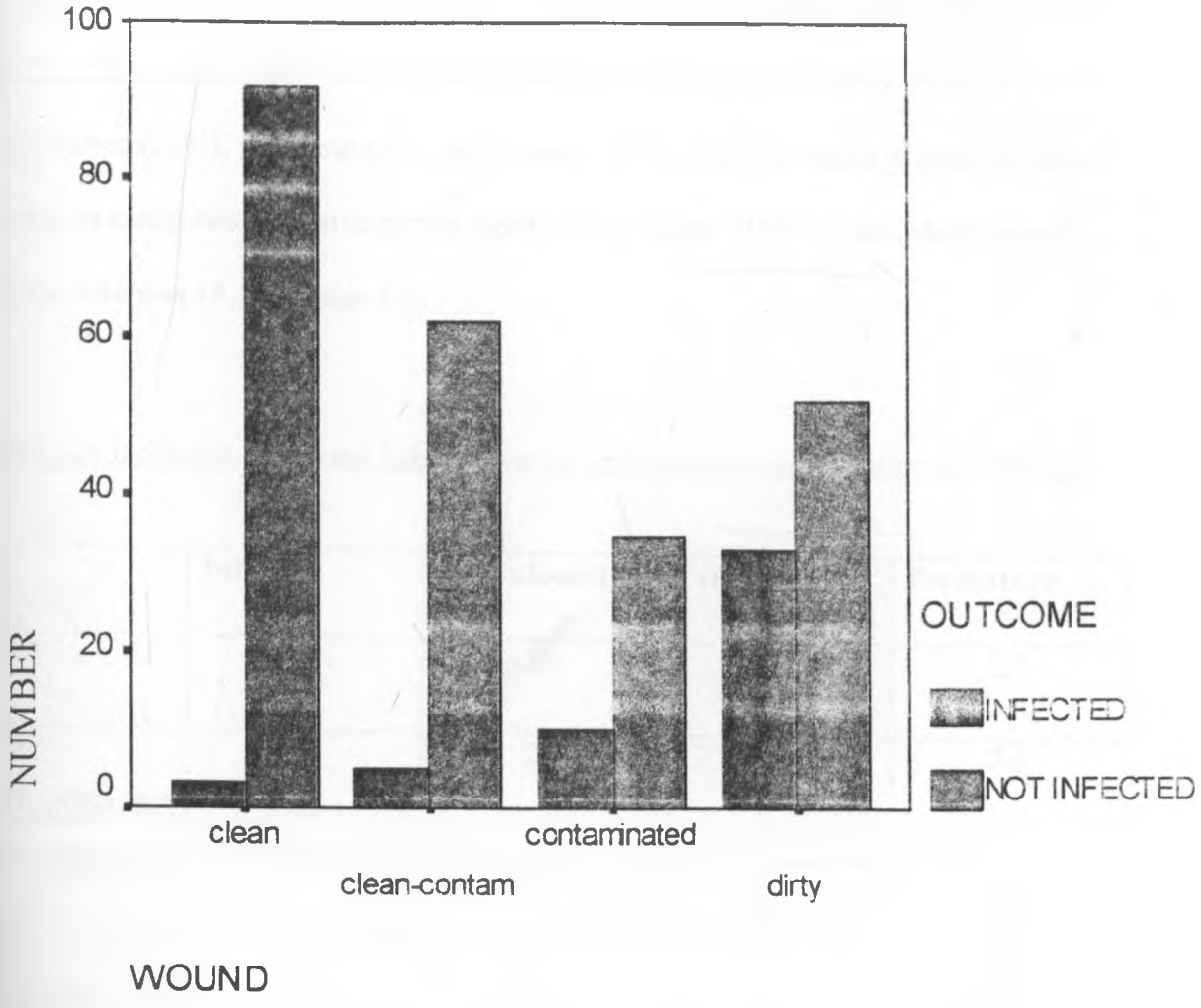
1.1 ENDOGENOUS CONTAMINATION INFECTION RATE FOR KNH

All the patients' wounds were categorized according to the degree of endogenous contamination at the time of surgery, and infection rates for each category determined. Out of a total of 95 clean wounds, 3 got infected. giving the clean wound infection rate for KNH to be 3.1 per cent. The infection rate was noted to increase significantly with higher degrees of contamination (p-value <0.001). The rest of the rates for the other categories are shown in Table 1.1 and Figure 1.1

Table 1.1: Incidence of wound infection versus endogenous contamination

	Infected	**Not Infected**	**Total**	**Percentage**
CLEAN	3	92	95	3.1
CLEAN CONTAMINATED	5	62	67	7.4
CONTAMINATED	10	35	45	22.2
DIRTY	33	52	85	38.8
TOTAL	51	241	292	17.4

Figure 1.1 : Incidence of wound infection in relation to endogenous contamination



1.2 ENDOGENOUS CONTAMINATION INFECTION RATE FOR WARD 5A

The infection rates again increased significantly with increasing degree of contamination. There were a total of 97 patients out of overall total of 292 (33.2 %) operated in ward 5A. The clean wounds that got infected were 1 out of 37, giving a clean wound infection rate of 2.7%. There were infections in 2 out of 27 clean-contaminated (7.4%), 3 out of 12 contaminated (25%), and 8 out of 21 dirty cases (38%). The differences in rates between the various categories were statistically significant (p-value <0.001). The overall wound infection rate was 14.4% (Table 1.2)

Table 1.2: Incidence of wound infection versus endogenous contamination for Ward 5A

	Infected	**Not Infected**	**Total**	**Percentage**
CLEAN	1	36	37	2.7
CLEAN CONTAMINATED	2	25	27	7.4
CONTAMINATED	3	9	12	25.0
DIRTY	8	13	21	38.1
TOTAL	14	83	97	14.4

1.3 ENDOGENOUS CONTAMINATION INFECTION RATE FOR WARD 5B

There were a total of 98 out of overall 292 patients (33.6%) operated in ward 5B. The clean wound infection rate was 3.4% (1 out of 29). Infection was found in 2 out of 27 clean contaminated (7.4%), 3 out of 10 contaminated (30%), and 12 out of 32 dirty cases (37.5%) as shown in Table 1.3. The overall wound infection rate was 18.3%. The difference in outcome in the different wound categories was statistically significant (p-value 0.002).

Table 1.3: Incidence of wound infection versus endogenous contamination for Ward 5B

	Infected	**Not Infected**	**Total**	**Percentage**
CLEAN	1	28	29	3.4
CLEAN CONTAMINATED	2	25	27	7.4
CONTAMINATED	3	7	10	30.0
DIRTY	12	20	32	37.5
TOTAL	18	83	98	18.3

1.4 ENDOGENOUS CONTAMINATION INFECTION RATE FOR WARD 5D

There were a total of 97 out of overall 292 patients (33.2%) operated in ward 5D. The clean wound infection rate was 3.4% (1 out of 29). Infection was found in 1 out of 12 clean contaminated (7.7%), 3 out of 26 contaminated (15.4%), and 13 out of 29 dirty cases (44.8%) as shown in Table 1.4. The overall wound infection rate was 19.6%. Again, the difference in outcome in the different wound categories was statistically significant (p-value< 0.001).

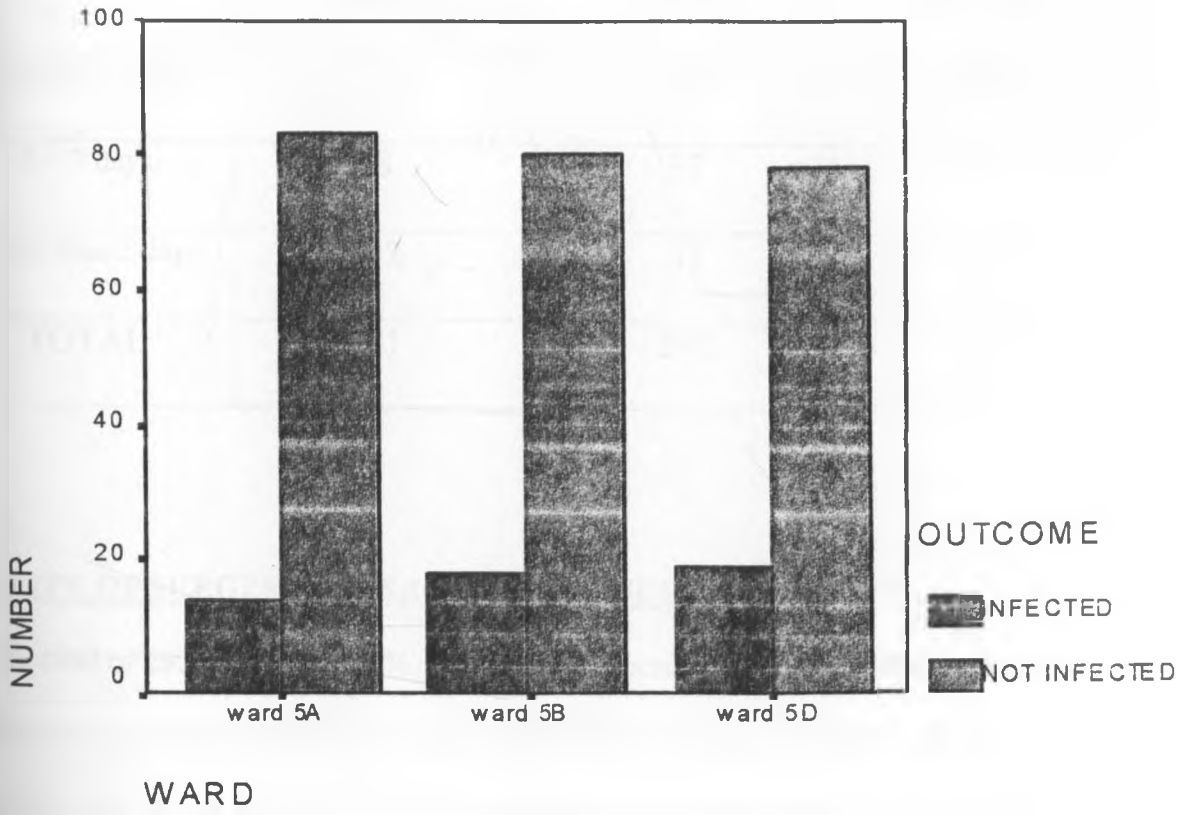
Table 1.4: Incidence of wound infection versus endogenous contamination for Ward 5D

	Infected	**Not Infected**	**Total**	**Percentage**
CLEAN	1	28	29	3.4
CLEAN CONTAMINATED	1	12	13	7.7
CONTAMINATED	4	22	26	15.5
DIRTY	13	16	29	44.8
TOTAL	19	78	97	18.3

1.5 COMPARISON BETWEEN THE DIFFERENT WARDS

The clean wound infection rates are 2.7% for Ward 5A, 3.4% for Ward 5B, and 3.4% for Ward 5D. The overall wound infection rates are 14.4% for Ward 5A, 18.3% for Ward 5B, and 19.6% for Ward 5D. Neither of these two rate comparisons was found to be significant (p-value = 0.614), as evidenced in Figure 1.2.

