Suction Machines as Fomites: Surveillance for Infection Control in Selected Special Areas and Wards of Gregorio T. Lluch Memorial Hospital, Iligan City

Basil Ruffi L. Acuzar
Kara Monina C. Mampao
Rex Richard A. Obeso

Abstract

A suction machine is one of the most commonly used equipment in the hospital mainly used when the patient is unable to mobilize fluids and thus prevents infections related to retained secretions of the respiratory tract. However, maintenance of sterility and proper care of the said equipment found at GTLMH has not been strictly practiced which might be a potential fomite for microbial proliferation. Bacteriological assessment to the said machine was done in order to determine and identify bacterial species and aid in the surveillance for infection control. Acquisition of samples was obtained through swabbing at different parts of the suction machine specifically the inside part of the collection bottle and the inside part of the connection tubing of Gregorio T. Lluch Memorial Hospital (GTLMH), Iligan City from different areas and wards: Emergency room, Neonatal Intensive Care Unit (NICU), OB-Gyne Emergency Room (OB-ER), Medicine ward, Surgery ward and Pediatric ward. Swab samples were subjected to the conventional method of identification of bacterial species. *Neisseria* sp. (17.4%), *Bacillus* sp. (15.2%), and Coagulase-negative *Staphylococcus* (CONS) (13%), *Micrococcus sp.* and *Proteus* sp. (8.7%),

ACUZAR earned his Bachelor of Science in Nursing at Mindanao State University – Iligan Institute of Technology and passed the Nurse Licensure Examination in July 2010. MAMPAO graduated cum laude from the Mindanao State University Iligan Institute of Technology in 2010 with a degree in Bachelor of Science in Nursing. She passed the Nurse Licensure Examination also in July 2010. OBESO earned his Bachelor of Science in Nursing at Mindanao State University – Iligan Institute of Technology. He passed the Nurse Licensure Examination in July 2010.

*Salmonella, Staphylococcus aureus*and *Shigella*sp. (4.3%), *Streptococcus* sp., *Klebsiella*sp. and *Pseudomonas* sp. (2.2%) were among the identified bacterial species. Other gram negative bacteria (17.4%) were still left unidentified. The high rate of admissions and more frequent use of suction machines in the Emergency room may be attributed to the increased incidence of having more bacterial species present compared to other areas in the hospital. The Neonatal Intensive Care Unit yielded the least number of identified bacteria which may be attributed to the sterility of the babies' respiratory tract. Between the connection tubing and collection bottle, the latter yielded the highest number of bacterial species. Moreover, the parts of the suction machine are not dependent on each other with respect to the total number of types of bacteria present. Accordingly, proper care and maintenance should be observed to reduce, if not, eliminate potential source of nosocomial infection that may pose a threat to patient's health condition.

Keywords: suction machine, bacteria, nosocomial infection, hospital acquired-infection, respiratory infection

Introduction

Nosocomial infections cause considerable morbidity and mortality; it affects more than two million patients annually (Fauci et al., 2008). Pneumonia accounts for 15–20% of nosocomial infections and almost all cases of bacterial nosocomial pneumonia are caused by aspiration of endogenous or hospital-acquired oropharyngeal flora. Nosocomial pneumonias are associated with more deaths than are infections at any other body site. However, attributable mortality for ventilator-associated pneumonia—the most common and lethal form of nosocomial pneumonia—is in the 6–14% range; this Figure suggests that the risk of dying from nosocomial pneumonia is affected greatly by other factors, including comorbidities, inadequate antibiotic treatment, and the involvement of specific pathogens (particularly *Pseudomonas aeruginosa* and *Acinetobacter*). Early-onset nosocomial pneumonia, which manifests within the first 4 days of hospitalization, is most often caused by community-acquired pathogens, such as *Streptococcus pneumoniae* and *Haemophilus* species. Late-onset pneumonias most commonly are due to *S. aureus*, *P. aeruginosa*, *Enterobacter* species, *Klebsiellapneumoniae*, or *Acinetobacter*—a pathogen of increasing concern in many Intensive Care Units (ICUs) (Fauci,*et* al., 2008). Most of the infections are due to the use

of improper technique in the handling of certain devices such as suction machines; such techniques can introduce pathogens in the airways or cause damage to the respiratory epithelium and increase the risk for infection. Spread of the infection is also facilitated by cross-contamination when healthcare personnel fail to observe proper hygiene and sanitation.

