INTRAVENOUS LINE TIP CULTURES AND BACTERAEMIA IN THE INTENSIVE CARE UNIT OF THE UNIVERSITY COLLEGE HOSPITAL, IBADAN

BY

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November 2009
DECLARATION

I hereby declare that this work is original. It has not been presented to any journal or any other examining body for award of a fellowship.

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MBBS (Ilorin), DA (Lagos)
CERTIFICATION

We certify that this work was done by Dr Adebayo A.A. at the University College Hospital, Ibadan. We have supervised the writing of this dissertation.

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DEDICATION

All praise is due to the ALMIGHTY who has guarded and guided me thus far. This work is dedicated to the loving memory of my father Alh. MT Adebayo (late), and my mother, Shola, Sunmbo, Zaynab, M'mad, U'khayr and Azeezah.
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SUMMARY

Patients in the intensive care unit (ICU) often require the insertion of various invasive devices such as peripheral venous lines, urinary catheters and tracheal tubes for monitoring and or therapy. These devices predispose them to a high risk of acquiring nosocomial infection.

The aim of this prospective study was to determine the microbial pattern and antibiotic sensitivity of agents causing colonization of intravenous (IV) line and bacteraemia in ICU patients.

This prospective observational study was conducted in the ICU of the University College Hospital (UCH) Ibadan, which is a 5-bedded unit. All patients admitted into the ICU over a 4-month period, from June to September 2004 were included in the study.

Intravenous lines once discontinued had their tips cut using a non-touch technique. Line tip culture was based on the Maki semi-quantitative roll technique. The tip was rolled onto 5% Blood agar and MacConkey plates using sterile forceps. Colony counts was performed after overnight incubation in 5% carbon dioxide (CO₂) at 37°C. Plates with no apparent growth were re-examined at 48 hours and 72 hours following further incubation. Results were recorded as positive if colony counts were more than 15; and negative for either no growth or less than 15 colonies. Following skin preparation with 70% alcohol, 5 ml of venous blood was withdrawn aseptically from all patients at a site different from the site of intravenous access, for culture on days one, two and three. Aerobic and anaerobic blood culture sets were incubated and bacterial isolates were identified using standard methods.
A hundred and twenty-one patients admitted during the study period had 242 peripheral intravenous lines. No central line was inserted during the study period. Seventy-three (60.3%) patients had two lines and the most frequent site of insertion was the dorsum of the left hand which accounted for 51 (21.1%) of the lines. Of the 242 peripheral intravenous lines, 175 were discontinued and removed. One hundred and seventy-four of these discontinued peripheral lines were processed. Sixty-five (37.4%) of these processed lines, from 50 patients had bacterial growth, with some patients having growth from more than one line. The bacterial isolates were *Staphylococcus aureus* 23 (35.4%), Klebsiella 17 (26.1%), Pseudomonas 13 (20%), coagulase negative Staphylococcus 7 (10.8%) and mixed growth 5 (7.7%). Among the 121 patients, blood culture was positive in four patients and the same organism (*Staphylococcus aureus*) was isolated from the catheter tip and blood in two and coagulase negative staphylococcus and Klebsiella were isolated from the other two patients. The other invasive devices inserted in these patients were urinary catheters in 108 patients (89.26%), tracheal tubes in 64 patients (52.89%), nasogastric tubes in 47 patients (38.84%), wound drains in 13 patients (10.74%) and chest tubes in 8 patients (6.61%).

This study revealed that bacterial colonisation of peripheral intravenous lines was common in patients admitted into the ICU.

Institution of guidelines for placement and management of intravascular access is desirable. The lines should be inspected daily and dressed as appropriate. Lines no longer in use should be removed and the site dressed. The site of intravenous cannulae and fluid administration sets should be changed every 48 – 72 hours.
CHAPTER ONE

INTRODUCTION

The intensive care unit (ICU) is an area of the hospital where facilities are concentrated for treatment of critically ill patients. The purpose of the ICU is to provide a level of care unattainable in other areas of the hospital for patients who are suffering an acute illness from which they have a realistic chance of recovery. In addition to nursing care, observation and monitoring, the patient may also require mechanical ventilation and cardiovascular support. In some centres separate ICUs exist for specialised fields of medicine such as coronary care, neurosurgery, paediatrics and transplant surgery. However, in the majority of hospitals, a general ICU deals with critically ill patients from various specialties.

Monitoring is essential in the critically ill patient. It assists diagnosis, guides adjustment of therapy and allows early detection of deterioration in the patient’s condition. Monitoring in the ICU can be achieved by the use of invasive, non-invasive or minimally invasive devices. Non-invasive monitoring include: electrocardiography (ECG), non-invasive blood pressure, pulse oximetry, capnography, peripheral temperature monitoring, non-invasive cardiac output monitoring using transthoracic electric bioimpedance, electroencephalography (EEG), transcutaneous O₂ and CO₂ monitoring and transthoracic echocardiography. An invasive procedure is one which requires the insertion of a device into the body through the skin or a body orifice. Invasive monitoring include: Invasive arterial pressure monitoring by arterial cannulation, central venous pressure monitoring, pulmonary artery catheterisation, urine output monitoring after bladder catheterisation, core body temperature monitoring (tympanitic,
midoesophagus), arterial blood gas monitoring and intracranial pressure monitoring. An example of minimally invasive monitoring is transoesophageal echocardiography. The invasive devices encourage colonisation by nosocomial organisms and greatly increase vulnerability to infection.

Intensive care unit patients are particularly susceptible to infection for a number of reasons. The body's natural defences are breached by invasive devices. The immune system may also be depressed by the severity of the patient's illness, and infection may be transmitted from other patients after incubation in items of equipment or by the staff. In addition, antibiotics prescribed for infection caused by relatively susceptible microorganisms may permit superinfection by resistant bacteria.

Nosocomial infections or hospital acquired infections are infections acquired as a result of hospitalisation and are not present or being incubated at the time of admission, or having been acquired in the hospital manifest after hospital discharge. Epidemiologically, any infection manifesting more than 48 hours after admission is considered nosocomial. Nosocomial infections result in increased morbidity and mortality (nosocomial infections and bacteraemia double or triple mortality in critically ill patients), prolonged hospital stay and increased medical expenses. It is estimated that 5% of patients admitted into an acute care hospital in the United State acquire a new infection with more than 2 million nosocomial infections per year and excess cost of $2 billion. Nosocomial infection can prolong hospital stay by 13.3 days. Infection is the most common cause of death, directly or indirectly, in patients who survive major trauma or full-thickness burns and is also the most frequent precipitating events in multiple organ failure.
Intensive care units contribute greatly to the care of patients with life threatening conditions and trauma, but are associated with an increased rate of nosocomial infections \(^{17, 21, 22, 23}\). Hospital acquired or nosocomial infections are among the common and serious complications encountered in the ICU and usually result from monitoring devices and invasive therapies \(^{17, 21, 22, 23}\). The costs of nosocomial infections are great, whether measured in terms of money or in morbidity and mortality. It is therefore appropriate to address measures to control nosocomial infections.

Instituting an infection control team is a cost effective means of controlling nosocomial infection; the implementation of infection control policies can result in considerable cost savings \(^6, 7, 8\). The infection control team, comprises the infection control doctor, the infection control nurse, the administrator and occasionally a medical technician, forms the core of the infection control committee \(^6, 7, 8\). The duty of the team includes surveillance and investigation of infection outbreak; advice and education of members of staff on all aspects of infection control; improving and monitoring the safe practices of patient care; advice on the sterilisation of new clinical equipment, the protection of patient and staff, and the safe handling of clinical waste; as well as advice on planning and building \(^6, 7, 8\).

This prospective project studied the rate of intravenous line infection and bacteraemia, as well as identifying the species of micro-organism involved.
AIMS AND OBJECTIVES

AIM:
The aim of this prospective study was to determine the microbial pattern and antibiotic sensitivity of agents causing colonization of intravenous line and bacteraemia in ICU patients of the University College Hospital, Ibadan.