Figure 1.2: Comparison in infection rates between the different wards (p-value 0.614)



2. EXOGENOUS CONTAMINATION

2.1 PRE-OPERATIVE STAY

Wound infection was assessed in relation to duration of pre-operative stay. Thirty one patients out of 222 who had a pre-op stay of less than 2 days developed infection (13.9%), whereas 8 out of 37 who had a pre-op stay of between 3 and 7 days got infection (21.6%). Of the 33 patients who had a pre-op stay of more than 7 days, 12 (36.4%) got infection (Table 2.1). These differences were found to be statistically significant (p-value 0.014).

Table 2.1 – Pre-op stay and wound infection

	Infected	Total	Percentage
Less than 2 days	31	222	13.9
2 – 7 days	8	37	21.6
More than 7 days	12	33	36.4
TOTAL	51	292	17.4

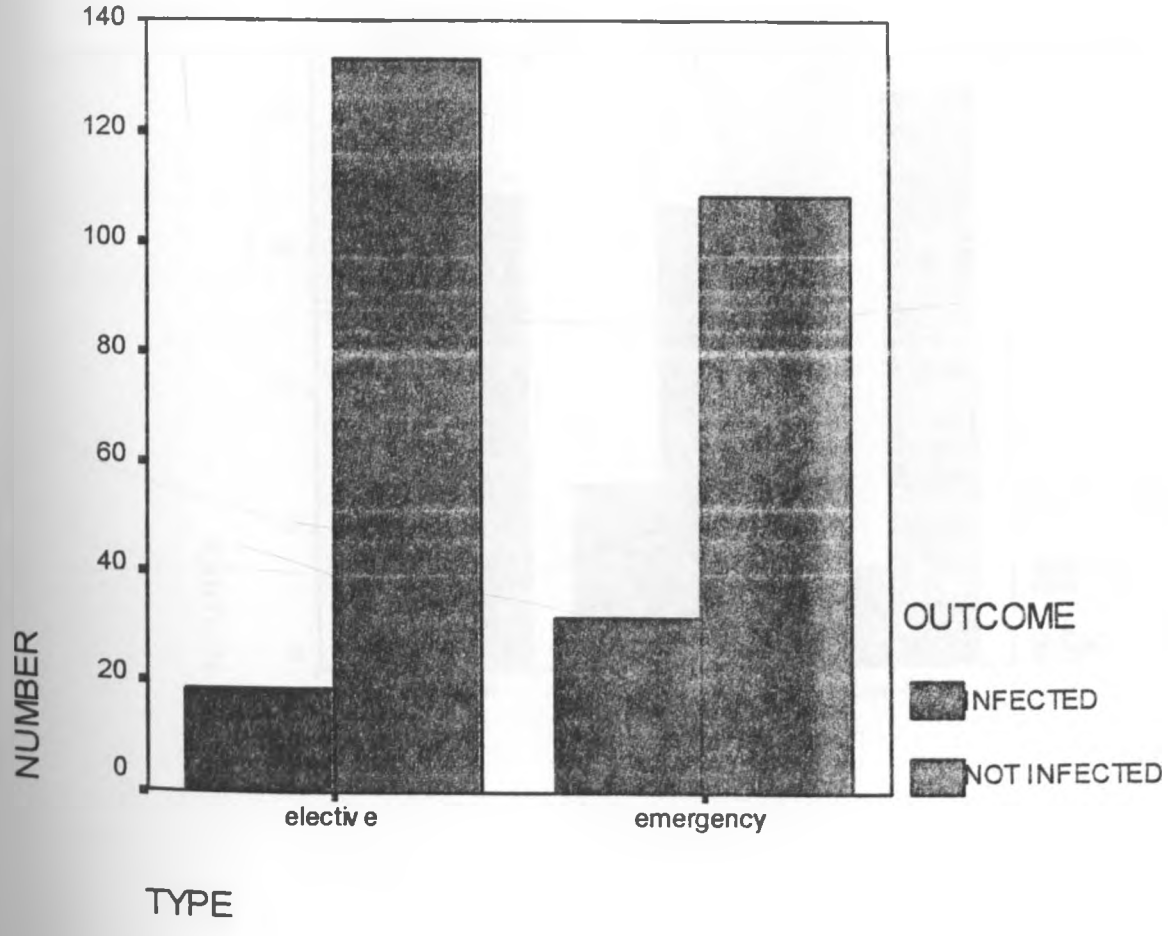
2.2 TYPE OF SURGERY (EMERGENCY VERSUS ELECTIVE)

Of the total of 292 cases, 152 (52%) had elective procedures and 140 (48%) underwent emergency operations. The infection rates were 12.5% (19 out of 152) for elective surgeries, and 22.9% (32 out of 140) for emergency surgeries (Table 2.2 and Figure 2.1). This difference was significant (p-value 0.02).

Table 2.2: Overall infection rates of elective versus emergency surgery

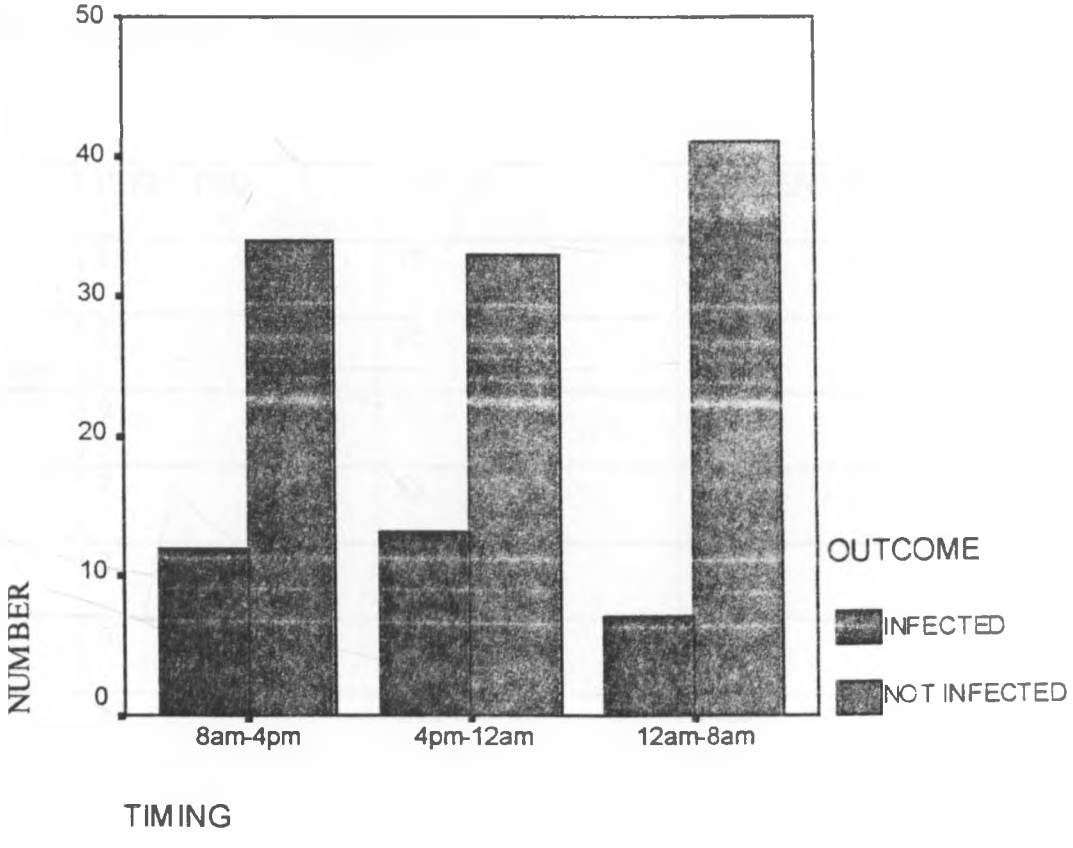
	Infected	Total	Percentage
Elective	19	152	12.5
Emergency	32	140	22.9
TOTAL	51	292	17.4

Figure 2.1: Elective versus emergency surgeries



There were a total of 140 emergency procedures, of which 32 got infected. There was no statistical significance between the infection rates according to the time of day or night (p-value = 0.235). Of 46 operated in the daytime between 8 am to 4 pm, 11 (23.9%) got infected, whereas 13 out of 46 (28.2%) that were operated between 4 pm and 12 midnight got infected. There were 48 procedures done between 12 am and 8 am, of which 8 (16.6%) got infected. (Figure 2.)

Figure 2.2 – Timing of emergency surgery and wound infections



2.4 SPECIFIC THEATRE

The theatres used by the three general surgical firms for emergency procedures were Theatres 1 and 2, and for elective procedures were Theatres 3, 6, 7 and 8. The infection rate for theatre 1 was 20% (15 out of 75), whereas that for theatre 2 was 26.1% (17 out of 65). There was no statistically significant difference between the rates of these two emergency theatres (p-value = 0.151). The rates of the remaining elective theatres are as shown in Table 2.3. Again, there was no significant difference between the rates of the four elective theatres (p-value = 0.21).

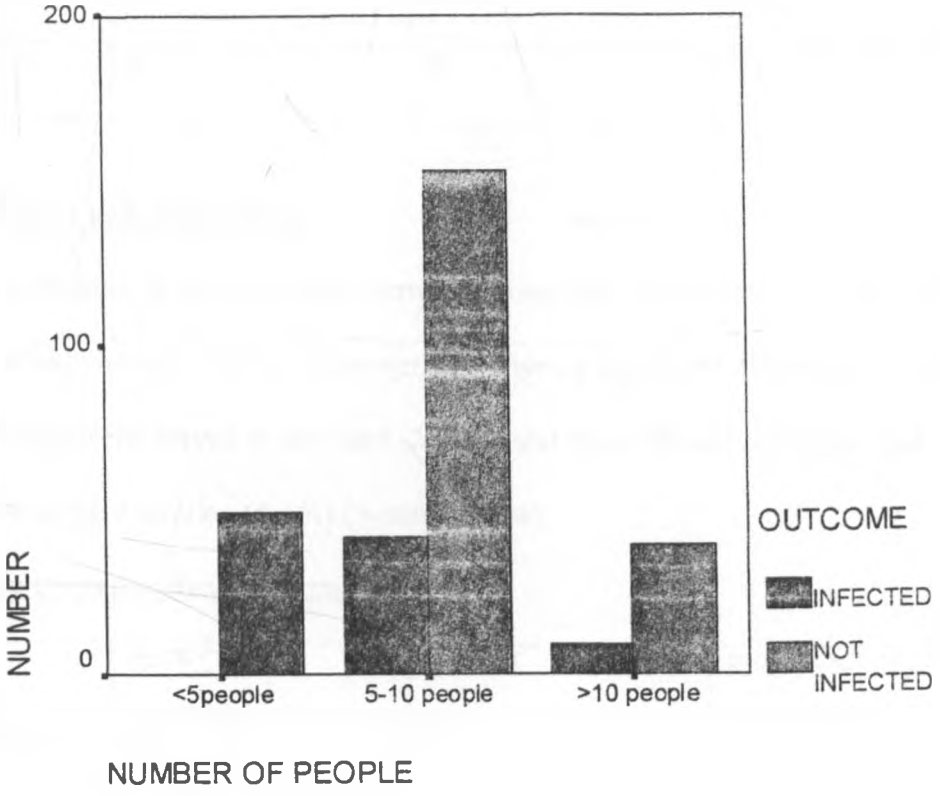
Table 2.3 – Specific Theatre and wound infection rate.