Efforts to lower the rates for nosocomial infections have been challenged by the growing numbers of antibiotic-resistant strains. The emergence and ongoing spread of antimicrobial-resistant bacteria is a major public health threat. Infections caused by these bacteria are associated with substantially higher rates of morbidity and mortality compared to infections caused by antimicrobial-susceptible bacteria (D'Agata*et* al., 2008). Since October 2001, the CDC (Centers for Disease Control) has enlisted the ICUs of medical centers to adopt the National Nosocomial Infections Surveillance System (NNIS). For site-specific nosocomial infections in the entire ICUs of medical centers, urinary tract infections topped the list (40.5%), followed by bloodstream infections (26%), and respiratory tract infections (16.9%). The top three pathogens for infections among the ICUs of medical centers were: *Pseudomonas aeruginosa*, *Escherichia coli*, and *Acinetobacterbaumanni*. While the top three pathogens for nosocomial infections in the non-ICUs were: *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa* (Nosocomial Infections Surveillance System, 2001).

Prolonged use of suction machines and improper sterilization techniques can hasten the risk for developing infections. Hence, the present study was undertaken to determine and identify the spectrum of bacterial flora found in the connection tubings of suction machines and its collection bottles in the different special areas and wards of Gregorio T. Lluch Memorial Hospital (GTLMH) in Iligan City. This study aims to facilitate in the surveillance, prevention and control of nosocomial infections; and aid healthcare institutions determine whether control efforts are succeeding and guide them as to where increased education and control measures should be focused.

Conceptual Framework

Figure 1 shows the conceptual model wherein the independent variables were the suction machines' connection tubing and its collection bottle. Connection tubing is a long tube where one end is attached to the machine and the other end is connected to the suction catheter. The collection bottle is a container where all the secretions are collected. During suctioning, secretions enter the tubing and are then collected in the bottle. Both materials can become breeding ground for bacteria. And if the maintenance and care of the variables are not strictly practiced, then these may be potential fomites for bacterial proliferation.

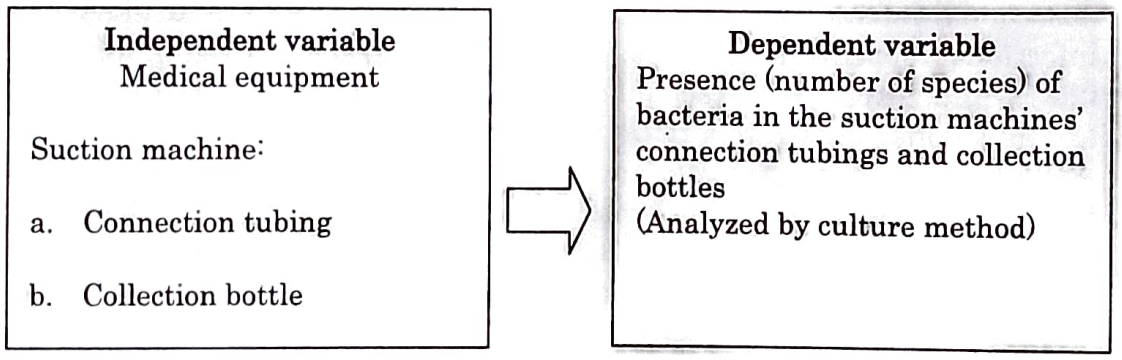

Figure 1. Conceptual Model

Objectives

The general objective of the study is to conduct a bacteriologic assessment of the connection tubing of the suction machine and collection bottle in the selected special areas and wards of Gregorio T. Lluch Memorial Hospital in Iligan City.

Specific objectives include the following:

1. Determine the presence of pathogens found in connection tubings of suction machines and collection bottles in selected special areas and wards of Gregorio T. Lluch Memorial Hospital.
2. Compare the bacterial species, through gram staining and biochemical tests, found among the selected special areas and wards of Gregorio T. Lluch Memorial Hospital.
3. Compare the bacterial species of the samples isolated from the connection tubings of the suction machines and collection bottles.

