CHAPTER ONE

INTRODUCTION AND OBJECTIVES

1.1. Introduction

Hospital privacy curtains are often used in health care settings to surround patient`s bed and provide privacy. Many factors contribute to the concern that these curtains are a potential source for the transmission of pathogenic microorganisms, this including caregivers and patients touch curtains frequently; in same setting, curtains are not often cleaned or changed; healthcare workers and patients who handle curtains do not necessarily cleanse their hands before (or after) touching them. The level of contamination on curtains is closely related to the infectious status of the patient who have spent time in proximity to curtains. For example it would be very surprising to find vancomycin –resistant *Enterococcus* (VRE) on divider curtain if no patient carrying VRE have spent time in the unit since the curtains were installed. Inversely, a curtains a higher risk of contamination by VER if patient carrying this organism have spent time in proximity to the curtain (Yves, 2013).

Exposure to pathogens on contaminated healthcare garments, uniforms, curtains and other fabrics can occur through direct contact or indirectly through airborne particle spread. Infection control procedures play an important part in all clinical settings to prevent and reduce the rate of cross-infection. Scrupulous hand washing by healthcare staff before and after contact with patients and before any procedure is reportedly the

single most important infection control measure. However, there are various items that are touched after hand washing and prior to patient contact (e.g. clinical surfaces and/or cubicle curtains) that could be contaminated with microorganisms. Therefore, the potential for cross infection is increased with frequent contact with cubicle curtains; particularly as some bacteria are able to survive on clinical fabrics for extended periods (Ria *et al.*, 2010).

Recent study suggests that contaminated environmental surface may play an important role in transmission of health care-associated pathogens (Boyce, 2007). Clothing including white coates appears to be contaminated in the first several hours of use. Other personnel effects with frequent hand contact such as pens, stethoscopes, and cell phones may have even higher level of contamination (Pandy *et al.*, 2010).

Antibiotic-resistant bacteria are implicated in an increasing amount of hospitalized patient infections worldwide. Among patient diagnosed with an infection, antibiotic resistance is associated with an increasing length of hospital stay, health care costs, and patient morbidity, and mortality. The risk of nosocomial infection depends on a number of factors. These include the ability of pathogens to remain viable on a surface, the rate at which contaminated surfaces are touched by patient and health care workers, the context in which the patient is exposed, and the levels of contamination that result in transmission to patient (Catano *et al.*, 2012).

Nosocomial infections- known also as hospital-acquired infections, hospital- associated infections, and hospital infections- are infections that are not present in the patient at the

time of admission to hospital but develop during the course of the stay in hospital (Thofren, 1983).

Despite documentation that the inanimate hospital environment (e.g., surfaces and medical equipment) becomes contaminated with nosocomial pathogens, the data that suggest that contaminated fomites lead to nosocomial infections do so indirectly. Pathogen for which there is more-compelling evidence of survival in environmental reservoirs includes *Clostridium difficile*, Vancomycin-resistant *Enterococci*, and methicillin-resistant *Staphylococcus aureus* (Weinstein, 2014).

Hospital curtains that surround patients beds give privacy could provide a source for transmission of healthcare associated pathogens for several reasons. First, they are commonly touched by patients and healthcare worker. Second, in many institutions, they are cleaned or changed infrequently finally, healthcare worker may be less likely to disinfect their hands after contact with inanimate object than after direct contact with patient, proper hand hygiene compliance is far from being 100 percent. High- touch hard surfaces are disinfected daily, if not more. However, solutions such as antimicrobial hard surfaces and UV technology have been implemented as an additional safeguard to reduce environmental contamination and further prevent the spread of healthcare associated infections (HAIs). If you think about the number of times a nurse puts her hand into her pocket or reaches to pull back a privacy curtain (Burden *et al*., 2011).

1.2. Rationale

Contaminated environmental surface such as a hospital curtains may play an important role in transmission of healthcare- associated pathogen (Boyce, 2007). Many study conducted on contaminated environmental surface, clothes, curtains, cell phone, white coats, stethoscopes and computer keyboard may have even higher levels of contamination. Hospital privacy curtains were contaminated with vancomycin-resistant *Enterococci*, ethicillin-resistant *Staphylococcus aureus* and *Clostridium difficile*. Hospital curtains are a potential source for dissemination of healthcare-associated pathogens (Trillis *et al.*, 2008). Privacy curtains that separate the patient ped are a potentially important site of bacterial contamination in hospitals. This study demonstrates to examine the frequency of contamination of hospital privacy with healthcare- associated pathogens, and testing hypothesis that pathogens on culture can easily be acquired on hands.