SPECIFIC OBJECTIVES:
The specific objectives were to determine the following:

a. the average number of intravenous line(s) and other invasive devices such as tracheal tubes, urethral catheter and wound drains in patients on admission in the ICU of the University College Hospital, Ibadan.

b. the rate of intravenous line infection.

c. the microbiologic isolates from the catheter tips.

d. the microbiologic isolates from blood.

e. the antibiotic sensitivity of the isolates.
CHAPTER TWO

REVIEW OF LITERATURE

Nosocomial Bacteraemia

Nosocomial infection complicates the course of at least 40% of patients admitted into the ICU and usually results from monitoring and life support devices. It has been estimated that each year approximately 200,000 hospitalized patients develop nosocomial bacteraemia in the USA out of which 75,000 die. These infections portend 850 million dollars in added cost and extra length of stay in survivors.

In a study carried out on paediatric patients at the Lagos University Teaching Hospital, Lagos, Nigeria, nosocomial infection resulted in mean extra length of stay of between 5.58 and 13.37 days depending on site of infection. It also resulted in 8,696 dollars of extra total cost of antibiotic therapy for the 310 infected patients with hospital acquired infection.

Approximately 30% of nosocomial bacteraemia are related to the use of intravascular devices. The remainder are the result of infection acquired through other routes e.g. secondary to nosocomial pneumonia or abdominal sepsis.

The most common site of introduction of infection, when the integrity of the vascular system is breached by cannulae, is the area of skin puncture. Contamination from this site is with the patient’s own flora, such as Staphylococcus epidermidis, diphtheroids and some anaerobic organisms. Although Staphylococcus epidermidis is often thought of as a benign organism, it now appears to be a major pathogen.
The skin of patients who have been hospitalized for some days and of those who have received antibiotics therapy is often colonized with more virulent bacteria. The hands of medical staff and nurses are often contaminated with *Staphylococcus aureus* and Gram-negative bacilli\(^1\), and they may spread infection during insertion of the cannulae or subsequent dressing of the site. Other common sites of infection transmission by health care workers include the skin, hair, nose, and mouth\(^33\).

External signs of infection (erythema, swelling or pus) are present in less than 50% of subsequently proven catheter-related infections, and the diagnosis is made often by process of exclusion when no other source of bacteraemia is found\(^1\). Maki et al, described a semi-quantitative culture technique which is claimed to identify if the catheter is the source of infection\(^34\). In the microbiology laboratory, the cut tip of the catheter is rolled back and forth over the surface of 5% blood agar four or five times using sterile forceps. It is then incubated aerobically at 37\(^\circ\)C for at least 72 hours and inspected daily for microbial growth. Anaerobic cultures are not necessary. A positive culture is defined as 15 or more colonies. Many positive catheter cultures have a confluent growth\(^34\). This semi-quantitative culture technique is virtually 100% sensitive and about 30% specific for catheter-related bacteraemia\(^24, 35\).

Other suggested techniques for diagnosing catheter related infection include, direct Gram staining of catheter segments for rapid morphological diagnosis\(^27\), flushing or sonication in liquid media, or vortex of the tip in sterile water followed by quantitative culture\(^36, 37, 38\). Intravascular catheter infection can involve all types of catheters, that is, peripheral venous, central venous, pulmonary arterial catheters and arterial lines.
Peripheral Venous Catheters

Intensive care patients get at least one peripheral line \(^{24}\). Plastic cannulae are associated with a higher incidence of infection than steel scalp vein needles, because it is easier to maintain plastic cannulae in place for a longer period \(^{39}\). Infection is more likely with catheters placed distally (hands versus arms), in the lower limbs, and by cut-down. Risk factors include colonization of the skin, hub contamination, moisture under the dressing, and prolonged catheterisation. Incidence of infection is reduced to less than 5% if peripheral lines are changed every 72 hours and lowest rates observed when intravenous therapy teams inspect the insertion site daily \(^{39}\).

Central Venous Catheters

Central venous catheters are inserted for patient monitoring, fluid, blood product and medication therapy, and for obtaining blood specimen. Because central catheters require skill for insertion, they frequently stay longer than peripheral intravenous ones. The longer the device is left in place, the higher the risk of infection \(^{39}\). There is an increased risk of catheter colonization in the presence of distal infection, bacteraemia, or tracheostomy \(^{39,40}\). The presence of the traditional central venous pressure (CVP) manometer and manipulation of the catheter for blood sampling, intermittent medication, or flushing may increase the risk of contamination \(^{24,29}\).

Peripherally inserted central venous catheters (PICC, long lines) and tunnelled silicone catheters, which are other options of access to the central veins, have a lower infection rate compared to centrally inserted central venous catheters; they can also be used in the ambulatory or home care setting \(^{41,42}\).
Tunnelled silicone catheters such as Hickman, Broviac and Groshung catheters, were developed to reduce the risk of infection while allowing long term central catheterisation for intravenous therapy inside and outside of hospitals. The technique allows the catheter to travel under the skin for 1 to 2 inches before entering the thoracic cavity, the catheter exits in an area conveniently reachable by the patient so that they can provide catheter site care. Tunnelled silicone catheters can be inserted percutaneously or by cut-down, the procedure is done in the operating room and under guidance of fluoroscopy, which makes it expensive and time consuming. These catheters are well tolerated by patients, and can be used for fluid resuscitation; however, CVP monitoring cannot be done with these catheters.

Technology advancement has provided safer and less traumatic catheter insertion methods and materials that are better tolerated in the peripheral venous system. Combined with cost containment issues and expansion of the role of the qualified paramedical personnel, there has been increasing use of PICC. The catheters are made of silicone, polyurethene, or elastomeric hydrogel. They are available in both single and double lumen varieties with dual port infusion and range in gauges from 16 to 23. A flexible, blunt-tipped stylet or guidewire is usually provided to help insertion. The catheter can be inserted by the Seldinger’s technique, through a peel away sheet or by the catheter-over-needle technique. Veins below, at or above the antecubital space, including cephalic, basilic, medial cephalic and medial basilic veins, are used for venipuncture and insertion of PICC. Peripherally inserted central lines are easier to insert compared with other central lines, can be in use for weeks or months, have low infection and other complication rates, are well tolerated by
patients and are useful in the ambulatory setting. Peripherally inserted central lines should, however, not be used for CVP monitoring or fluid resuscitation \(^{41,42}\).

**Total Parenteral Nutrition (TPN)**

Several aspects of total parenteral nutrition make it special. During TPN, central venous catheters become readily colonized, even when these lines are dedicated to TPN solely. The reasons include the composition of the infusate which supports the growth of different micro-organisms especially Candida species \(^{43}\). In addition, TPN catheters stay for a longer period of time than either the peripheral or central venous catheter. Also, the hypertonicity of the infusates tends to cause thrombosis, which may increase the risk of infection. Because patients who require TPN are frequently severely ill, debilitated and have a reduced cellular immunity and many have infection prior to insertion of catheter, the risk for bacteraemia is higher \(^{24,29}\). A ten-fold decrease in infection is seen when there is a TPN monitoring team \(^{44}\).

The risk of infection is increased if the integrity of the delivery system is interrupted and for these reasons the Centres for Diseases Control have recommended that the administration of TPN be done by a TPN team \(^{45}\).

**Pulmonary Artery Catheters**

The use of indwelling balloon-tipped pulmonary artery catheter \(^{46}\) has revolutionised the management of haemodynamically unstable, critically ill patients \(^{24,29}\). Such a catheter is passed through one of the great veins, across the tricuspid and pulmonary valves, and into the pulmonary vasculature. They are not routinely changed and are usually in place for several days. Duration of catheterisation greater than 72 hours and the frequent repositioning of the lines produce bacteraemia \(^{29,47}\). There is
anassociation between right-sided endocarditis and pulmonary artery catheterisation, presumably from trauma\textsuperscript{48-51}.

**Arterial Lines**

The main indications for arterial cannulation in the ICU are for continuous direct arterial pressure assessment, for arterial access for repeated blood sampling including arterial blood gasses (ABG) and for assessment of cardiac contractility by visualisation of the upstroke of the pressure tracing. Arterial cannulation can be achieved by surgical cut-down or percutaneous insertion\textsuperscript{4, 5, 12, 41, 42}. The latter method is usually preferred because of a threefold to eightfold lower risk of infection\textsuperscript{52, 53}. In patients with weak or nonpalpable pulse, the radial artery or dorsalis pedis can be cannulated by cut-down\textsuperscript{4, 5, 12, 41, 42}.