Scope and Limitation

This study is focused on taking samples from the suction machines' connection tubings' and collection bottles' inner part through swabbing. The said procedure was conducted at the different special areas and wards of Gregorio T. Lluch Memorial Hospital namely, Neonatal Intensive Care Unit, Emergency Room, OB-Gyne emergency room, Medicine ward, Pediatric ward, and Surgery ward. Suction machines were rarely used in the recovery room so it was excluded in the study; the operating room was also not included since the suction machine was mainly indicated for use in the gastrointestinal tract and the study focuses on the use of such machines for the respiratory tract. The researchers used Nutrient Agar (NA) and Nutrient Broth (NB) as growth media for bacteria. The samples were collected and tested for duration of 3 months from October to December 2009. The suction catheters were excluded because they are disposed right after use ideally. Quantification of the various species is not part of the study. The researchers examined the presence and quantity of bacterial species which play a significant role in respiratory nosocomial infections.

Related Studies

Local

Local studies were also cited that were concerned about nosocomial infections. The said studies were all focus on hospital equipment and hospital policies.

One study includes the stethoscope-cleaning practices of nurses and clerks on duty at Santo Tomas University Hospital and the effectiveness of common antiseptics used in disinfecting the stethoscope. The study comprises of 10 clerks, 8 interns and residents, and 4 nurses. The stethoscope that was examined was positive for *Staphylococcus aureus.* The study proves the fact that microorganisms can grow in stethoscopes and can be a potential source of nosocomial infections. On the other hand, all disinfected stethoscopes, regardless of the agent used, failed to grow any organism after incubation (Africa-Purino,*et* al., 2000).

Another study conducted at University of the Philippines-Philippine General Hospital compared the nosocomial rates before and after the implementation of cohorting among pediatric patients. The study used the Fisher's exact test as their statistical analysis. The study concluded that there was a reduction in the overall nosocomial infection rate from 16.99% to 13.85% upon the implementation of cohorting was observed to be not significant. Cohorting reduced the nosocomial infection rates at the wards but other factors such as discontinuing use of recycled syringes and regular orientation of the hospital staff regarding the basic principles and infection control also contributed to this outcome (Frago,*et* al., 2003).

Since the study revealed a significant reduction in nosocomial infection rates, cohorting should be implemented in the different hospitals especially in Gregorio T. Lluch Memorial Hospital where prevalence of nosocomial infection is high.

Foreign

In relation to the local studies, foreign research could also correlate or reinforce our study.

In Germany, a study was conducted wherein the researchers evaluated the possible role of prolonged application of Closed-In-Line

Suction Catheters (CISC) to cause enhanced colonization of both the biomaterial and the lower respiratory tract. The prospective, randomized study included 23 mechanically ventilated patients. The CISC tips, adjacent segments and tracheobronchial aspirates of each patient were examined for microbial growth. The results have shown that application for 72 h significantly enhanced the microbial growth on the CISC tips and on the adjacent catheter segment. Usage for 3 days led to a significant increase in colonization in the lower respiratory tract. Therefore, normal saline instillation in conjunction with endotracheal suctioning may lead to a dispersion of microorganisms into the lower respiratory tract. More effective self-cleaning mechanisms are necessary to decontaminate the CISC surface after suctioning (Freytag *et* al., 2002).

Another study at An-Najah University in 1995 was conducted wherein they investigated the incidence of pathogenic bacteria in the environments of Nablus hospitals and identifying sources of contamination within their environments. The study was carried out on two hospitals in Nablus. Another study is being carried out on the other two hospitals in Nablus and on Tulkarim hospitals. In their study, both blood agar and MacConkey plates were used for the isolation of bacteria from the environments of two hospitals in Nablus. *Pseudomonas aeruginosa*, *Escherichia coli* and Staphylococci were isolated from saline solution kept in glass bottles for washing and cleansing wounds, suction machines, respirators, endotracheal tubings, oxygen pumps and sinks. *Alcaligenesodorans* was isolated from the suction machines and Betio' solution. *Aeromonas* species were isolated from deionised water and sinks. In their study, the most predominant microorganism isolated from the two hospital environments was *P. aeruginosa*. This microorganism was isolated from suction machines and normal saline. As a conclusion, it is possible that hospital equipment can be a potential source of nosocomial infections. With proper disinfection and cleaning, nosocomial infection brought about by hospital equipment can be avoided (Faydil*et* al., 1995).