1.3. Objectives

1.3.1. General objective

To isolate and identify bacteria from hospital curtains.

1.3.2. Specific objectives

1. To determine bacterial load in hospital curtains.
2. To determine bacterial species.

CHAPTER TWO

LITERATURE REVIEW

Each cubicle curtain was 249 cm length and 245 cm width with a 12.5 cm distance from the ground. The curtains were made of 60% polyester and 40% cotton, drawn around an overhead track completely enclosing the treatment cubicle for patient privacy pre and post treatment. Ethical approval was granted from University of Brighton School of Health Professions research governance panel (Ria *et al.*, 2010).

2.1. Hospital contamination

A survey was carried out to assess the amount of bacterial contamination on the inner walls of the hospitals linen chutes. It was shown that the average bacterial count in these chutes was low by general hospital standards (19·7 bacterial colonies per Rodac plate). This concentration was eight times less than the average concentration found on the floor surface at each linen disposal and collection point (153 bacterial colonies per Rodac plate).Three chutes sampled during the survey were periodically cleaned but appeared to derive only very limited benefits from the cleaning method they used (Whyte *et al*, 1969).

The hospital bed is comprised of different components, which pose a potential risk of infection for the patient if not adequately decontaminated. Experimental investigations involving methicillin-resistant *Staphylococcus aureus* (*S. aureus*), vancomycin-resistant Enterococci, *Acinetobacter* species, and other pathogens. Often only the bedrail has been sampled during investigation of outbreaks, rather than more important potential

reservoirs of infection, such as mattresses and pillows, which are in direct contact with patients. It is essential that these items and other bed components are adequately decontaminated to minimise the risk of cross-infection, but detailed advice on this aspect is often lacking in reports and official documents. Clear guidelines should be formulated, specifying the decontamination procedure for each component of the bed. In outbreaks, investigation should include an assessment of mattresses and pillow contamination as a critical aspect in outbreak management (Creamer and Humphreys, 2008).

The analyzed studies highlighted the presence of bacteria on monitors, bed grids, tables, faucets, telephones, keyboards and other objects. There was a prevalence of *S. aureus* resistant to methicillin, *Clostridium difficile*, *Acinetobacter baumannii* (A. *baumannii*) and *Enterococcus* resistant to vancomycin, being the predictive factor the previous occupation of patients colonized by these microorganisms. These evidences reinforce the need for knowledge and control of the sources of pathogens in the hospital environment (De Oliveira and Damasceno, 2010).

The contaminated surface environment in hospitals plays an important role in the transmission of methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Enterococcus* species. (VRE), *Clostridium difficile*, *Acinetobacter* species. Improved surface cleaning and disinfection can reduce transmission of these pathogens. 'No-touch' methods of room disinfection (i.e., devices which produce ultraviolet light or hydrogen peroxide) and 'self-disinfecting' surfaces (e.g., copper) also show promise to decrease contamination and reduce healthcare-associated infections (Weber *et al.*, 2013).

Study condacted by Livshiz reported the rates of National Pollutant Inventory **(** NPI) contamination ranged from 23% to 100%. Normal skin or environmental flora were found on almost all positive cultures. Potential pathogens, e.g., *S. aureus*, were present on up to 86%, and *Pseudomonas* spp. and/or Enterobacteriaceae in 38% of positive cultures. Multi-drug resistant organisms were isolated from up to 25% of items. (Livshiz *et al.*, 2015).

2.2. The common hospital bacteria

Methicillin-resistant *S. aureus* and vancomycin-resistant Enterococci are major hospital pathogens in hospital settings. These organisms are mainly transmitted by direct skin contact with infected/colonized patients. Air borne transmission may rarely occur in MRSA positive cases with upper respiratory infections. Contamination in immediate environment requires proper disinfection after contact. Screening patients for MRSA and VRE can be restricted against those in/from the high risk areas. The clinical pictures, methods for screening and the precautions were also discussed based on the nature of communicability in both pathogens (Hori, 2002).

Multiple-antibiotic-resistant *A. baumanii*, including meropenem resistance, was first isolated from a patient in the general intensive care unit of a tertiary-referral university teaching hospital in Birmingham in December 1998. Similar strains were subsequently isolated from 12 other patients, including those on another intensive care unit within the hospital. The outbreak followed an increase in the use of meropenem in both the units.