The predominant determinants of infection risk are: percutaneous versus cut-down insertion and extended arterial cannulation times. The risk of infection is high with duration of insertion greater than 96 hours; the risk for percutaneous site less 96 hours is almost non-existent\textsuperscript{52, 53}. Incidence and aetiology of infection also depends on the type of ICU. Postoperative cardiac units have lower infection rates than other ICUs presumably because patients are healthier and are exposed to fewer antibiotics\textsuperscript{54, 55}. 
CHAPTER THREE

MATERIALS AND METHODS

This study was conducted in the Intensive Care Unit of the University College Hospital Ibadan, which is a 5-bedded general intensive care unit serving 840 acute beds in the tertiary health facility. All patients admitted over a 4-month period, from June to September 2004, were included in the study.

After obtaining approval from the hospital ethics committee and informed written consent from the patients or relations, peripheral intravenous lines once discontinued had their tips cut using a non-touch technique and transported to the medical microbiology laboratory in sterile universal bottles. Details of the intravenous lines including time of placement and duration, anatomic location, indication for placement, technique of placement and indication for discontinuation were recorded on the data collection form (appendix 1).

Line tip culture was based on the Maki semi-quantitative roll technique. The tip was rolled onto 5% Blood agar and MacConkey plates using sterile forceps. Colony counts was performed after overnight incubation in 5% carbon dioxide (CO₂) at 37° C. Plates with no apparent growth were re-examined at 48 hours and 72 hours following further incubation. Results were recorded as positive if colony counts were more than 15; and negative for either no growth or less than 15 colonies.

Following skin preparation with 70% alcohol, 5 ml of venous blood was withdrawn aseptically from all patients at a site different from the site of intravenous access, for culture on days one, two and three. Aerobic and anaerobic blood culture
sets were incubated and bacterial isolates were identified using standard methods. These methods included: daily inspection, sub culturing on blood agar plates when growths were apparent and staining techniques. Sensitivity testing was carried out on all isolates.

Demographic data, diagnosis, date of admission, presence of other invasive devices such as tracheal tubes and urinary catheters, vital signs (range), dates of collection of line tip and blood specimens and information regarding antibiotic therapy (names) were collected using the data collection form shown in appendix 1.
RESULTS

One hundred and twenty one patients were admitted into ICU over a 4-month period, between 1st of June and 30th of September 2004. The distribution of patients by age, gender and admitting subspecialty is as shown in the figures 1, 2 and 3 respectively. The age range of patients admitted was 1 to 72 years (mean 33.5 years±18.97). Male patients were 66 (54.54%) and the age range 21-30 years were the most commonly admitted group of patients. Neurosurgical admissions with 37 (30.58%) had the highest frequency; these were patients with severe traumatic brain injury and post craniotomies. Maxillofacial admission was one (0.83%). Polytraumatised patients excluding those with head trauma were grouped together as trauma and were eight (6%).

The patients had 242 peripheral intravenous lines. All the intravenous lines inserted during the study period were peripheral lines. Figure 4 shows the number of lines per patient: thirty-one patients had 1 line each, 73 patients had 2 lines each, 9 patients had 3 lines each, 4 patients had 4 lines each, 3 patients had 5 lines each, while 1 patient, who was on admission for 31 days, had 7 lines. The most common site of insertion of intravenous lines was the dorsum of the left hand which accounted for 51 (21.1%) of the lines as shown in figure 5. Percutaneous insertion was the most common technique of insertion as shown in figure 6. During the study period, 54 patients died; the remaining 67 patients were discharged to the wards with one functional peripheral intravenous line each. Figure 7 shows the length of stay of patients in the ICU. Out of the 242 peripheral intravenous lines, discharged patients were transferred to the wards with 67 peripheral intravenous lines, which were, however, not followed up. Figure 8
shows the indications for discontinuation of the remaining 175 lines; 30 lines were electively removed, to allow catheter tip samples accompany collected blood samples, in patients in whom there was no other indication for discontinuation of intravenous access. Figure 9 shows the duration of insertion of the peripheral intravenous lines. One hundred and seventy four lines of the discontinued 175 were processed; one line was discontinued and discarded before the arrival of the principal investigator. Sixty-five (37.4%) of the processed lines, from 50 patients, had bacterial growths: thirty-five patients had growth from one line; fourteen patients had growth from 2 lines; while one patient had growth from 3 lines. Figures 10, 11 and 12 show the duration of insertion, indication for removal, and length of hospital stay in patients with positive and negative catheter tip cultures. The bacterial isolates were \textit{Staphylococcus aureus} 23 (35.4%), Klebsiella 17 (26.1%), Pseudomonas 13 (20%), coagulase negative \textit{Staphylococcus} 7 (10.8%) and mixed growth 5 (7.7%). These are shown in table 1. Among the 121 patients, blood culture was positive in four (3.3%) patients and the same organism (\textit{Staphylococcus aureus}) was isolated from the catheter tip and blood in two of the patients. In the remaining two patients, the isolates were coagulase negative staphylococcus and Klebsiella. The bacterial isolates from the catheter tip and blood cultures had similar antibiotic sensitivity pattern. Table 2 shows these antibiotic sensitivity pattern of these bacterial isolates. The \textit{Staphylococcus sp.} were mainly sensitive to cloxacillin, and moderately to pefloxacin but were resistant to gentamicin, cotrimoxazole, tetracycline, erythromycin and chloramphenicol. The Klebsiella were sensitive to ofloxacin and perfoxacin but resistant to tetracycline, augmentin and
cotrimoxazole. The Pseudomonas were sensitive to gentamycin, pefloxacin but resistant to tetracycline, cotrimoxazole and amoxicillin.

During the study period, other invasive devices were inserted in the patients. The commonest were urinary catheters which were inserted in 108 patients (89.26%), followed by tracheal tubes inserted in 64 patients (52.89%), then nasogastric tubes were inserted in 47 patients (38.84%). Thirteen patients (10.74%) had wound drains inserted in them, while chest tubes were inserted in 8 patients (6.61%). Eight of these intubated patients had tracheostomy performed on them on account of prolonged intubation. Figure 13 shows the various invasive devices in these patients. Sixty-eight patients had at least an episode of pyrexia in the first 72 hours of admission. One hundred and eight patients were on antibiotic therapy during the course of admission. The main antibiotic regimens were a third generation cephalosporin alone in 36 patients (33.33%), a third generation cephalosporin with metronidazole in 28 patients (25.93%) or ciprofloxacin with metronidazole in 28 patients (25.93%); this is shown in table 3.
Figure 1

Age distribution of patients

Age range (years)

Number of patients

1 - 10 years: 19
11-20 years: 7
21-30 years: 33
31-40 years: 20
41-50 years: 20
51-60 years: 10
61-70 years: 10
71-80 years: 2

80 years and above: 2
Figure 2

Gender distribution of patients

55 (45%) male
66 (55%) female
Figure 3

Patient distribution by subspecialty

MFU: Maxillofacial unit, Paed. Surgery: Paediatric Surgery Unit, ENT: Ear, Nose and Throat Unit, Obgyn: Obstetric and Gynaecology Unit, Gen. Surgery: General Surgery Unit.
Figure 4

Number of lines per patient

Number of lines

Number of patients

1 2 3 4 5 6 7

31
73
9
4 3
1
0
10
20
30
40
50
60
70
80

1 2 3 4 5 6 7

Number of lines

Number of patients
Figure 5

Site of insertion of peripheral IV lines

<table>
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<tr>
<th>Site</th>
<th>Number of lines</th>
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<td>scalp</td>
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<td>right foot</td>
<td>12</td>
</tr>
<tr>
<td>right antecubital fossa</td>
<td>18</td>
</tr>
<tr>
<td>left antecubital fossa</td>
<td>20</td>
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<tr>
<td>right hand</td>
<td>38</td>
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<tr>
<td>right arm</td>
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</tr>
<tr>
<td>left arm</td>
<td>48</td>
</tr>
<tr>
<td>left hand</td>
<td>51</td>
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</table>
Figure 6

Technique of insertion of peripheral IV lines

233 (96%)

9 (4%)

Percutaneous
Cut down
Figure 7

Length of stay of patients in the ICU
Figure 8

Indications for removal of peripheral IV lines

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<th>Indications</th>
<th>Number of lines</th>
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<tr>
<td>Blocked</td>
<td>66</td>
</tr>
<tr>
<td>Died</td>
<td>62</td>
</tr>
<tr>
<td>No longer needed</td>
<td>17</td>
</tr>
<tr>
<td>Electively removed</td>
<td>30</td>
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</table>
Figure 9

Duration of insertion of peripheral IV lines

- Duration (days):
  - 1: 27
  - 2: 40
  - 3: 43
  - 4: 43
  - 5: 11
  - 6: 15
  - 7: 11
  - 8: 1
  - 9: 1
  - 10: 1
  - 11: 1

- Number of lines:
  - Duration (days):
    - 1: 27
    - 2: 40
    - 3: 43
    - 4: 43
    - 5: 11
    - 6: 15
    - 7: 11
    - 8: 1
    - 9: 1
    - 10: 1
    - 11: 1
Figure 10

Duration of insertion of positive and negative lines

The bar chart shows the duration of insertion (in days) and the number of positive and negative lines. The x-axis represents the duration of insertion, ranging from 1 to 11 days. The y-axis represents the number of lines, with values ranging from 0 to 50.