At the Department of Environmental Health Sciences, University Medical Center Freiburg, Freiburg, Germany in 2008, a study was conducted to ascertain the desirability of replacing closed suction systems after 72 h rather than after 24 h (manufacturer's recommendations) because it is possible that a reduction in the frequency of manipulations might reduce the risk of exogenous nosocomial pneumonia. The

researchers investigated the presence of time-dependent differences (after 24 h and 72 h) in pathogen survival/growth in artificially contaminated closed suction catheters. The results of the study showed the mean *S. aureus* load was 9.4 CFU/catheter after eight suction procedures and 6.2 CFU/catheter after 24 suction procedures (3 days). Mean growth of *P. aeruginosa* was 5.3 CFU/catheter, and 8.2 CFU/catheter after 3 days. There was no statistically significant difference between day 1 and 3 for *S. aureus* ($p = 0.474$), but there was for *P. aeruginosa* ($p = 0.004$). In conclusion to the study the findings show that, from an experimental point of view, it remains controversial whether routine change of closed suction catheters can be extended from 24 h to 72 h. However, clinical evidence suggests that prolonged use of a closed suctioning system is safe (Meyer*et* al., 2008).

Another study was focused on the outbreak of Methicillin-resistant *Staphylococcus aureus* (MRSA) in the Pediatric Intensive Care Unit (PICU) at T.N Medical College, Mumbai in year 2000. The purpose of the said study was to determine the origin of the outbreak of MRSA in the PICU. MRSA was the cause of the nosocomial infection in the unit. This study concluded that the root of the outbreak was the portable suction machine that is used by most patients in the ward. With proper handling and cleaning of the said equipment, nosocomial infections can be prevented (Deep *et* al., 2000).

Research Design

This study employs a descriptive-survey and a descriptive-comparative type of study design and aims to identify bacteria present in the suction machines that may cause respiratory nosocomial infection. It is a descriptive-survey, because the study identifies the bacterial species found in the suction machines in the selected areas of GTLMH. As a descriptive study, it aims to obtain information regarding the different bacterial species present in the sampling sites. Collection of samples was done through swabbing. Identification was done via gram staining and series of biochemical tests. As a comparative study, a comparison was done on the density of bacteria from samples obtained from the connection tubing to those collected from the collection bottle. Further evaluation

was also made on bacterial species and density present in the different wards and special areas of Gregorio T. Lluch Memorial Hospital.

Methodology

Collection of Swabbed Samples

Using a dry, sterile cotton tip applicator, swab specimens from the inside part of the connection tubing and inside part of the collection bottle of the suction machine were collected by rubbing with even pressure encircling the tubing and bottle. Aseptic technique was observed all throughout the procedure. Swabbing was done quickly to avoid contamination. The specimens were then placed in the labelled screw capped tubes filled with 10 millilitres (ml) of Nutrient broth. The samples were then stored in an ice box at 20°C and transported immediately to the Biology laboratory at the College of Science and Mathematics, Mindanao State University-Iligan Institute of Technology. Tubes were then allowed to stabilize at room temperature. The contents were then mixed thoroughly.

Preparation of Samples for Serial Dilution

Sterile blue tips and 9 ml distilled water diluents were prepared. Aseptic techniques were strictly followed in conducting serial dilution. Using a micropipettor, 1 ml was aseptically transferred from the sample tubes into the diluents (1:10). This was then slightly mixed, and from this first dilution, another 1 ml was pipette out into another tube with diluents (1:100). After slight mixing, another 1 ml was pipette out and diluted into the final diluents (1:1000) as depicted in Figure 2.