Environmental screening revealed the presence of the multiple-resistant *Acinetobacter* species on fomite surfaces in the intensive care unit and bed linen. The major source appeared to be the curtains surrounding patients' beds. Typing by pulsed field gel electrophoresis demonstrated that the patients' isolates and those from the environment were indistinguishable. Rigorous infection control measures including increased frequency of cleaning of the environment with hypochlorite (1000 ppm) and twice-weekly changing of curtains were implemented, along with restriction of meropenem use in the units (Das *et al.*, 2002).

1163 clinical isolates were analyzed. The frequencies of Gram-positive and Gram-negative bacteria were 30.4% and 56.2%, respectively. *S. aureus* was the most common isolate among the Gram-positive organisms, while *Pseudomonas aeruginosa* (*P. aeruginosa*), *Escherichia coli* (*E. coli*), and *Klebsiella pneumoniae* (*K. pneumoniae*) were the most Gram-negative isolates. The proportion of methicillin-resistant *S. aureus* (MRSA) to all *S. aureus* was 65.2%. Six vancomycin-resistant Enterococci were isolated in 2003. Extended-spectrum beta-lactamase (ESBL)-producing *K. pneumoniae* accounted for 20% of *K. pneumoniae* isolates since 2005. Carbapenem-resistant *P. aeruginosa* accounted for 34% of *P. aeruginosa* isolates. The nosocomial infection rate was not reduced after moving to a new hospital building in 2003. Urinary tract infection (30.2%) was the most common nosocomial infection, followed by bloodstream infection (26.5%) and lower respiratory tract infection (25.3%) (Lee *et al.*, 2009).

Other study abstracted Methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant *Enterococcus* (VRE) have achieved significant rates of colonization and infection in most intensive care units (ICUs). Both pathogens share common epidemiologic characteristics that suggest similar surveillance and control strategies. MRSA and VRE are readily found on colonized patients and their environment; healthcare workers' hands are a major vector of patient-to-patient transmission (Lin and Hayden, 2010).

Recent study in Miami showed the *P. aeruginosa* was the most common Gram-negative organism isolated in all pneumonia classes healthcare-associated pneumonia [HCAP, (11.1%); hospital-acquired pneumonia (HAP), (7.4%); ventilator-associated pneumonia (VAP), (9.4%)]. *Acinetobacter* species. Were also found with similar frequencies across pneumonia groups. To address potential enrollment bias toward patients with MRSA pneumonia (Quartin *et al.,* 2013*).*

2.3. Hospital acquired infection

Study of nosocomial infection surveillance in a 15-bed adult combined medical and surgical ICU of Farwaniya Hospital, Kuwait. Of 1,173 patients hospitalized in the ICU for an aggregate duration of 6,855 days, 89 patients acquired a total of 140 nosocomial infections; 46 (33%) ventilator-associated pneumonia (VAP), 33 (24%) central-line-associated bloodstream infection and 15 (11%) catheter-associated urinary tract infection, 22 (16%) cutaneous infection and 24 (17%) other infections. The culture-confirmed nosocomial infections, 81 (68%) were Gram-negative, 32 (27%) Gram-positive and 6

(5%) fungal. The most frequent organism was *P. aeruginosa* (20, 17%), followed by *A. baumannii* (15, 13%), *Klebsiella* species. (13, 11%) and *E. coli* (10, 8%). The crude mortality was 27% among ICU-infected patients (Aly *et al.,* 2008).

Study conducted to determine the distribution of the bacterial isolates of Hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP), their antimicrobial resistance patterns, and impact of discordant antibiotic therapy on clinical outcome in Asian countries showed, major bacterial isolates from HAP and VAP cases in Asian countries were *Acinetobacter* species. *P. aeruginosa*, *S. aureus*, and *K. pneumoniae*. Imipenem resistance rates of *Acinetobacter* and *P. aeruginosa* were 67.3% and 27.2%, respectively. Multidrug-resistant rates were 82% and 42.8%, and extensively drug-resistant rates were 51.1% and 4.9%.

Multidrug-resistant rate of *K. pneumoniae* was 44.7%. Oxacillin resistance rate of *S. aureus* was 82.1%. All-cause mortality rate was 38.9%. Discordant initial empirical antimicrobial therapy increased the likelihood of pneumonia-related mortality (Chung *et al.,* 2011).