	INFECTED	TOTAL	PERCENTAGE
Theatre 1	15	75	20
Theatre 2	17	65	26.1
Theatre 3	9	72	12.5
Theatre 6	7	55	14.5
Theatre 7	2	17	11.7
Theatre 8	0	8	0
TOTAL	51	292	17.4

2.5 NUMBER OF PEOPLE IN THE OPERATING ROOM

There was a significant rise in increase of post-op wound infections in procedures done in theatres in which there were more than 5 people (51 out of 243, or 20.9%), including transients, compared with those with 5 people or fewer (none out of 49) (p-value 0.002). However, there was no significant difference noted between sub-groups of the over-5 group, with 21.5% infection rate (42 out of 195) in those with 5 to 10 people and 18.8% infection rate (9 out of 48) in the over-10 group (p-value = 0.66). (Figure 2.3)

Figure 2.3 – Number of people present versus infection:



2.6 SUBJECTIVE HOTNESS OF THEATRE

The surgeon operating was asked of his subjective feeling of the theatre temperature as one of three choices: hot, comfortable or cool. Of the cases in which surgeons felt hot during operation, 10 out of 25 (40%) developed wound infection. This was significantly different than the cases in which the surgeon felt comfortable. where 37 out of 222 (16.6%) developed infection, or in which the surgeon felt cool, where 8.9% developed infection (p-value <0.001). (Table 2.4)

Table 2.4 – Subjective hotness / coolness of theatre versus wound infection

	INFECTED	TOTAL	PERCENTAGE
HOT	10	25	40
COMFORTABLE	37	222	16.8
COOL	4	45	8.9

2.7 PRE-OPERATIVE SHAVING

There was no difference in infection rates between those that were shaved (17.0%) and those that were not shaved (17.7%). However, there was a significant difference in rates between those that were shaved in the ward (26.3%) and those shaved in theatre, just before the start of the operation (6.1%) (p-value 0.024).

Table 2.5 – Pre-operative shaving versus infection

	INFECTED	TOTAL	PERCENTAGE
Shaved in Ward	15	57	26.3
Shaved in theatre	3	49	6.1
Not shaved	33	153	17.7

2.8 NUMBER OF BLADES USED

Out of total of 292 patients, 24 had traumatic wounds. Of the remaining 268 cases, 152 had surgical incisions created with only one blade, and 116 with 2 blades. There was no significant difference in the rates of infections between the two groups, with a rate of 18.4% for one blade and 17.2% for 2 blades (p-value = 0.35). (Table 2.6)

Table 2.6 – Number of blades used versus infection

	INFECTED	TOTAL	PERCENTAGE
One blade	28	152	18.4
Two blades	20	116	17.2
TOTAL	48	268	17.9

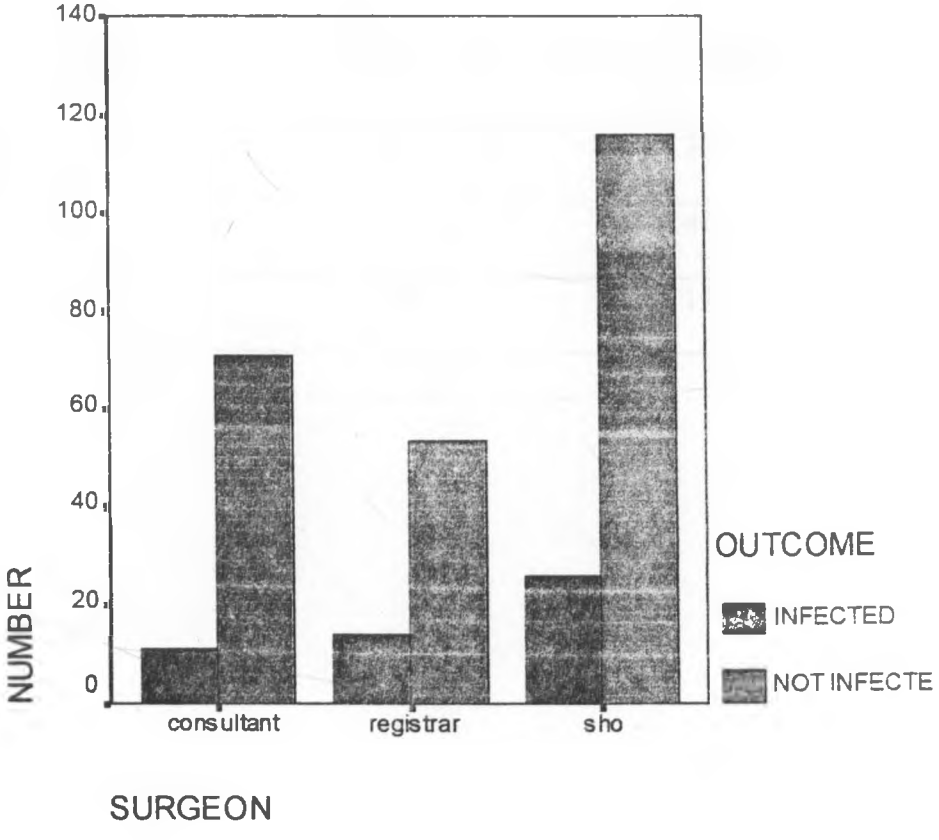
2.9 SENIORITY OF SURGEON

This implied the level of the main surgeon during the surgery, and could be a consultant, registrar (post M.Med) or SHO (M.Med trainee). This did not equate to who actually sutured the wound, which was done by the SHOs in most cases. The infection rate was lower in the consultant group (13.4%), and was similar in the registrar and SHO groups (19.1% and 19.0% respectively). The difference between the 3 groups was not significant (p-value = 0.481). (Table 2.7 and Figure 2.4)

Table 2.7 – Seniority of main surgeon versus infection

	INFECTED	TOTAL	PERCENTAGE
Consultant	11	82	13.4
Registrar	13	68	19.1
SHO	27	142	19.0
TOTAL	51	292	17.4

Figure 2.4 – Seniority of main surgeon versus infection



2.10 DURATION OF SURGERY

This was calculated from the time the incision was made to the time the last stitch was placed. A significant increase was noted in infection rates with an increase in the duration of surgery, with 6.8% at 0 – 1 hours, 15.4% at 1 - 2 hours, 33.3% at 2 – 3 hours and 47.3% with duration exceeding 3 hours (p-value <0.001). (Table 2.8).

Table 2.8 – Duration of Surgery

DURATION	INFECTED	TOTAL	PERCENTAGE
0 – 1 hours	6	88	6.8
1 – 2 hours	22	143	15.4
2 – 3 hours	14	4	33.3
> 3 hours	9	19	47.3
TOTAL	51	292	17.4

3. PATIENT HOST FACTORS

3.1 PATIENT AGE

There was an increase in the rate of infection with increasing age. In the <20 year age group, this was 7.4%. In the 21 – 40 year group, the infection rate was 17.4%, whereas it was 17.8% in the 41 - 60 year age group and 22.2% in the 61 – 80 year age group. The infection rate was 25% in the over 80 year age group. However, the differences in the infection rates were not statistically significant (p-value = 0.545). (Table 3.1)

Table 3.1 – Patient age versus infection

PATIENT AGE	INFECTED	TOTAL	PERCENTAGE
< 20 years	2	28	7.1
21 – 40 years	25	143	17.4
41 – 60 years	13	73	17.8
61 – 80 years	10	44	22.2
> 80 years	1	4	25
TOTAL	51	292	17.4

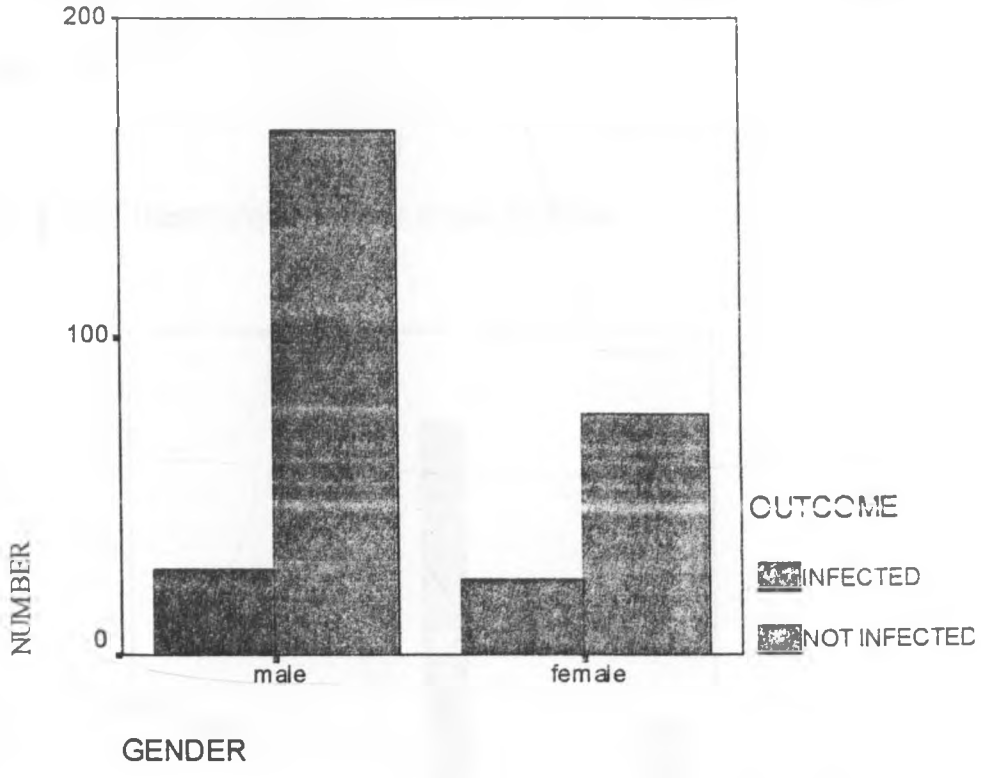
2.2 PATIENT GENDER

There were 192 males (65.8%) and 100 females (34.2%). Of these 27 males (14.1%) and 24 females (24%) got post-operative wound infection (Table 3.2 and Figure 3.1). This difference was found to be significant (p-value = 0.034).