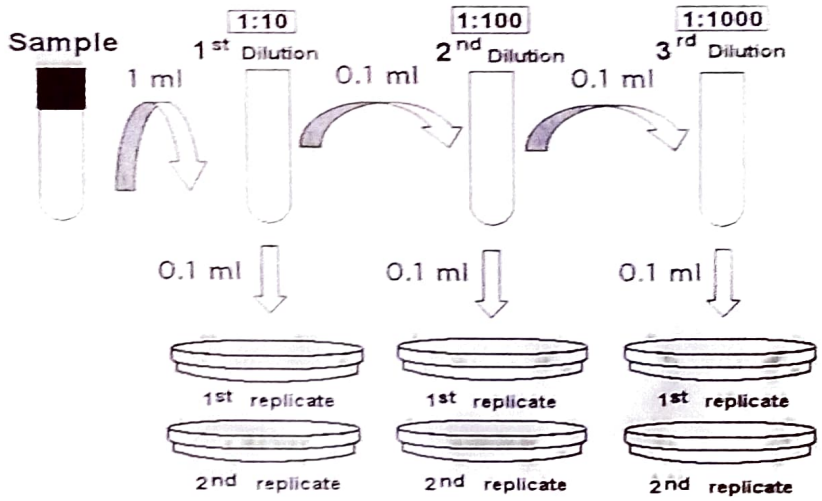

Figure 2. Serial Dilution Process

Spread Plate Method of Isolation

Using a micropipettor, 0.1 ml was collected from the sample tubes and introduced into the nutrient agar plate. The same amount was pipette from prepared dilutions of 1:10, 1:100, and 1:1000 then these were dispensed into the NA plates. It was then spread using an L-rod. The same process was done for each respective duplicate for each dilution. The plates were incubated for 24 hours at room temperature.

Heterotrophic Plate Count

After collecting the samples, serial dilution was done to reduce the concentration of microscopic organisms in a sample. Samples include the collection tubing and connection bottle of each suction machine. Spread plate technique was then performed wherein the samples were appropriately diluted and a small fractional amount was transferred to an agar plate. In each dilution including the original sample, there were two

(2) replicates. Hence, eight (8) plates were produced in each sample. After colonies were grown, they were then counted. Heterotrophic plate count was then made to estimate the number of live heterotrophic bacteria that were present in a sample. Results were interpreted as TFTC, TNTC. If the number was less than thirty (30) it was considered as "Too few to count (TFTC)". Hence, it was discarded. If the number was more than three hundred (300), on the other hand, it was labelled as "Too numerous to count (TNTC)" but considered viable. These viable samples were then subjected for isolation, purification and maintenance of bacterial isolates.

Isolation, Purification and Maintenance of Bacterial Isolates from Suction Machines

A representative isolate of each colony type was chosen according to its cell morphology and streaked for isolation onto a nutrient agar plate using Multiple Interrupted Streak method as shown Figure 3. It was then allowed to incubate for 24 hours at room temperature. The isolated colonies formed were streaked and isolated twice over to ensure that the bacterial isolates were not contaminated. Modified sterile vial slant with nutrient agar were utilized for stocking the pure bacterial isolated for further testing.