Nosocomial infections in an intensive care unit (ICU) are common and associated with a high mortality. A retrospective study in Fiji's largest ICU (2011-12) reported that 114 of a total 663 adult ICU admissions had bacteriological culture-confirmed nosocomial infection. The commonest sites of infection were respiratory and bloodstream. Gram negative bacteria were the commonest pathogens isolated, especially *K. pneumoniae*

(extended-spectrum β-Lactamase-producing), *Acinetobacter*, and *Pseudomonas* species. Mortality for those with a known outcome was 33%. Improved surveillance and implementation of effective preventive interventions are needed (Naidu *et al.*, 2014).

2.4. Contamination of hospital privacy curtains

Recent survey, found that 42% of hospital privacy curtains were contaminated with vancomycin-resistant Enterococci, 22% with ethicillin-resistant *S. aureus*, and 4% with *C. difficile*. Hand imprint cultures demonstrated that these pathogens were easily acquired on hands. Hospital curtains are a potential source for dissemination of healthcare-associated pathogens (Trillis *et al.*, 2008).

study was conducted an urban academic 650-bed teaching hospital providing tertiary care to the city of Medellin, Colombia in this study Cultures from 30 computer keyboards, 32 curtains, 40 cell phones, 35 white coats, and 22 ties were obtained. Show in total, 235 bacterial isolates were obtained from 159 surfaces sampled. 98.7% of the surfaces grew positive bacterial cultures with some interesting resistance profiles. Which conclude there are significant opportunities to reduce patient exposure to frequently pathogenic bacteria in the hospital setting; patients are likely exposed to many bacteria through direct contact with white coats, curtains, and ties. They may be exposed to additional bacterial reservoirs indirectly through the hands of clinicians, using computer keyboards and cell phones (Catano *et al.*, 2012).

Privacy curtains are rapidly contaminated with potentially pathogenic bacteria. Twelve of 13 curtains (92%) placed during the study showed contamination within 1 week. Forty-one of 43 curtains (95%) demonstrated contamination on at least 1 occasion, including 21% with Methicillin-resistant *S. aureus* (MRSA) and 42% with vancomycin-resistant *Enterococcus* (VRE). Eight curtains yielded VRE at multiple time points: 3 with persistence of a single isolate type and 5 with different types, suggesting frequent recontamination (Ohl *et al.*, 2012).

2.5. Hospital hygiene and associated with hospital-acquired infection

Cross-transmission of microorganisms by the hands of health care workers is considered the main route of spread of nosocomial infections. Study to determine the process of bacterial contamination of health care workers' hands during routine patient care in a large teaching hospital.Bacterial contamination increased linearly with time on ungloved hands during patient care (average, 16 colony-forming units [CFUs] per minute; 95% confidence interval, 11-21 CFUs per minute). Patient care activities independently ($P<.05$ for all) associated with higher contamination levels were direct patient contact, respiratory care, handling of body fluid secretions, and rupture in the sequence of patient care. Contamination levels varied with hospital location; the medical rehabilitation ward had higher levels (49 CFUs; $P=0.03$) than did other wards. Finally, simple hand washing before patient care, without hand antisepsis, was also associated with higher colony counts (52 CFUs; $P=0.03$) (Pittet *et al.*, 1999).

Study in Chulalongkorn University, Bangkok, Thailand. To determine the baseline compliance and assess the attitudes and beliefs regarding hand hygiene of HCWs and visitors in intensive care units (ICUs). Resulted overall hand-hygiene compliance obtained from this observational study was less than 50% and differed markedly among various professional categories of HCWs and visitors. In questionnaire-based study, patient needs perceived as a priority (51.2%) was the most common reason for non-compliance, followed by forgetfulness (35.7%), and skin irritation by hand-hygiene agents (15.5%). Subjects believed to improve their compliance by multiple strategies including available low irritating hand-hygiene agents (53.4%), information of current nosocomial infection rate (49.1%), and easily accessed hand-hygiene supplies (46.3%). Almost all subjects (99.7%) claimed to know correct hand-hygiene techniques. Hand washing with medicated soap was perceived to be the best mean of hand decontamination (37.8%) (Patarakul *et al.*, 2005).

Recent study to evaluated steam cleaning method for hospital curtains. A standardised microbiological screening method was used to sample the environment before and after cleaning in order to quantify total viable counts as well as identify specific organisms. The results showed the Steam cleaning of curtains reduced microbial counts, but had little effect on *S. aureus* and other potential pathogens. These results might help managers assess the costs of different cleaning methods against potential infection control benefits in a hospital (White *et al.*, 2007).

CHAPTER THREE

MATERIALS AND METHODS

3.1. Study design

3.1.1. Type of study

This is a descriptive cross sectional study.