Table 3.2 – Gender versus wound infection

GENDER	INFECTED	TOTAL	PERCENTAGE
Male	27	192	14.1
Female	24	100	24
TOTAL	51	292	17.4

Figure 3.1 – Patient Gender versus infection



3.3 ANAEMIA

This was assessed either by a haemoglobin level, or in certain emergency cases, by subjective assessment of presence or absence of pallor. There was a significant difference in infection rates in patients with a low haemoglobin levels compared to those with higher levels (p-value 0.001)). There was also a significant difference between infection rates in those who were clinically pale and those who were not (p-value < 0.001). Those with Hb of less than 10 g/dl had an infection rate of 55.5%, compared with 27.9% in those with Hb of 10 – 12g/dl and 7.48% in those with a level more than 12g/dl. Fifty per cent of those with pallor got infection, compared with 12.5% of those without pallor. (Figure 3.2 and Table 3.3)

Figure 3.2 – Level of Haemoglobin / Pallor versus infection

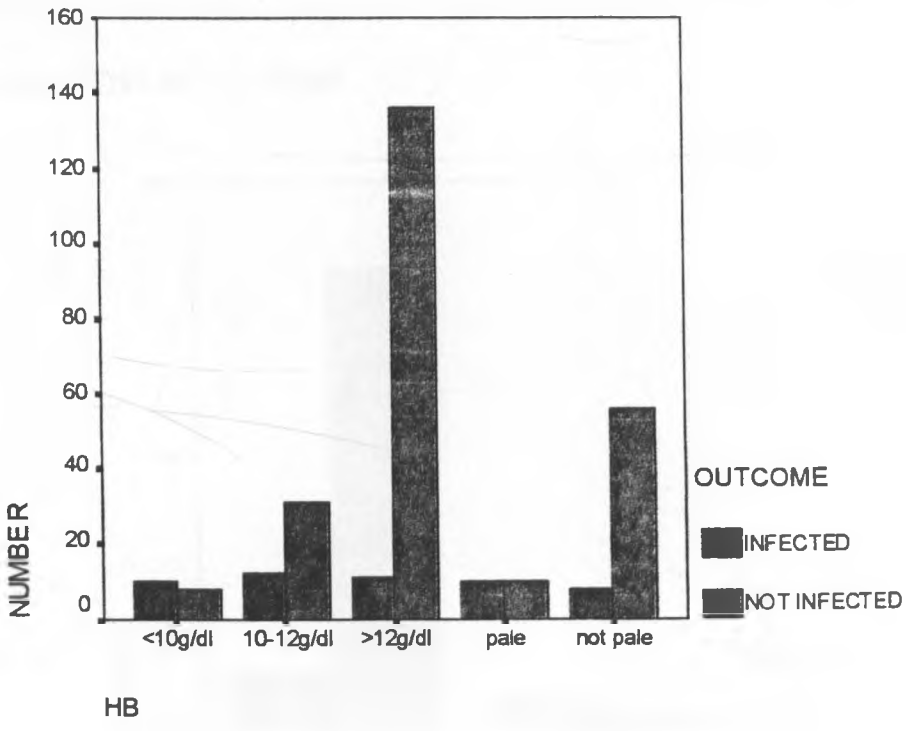


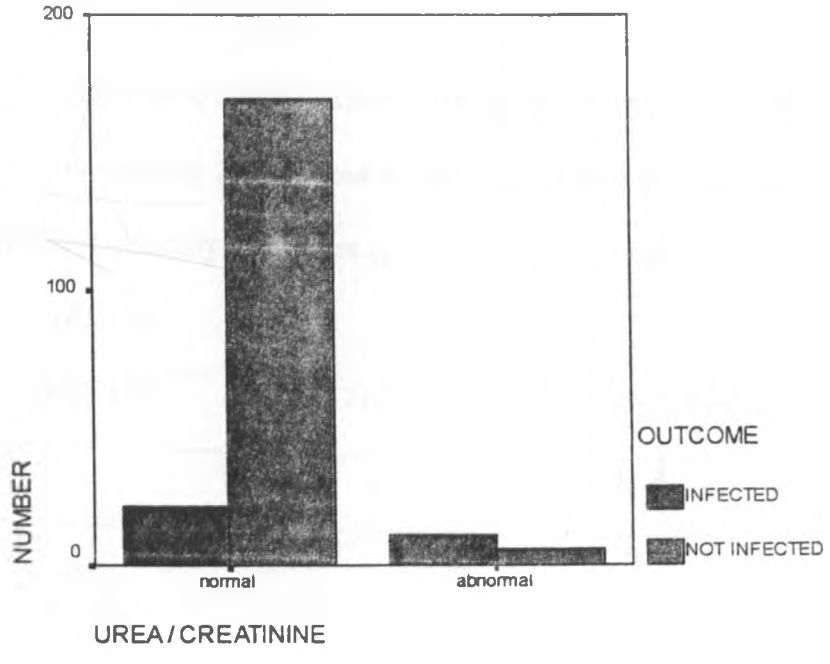
Table 3.3 – Level of anaemia versus infection

HB / PALLOR	INFECTED	TOTAL	PERCENTAGE
Hb < 10g/dl	10	18	55.5
Hb 10 – 12 g/dl	12	43	27.9
Hb > 12g/dl	11	147	7.48
Pallor +	10	20	50
No Pallor	8	64	12.5
TOTAL	51	292	17.4

3.4 SERUM UREA AND CREATININE

These were done in 208 out of the 292 cases. Of the 191 cases with normal result, 22 (11.5%) got infection. This was significantly different in comparison to 11 out of 17 (64.7%) infections in cases with a raised urea or creatinine (p-value 0.001). (Figure 3.3)

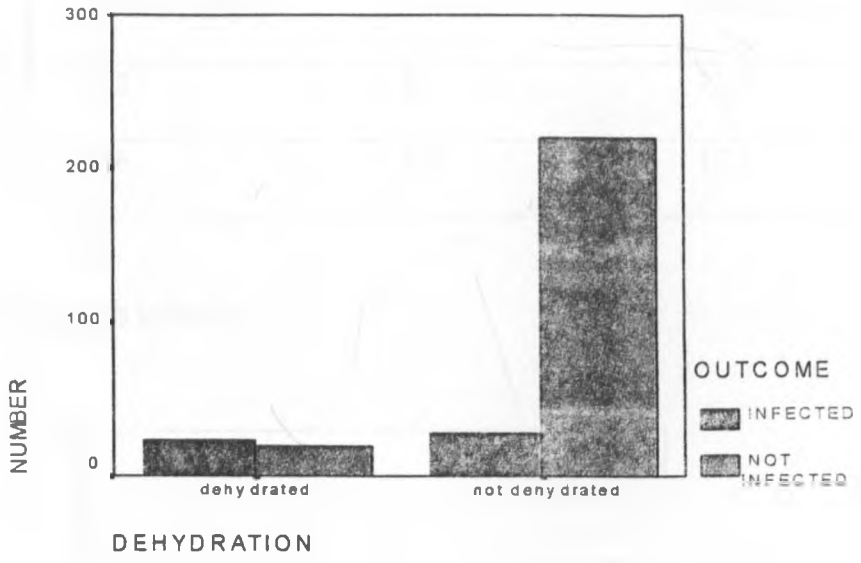
Figure 3.3 – Serum Urea and Creatinine



3.5 DEHYDRATION

There were 43 cases of dehydration, which was assessed clinically on admission by looking at the mucous membranes and skin turgor. Of these, 23 or 53.4% got infection, while only 11.2% (28 out of 249) of those without dehydration got infection. This difference was significant (p-value <0.001). (Figure 3.4)

Figure 3.3 – Dehydration versus infection



3.6 SHOCK

This was determined clinically by a low blood pressure and tachycardia, with supporting history and physical signs. There were only 7 patients with shock, of which 3 (42.8%) got infection. Forty-eight of the remaining 285 without shock (16.8%) also got infected. This difference was however not statistically significant (p-value = 0.073). (Table 3.4)

Table 3.4 – Shock versus infection

SHOCK	INFECTED	TOTAL	PERCENTAGE
Present	3	7	42.8
Absent	48	285	16.8

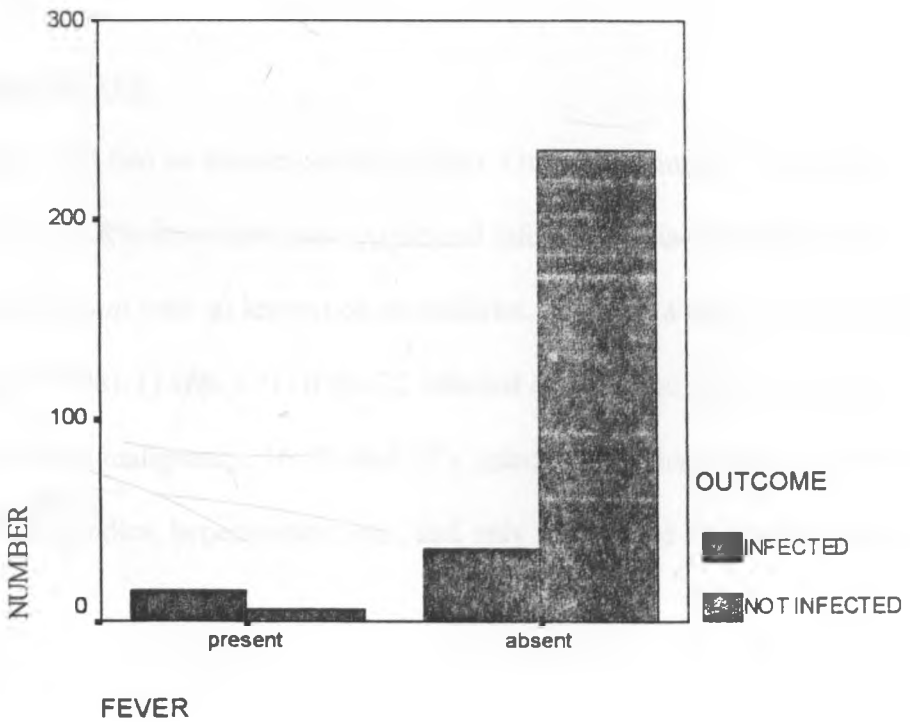
3.7 PRE-OPERATIVE FEVER

The temperature was measured in the ward, or in casualty and recorded in degrees celsius. Of the 21 that had fever (temperature > 37.5°C), fifteen or 71.4% got infection, compared with 36 out of 271 (13.3%) of those without any fever. This difference was found to be significant (p-value <0.001). (Table and Figure 3.5)

Table 3.5 – Fever versus infection

FEVER	INFECTED	TOTAL	PERCENTAGE
Present	15	21	71.4
Absent	36	271	13.3

Figure 3.5 – Fever versus infection



3.8 SUBJECTIVE NUTRITIONAL STATUS

This was assessed, and patients were categorized as wasted, normal or overweight. Twenty-one out of 54 cases classed as wasted got infection (38.9%). There was infection in 23.8% of the overweight group, compared with 11.5% of the normal group (Table 3.6). These differences were found to be significant (p-value 0.01).