- The bars are color-coded to distinguish between positive and negative lines. Blue bars represent negative lines, and red bars represent positive lines.

The chart indicates the following:
- For a duration of 1 day, there are 27 negative lines and 0 positive lines.
- For a duration of 2 days, there are 35 negative lines and 5 positive lines.
- For a duration of 3 days, there are 30 negative lines and 13 positive lines.
- For a duration of 4 days, there are 17 negative lines and 8 positive lines.
- For a duration of 5 days, there are 7 negative lines and 4 positive lines.
- For a duration of 6 days, there are 5 negative lines and 5 positive lines.
- For a duration of 7 days, there are 10 negative lines and 10 positive lines.
- For durations of 8, 9, 10, and 11 days, the number of lines is very low, with 0, 3, 2, and 1 lines, respectively.
Figure 11

Catheter tip culture and indications for removal of peripheral IV lines

- Blocked: 38
- Died: 22
- No longer needed: 17
- Electively removed: 5

Number of lines

- Negative
- Positive
Figure 12

Duration of hospital stay in patients with positive and negative catheter tip culture

![Bar graph showing the duration of hospital stay in patients with positive and negative catheter tip culture. The x-axis represents the duration in days (1-31), and the y-axis represents the number of patients. The bars indicate the number of patients with a negative and positive catheter tip culture for each duration.]
Figure 13

Other Invasive Devices inserted in the Patients

Number of patients

<table>
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<tr>
<th>Devices</th>
<th>Number of patients</th>
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<td>urinary catheter</td>
<td>108</td>
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<tr>
<td>tracheal tubes</td>
<td>64</td>
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<td>nasogastric tubes</td>
<td>47</td>
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<td>wound drains</td>
<td>13</td>
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<td>chest tube</td>
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Table 1: The bacterial isolates from IV line tips culture

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<tr>
<th>Organism</th>
<th>Number (n)</th>
<th>Percentage (%)</th>
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<tr>
<td>Staphylococcus aureus</td>
<td>23</td>
<td>35.4</td>
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<td>Klebsiella sp</td>
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<td>26.1</td>
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<td>Pseudomonas sp</td>
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<td>Coagulase negative staphylococcus (CONS)</td>
<td>7</td>
<td>10.8</td>
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<tr>
<td>Multiple organisms</td>
<td>5</td>
<td>7.7</td>
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<td>Total</td>
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Table 2: The antibiotic sensitivity pattern of bacterial isolates

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</table>

n = number of isolates

1+ to 4+ indicates degree of sensitivity of bacteria to antibiotics

- indicates resistance

x indicates number of isolates not tested against the antibiotics

Cxc = cloxacillin, Ofl = ofloxacina, chl = choramphenicol, Amo = amoxicilllin, Aug = augmentin,
Pef = pefloxacina, Gen = gentamicin, Tet = tetracycline, Cot = cotrimoxazole, Ery = erythromycin
Table 3: Antibiotic therapy in the ICU

<table>
<thead>
<tr>
<th>Antibiotic therapy</th>
<th>Number of patients (percentage)</th>
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<tbody>
<tr>
<td>Cephalosporin alone</td>
<td>36 (33.33%)</td>
</tr>
<tr>
<td>Cephalosporin and metronidazole</td>
<td>28 (25.93%)</td>
</tr>
<tr>
<td>Ciprofloxacin and metronidazole</td>
<td>28 (25.93%)</td>
</tr>
<tr>
<td>Augmentin alone</td>
<td>6 (5.56%)</td>
</tr>
<tr>
<td>Ciprofloxacin alone</td>
<td>5 (4.63%)</td>
</tr>
<tr>
<td>Augmentin, metronidazole and genticin</td>
<td>3 (2.78%)</td>
</tr>
<tr>
<td>Augmentin, metronidazole</td>
<td>1 (0.92%)</td>
</tr>
<tr>
<td>Metronidazole alone</td>
<td>1 (0.92%)</td>
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CHAPTER FOUR

DISCUSSION

The Intensive Care Unit (ICU) of the University College Hospital (UCH), Ibadan is a general ICU admitting patients from all subspecialties in the hospital. In this study, all patients had at least one peripheral intravenous line inserted, there were no central catheters inserted during the study period, all were peripheral intravenous lines. Intravenous access in the ICU setting is routine for the administration of fluids, blood products, drugs, parenteral nutrition and haemodynamic monitoring.

Intravenous catheter insertion puts the patient at risk of various complications, including catheter related infection from colonization of the device. Vascular catheter associated infection is associated with an increased morbidity, mortality, prolonged hospital stay and extra cost. The infections associated with catheters occur either due to microbial colonisation of the intracutaneous or intravascular portion of the device or due to contamination of the catheter hub or infusate administered through the catheter. Percutaneously inserted intravenous catheters are associated with a low rate of local infections and blood stream infections (BSI) are rare.

Culture of the catheter tip was traditionally done using a specimen kept in a broth; this technique gave highly variable and unreliable results. However, Maki and colleagues described a semi-quantitative technique that defined a positive catheter tip has yielding 15 or more colonies. This technique has a predictive value ranging between 76% and 96%. Several investigators have tried to modify Maki’s technique to improve the predictability of the procedure. Cleri et al. and Brun-Buisson et al. reported a technique for quantitatively culturing catheter in broth, with the advantage of
being able to detect organisms within the catheter lumen and the ability to compare relative numbers of organisms in mixed infections. This system is more cumbersome than other suggested techniques such as direct Gram staining of catheter segments (Cooper and Hopkins) and acridine orange staining of the catheter (Zuffrey et al.)

The Maki semi-quantitative technique has found wide application because it is simple and has a high predictive value for catheter related infection and it has also been validated for use for non-staphylococcal organisms, and was therefore chosen in this study.

The rate of colonization of peripheral intravenous catheters in this study was 37.4%. Rates described in literature range from 3.8 - 57%. The results of isolates in this study corroborate with the result of a prospective study by Oni et al. conducted on 52 medical and surgical patients on the general wards, they found that of the 52 patients, 8 (15.4%) had microorganism isolated from the peripheral intravenous catheter tips, 4 (7.7%) had microbes from the catheter tip alone, while 4 (7.7%) had microorganisms from both catheter tip and blood. Organisms isolated were Staphylococcus aureus in 2 patients, Proteus mirabilis, and Klebsiella aerogenes in one each. The isolates from the blood catheter had the same antibiotic sensitivity pattern. The result of this study also corroborates with the findings of the UCH infection surveillance subcommittee, which reported Klebsiella and Staphylococcus aureus as the two leading causes of nosocomial infection, from January to November, 2004.

Using the semiquantitative technique of Brun-Buisson, et al. in a study conducted in a PICU among 800 paediatric patients with 135 intravenous lines consisting of 103 peripheral and 32 central. Of the 103 peripheral intravenous
catheters, 52.5% (54) were colonized. The organisms isolated were Pseudomonas (33.3%) and coagulase negative Staphylococci (29.6%). Of the 54 patients with positive tip cultures, 19 (35.19%) had positive corresponding blood cultures. Only 7 patients had similar organisms grown from both the tip culture and simultaneous blood culture; 2 had clinical features of sepsis with no other infective source identified. The semi-quantitative technique of Brun-Buisson et al. used in this study, which ensured recovery of organisms present both at the tip and within the lumen, required the catheter be dipped in 1 mL of sterile water in a tube and vortexed for one minute, the suspension (0.1 mL) was then plated over culture media, and the catheter tip immersed in Trypticase-soy broth, accounted for the high rate of catheter colonisation, as this technique may yield rates twice that of Maki et al.