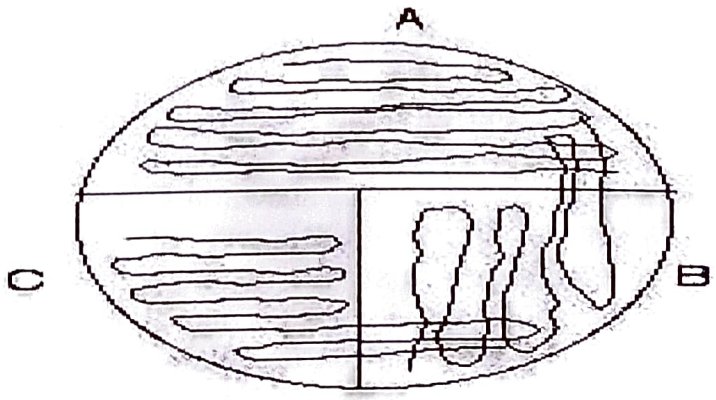

Figure 3. Multiple Interrupted Streak Method

Gram staining

The Gram stain is used to classify bacteria on the basis of their forms, sizes, cellular morphologies, and Gram reactions. It is additionally a critical test for the rapid presumptive diagnosis of infectious agents and serves to assess the quality of clinical specimens. The Gram stain, which divides most clinically significant bacteria into 2 main groups, is the first step in bacterial identification. A drop of distilled water was placed on a clean glass slide. Using aseptic techniques, an inoculum from 24-hour-old culture was removed and smeared onto the clean glass slide. This was allowed to dry, and heat-fixation was conducted by gently and thoroughly heating the glass slide through a flame three times. The bacteria smear was first stained with the basic dye crystal violet for 30 seconds and washed thoroughly with running water. The smear was then treated with Gram's iodine solution for 1 minute and then rinsed with ethanol. Finally, the counterstain safranin was applied for only 30 seconds, and it was rinsed with running water. The slide was set to dry for a minute, then microscopy followed and the shape, arrangement, and gram reaction were noted. All stained slides were then examined in a microscope under low power objective (LPO) and oil immersion objective (OIO). Results from gram staining reaction was differentiated by the color of bacterial cells in which the gram negative will appear pink while those that are gram positive will appear purple (Bruckner, 2008).

Cellular Characterization on Cell Shape and Cell Arrangement

Characterization of the different bacterial isolates included the whole shape of the colony, size in millimeters, edge/margin, elevation, color, opacity, surface, and consistency as shown in Figure 4.

The shape of the colony refers to the overall Figure exhibited by the bacterial colony: round, irregular, filamentous, rhizoid and curled. The edge of the bacterial isolate is a colony morphology characteristic likewise considered in such forms as: entire, filamentous, undulate and lobate. Another cultural characteristic of bacterial isolates on nutrient agar growth is the elevation which assumes the forms as: raised, flat, convex and umbonate.

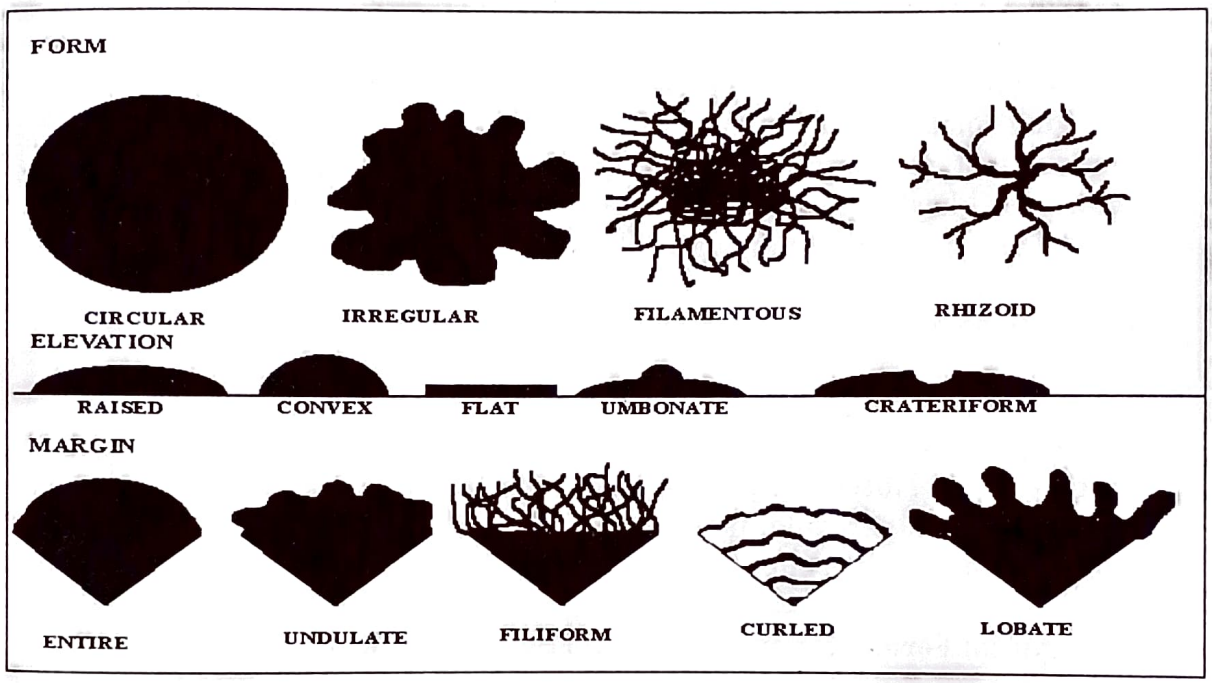

Figure 4. Different types of colonial morphologies, regarding the shape, edge, and elevation of the colony (Hurlbert, 1999).