3.1.2. Study area

Samples were collected from hospital located in different localities in Khartoum State. The practical part was carried out in the Research Laboratory, Sudan University of Science and Technology.

3.1.3. Study duration

Study was conducted during the period from March to June 2015.

3.2. Collection of samples

The samples were collected following the method of Uneke *et al*., (2010) with some modification. The internal surface of each curtain was swabbed with sterile swab moistened by sterile distilled water. The cottony part of swabs was placed in 2 ml sterile distilled water in small test tube. The tube was then coded and placed upright in a pox. This was repeated each sample.

3.3. Laboratory work

After collection the samples were then taken to the Research Laboratory, where the medium was kept. Before inoculation the sample was applied to vortex and dilution in 6 tubes of sterile distil water by adding 1× of suspension to 9× of sterile distil water in serial (10fold). The last 3 dilutions were inoculated, 20µl from each dilution in 3 plates containing nutrient agar, allow to dry 15-20 mentis, each plate was labeled. The cultures were incubated at 37ºC overnight. After incubation period plates were assessed for growth.

3.3.1. Bacterial load

Pour plate method was used to calculate the bacterial load. A measured amount of suspension 20µl was mixed with nutrient agar medium in Petri dish. After incubation the number of colonies was counted. The average number of colonies should be between 30 and 300 colonies. To calculate colony forming unit (cfu) use this equation:

Cfu/ml= overage number of colonies for a dilution ×2×dilution facter.

3.3.2. Bacterial identification

Identification of bacteria was done macroscopically by colonial morphology, microscopically by Gram stain and Biochemical testes.

3.3.2.1. Biochemical tests

3.3.2.1.1. Catalase test

Catalase enzyme acts as catalyst in hydrogen peroxide to oxygen water. This test is used to differentiate staphylococci from streptococci. 2-3 ml of 3% hydrogen peroxide poured into a test tube. A sterile wooden stick used to remove a good growth of the tested organism and immerse it in the hydrogen peroxide solution. Immediate active bubbling indicated as positive result (Cheesbrough, 2000).

3.3.2.1.2. Coagulase test

Coagulase is an enzyme that causes plasma to clot by converting fibrinogen to fibrin when bacteria incubated with plasma. This test used to differentiate coagulase positive *Staphylococcus aureus* from coagulase negative staphylococci. Drop of normal saline on each end of a slide, a colony of tested organism in each of the drop was mixed to make a thick suspension, a loopful of plasma was added to the suspension and mix gently. Positive result clumping within 10 second (Cheesbrough, 2000).

3.3.2.1.3. Deoxyribonucease (DNAse) test (DNA hydrolysis)

DNase enzyme hydrolyzes deoxyribonucleic acid DNA. This is used to differentiate *Staphylococcus aureus* which produce DNase enzyme from other staphylocci. The organism inoculated by using sterile loop on a medium which containing DNA and incubates at 37˚C overnight. After the period of incubation cover the surface of the plate

with 1 mol/l hydrochloric acid solution. Tip off the excess acid. Positive result clearing around the colonies (Cheesbrough, 2000).

3.3.2.1.4 Monnitol fermentation test

A useful selective medium for *Staphylococcus aureus* which ferments Monnitol produce acid which convert the color of medium from pink to yellow. The tested organism inoculated by used loop and incubated at 37˚C overnight. After the period of incubation *Staphylococcus aureus* produce yellow colonies with yellow zones (cheesbrough, 2000).

3.3.2.1.5 Novobiocin susceptibility test

The mechanism of novobiocin-resistance includes inhibition of cell wall synthesis. The novobiocin disk can be used to differentiate *Staphylococcus saprophyticus* from other coagulase-negative staphylococci. Prepare a suspension of the tested organism in normal saline equal to MacFarland 0.5 standard. By sterile swap inoculate a Mueller Hinton agar by streaking the swap over the entire agar surface. the agar surface Allowed to dry, by sterile forceps apply disk to the agar surface incubate at 37˚C overnight. After incubation period the diameter of the zone of inhibition was measured using metric ruler. Sensitive – zone of inhibition equal or greater than 16 mm (*S. epidermidis*), resistant - zone of inhibition less than 16 mm (*S. saprophyticus*) (Collee *et al*., 1996).