Table 3.6 – Subjective nutritional status versus infection

NUTRITIONAL	INFECTED	TOTAL	PERCENTAGE
Wasted	21	54	38.9
Overweight	5	21	23.8
Normal	25	217	11.5
TOTAL	51	292	17.4

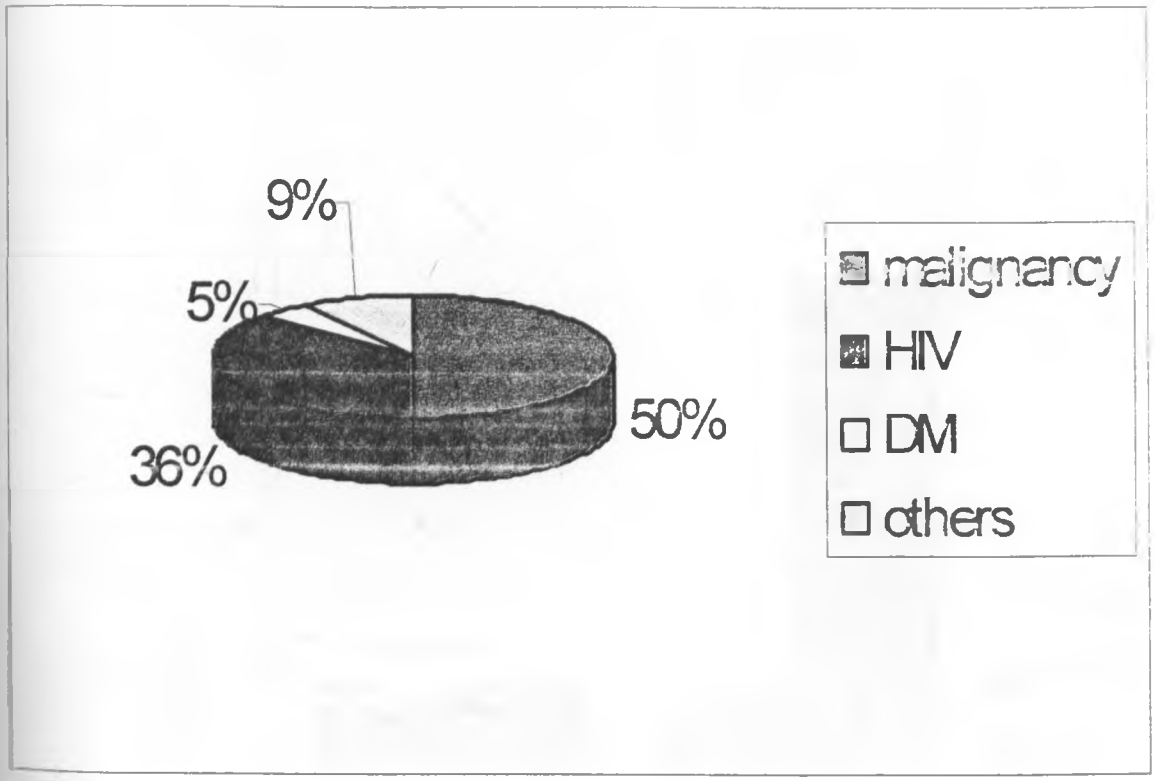
3.9 CO-MORBIDITIES

Out of 292 cases, 213 had no known co-morbidities. Of the remaining 79 who had co-morbidities, 22 or 27.8% developed post-op wound infection. This was significantly different from the group with no known co-morbidities, who had a rate of 13.6% (29 out of 213) (p-value 0.008). (Table 3.7) Of the 22 infected cases in the group with co-morbidities, 50% had malignancy, 36.4% had HIV infection, 9.1 had other miscellaneous co-morbidity like jaundice, hypertension, etc., and only 4.5% were known to be diabetic (Figure3.6).

Table 3.7 – Co-morbidity versus infection

COMORBIDITY	INFECTED	TOTAL	PERCENTAGE
Present	22	79	27.8
Absent	29	213	13.6
TOTAL	51	292	17.4

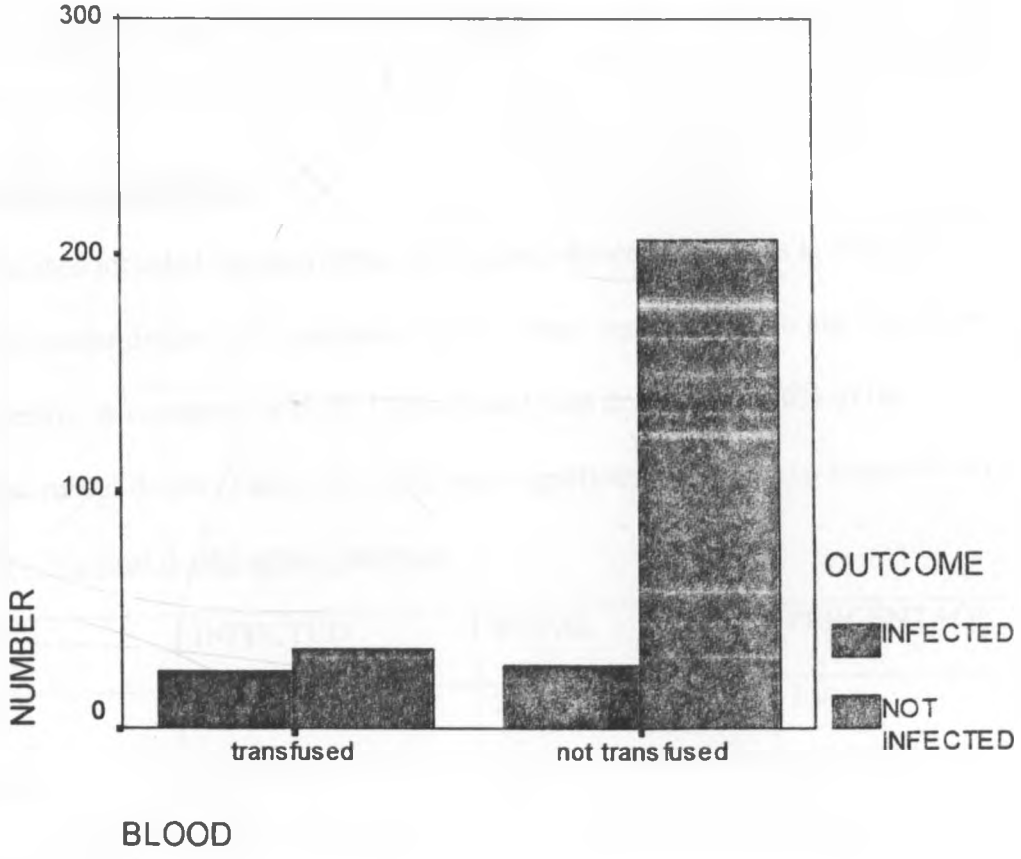
Figure 3.6 – Pie Chart on proportion of type of comorbidity in infected cases



3.10 BLOOD TRANSFUSIONS

A total of 58 patients received blood during their stay. Out of these, 24 or 41.4% developed post-op wound infection. This was significantly different in comparison to the lower rate of 11.5% (27 out of 234) in those who did not receive any blood transfusion (p-value <0.001). (Figure 3.7)

Figure 3.7 – Blood Transfusion versus infection



3.11 ANATOMICAL SITE OF INCISION

The anatomical site of the surgery was recorded, and followed up for infection. There were significantly lower infection rates in the head and neck region (3.6%), compared to the upper trunk (chest / breast) (15.4%), the limbs (14.2%) and the abdomen (21.2%) (p-value 0.033). (Table 3.8)

Table 3.8 – Anatomical site versus infection

SITE	INFECTED	TOTAL	PERCENTAGE
Head and neck	2	56	3.6
Chest and breast	4	26	15.4
Limbs	1	7	14.2
Abdomen / groin	44	203	21.7

3.12 SURGICAL DRAINS

The drains used included vacuum drains in 33 cases, closed tube drains in 127, corrugated rubber drains in 17, and none in 115. There was infection in just 3% of the vacuum drains, as compared with 25.1% in closed tube drains and 70.6% of the corrugated rubber drains (Table 3.9). This was a significant difference (p-value <0.001).

Table 3.9 – Surgical drains versus infection

DRAIN	INFECTED	TOTAL	PERCENTAGE
Vacuum	1	33	3.0
Closed tube	32	127	25.1
Corrugated rubber	12	17	70.6
None	7	115	6.1

3.13 USE OF ANTIBIOTICS

This study also collected information on the way antibiotics are used before, during or after surgery. It went a step further to evaluate the use of antibiotics in clean and clean-contaminated cases in relation to the outcome of wound infection. The results are shown in Tables 3.10, 3.11 and 3.12. For clean cases, often no antibiotics are required, or one may prescribe prophylactic antibiotics at induction with or without 3 further doses, as would be expected in clean-contaminated cases. However, as shown in Figure 3.8, there is an obvious discrepancy between the group of clean and clean-contaminated (total of 162 out of 292 or 55.5%) versus the actual total of those who received no or prophylactic antibiotics of 35 out of 292 (12%). In other words, 127 out of 165 clean and clean-contaminated cases (78.4%) were subject to a full therapeutic course of antibiotics, without any indication. This indicated a serious overuse of antibiotics in the clean and clean contaminated cases. Of the contaminated and dirty group, antibiotic therapy was actually started post-operatively in the ward in 72.3% (94 out of 130), and only 27.7% (36 out of 130) received pre- or intra-operative antibiotics.