Biochemical Characterization and Identification of Heterotrophic Bacteria

Bacteria are characterized and classified mostly by their enzymes or biochemical reactions. As they grow on various types of media, they produce certain types of metabolites that are detected by their interaction with test reagents which may result in a color change (Leboffe *et* al, 2006).

Series of biochemical tests were done for the identification of the kinds of bacteria found in the connection tubing and collection bottles from the suction machines. Prior to the conduction of such tests, samples were first taken and grown in Petri dishes with culture media; the samples were then isolated to achieve a more purified selection of

bacteria. Afterwards the isolated bacteria were incubated to allow growth isolated colonies were expected to grow, then, the number of isolated bacteria were then counted. If the count reaches between 30-300 colonies, it was considered viable to undergo the different biochemical tests. The following biochemical tests were done for identification of isolates: catalase test, mannitol fermentation test on MSA, coagulase test or also known as blood hemolysis on blood agar, Hydrogen sulfide production using TSI agar and gram-negative bacterial growth on EMB agar.

A. Catalase test

This test identifies bacterial strains which produce the catalase enzyme, which converts hydrogen peroxide to water and oxygen gas. Cultures from Nutrient Agar were added with few drops of thirty percent (30%) hydrogen peroxide. If there are bubble formations, it is positive for catalase reaction (Leboffe *et* al, 2006).

B. Mannitol Fermentation on Mannitol Salt Agar (MSA)

Mannitol Salt Agar (MSA) contains the carbohydrate mannitol, 7.5% sodium chloride (NaCl), and the pH indicator phenol red. Phenol red is yellow below pH 6.8, red at pH 7.4 to 8.4, and pink greater than or equal to pH 8.4.The sodium chloride makes the medium selective for Staphylococci because most other bacteria cannot survive in this level of salinity. The pathogenic species of *Staphylococcus* ferment mannitol and produce acid, which turns the pH indicator yellow. Non-pathogenic staphylococcal species grow but produce no color change. The development of yellow halos around the bacterial growth provides strong evidence that the organism is a pathogenic *Staphylococcus* (usually *S. aureus*). Good growth produces no color change is evidence for non-pathogenic *Staphylococcus* (Leboffe *et* al., 2006).

Mannitol Salt agar (MSA) was prepared and was then poured in Petri dishes. The Petri dishes were then divided into 4 divisions each plate each dish was divided into 4 quadrants. Using aseptic technique, an inoculum from the mother culture was then streaked [inoculated] onto the Petri dishes. It was then allowed to incubate at room temperature for 24 hours.