3.3.2.1.6 Oxidase test

The oxidase test is used to determine the bacteria that produce certain cytochrome oxidase enzyme, which catalyze the transport of electron between the electron donors in

the bacteria and redox dye (tetramethyl .P.phenylenediamine) the dye is reduced to deep purple color. By using disc impregnated with reagent such as tetramethyl .P.phenylenediamine dihydrochloride (TMPD), which is redox indicator. Oxidase disc were placed on sterile petri dishes, and colonies to be tested were picked up with a wood and smear made, deep purple color within 5-10 seconds indicate positive result (Collee *et al*., 1996).

3.3.2.1.7 Fermentation of sugar, H_2S and gas production

The fermentation of sugar, production of hydrogen sulphide (H_2S) and gas production was carried out by using Kiligler iron agar (KIA Oxoid Company) tubes inoculated with test organism by using sterile straight loop, by stabbing button firstly then the slop streaked. Then the tube closed with sterile cotton and incubated at 35-37˚C overnight. Yellow slope indicate lactose fermentation, yellow butt indicates glucose fermentation, red color indicates no fermentation, air bubbles indicates gas production and blacking in the media indicates H_2S production (Cheesbrough, 2000).

3.3.2.1.8 Urease test

The test is used to determine the ability of the organism to produce the enzyme urease, which hydrolyzed urea. When the strain is urease producing, the enzyme will break down the urea (by hydrolysis) to give ammonia and carbon dioxide, with the release of ammonia. The organism is cultured in a medium which contain urea and the indicator phenol red. The medium becomes alkaline as shown by change in color of the indicator to

pink-red. A slope of urea agar medium incubated with test organism and examined for 24 hour of incubation. Change of the color to red indicates positive reaction (Cheesbrough, 2000).

3.3.2.1.9 Indole test

This test demonstrates the ability of certain bacteria to decompose the amino acid tryptophan to indole, which accumulates in the media. Indole is then tested for by colorimetric reaction with p-diamethyle-aminobenzaldhyde. Tryptophan broth was then inoculated with test organism and incubated for 24 hour at 37˚C. 5 ml of kovacs reagent added and shacked gently, A red color in the alcohol layer indicate positive reaction (Collee *et al*., 1996).

3.3.2.1.10 Motility test

This test used to test movement of bacteria by show turbidity after inoculums. The test was done by using semisolid agar. Which by adding of 0.2-0.5% of agar into nutrient broth. In a semisolid media motile bacteria (swarmed) and give diffuse spreading growth that is easily recognized by naked eye, thus may be detected more easily than microscopically (hanging drop) method (Collee *et al*., 1996).

3.3.2.1.11 Citrate utilization test

This test is one of several technique used occasionally to assist in based on the ability of an organism to use citrate as its only source of carbon, and tested for the ability of an organism to utilize citrate as sole carbon and energy source for growth and ammonium as

sole source of nitrogen, simmons citrate inoculated by test organism and incubated at 37˚C for 24 hour. A green color indicates positive result (Collee *et al*., 1996).

CHAPTER FOUR

RESULTS

Hundred curtains in 4 hospitals were selected in different locations in Khartoum State were examined for bacterial contaminations. All sample were cultured on stander bacteriological media to determine bacterial load of the hundred swaps examined. 27(27%) were yielded bacterial growth, and the rest 73(73%) failed to show any bacterial growth (Table 1). The frequency of contamination of curtains according to hospital was as 4% in hospital A, 2%in hospital B, 14%in hospital C, 7% in hospital D and number of samples (Table 2).The result revealed that the mean of bacterial load in all contaminated curtains was 8.21×10^6 cfu/ml. the mean bacterial load of each hospital was as follows 0.76×10^6cfu/ml in hospital C,0.78×10^6 cfu/ml in hospital B, 0.79×10^6cfu/ml in hospital D, 1.11×10^6cfu/ml in hospital A (Table 3).

From the contaminated curtains; 29 bacterial strains were isolated. Majority of these isolate were Gram-positive bacteria 19(65.5%) and 10(34.5%) Gram-negative bacteria. According to hospitals Gram positive and negative bacteria were 4(21%)and 0(0%)in hospital A, 2 (10.5%) and 0(0%) in hospital B, 8(42.1%) and 8 (80%)in hospital C and 5(26.3%) and 2(20%) in hospital D (Table 4).

The most frequent isolate of Gram-positive bacteria were *Bacillus* species 11(57.9%), followed by *Staphylococcus aureus* 7 (36.8%) and *Staphylococcus epidermidis* 1(5.3%) (Table 5).

The most frequent isolate of Gram-negative bacteria were *Pseudomonas aeruginosa* 6(60%), and *Klebsilla pneumoniae* 4 (40%) (Table 6).