In a retrospective study conducted on patients of a tertiary hospital, Peacock et al. found line tip cultures were positive in 1275 (46.3%) out of 2753 specimens. Further evaluation of 792 positive line tip episodes in 654 patients where blood cultures were performed alongside, identified 825 line tip isolates. Of these, 194 (23.5%) were associated with a blood culture positive for the same organism. The retrospective Peacock et al. study, using the Maki semi-quantitative technique, was carried out on patients being investigated for catheter related sepsis and therefore accounted for the higher yield of isolates from the catheter tip (46.3%) compared to 37.4% obtained in this study where all catheter tip were investigated irrespective of patient diagnosis.

Staphylococcus aureus (Staph. aureus), which was the commonest organism isolated in this study (found in 35.4% of the isolates), is a member of the genus staphylococcus which was first described by the Scottish surgeon Sir Alexander
Ogston. He noted that a number of pyogenic illnesses were caused by a cluster-forming organism. It is a Gram-positive coccus about 1μm in diameter, usually arranged in clusters, non-sporing, nonmotile, and usually non-capsulate. As opposed to other members of the group, it is characterised by the ability to clot plasma by the action of the enzyme coagulase. Other distinctive diagnostic features are its ability to produce thermostable nuclease that break down DNA, and the production of surface-associated proteins known as clumping factors that react with fibrinogen. Staphylococcus aureus is found in the nose of 30% healthy individuals and may be found on the skin. It causes infection most commonly at the sites of lowered host resistance for example damaged skin or mucous membranes.

The main sources of infection are infected lesions such as wounds, burns, secondarily infected skin lesions from patients and healthy carriers. Together with other members of the genus, it can result in a wide variety of infections, such as boil, carbuncles, wound infections, abscesses, osteomyelitis, pneumonia, bacteraemia and toxic shock syndrome.

Diagnosis is by demonstrating the characteristic Gram-positive cocci arranged in clusters under microscopy from appropriate specimen. It can also be readily cultured on blood agar.

Staphylococcus aureus and other staphylococci are inherently sensitive to many antimicrobial agents, but about 90% of those found in hospitals are now resistant to bezylpenicillin due to production of penicilinase, a β-lactmase. Penicillanase also inactivates most of the other penicillins, except a few compounds like methicilin, cloxacillin and flucloxacillin as these antibiotics exhibit stability to the enzyme. Antibiotic
resistance can arise by various mechanisms. Methicillin resistant staphylococcus aureus (MRSA) is an increasing infection control and therapeutic problem. These strains which are often resistant to other antibiotics such as aminoglycosides and fluoroquinolones probably arose as a result of mutation and acquisition of resistant plasmids. The choice of antibiotics depends on the sensitivity pattern since various strains of the organism have different sensitivity pattern. The choice should be based mainly on the result of the sensitivity test made on the culture of the strain isolated from the patient.

Klebsiella, which was found in 26.1% of the isolates, were Gram negative bacilli measuring 1-2μm long and 0.5-0.8 μm wide, capsulated and non-motile. The organisms grow between 12-37 °C (optimum, 37°C) and are killed by moist heat at 55°C in 30 minutes. Klebsiella is a cause of community-acquired bacterial pneumonia, occurring particularly in chronic alcoholics and showing characteristic radiographic abnormalities due to a severe pyogenic infection which has a high fatality rate if untreated. The vast majority of Klebsiella infections, however, are associated with hospitalization. As opportunistic pathogens, Klebsiella spp. primarily attack immunocompromised individuals who are hospitalized and suffer from severe underlying diseases such as diabetes mellitus or chronic pulmonary obstruction and critically ill patients in the ICU. Nosocomial Klebsiella infections are caused mainly by Klebsiella pneumoniae, the medically most important species of the genus.

Klebsiella species are ubiquitous in nature. Klebsiellae probably have two common habitats, one being the environment, where they are found in surface water, sewage, and soil and on plants, and the other being the mucosal surfaces of mammals.
such as humans, horses, or swine, which they colonize. In humans, *K. pneumoniae* is present as a saprophyte in the nasopharynx and in the intestinal tract.

It is usually resistant to penicillin, ampicillin and amoxicillin but sensitive to cephalosporin for example cefuroxime and ceftaxime. Resistance to chloramphenicol and tetracycline varies from strain to strain; often sensitive to gentamycin and other aminoglycosides. Klebsiella acquires resistance to antibiotics early and therefore, its emergence is as a result of widespread antibiotic use. Despite frequently reported nosocomial outbreaks of multiple-drug-resistant *Klebsiella pneumoniae*, many antibiotics have proved useful against *Klebsiella* infections during the last two decades. Third-generation cephalosporins became the drugs of choice with usual minimal inhibitory concentration. In this study, the isolated *klebsiella* were sensitive to ofloxacin and perfoxacin.

*Pseudomonas*, found in 20% of the isolates of this study, is a genus of Gram-negative bacilli belonging to the family Pseudomonadaceae. More than half of all clinical *Pseudomonas* isolates produce the blue-green pigment pyocyanin. These pathogens are non-sporing, non-capsulate, and usually motile by use of one or two polar flagellae. They are aerobes but can grow anaerobically if nitrate is available. *Pseudomonas* is widespread in nature, inhabiting soil, water, plants, animals and humans. *Pseudomonas aeruginosa* (*P. aeruginosa*) is an important cause of infection, especially in patients with compromised host defense mechanisms. It is the most common pathogen isolated from patients who have been hospitalized longer than 1 week and is a frequent cause of nosocomial infections such as pneumonia, urinary tract infections (UTIs), and bacteraemia. *Pseudomonas* can multiply in nebulizer fluid or on instrument and
environmental surfaces; therefore, proper cleaning, sterilization, and disinfection of reusable equipment or fluids are required. *Pseudomonas* infections are complicated and can be life threatening. However, it is an opportunistic pathogen and rarely causes disease in healthy persons. Most cases of infection are associated with a breakdown of a physical barrier to infection or with an underlying immune deficiency. Adding to its pathogenicity, this bacterium has minimal nutritional requirements and can tolerate a wide variety of physical conditions. *Pseudomonas* is both invasive and toxigenic. Production of extracellular proteases adds to the organism's virulence by assisting in bacterial adherence and invasion. The three stages of infection are bacterial attachment and colonization, local invasion, and bloodstream dissemination and systemic disease. The importance of colonization and adherence is most evident when studied in the context of respiratory tract infections and those that complicate mechanical ventilation.

In hospitalised patients, pseudomonas infection is usually localised, such as in catheter related urinary tract infection, infected ulcers, burn and eye infections. In immunosuppressed patients, pseudomonas infection frequently becomes generalised. It is not usually a common cause of Gram-negative septicaemia or necrotising pneumonia. *Pseudomonas* infections are treated with a combination of an anti-*Pseudomonas* betalactam (e.g., penicillin or cephalosporin) and an aminoglycoside. Carbapenems (e.g., imipenem, meropenem) with anti-*Pseudomonas* quinolones may be used in conjunction with an aminoglycoside. The Pseudomonas isolated in this study was also sensitive to ofloxacin and gentamicin. With the exception of cases involving febrile patients with neutropenia, in whom monotherapy with ceftazidime or a
carbapenem (e.g., imipenem, meropenem) is used, a two-drug regimen is recommended. Empiric anti-microbial therapy must be comprehensive and should cover all likely pathogens in the context of the clinical setting.

The incidence of hospital acquired infection is higher in the ICU compared with other parts of the hospital. The reasons for this higher incidence include the fact that patients admitted to the unit are very ill and so are certain to be suffering some immunocompromise from the outset. Their immune competence is further reduced as various life-support systems are attached to them. Invasive devices such as intravenous lines, tracheal tubes and urinary catheters which are commonly inserted in the patients are associated with significant added risk of infection. Patients in the ICU are handled by staff with greater frequency and are more likely to be prescribed antimicrobial drugs than elsewhere; which is why second and third infections are more common here than in other parts of the hospital, and why these infections are more often polymicrobial.

The main infections in the ICU are of the lower respiratory tract in patients on mechanical ventilatory support, urinary tract infection and intravascular catheters related infections, and are often associated with bacteraemia. Most infections are endogenous.

Main areas of cross infection in the ICU are: hands of staff and attendants; assisted ventilation equipment; suction and drainage bottles; intravenous lines- central and peripheral; urinary catheters; wounds and wound drains; disinfectant containers; dressing trolleys (on which disinfectant jars/bottles are stored).