Table 3.10 – Pattern of use of antibiotics (percentage in brackets)

Type	No abx	Prophylaxis	Rx postop	Rx pre/intra-	Total
Clean	20 (21.1)	10 (10.5)	64 (67.3)	1 (1.1)	95 (32.5)
Clean-cont		5 (7.5)	45 (67.2)	17 (25.3)	67 (22.9)
Contaminatd			33 (73.3)	12 (26.7)	45 (15.4)
Dirty			61 (71.8)	24 (28.2)	85 (29.2)
TOTAL	20 (6.9)	15 (5.1)	203 (69.5)	54 (18.5)	292 (100)

Table 3.11 – Antibiotic use in Clean cases versus infection

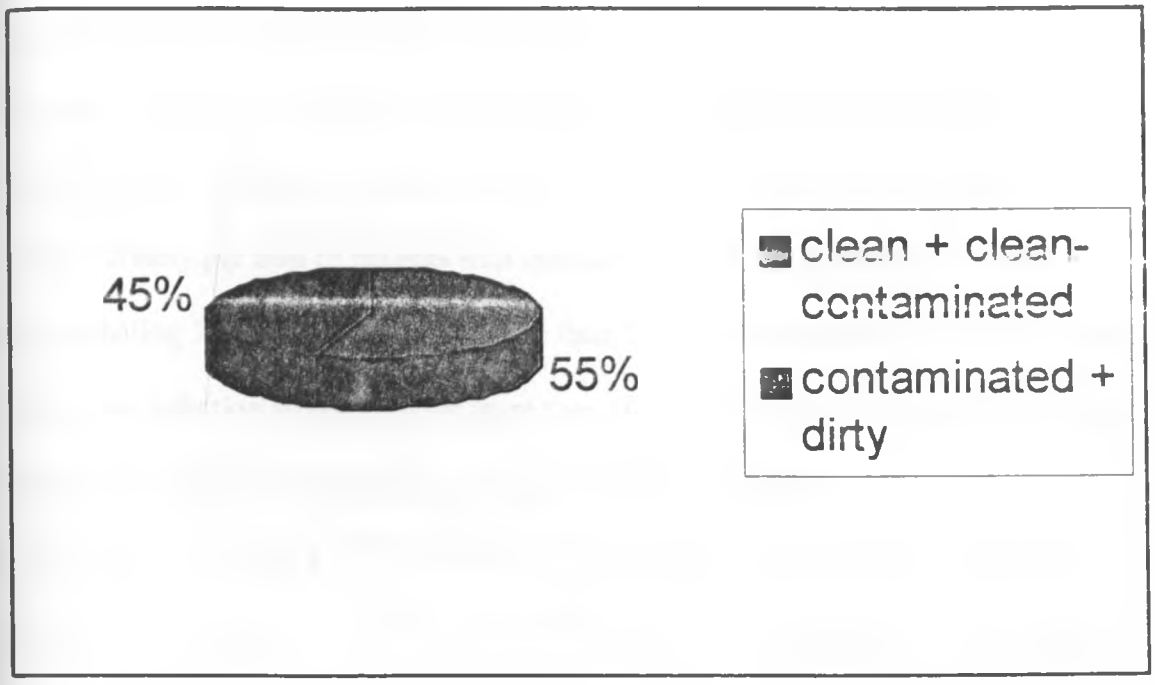
ANTIBIOTIC USE	INFECTED	TOTAL	PERCENTAGE
None	0	20	0
Prophylaxis	0	10	0
Rx – postoperative	3	64	4.7
Rx – pre/ intraoperative	0	1	0
TOTAL	3	95	3.2

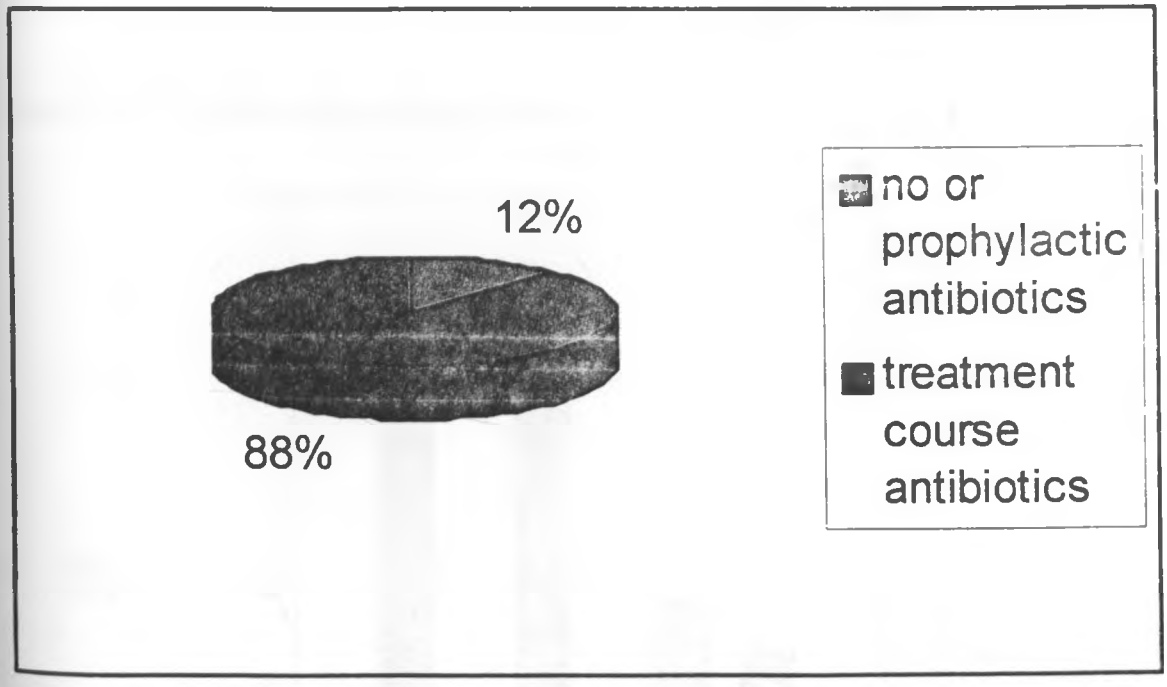
Table 3.12 – Antibiotic use in Clean-contaminated cases versus infection

ANTIBIOTIC USE	INFECTED	TOTAL	PERCENTAGE
Prophylaxis	0	5	0
Rx – postoperative	5	45	11.1
Rx – pre/ intraoperative	0	17	0
TOTAL	5	67	7.4

It is evident from the above tables that there was a wide variance in the pattern of antibiotic use for clean and clean-contaminated. Majority of patients received full treatment courses. Of those who received no or prophylactic doses of antibiotics, none developed post-op wound infection.

Figure 3.8 Comparison between antibiotic use versus expected indication





4. EFFECTS OF WOUND INFECTIONS

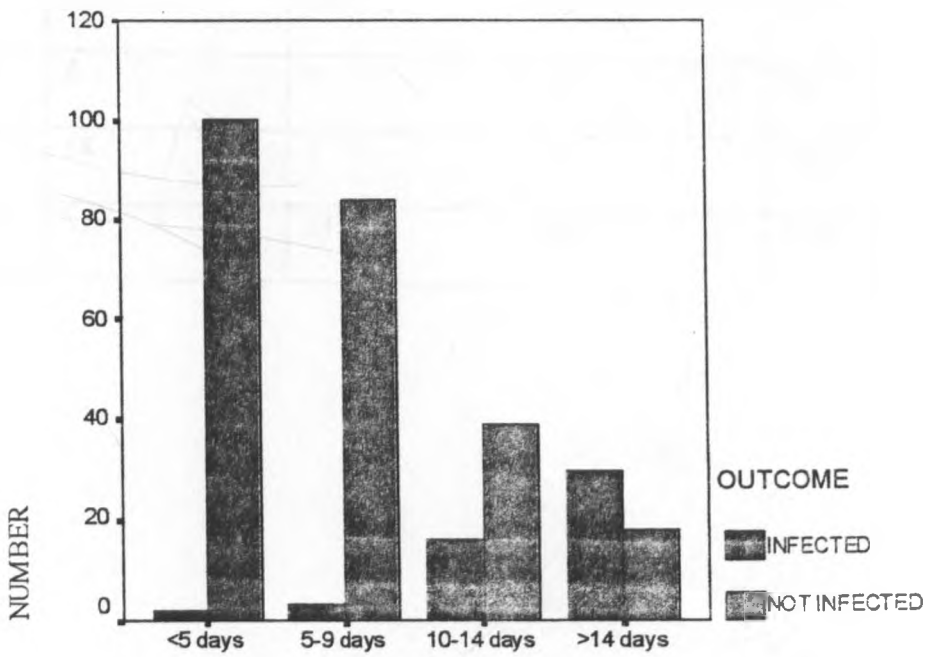
4.1 POST-OPERATIVE HOSPITAL STAY

As shown in Table 4.1 and Figure 4.1, there was a significant increase in the post-op stay of patients who developed wound infection, as compared with those who did not (p-value <0.001). Ninety per cent of patients with infection stayed in hospital for more than ten days, including 58.8% who stayed for more than 14 days, as compared to 23.6% of those without any infection who stayed for more than 10 days, and 7.5% for more than 14 days.

Table 4.1 – Infection versus post-op stay (percentage in brackets)

POST-OP→	<5 DAYS	5-9 DAYS	10-14 DAY	>14 DAYS	TOTAL
Infected	2 (3.9)	3 (5.9)	16 (31.4)	30 (58.8)	51 (100)
Not infected	100 (41.5)	84 (34.9)	39 (16.2)	18 (7.4)	241 (100)
TOTAL	102	87	55	48	292