Table 1. Bacterial growth after primary cultivation of samples

Specimens	No	%
Growth	27	27
No growth	73	73
Total	100	100

Table 2. Distribution of sample according to hospitals and load of contamination

Hospital name	Number of Sample	load of contamination
A	10	4(40)
B	20	2(10)
C	50	14(28)
D	20	7(35)
Total	100	27(27)

Table 3. Everage of bacterial load according to hospitals

Hospital	Cfu/ml
A	76×10^4
B	78×10^4
C	79×10^4
D	111×10^4
Total	82.1×10^4

CFU: colony forming unit.

Table 4. Frequency of Gram-positive and negative bacterial species according to hospitals

Hospital	Gram-positive	Gram-negative
A	4(21%)	0(0%)
B	2(10.5%)	0(0%)
C	8(42.1%)	8(80%)
D	5(26.3%)	2(20%)
Total	19(65.5%)	10(34.5%)

Table 5. Frequency of Gram-positive species according to hospitals

Hospital	*S. aureus*	*Bacillus* spp	*S. epidermidis*	Total
A	0(0%)	3(27.2%)	1(100%)	4
B	0(0%)	2(18.2%)	0(0%)	2
C	4(57.1%)	4(36.4%)	0(0%)	8
D	3(42.9%)	2(18.2%)	0(%0)	5
Total	7(36.8%)	11(57.9%)	1(5.3%)	19

Table 6. Frequency of Gram-negative species according to hospitals

Hospital	*Pseudomonas aeruginosa*	*Klebsiella pneumoniae*	Total
A	0(0%)	0(0%)	0
B	0(0%)	0(0%)	0
C	6(60%)	2(50%)	8
D	0(0%)	2(50%)	2
Total	6(60%)	4(40%)	10

CHAPTER FIVE

DISCUSSION

5.1. Discussion

Divider curtains are often used in health care settings to surround patient's bed and provide privacy. However studies implicated curtains may act as reservoirs for bacteria and a potential source of hospital acquired infection.

Of the 100 curtains sampled, 27(27%) were yielded bacterial growth. The rest 73(73%) failed to show any bacterial growth. This may be due to contamination by other micro organisms such as fungi or other bacteria required additional growth conditions.

The results of this study demonstrate that the swabbed curtains were contaminated with bacteria, most of which are common Gram- positive bacteria.

The rate of curtains contamination (27%) observed in this study indicates that curtains may play an important role in transmitting organisms in hospital environment. This rate is less that reported in USA (70%, 92% and 98.7%) by (Trillis *et al.*, 2008), (Ohl *et al.*, 2012), and (Catano *et al.*, 2012) respectively. the mean bacterial load of each hospital was as follows: 0.76×10^6cfu/ml, 0.78×10^6 cfu/ml, 0.79×10^6cfu/ml and 1.11×10^6cfu/ml in hospital C , B, D and A respectively. The differences in bacterial load between hospitals due to multiple strategies followed by the hospital including hand-hygiene and routine cleaning of the curtains and the frequencies of patients that admitted to hospital.

Moreover, some of the hospitals are newly constructed. The majority of these isolate were Gram-positive bacteria 19(65.5%), and 10(34.5%) Gram-negative bacteria, in fact that normal skin flora is made up of Gram-positive organisms, making it likely that organisms transferred to curtains during patient or healthcare contact, different from study done by Lee *et al.*(2009) which show Gram-positive and Gram-negative bacteria were (30.4%) and (56.2%). The isolated Gram-positive bacteria were (65.5%), this might be due to the direct contact of the curtains to human skin flora, which contains most o f Gram positive bacteria. This result line with the of Trillis *et al.*, (2008) who found Gram-positive isolate were more frequent (68%), Ohl *et al.*, (2012) (63%). The Gram- positive isolate included in this study were *Bacillus* species 11(57.9%), followed by *Staphylococcus aureus* 7 (36.8%) and *Staphylococcus epidermidis* 1(5.3%).vancomycin-resistant Enterococci, *Staphylococcus aureus*, and *Clostridium difficile* were included in Trillis *et al.*, (2 008) study. Were on *Bacillus* species and *Staphylococcus epidermidis* isolate in Trillis *et al.*, (2 008) study and Ohl *et al*., (2012) study. *Staphylococcus aureus* was (36%) of total isolate which was high in comparable with (22%) in Trillis *et al.*, (2008) study and (21%) in Ohl *et al.*, 2012. *Staphylococcus aureus* is normal flora of human skin but its potentially pathogen and also well documented fact that *Staphylococcus aureus* is a primary causative agent of hospital acquired infection (Hori, 2002). The most frequent isolate of Gram-negative bacteria reported in this study were *Pseudomonas aeruginosa* 6(60%), and *Klebsilla pneumoniae* 4 (40%) were agreement with (Lee *et al.*, 2009) study and (Quartin *et al.*, 2013*)* study.