The institution of a disinfection policy to include general hygiene, aseptic procedure, waste disposal and antibiotic policy is recommended for the prevention of
nosocomial infection. A sensible disinfection policy can save the hospital money and reduce the number of nosocomial and cross-infections. Many hospitals do not have a sensible disinfection policy and practices are more often based on tradition and habit than on logic. Disinfection and sterilisation are necessary to prevent cross-infection from equipment, surfaces and skin. A disinfection policy should list the purposes and equipment for which sterilisation or disinfectants is required, those for which no disinfection is necessary and those for which it is not cost effective, for example disposable single use items. The policy should select effective disinfectant for each procedure. It should arrange for disinfectants to be distributed to the point of use at the optimum dilution, and that no further dilution occurs at the point of use. The policy should ensure that expiry dates of the disinfectants are adhered to and that empty containers are returned to pharmacy. The pharmacy has a role to play in implementing the policy. The pharmacy should ensure that disinfectant containers are thoroughly cleaned, washed and dried; that containers are filled with the correct solution at the right dilution; containers are clearly labelled with contents, in use dilution and expiry date; that disinfectants are not exposed to inactivating substances, such as cork, rubber or incompatible detergents; and that disinfectants are diluted to manageable quantities, for example 500 ml or less, to reduce waste and the chance of partially filled bottles being left on the ward.

Care of the hands. Hands are the most important vehicle in cross infection. However, health care workers do not wash their hands as often as they should. The purpose of hand-washing is to remove dirt, and reduce the load of bacteria on the skin of the hands. There are two types of hand-washing: social and
aseptic. Social hand-wash should be carried out routinely before and after coming in contact with patients; when starting work and when going off duty; when they become obviously dirty; when they are contaminated with body fluids or organic matter; after visiting the toilet; after removing gloves; after a non-sterile procedure; and after contact with patients during ward rounds or routine procedures such as bed-making. Aseptic hand-wash should be carried out when an aseptic procedure is about to be performed on a patient. Aseptic hand-wash requires meticulous cleaning of the hands and the use of a sustained action disinfectant and it is usually accompanied by the use of sterile gloves.

Soap and water remove most organic contamination and most of the transient bacterial floral and are acceptable as a social hand wash. In hospitals this includes important potential causes of hand borne cross-infection. The resident floras of the hands are less likely to cause infection, except in immunocompromised patients. Resident bacteria are reduced in number by hand-washing, particularly if a detergent containing an antiseptic is used, but they cannot be eliminated. Though acceptable as a social hand-wash, bars of soap may, however, be left lying in pools of water, where they become contaminated with antibiotic-resistant Gram negative bacilli, which are then transmitted to the hands of staff and then to patients. If bar soaps are used they should be stored dry—either on a string or fixed to the wall by magnet holders. Medicated soap, which incorporates a bactericidal agent (for example, Triclosan®, Irgasan®) is useful in reducing the transmission of methicillin-resistant Staphylococcus aureus. Soap and water should be supplemented with an alcohol-containing sustained action disinfectant prior to carrying out an aseptic technique.
Disinfectants are agents that kill the vegetative states of microbes. When these agents are less toxic enough to be used on skin and mucosa they are called antiseptic. The commonly used antiseptics are alcohols, chlorhexidine and iodine and iodophors.

The two alcohols most frequently used for antisepsis and disinfection are ethanol and isopropyl alcohol (isopropanol). They are rapidly active, killing vegetative bacteria, M. tuberculosis and many fungi and inactivating lipophylic viruses. The optimum bactericidal concentration is 60-90% by volume in water. They probably act by denaturation of proteins. They are not used as sterilants because they are not sporicidal, do not penetrate protein-containing organic material, may not be active against hydrophilic viruses, and lack residual action because they evaporate completely. They have a skin drying effect. When it is desired to reduce the bacterial load on the hands that are not soiled, washing can be replaced by the application of alcohol. The inclusion of a non-volatile antiseptic (chlorhexidine, for example) adds a residual effect to the immediate action of alcohol. If an emollient like glycerine and perhaps perfume are added, the result is a de-germing lotion or handrub that when applied does not dry the skin too much.

Chlorhexidine is a cationic biguanide with very low water solubility. It is an antiseptic active against vegetative bacteria and mycobacteria and has moderate activity against fungi and viruses. It strongly adsorbs to bacterial membrane, causing leakage of small molecules and precipitation of cytoplasmic proteins. It is active at pH 5.5-7.0. Chlorhexidine is slower in its action than alcohols, but because of its persistence it has residual activity when used repeatedly, producing bactericidal activity equivalent to alcohols. It is most effective against gram positive cocci and less active
against gram-positive and gram-negative rods. It inhibits spore germination. It is resistant to inhibition by blood and organic materials. However, anionic and non-ionic agents in moisturisers, neutral soaps, and surfactants may neutralise its action. Chlorhexidine has a very low skin sensitising or irritating capacity.

**Iodine** in a 1:20,000 solution is bactericidal in 1 minute and kills spores in 15 minutes. Tincture of iodine USP contains 2% iodine and 2.4% sodium iodide in alcohol. It is the most active antiseptic for intact skin. It is not commonly used because of serious hypersensitivity reaction and because of its staining of clothing and dressings.

**Iodophors** are complexes of iodine with a surface-active agent such as polyvinyl pyrrolidone (PVP, povidone iodine). Iodophores retain the activity of iodine. They are less irritating and less likely to produce skin hypersensitivity than tincture of iodine. They act as rapidly as chlorhexidine and have a broader spectrum of action, but they lack the persistent action of chlorhexidine.

**Alcohol-based sustained-action disinfectants** (for example, Hibisol®) are extremely useful and are an excellent means of providing hand disinfection in arrears where washing facilities are lacking or where the staff are too busy to disinfect their hands between patients. A container of Alcohol-based sustained-action disinfectant in a high dependency unit results in a significant increase in compliance with disinfection policy.

In the ICU where the risk of nosocomial infection is high and hand-washing ought to be more frequent, the use of disinfectant surgical scrub is encouraged with the intention of reducing the bacterial population of the hands. However, if this leads to
damage to the skin, then the hands may be more dangerous than if ordinary soap had been used, or even if they had not been washed at all \(^6, 7, 8\). An option to prevent this is to provide several different hand-care regimes in high risk arrears, to be used alternatively or sequentially at the discretion of the members of staff or according to a protocol. The aim is to reduce the possibility of damage to the hands that can follow the repeated use of a single method on its own. Such techniques as washing with ordinary soap, with a surgical scrub, the use of a de-germing lotion, the wearing of gloves and the washing and the de-germing of gloved hands between procedures might be used in rotation or as the task being performed demands. In other clinical arrears, hand-washing with ordinary soap is all that is necessary, though the de-germing has a place as a quick alternative for use during procedures that demand more than one hand-wash to complete \(^6, 7, 8\). De-germing lotions have a particular application where facilities for washing hands are inadequate \(^6, 7, 8\).

**Aseptic procedure** is the introduction of a sterile item such as an intravenous cannula or urinary catheter into a patient using a no touch technique \(^6, 7, 8\). The essential aspects of the procedure are that: the entry site must be properly disinfected; the hands of the staff must be disinfected (and gloved); sterility of the article is maintained by minimising contact with non sterile surfaces. Intravenous therapy, for example, is one of the most common invasive procedures performed in hospital, about 25% of in-patients have a peripheral cannula in situ at any given time \(^7\), yet it is also one of the most neglected in terms of hospital-acquired infection.

Possible sources of intravenous cannula infection are \(^6, 7, 8\):
• Factors related to equipment and fluids: Cannula material that is itself thrombogenic. (For example polyethylene and polypropylene), contaminated fluid administration set, hypodermic needles used as air inlets, three-way taps and stop cocks, aminated Infusion fluids, dirty dressings, adhesive tapes, contaminated splints used to stabilise joints and large bandages used to cover the insertion site.

• Factors related to insertion and duration include: skin flora, hands of staff, hands of other patients or visitors, contaminated disinfectants, unstable cannulae movement increases risk of bacterial contamination, cannulae left in for over 72 hours, insertion of cannulae into a previously infected vein.