Figure 4.1 – Infection versus post-operative stay



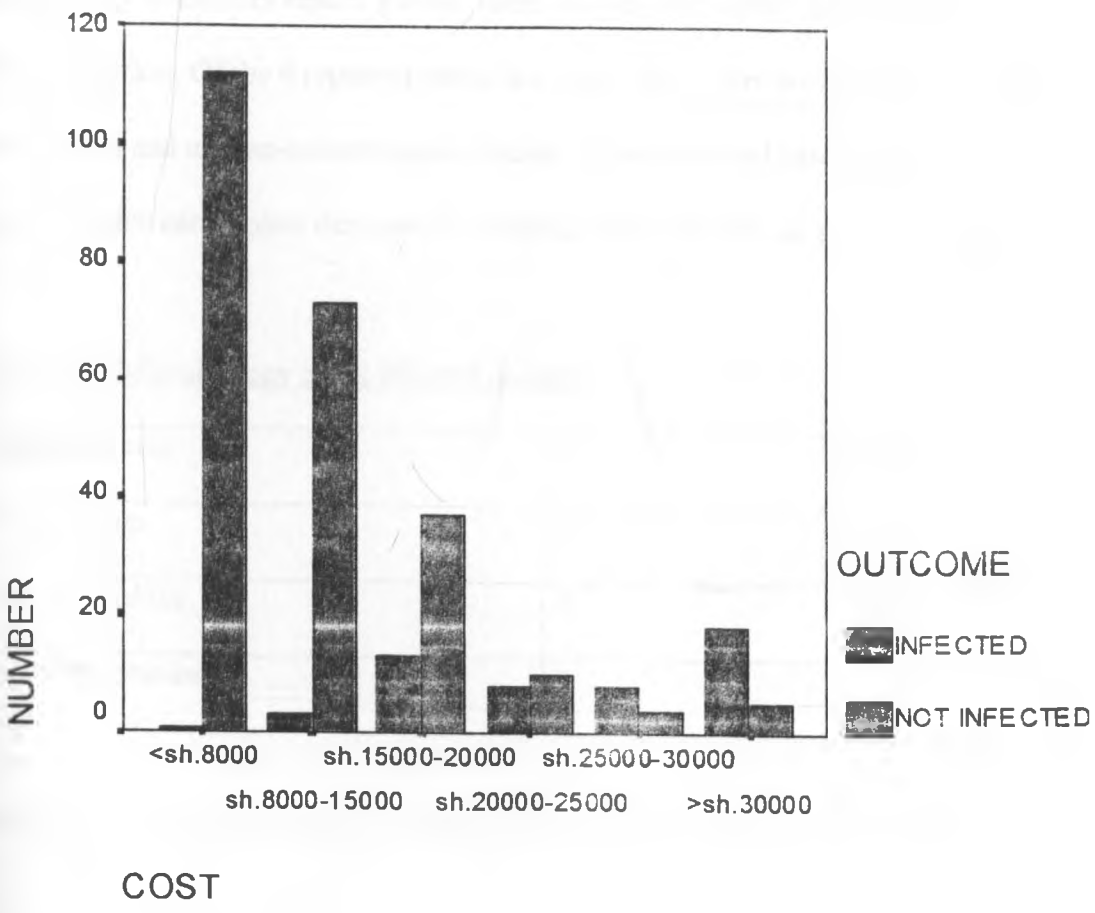
4.2 COST COMPARISON

At the end of the study, the patients' in-hospital total bills were evaluated to relate them to their outcomes. Again, there was a significant increase in the amount of bill in patients with infection in comparison to those without infection (p-value 0.001). Out of all patients who paid a bill of less than eight thousand Kenya shillings, 99.1% had no infection (112 out of 113). On the other hand, of the 23 cases who had a bill of more than KShs. 30,000, eighteen or 78.3% had a post-op wound infection. (Table and Figure 4.2).

Table 4.2 – Cost comparison between infected and non-infected cases

Cost (KShs)	Infected	Not infected	Total	Percentage
<8000	1	112	113	0.89
8000-15000	3	73	76	3.9
15000-20000	13	37	50	26
20000-25000	8	10	18	44
25000-30000	8	4	12	66
>30000	18	5	23	78.3
TOTAL	51	241	292	17.4

Figure 4.2 – Infection versus cost



4.3 LABORATORY EVALUATION OF INFECTION

This entailed reviewing patient files at the end of the study to see how many of the cases with clinical wound infection, as defined by a purulent discharge, actually had a laboratory report on the microscopy, culture and sensitivity. This was to evaluate the practice of seeking microbiological lab evidence. Of the 51 infections, only 6 cases had a microbiology laboratory report. Hence, there was no such report in 88.2% of cases with wound infection. Of the 6 reported cases, four were from dirty wounds, and one each from a clean and a clean-contaminated wound. All six reported cases had abdominal surgery, which can explain the type of microbial flora cultured, as shown in Table 4.3.

Table 4.3 – Microbiology of six infected wounds

Escherichia coli	3
Klebsiella spp	2
Proteus mirabilis	2
No growth obtained	1

Note that 2 of the 6 cases had mixed infection with more than one bacterial species.

DISCUSSION

Post-operative wound infections remain an important cause of concern in any surgical unit, as they largely reflect the quality of care given to the surgical patient. Hence, a prospective study was carried out at the Kenyatta National Hospital, the national referral and University of Nairobi teaching hospital, to assess post-operative wound infections after a gap of more than fifteen years. This study had a sample size of 292, which was larger than the two previous studies done at KNH [9,10]. The three main variables studied were endogenous contamination, exogenous contamination and patient factors.

This study reports an improvement in the clean wound infection rate of KNH, which was found to be 3.1%. Previous studies reported rates of 12% in 1987 and 16.5% in 1981[9,10]. This could possibly be a reflection of the improvement in the services accorded to patients seeking surgical treatment at KNH. A recent study by Nyabanda on 'The value of single dose flucloxacillin in clean major surgical operations' at KNH in 2002 revealed a clean-wound infection rate of 1.6% without prophylaxis [59]. This also re-emphasizes the trend of improvement as noted in this study.

The 1967 Foothills study by Peter Cruse[4, 11], however, gave a clean-wound infection rate of 1.4%. However, comparison with other developing countries in Africa reveals rates ranging from 3.53% in Tunisia to 21% in Ethiopia [23,24].

The overall wound infection rate of KNH has also improved in comparison to the two previous studies. This study yielded an overall infection rate of 17.4%, compared to 25% in Jani's study and 45.4% in Masiira-Mukasa's study [9,10]. The Foothills study had an overall infection rate of 4.4% [4]. However, the overall wound infection rate can vary dramatically from place to place, depending on the predominant type of surgery being

done. Hence, a unit that deals predominantly with thyroid surgery may have a lower overall wound infection rate than one that deals more with bowel surgery. Thus, the overall wound infection rate is inferior to the clean wound infection rate in determining the quality of care.

In this study, no significant difference was found in the clean wound infection rates of the three general surgical firms. There was also no difference in the overall wound infection rates between the three wards or firms. The most important finding in the endogenous contamination variable was that, irrespective of the unit, the infection rate was highly predictable from the level of endogenous contamination, with significant differences between infection rates yielded from clean, clean contaminated, contaminated and dirty wounds (p-value<0.001). This is indeed consistent across the globe, hence indicating that endogenous contamination of the wound is the single-most important determinant of wound infection [4].

There were many sub-variables in the exogenous contamination variables. As seen with other studies, there was a direct relationship between occurrence of wound infection and duration of pre-operative hospital stay. Hence, the longer the patient stays in hospital before an operation, the greater the likelihood of getting wound infection. This can be explained by the risk of acquiring nosocomial infection before surgery. It is also likely that a patient staying in a hospital environment for a long time before surgery may be depressed, and may not feed well. This in turn may lead to lowered immunity.

There was also a significant difference in rates between emergency and elective surgeries. This can be explained partly by the fact that emergency surgeries are carried out on a physiologically unstable and often ill-prepared patient. Also, emergencies tend to

fall more in the contaminated and dirty group. The other possible reason is that most emergencies are done by less-experienced surgeons, usually the senior house officers.

There was no difference noted in rates according to the time of day or night when the emergency was done. In fact, the rate was actually slightly lower between 12 midnight and 8 am, possibly due to the fact that there were fewer people inside the theatre at that time. Also, there was no difference between rates in different emergency or elective theatres. However, there was a difference in rates in relation to the number of people. If there were less than 5 people, the rate was significantly lower than if there were more than 5 (p-value 0.002). This may be because the less the people, the less the talk and dispersion of particles, and hence the greater the margin of safety. However, there was no difference if there were between 5-10 or more than 10 people. In any teaching institution, it may be difficult to reduce the number of people inside the theatre.

The subjective assessment of the theatre temperature was a crude way of assessing the ambience. By asking the surgeon of his feeling of hotness or coolness, there may be a margin of error due to differences in personal thresholds and perceptions. A better way would be to have room thermometers in each theatre, especially if the air-conditioning is not functional, as is the case quite often. However, the surgeon's personal feeling of hotness reflected his state of comfort during the surgery. It is a known fact that an uncomfortable surgeon perspiring heavily is more prone to making error [46]. This could explain the significant difference in infection rates between surgeons who felt hot versus those who were comfortable or cool (p-value <0.001).

Pre-operative shaving again confirmed findings of most other studies [6,39,40]. A significant increase in infection rate was noted if the site was shaved in the ward, compared to if it was shaved on the operating table (p-value 0.02). This is because

bacteria get time to colonize and multiply in the serum oozing from the razor nicks, if shaved in the ward. However, there was no difference in the rates of infection between those shaved in theatre versus those not shaved at all. Contrary to traditional practice, and in line with current evidence, this study failed to show any difference in rates between use of one blade or two blades to make an incision [4,11,26]. It is also known that diathermy use in incisions does not alter infection rates either.

The infection rates of different levels of surgeons were compared. It was no surprise that the consultants, who have far more experience, had the lowest infection rates. The rates between registrars and SHOs were similar. There is a direct relation between the length of an operation and the infection rate [3,50]. This was also true in this study, with significant differences with increasing duration (p-value <0.001). This is due to increase in bacterial contamination with time. There is also more tissue damage with prolonged time, by dessication or directly.

There was a trend noted of increasing infection with advancing age of the patient, but this was not significant. In this day and age, HIV infection amongst the younger age group may actually contribute to a falling age with infections. It has also been observed that cancers are now occurring in younger people more than they used to. Aging itself contributes to the weakening of the body's immune and other systems. Strangely, this study had a significant difference in infection rates between males and females. Studies elsewhere have not shown any such difference[4].

A low haemoglobin or subjective assessment of pallor significantly increased infection rates, as did raised urea / creatinine and dehydration. This is because of an altered state of physiology in the patient host factors, which in turn affects the general and local defences. It was interesting to note that not all patients had a Hb or UEC result

before surgery, despite the presence of an emergency lab as well as an ICU lab. Shock is known to cause higher infection rates, but failed to do so in this study, because of the relatively fewer numbers of patients in shock. Presence of fever before an operation significantly increased wound infection, and this may be an indication of presence of infection before surgery.

The nutritional status of the patient was assessed crudely, by a subjective clinical assessment. Ideally, weight and height should have been taken, as well other indices such as mean arm circumference or skin caliper triceps fold thickness. This was a limitation in a single-researcher study. However, good clinical methods as are taught can be fairly accurate in deciding a wasted or overweight patient from normal. There was a significant increase in infection rates in malnourished cases. This also reflects the protein imbalance and general state of compromised immunity.

The presence of comorbidities yielded a significant increase in infection, notably malignancy, followed by HIV infection. There was only one known diabetic. All these are well known entities, which again influence the general host immunity. Blood transfusions are also known to lower the immunity, and hence accounted for a significant increase over those who were not transfused (p-value <0.001). Besides blood transfusion is required in a patient who is either anaemic or in haemorrhagic shock. In both instances, the host physiology is altered, thus making the patient more prone to infection. However, when blood is needed for volume restoration, its role remains a priority.