5.2. Conclusion

It is concluded that the percentage of hospital curtains contaminated is slightly high and privacy curtains are rapidly contaminated with potentially pathogenic bacteria. Strategies to minimize the transmission of infection from curtains have been proposed, including the use of disposable curtains, especially for clinical high-risk environment, standardized microbiological screening method was used to sample the environment before and after cleaning of the curtains in order to quantify total viable counts as well as identify specific organisms. Instead hospital should develop more rigorous programs and protocols for curtains cleaning and disinfection as a standard of care. Hospital hygiene may be associated with hospital-acquired infection for that reasons the proper cleaning methods such as steam cleaning method for hospital curtains should be done (White *et al*, 2007).

5.3. Recommendations

1- Health care providers should make sure to wash their hands after routine contact with the curtains and before interacting with patient.
2- Further studies should investigate the role of privacy curtains pathogen transmission and provide interventions to reduce curtains contamination and validate the result of this study.
3- Hand washing and regular cleaning of curtains are highly recommended.
4- Wrong the gloves are very essential before interacting with patient.

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Appendices

a- Acetone alcohol

Equal volume of ethanol (90%) and acetone solution are mixing.

b- Crystal violet stain

Crystal violet 20 g in absolute ethanol 195 ml, 9 g of ammonium oxalate in 200 ml distilled water mixed together with stain solution, the volume completed with distilled water until one liter.

c- Gram iodine

Piotassiumiodide 20 g and iodine 10 g dissolved in one liter distilled water.

d- Kovac reagent

p-dimethylaminobenzaldhyde 10 gm in amyl or isoamyl alcohol 150 ml, the volume completed to 200 by adding concentrated HCL.

e- Normal saline(90%physiological saline)

9 g salt in 70 ml distilled water as the dissolved completely the complete to 100 ml.

f- Safranine solution

25 of safranine powder in 100 of 95% ethanol alcohol.

g- Indole medium

Formula of tryptophan broth

Peptone or pancreatic digest of casein	2 gm
Sodium chloride	0.5 gm

Distilled water	100 ml

Preparation

Dissolve the ingredient in water by heating. Autoclave for 15 minutes at 121 C˚ dispense in test tube.

h- Kiligler iron agar

Formula/ Liter

Enzymatic digest of animal tissue	10 gm
Enzymatic digest of casein	10 gm
Lactose	10 gm
Dextrose	1 gm
Sodium thiosulfate	0.5 gm
Phenol Red	0.025 gm
Agar	15 gm
Ferric Ammonium citrate	0.5 gm
Sodium Chloride	5 gm

Preparation

52 grams of the medium in one liter of distilled water. Sterilization at 121C˚ (15 Ibs. Pressure) for 15 minutes in autoclave. Cool and pour the media in a slanted position to obtain butts of 1.5-2 cm depth.

i- Nutrient agar

15 gm nutrient agar powder in one liter of distilled water, then sterilization by autoclave at 121C˚ for 15 minutes. Cooled to about 50 C˚ and poured into sterile petri dishes in 15 ml amount. The poured media left to solidify at room temperature.

j- Urea agar

Enzymatic digest of gelatin	1 gm
Dextrose	1 gm
Sodium Chloride	5 gm
Monopotassium	2 gm
Urea	20 gm
Phenol red	0.012 gm
Agar	15 gm \

Preparation

29 gm of the urea base in 100 ml of purified water until dissolved completely. Autoclave at 121 C˚ for 15 minutes. Cool sterilized to 45-50 C˚ and add the sterile urea agar base. Then mixed thoroughly and dispense into tubes in a slanted position.

k- Simmons citrate agar

Formula / Liter

Magnesium sulfate	0.2 gm
Ammonium dihydrogen phosphate	1 gm
Dipotassium phosphate	1 gm
Sodium citrate	2 gm
Bromothymol blue	0.08 gm
Agar	15 gm

Preparation

Suspend 24.28 grams in 1000 ml distilled water. Heat to boiling to dissolve the medium completely. Mix well and distribute in tubes or flasks. Sterilize by autoclaving at 15 Ibs pressure (121 C˚) for 15 minutes. Final ph is 6.8.