In order to reduce the risk of cannula colonisation by bacteria, intravenous cannula should be inserted following a recommended procedure as outlined below 6, 7, 8, 41, 42:

1. Ensure that the patient is comfortable and aware of the procedure- this reduces anxiety.
2. Collect all the equipment necessary to set up an intravenous infusion.
3. Apply a tourniquet to the patient’s non-dominant forearm.
4. Disinfect hands.
5. Disinfect the intravenous insertion site with 70% isopropyl alcohol for at least 30 seconds and allow to dry before inserting the cannula. (Note that the intravenous site should not be touched after disinfection).
6. Select a cannula that will fit easily into the vein. The correct sized cannula reduces trauma and congestion of the vein.
7. Insert the cannula as swiftly and as aseptically as possible. Do not attempt repeated insertion with the same cannula. If the first insertion is not successful the procedure should repeated with a new cannula.

8. Look out for a flash back and then advance the cannula slowly.

9. Anchor the cannula with clean tape.

10. Release the tourniquet.

11. Connect up the administration set.

12. Clean the site with 70% isopropyl alcohol swab.

13. Leave the site visible and dry.

14. Discard all Sharps carefully in a sharps container.

15. Wash and dry hands.

Once inserted intravenous lines should be inspect regularly for swelling or signs of infection and the site should be kept clean and dry. The intravenous line should be re-sited after 72 hours using aseptic technique.

**Isolation**, the separation of an infectious patient from other people, is probably the oldest form of infection control still practised. For example, source isolation (equivalent to the old barrier nursing) is when a patient with an infection is isolated from other patients and staff. Protective isolation (equivalent to reverse barrier nursing) is when an especially susceptible patient is isolated to protect him/her from infection carried by others. The aim of isolation precaution is to reduce the risk of the spread of infection, before and after diagnosis, to susceptible individuals including health care workers.
Approach to isolation nursing is divided into: conventional approach or universal infection control precautions (UICP). The conventional approach has a detailed written policy, which is activated by clinical or laboratory diagnosis of infection. The conventional approach can either be category-specific or disease-specific. In the 1983 CDC category-specific variety, seven different types of isolation were defined, while the UK version had four different types. For each type a separate list of procedures is laid down. In the disease-specific source isolation, the precautions are individual to each infection according to its ‘infectiousness’ and the route by which it is spread. The CDC recommendations list 160 different diseases and conditions, each with its own precautions. The advantage of the conventional approach is that it does not require thought or judgement by staff who may be inexperienced before implementation. It, however, does not allow staff to tailor isolation precautions to the needs and abilities of the patient. In addition, many hospitals would find it difficult to apply the full CDC recommendations for lack of sufficient isolation accommodation.

The universal infection control precautions (UICP) method requires clinical staff to wear, and change gloves in clearly defined clinical situations. They are also required to make a risk assessment of when additional protective clothing is required. Additional protective clothing come into play for infections spread by droplets or airborne route, and some spread by contact. This approach has been widely adopted. However controversial it may once have been, the UICP method is now probably the most important method of protecting patients and staff form infection. UICP involves hand-washing and the use of gloves when handling blood, body fluids and contaminated materials. These standard precautions are to be applied to all patients
receiving care in a hospital, regardless of their diagnosis or presumed infection status. Used wisely, it can limit the need for single room isolation. Patients diagnosed as or suspected of having transmissible or epidemiologically important infection, particularly those spread by droplets, airborne or contact, may need additional precautions. The main additional requirement for airborne, droplet and some type of contact spread (e.g. antibiotic-resistant organisms) is a single room.

A single room with shut doors is intended to prevent the transmission of organisms spread by the airborne route, and to prevent gross contamination of the environment outside of the room with certain organisms spread by contact. An extraction system providing 8-10 air changes per hour is desirable to prevent airborne spread. For non-airborne infections requiring a single room, it is preferable to keep the door closed. Confinement to a single room can be an unpleasant experience. While it is necessary to restrict the patient, it can also discourage staff from entering the room. The patient can feel deprived of human contact, so a single room should not be used if airborne transmission is unlikely or if there is little risk of heavy environmental contamination.

The architectural design of the ICU has little influence on the infection rate, and the dry environment e.g. walls, floors and ceilings do not require any particular attention. At least one single bedded ventilated cubicle suitable for source or protective isolation is advised if the unit has an open plan layout. A negative ventilation is required for the isolation cubicle and this should be checked regularly. Plenum (positive pressure) ventilation is not required to prevent spread of infection in the main
unit, but may be necessary to provide a suitable working environment; 8-12 air changes per hour should be sufficient.

A recommended Infection control policy include:

- Layout of the unit and siting of equipment: The ICU should ideally be situated close to the operating theatre and Accident and Emergency Department and should be readily accessible, but separate from the ward arrears. The unit usually contains six to ten beds, including one or two isolation cubicles for communicable diseases. The beds should be 2.5 – 3 metres apart, to allow free movement of staff and equipment. The ICU should function independently with a dedicated nursing staff who are well-trained in the management of high dependency patients and are familiar with infection control principles.

- Disinfection and sterilisation of specialised equipment should not be carried out in the ICU; all equipment should be sent to the sterile supply department (SSD). A policy on disposable and reusable items should be clearly defined.

- Hands are the most common vehicle of transmission of organisms and so facilities should be provided for hand washing and disinfection. A container of alcohol-chlorhexidine (Hibisol) should be available at the entrance. Wash hand basins must be provided. All visitors and staff should decontaminate their hands before touching any patient.

- Aseptic technique should be used for intravenous therapy and urinary catheterisation.

- Protective clothing: gloves (sterile for aseptic procedures e.g. insertion of CVP lines and non-sterile for other procedures, e.g. emptying urinary drainage bags);
plastic aprons when dealing with patient body fluids; disposable high filter masks for aseptic procedures.

- Antibiotic and disinfectant usage: antibiotic usage must be restricted to essential use only. An antibiotic policy on prophylaxis and empirical therapy is essential and should be prescribed with logic and restrain; selective gut decontamination by non-microbial should be considered for reducing endogenous infection; disinfectant should be kept to a minimum and should never be stored in open containers. Wherever possible heat disinfection should be used; all equipment should be sent to the SSD to be sterilised.

- Cleaning programme: cleaning must be done daily and all surfaces must be wiped with a damp cloth to remove dust and dirt; disinfectant are not required for environmental cleaning (unless specified, for example for an unusual outbreak); the main ward should be cleaned first and then the cubicles; a total clean of all areas, including the stores, should be done at least every 2 weeks; all equipment should be wiped and kept covered to protect from dust when not in use.

- Visitors (including staff) to the ICU should follow the same protocol: street coats and white coats must be removed; hand should be disinfected with alcohol-chlorhexidine on entering the ICU; the proper procedure should be followed when attending the patient; hands should be disinfected before leaving the unit.

- Waste and sharp disposal: there must be adequate facilities for disposing of body fluids, excrement, clinical and non-clinical waste; a sharps policy must be implemented and followed. The ICU is a busy area and there is a high risk from inoculation accidents.
- Staff: there must be adequate work and rest facilities; all staff working on the unit must be offered hepatitis B immunisation; training and education should consist of formal and informal infection control lectures and tutorial and ward rounds.

The intensive care unit of the University College Hospital Ibadan is a 5-bedded open ward with an isolation cubicle. It is in close proximity to the operating theatre. It has its own dedicated nursing staff. Sterilisation of all specialised equipment takes place in the CSSD. There are two wash hand basins for soap and water or chlorhexidine hand wash. Urinary and intravascular catheterisation and tracheal suctioning are done using aseptic technique. The UICP is implemented with the use of gloves when there is a chance of contact with patients’ body fluid; additional precaution such as aprons, masks and goggles are worn when required. A general environmental cleaning is done daily; all surfaces are wiped with a damp cloth to remove dust and dirt. The floor is mopped at least twice daily. The unit staff are expected to remove their street clothes and wear clean hospital linen on resumption of duty. White coats are removed before entering the unit and clean hospital gowns are worn on street clothes. Hand disinfection using soap and water or chlorhexidine is expected of all staff and visitors before and after attending a patient. Shoes must be changed before entering the unit. Clinical waste is properly disposed; a sharps container is provided for proper sharps disposal.