The anatomical site also reported significant differences in wound infection. The head and neck had the lowest rate of infection, despite many dirty traumatic wounds. This is because of the good vascularity of these areas. The abdomen had the highest rate in this study. This is because of the bacteria incriminated in this site, mainly gut flora. The local

wound factors included factors such as use of drains. It was quite evident that the improvised vacuum drain had the least infection rate, followed by the closed tube rain. The corrugated drain had a significant increase in post-operative wound infection, as has been the case in other studies [4,58].

This study also highlighted the tremendous amount of antibiotic abuse going on in the surgical wards. Clean wounds were subject to full five or seven day courses post-operatively. This added to the expenditure as well as risk of side effects, whereas it was totally unnecessary. The same scenario was seen with clean-contaminated cases, where prophylaxis would otherwise suffice. In the dirty and contaminated groups, where antibiotics are indicated, the drugs were being started postoperatively. It is a well-known fact that antibiotics given at induction will achieve optimal concentrations at the time of starting surgery, when they would work better. These problems could be due to two reasons: first, a lack of proper antibiotic guidelines or protocols, and secondly, the unavailability of these vital resources within the precincts of the operating theatres. There was also a highlight on the practice, or lack of it, in swabbing all clinically infected wounds. Only eleven percent of infected wounds actually had a microbiology report.

The effect of post-operative wound infections on hospital stay, morbidity and suffering as well as the financial burden is indeed phenomenal, as evidenced by this study, and supported by other studies [27,28,29,30]. At a time when we, as a nation and people, are struggling to revive an ailing economy and health sector, it should become an important responsibility of every surgeon to try and prevent surgical wound infections in his work place. This can be done by adhering to time-honoured principles of surgery, such as ensuring absolute sterility, gentle tissue handling, meticulous haemostasis, and proper patient workup amongst others, and by putting these principles into practice.

CONCLUSION:

- Endogenous contamination of the wound is the single-most important factor in causation of post-operative wound infection.
- The clean-wound infection rate for KNH is 3.1 per cent, which is a marked improvement from previous studies.
- The overall wound infection rate is not as important as the clean-wound infection rate. For KNH, it is 17.4 per cent, and this is also better than past rates.
- Exogenous contamination also has a role to play in wound infections, especially prolonged pre-operative hospitalization, shaving of the operation site in the ward, longer duration of surgery, use of open drains, more people inside theatre, and emergency operations, which all have a significant increase in post-operative infections.
- There is no significant difference noted in infection rates between individual firms, theatres, level of surgeon, numbers of blades used, or time of emergency.
- Patient factors such as age, comorbidities including malignancy and HIV, nutritional status, low haemoglobin, high urea, dehydration, fever and blood transfusion are associated with an increase in the incidence of wound infections.
- There is rampant abuse of antibiotics, especially for clean and clean-contaminated wounds. The timing of giving the antibiotics in other cases is also inappropriate.
- There is very little microbiology laboratory assessment of infected wounds.
- Post-operative wound infections cause great suffering to patients, prolonged stay in hospital, and increase in hospital bills, thus taking a toll on health services and the economy.

RECOMMENDATIONS:

- Post-operative wound infections should be monitored on a continuous basis. by way of an on-going surveillance.
- Further improvement of the clean-wound infection rate is recommended, by minimizing factors implicated in exogenous contamination.
- Pre-operative stay should remain as short as possible.
- Shaving of the operation site must not be done in the wards. but on the operating table
- The initial blade used for skin incision can be safely re-used for deepening the incision.
- The use of corrugated rubber or any open drains is to be discouraged.
- Training of junior surgeons and SHOs should be further enhanced by organizing CME workshops on basic surgical skills and infection control.
- Where possible, the duration of the operation should be reduced, by ensuring that all necessary instruments and theatre machinery are available and working.
- All surgical patients going to theatre should have a haemoglobin and UEC report, preferably right from Casualty, and dehydration or anaemia should be corrected.
- Blood transfusion should be avoided, unless absolutely necessary.
- For elective cases, malnutrition should be treated before surgery.
- Formal antibiotic guidelines on prophylaxis are needed for KNH, with special emphasis on clean and clean-contaminated wounds.
- There should be a basic stock of antibiotics within theatres.
- All wounds which discharge pus should be swabbed for microbiological assay.

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APPENDIX I

DATA COLLECTION SHEET SAMPLE

Personal details:

Name: _____ IP No.: _____

Age: _____ Date of birth: _____ Sex: M / F (circle)

Date of admission: _____ Ward: _____

Date of operation: _____ Length of preop stay: _____

Date of discharge/ death: _____ Length of postop stay: _____

Initial diagnosis / impression: _____

Operative diagnosis: _____

Type of Surgery:

Operation: _____

Time started: _____ Time ended: _____ Duration: _____

Elective Surgery: ☐

Emergency Surgery: ☐ Non-trauma - ☐

Trauma - ☐ Penetrating / Blunt (circle)

Hours since open trauma - < 4 hrs ☐ > 4 hrs ☐

Time of day/ night – 8am-4pm / 4pm-12am / 12am-8am

Any break in sterile technique? YES / NO. Was it minor or major? (delete)

Was GIT / UGT / Resp tract entered during surgery? YES / NO (delete)

Was there a significant spillage of hollow viscus contents? YES / NO (delete)

Any pus encountered? YES / NO. Any perforated viscus found? YES / NO (delete)

CLEAN ☐ CLEAN-CONTAMINATED ☐ CONTAMINATED ☐ DIRTY☐

Patient variables:

Haemoglobin _____ PCV _____ Subjective assessment PALE: YES / NO

Urea _____ Na+ _____K+_____ Subjective " DEHYDRATED: YES / NO

Pulse _____ BP _____ Temp _____ Assessment SHOCK: YES / NO

Nutritional build: WASTED / NORMAL / OBESE (delete)

Comorbidities: MALIGNANCY: YES / NO / don't know

DIABETES: YES / NO / don't know (FBS/ RBS ___)

HIV: YES / NO / don't know

OTHERS: _____(specify)

Blood Transfusions: PREOP _____ units

INTRAOP _____ units

POSTOP _____ units

Smoker: YES / NO Alcoholic: YES / NO ASA GRADE: _____

Operating Room Variable:

Main theatre: ☐ / Trauma theatre: ☐ (tick one).

Specific theatre: 1 / 2 / 3 / 6 / 8 / other ___ (main); 1 / 2 (trauma) (circle)

Number of people (including transients) <5 ☐ 5-10 ☐ >10☐

Previous case: Clean / Clean-contaminated / Contaminated / Dirty (circle)

Was theatre cleaned prior to present case? YES / NO

Any communication with outside (open door)? YES / NO

Was the temperature HOT / COMFORTABLE / COOL? (delete)

Surgeon variable:

Level of main surgeon – CONSULTANT / SNR REGISTRAR / SHO (delete)

Who closed the wound? CONSULTANT / SNR REGISTRAR / SHO (delete)

Hand scrub – SOAP / SOLUTION (delete)

Patient skin prep:

Was site shaved? YES / NO (delete). Where was shaving done? WARD / THEATRE

Skin prep? SCRUBBED – YES / NO (delete)

SAVLON / POV.IODINE ☐

POV.IODINE + SPIRIT ☐

Local wound factors:

Site of incision _____ Length of incision _____

Number of blades used: 1 / 2 (circle) Diathermy used in incision? YES / NO

Drain left in situ? YES / NO Which type? _____

Method of wound closure? _____

Suture type used? _____

Drugs variable:

Antibiotics: YES / NO Type _____

Dose _____

Route _____

Duration _____

Preop _____ Introp _____ Postop _____

Other Drugs: Steroids / Chemotherapy

OUTCOME:

Clinical Inspection of wound

Day:	Infected:	Possibly Infected:	Not Infected:
03	_____	_____	_____
05	_____	_____	_____
07	_____	_____	_____
10	_____	_____	_____
SOPC____	_____	_____	_____

Microbiology of purulent discharge_____

Postoperative stay _____

Any other information _____ _____

APPENDIX II

INFORMED CONSENT FORM

I / parent / guardian of (delete as applicable) _____

of _____ hereby consent to participate in the research study on POST-OPERATIVE WOUND INFECTIONS AT KNH, by Dr _____.

I have been explained to the nature and importance of the study by the aforementioned researcher. I also understand that participation in this study will not affect my treatment in any way whatsoever. It is within my rights to refuse to participate in or to withdraw from the study if I so wish. I also understand that any information about myself / my child / my protégé/e (delete as applicable) will be treated in the strictest confidence.

Signed _____ Date _____

I confirm that I have clearly explained to the patient the nature of this study and the contents of this consent form.

Signed _____ Date _____

Dr Jaimin R. Bhatt

P.O.Box 40374, Nairobi, 00100

Tel : 2726300 ext 43773

APPENDIX III

PATIENT INFORMATION FORM

- This is a study evaluating POST-OPERATIVE WOUND INFECTIONS at KNH.
- You will only be enrolled for this study after giving your informed consent.
- You are not obliged to enroll for this study.
- By enrolling onto this study, you will be asked a few questions by the researcher.
- The rest of the data will be provided by the medical staff looking after you.
- The researcher will visit you regularly after your surgery and inspect your operation wound for any signs of infection.
- This could benefit you directly by being under closer extra surveillance by the researcher.
- This study will have important benefits on the quality of service provided to the patients seeking surgical care at KNH, by trying to address issues which may have a bearing to the causation of wound infections.
- This study will not affect your treatment in any deleterious way whatsoever.
- You will not be subject to any extra tests by the researcher. Whatever will be done will be at the discretion of the doctors of the ward under whose care you are.
- It is within your rights to refuse to participate in or to withdraw from the study if and when you wish.
- All information gathered in this study will be treated in the strictest confidence.
- Thank you for your time.

KENYATTA NATIONAL HOSPITAL
Hospital Rd. along, Ngong Rd.
P.O. Box 20723, Nairobi.

Tel: 726300-9
Fax: 725272
Telegrams: "MEDSUP", Nairobi
Email: KNHplan@Ken.Healthnet.org

Ref: KNH-ERC/01/1716

Date: 13 March 2003

Dr. Jaimin R. Bhatt
Dept. of Surgery
Faculty of Medicine
University of Nairobi

Dear Dr. Bhatt,

RESEARCH PROPOSAL "EARLY POST-OPERATIVE WOUND INFECTIONS AT THE KENYATTA NATIONAL HOSPITAL: A PROSPECTIVE STUDY" (P141/12/2002)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** the revised version of your above cited research proposal.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely,

PROF. A.N. GUANTAI
SECRETARY, KNH-ERC

cc Prof. K.M. Bhatt, Chairperson, KNH-ERC
The Deputy Director (C/S), KNH
The Dean, Faculty of Medicine, UON
The Chairman, Dept. of Surgery, UON
CMRO
Supervisor: Prof. Pankaj G. Jani, Dept. of Surgery, UON