UCH has an Infection Control Team that monitors the level of hospital acquired infection by monitoring the culture results of specimens sent from all the units of the hospital. The Infection Control Team publishes quarterly, the result of bacterial isolates of these samples. The team also investigates all acute infection outbreaks. Screening of staff especially those working in the theatre and ICU is conducted by the team. The
team also oversees the continuing education of all grades of staff, for example, by
organising seminars. Recommendation and advice on handling of clinical waste is also
undertaken by this team.
LIMITATIONS OF STUDY

The limitations of this study as listed below were due mainly to funds constraints. They included:

Inability to culture tracheal aspirate, urine specimen, wound swab, nasogastric aspirate and aspirate of drains.

Blood specimen for culture was not taken beyond the first three days of admission.

Blood specimen could not be taken as often as recommended (up to 6 or 8 hourly) from patients suspected of having infection.

The above mentioned limitations were due to funds constraint.

Most patients were commenced on antibiotics before specimens for blood culture were obtained and it was impossible to stop antibiotics for 24 hours to enhance yield from blood culture, as this may be unethical.
CONCLUSION

This study has shown that infective complications of intravenous therapy ranging from contamination, colonisation and exit site infection is common in patients receiving intravenous therapy in the ICU. Instituting and implementing infection control policy will ensure reduction of catheter related infection. Prevention is important in our society because health system funding is mainly from out of pocket payment by patients and his or her relations and the cost of treating infection episodes is enormous.
RECOMMENDATIONS

Institution of guidelines for placement and maintenance or management of intravascular access is desirable. The lines should be inspected daily and dressed as appropriate.

Site of intravenous access, cannulae and fluid administration set should be changed every 48 – 72 hours.

Strict asepsis should be followed in administering drugs and fluid through the intravenous site.

There should be regular surveillance of NI in the ICU.

Regular and proper hand washing, including provision of running water, hand washing lotion and availability of adequate number of hand washing basins should be the norm.

Site and time of insertion and the size of cannula inserted should be documented in the patients chart.
APPENDIX I

INTRAVENOUS LINE TIP CUTFURES AND BACTERAEMIA IN THE ICU OF UNIVERSITY COLLEGE HOSPITAL, IBADAN, PROFORMA

1. Serial number:
2. Hospital number:
3. Age/ date of birth:
4. Sex:
5. Address:
6. Diagnosis:
7. Unit:
8. Date of admission:
9. Intravenous catheter placement:

<table>
<thead>
<tr>
<th>Date of placement</th>
<th>Technique of placement (percutaneous /cut down)</th>
<th>Indication</th>
<th>*Site</th>
<th>Duration</th>
<th>**Signs of inflammation</th>
<th>Indication for removal</th>
</tr>
</thead>
</table>

10. Presence of other invasive devices:
   Tracheal tube: Yes/No. If yes Duration/Date of insertion. Date changed
   Urinary catheter: Yes/No. If yes Duration/Date of insertion. Date changed. Others (specify):
11. Other risk factors for bacteraemia: chest infection
    - urinary tract infection
    - E.N.T. infection

13. Vital signs:

<table>
<thead>
<tr>
<th></th>
<th>Temperature °C</th>
<th>Pulse/min</th>
<th>RR/min</th>
<th>BP mmHg</th>
<th>SaO₂</th>
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</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
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<tr>
<td>Day 2</td>
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<tr>
<td>Day 3</td>
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</tbody>
</table>

14. Presence of pyrexia: Yes/No. If yes state

   Onset
   Duration
   Peak

15. Antibiotic therapy: Yes/No. State name(s).

   Indication
   Duration

16. Investigations done

   PCV   WBC   MP

17. Specimen collection

   A. Catheter tip - date collected

   B. Blood - *site of collection. (see below)

      - date/day collected - day 1
      - day 2
      - day 3
**Site**
S- scalp
N- neck
RACF- right ante-cubital fossa
LACF- left ante-cubital fossa
RFA- right forearm
LFA- left forearm
DRH- dorsum of right hand
DLH- dorsum of left hand
RG- right groin
LG- left groin

**Signs of inflammation**
S- swelling
P- pain
E- erythema
W- warmth
X- exudates
## APPENDIX 2

### MICROBIOLOGY RESULT FORM

<table>
<thead>
<tr>
<th>Number of catheter (tips)</th>
<th>Isolates</th>
<th>Antibiotic sensitivity pattern</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Sensitive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4+</td>
</tr>
<tr>
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<tr>
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<td></td>
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<tr>
<td>5</td>
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</table>

<table>
<thead>
<tr>
<th>Number of blood sample(s)</th>
<th>Isolate(s)</th>
<th>Antibiotic sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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APPENDIX 3

ETHICAL CONSIDERATIONS

Confidentiality of data: all information obtained from participants and the result of this study shall be treated as strictly confidential. Participants will be assured that such information shall not be made available to anyone without their prior consent. The details of all the various steps in this study shall be explained fully to the participants (or their relations where applicable) including the associated risks and benefits. For those who do not understand English, the details shall be read and explained in appropriate local languages. For participants who cannot give consent themselves, this would be obtained from their responsible adult relations.

The risks associated with this study is minimal and is limited to a slight pain experienced at the time of blood collection and at the moment of removal of the intravenous cannula. The benefit to the participants and community is the early detection of pathogenic bacteria when present, and the result obtained would assist in instituting appropriate prophylactic antibiotic therapy for subsequent patients predisposed to the risk of bacteraemia and intravenous line colonization in the I.C.U. Subjects reserve the right to decline participation in this study or withdraw consent at any time, and this will not in any way affect their treatment.

The overall cost of this study, inclusive of the cost of the cultures and the accompanying materials such as sterile needles and syringes, sterile gloves, sterile universal bottles, cotton wool and 70% alcohol shall be borne by the investigator, with no extra cost to the participants.
Title: Intravenous line tip cultures and bacteraemia in the ICU of University College Hospital, Ibadan.

Investigator:
Dr Adebayo A.A.
Dept of Anaesthesia,
University College Hospital, Ibadan.

Purpose of this study: to determine if the germ grown from the drip site is the same as that grown from the blood. In other words it is to determine the role germ(s) at the drip site plays in causing blood infection or invasion.

Steps involved in this study: the cannula at the drip site would be removed when no longer needed and the tip(s) cut. Also 5 mls (about one teaspoonful) of blood would be withdrawn from the patient on the 1st, 2nd and 3rd days. A small stick with cotton wool at its tip would be used to rub the skin. All these samples would be sent to the microbiology laboratory where they would be processed and examined under the microscope.

Risks and benefit: the risk associated with this study is minimal and limited to slight pain at the time of withdrawing blood, which is soon relieved. The benefit is that germs causing blood infection can be recognized early, and appropriate treatment commenced early. This study has been explained to me and I understand

a. What the study involves.
b. That refusal to participate will not affect my treatment in any way.

c. That I may withdraw at any time.

I therefore agree to take part in this study.

Name and Signature of subject with date: ________________________________

Relationship to patient: _____________________________________________

Full address: _______________________________________________________

Name and Signature of interviewer: _________________________________

Date: __________________________________________________________________
APPENDIX 5

UI/UCH INSTITUTIONAL REVIEW COMMITTEE

CERTIFICATION LETTER

Principal Investigator: Dr. A. A. Adebayo
IRC Protocol No: UI/IRC/03/0052
Protocol Title: INTRAVENOUS LINE TIP CULTURES AND BACTERAEMIA IN THE INTENSIVE CARE UNIT OF THE UNIVERSITY COLLEGE HOSPITAL, IBADAN.

STATUS: APPROVED

The Joint UI/UCH Institutional Review Committee has reviewed your protocol for a proposed project on “Intravenous Line Tip Cultures and Bacteraemia in the Intensive Care Unit of the University College Hospital, Ibadan.”

The protocol is set out to determine the microbial pattern and antibiotic sensitivity of agents in bacteraemia sepsis. This is to facilitate an appropriate and improved management of such patients in this environment.

THE RESEARCH PROTOCOL AND CONSENT FORM DESCRIBED ABOVE HAVE BEEN REVIEWED BY THE UI/UCH IRC WITH THE RESULTS AS INDICATED.

Adeyinka G. Falusi
Professor/Chair, UI/UCH IRC
E-mail: uiuchirc@yahoo.com

International Regulations require that any severe drug reaction and unexpected adverse occurrence to subjects during the conduct of this research be reported to the UI/UCH IRC Protocol and Data Management Office promptly. Any changes to this protocol must be submitted for review to the UI/UCH IRC.
REFERENCES