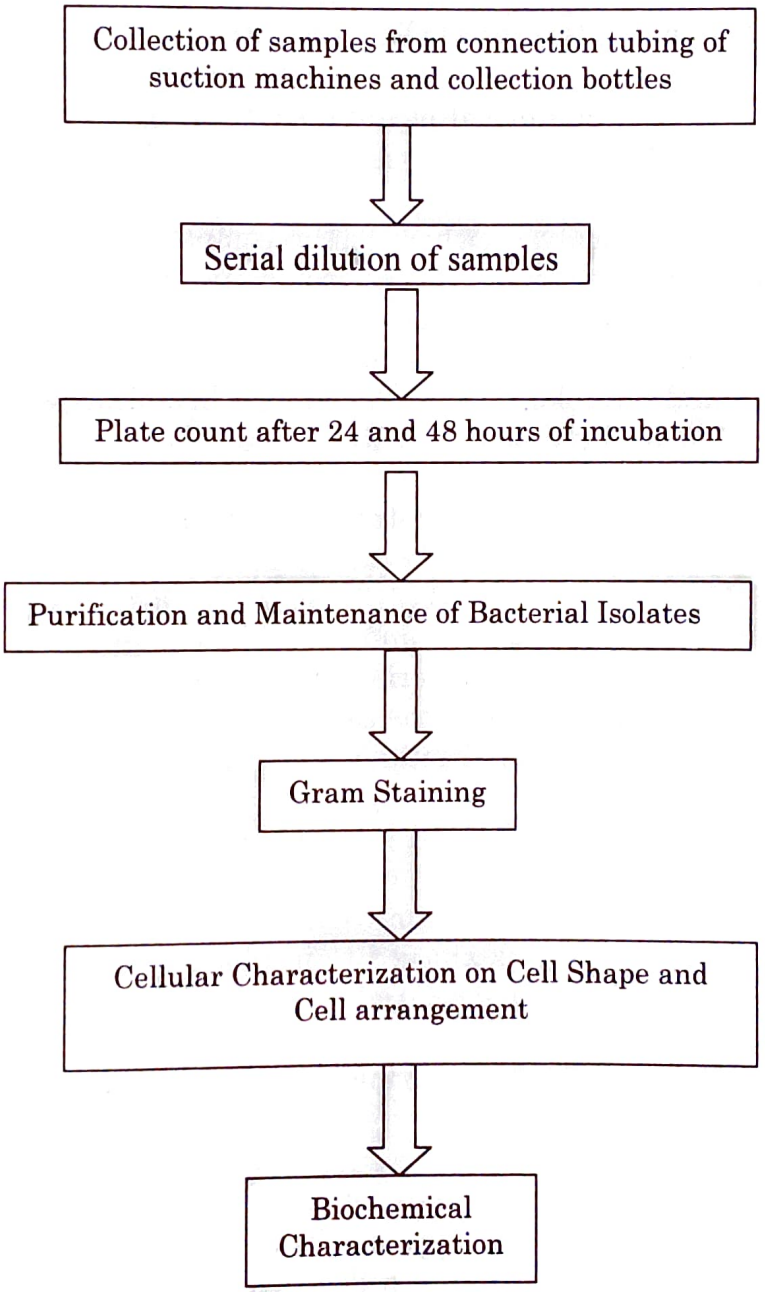

Figure 5. Schematic diagram of the procedure used.

C. Hemolytic Activity on Blood Agar Plates

Blood agar is a differential medium that allows distinction among bacteria based on their ability to lyse red blood cells. The researchers added human blood to the nutrient agar. There are three patterns of hemolysis: (1) Beta hemolysis, which is the complete lysis of red blood cells and hemoglobin. This results in complete clearing of the blood around the colonies, (2) Alpha hemolysis refers to the partial lysis of red blood cells and hemoglobin. This results in a greenish-grey discoloration of the blood around the colonies and (3), Gamma hemolysis which results in no change in the medium (Hurlbert, 1999).

D. Lactose Fermentation on Eosin Methylene Blue (EMB)

Eosin Methylene Blue (EMB) agar is both selective and differential. It contains the dyes eosin and methylene blue, which inhibit the growth of gram-positive bacteria and therefore select for gram-negative bacteria. It also contains the carbohydrate lactose, which allows differentiation of gram-negative bacteria based on their ability to ferment lactose (Collin, 2001).

EMB agar was prepared and was then poured in vials. The vials were then sterilized and had it in slanting position until agar was hard. Using aseptic technique, an inoculum from the mother culture was then streaked onto the vials. It was allowed to incubate at room temperature for 24-48 hours.

E. Hydrogen Sulfide Production on Triple Sugar Iron (TSI)

Triple Sugar Iron (TSI) Agar is a rich medium designed to differentiate bacteria on the basis of glucose fermentation, lactose fermentation, sucrose fermentation, and sulfur reduction. The medium was prepared as an agar slant with a deep butt, thereby providing both aerobic and anaerobic agar butt followed by a fishtail streak of the slant. The incubation period was 18 to 24 hours for hydrogen sulfide reactions. The production of hydrogen sulfide is indicated by the presence of a precipitate that blackens the medium in the butt of the tube (Leboffe*et* al., 2006).

As with the phenol red fermentation broths, if an organism can ferment any of the three sugars present in the medium, the medium will turn yellow. If an organism can only ferment dextrose, the small amount of dextrose in the medium is used by the organism within the first ten hours of incubation. After that time, the reaction that produced acid reverts in the aerobic areas of the slant, and the medium in those areas turns red, indicating alkaline conditions. The anaerobic areas of the slant, such as the butt, will not revert to an alkaline state, and they will remain yellow. This happens with *Salmonella* and *Shigella* (Austin, 2008).

Conclusion and Recommendations

Among the identified bacterial species were *Neisseria* sp. (17.4%), *Bacillus* sp. (15.2%), and Coagulase-negative *Staphylococcus* sp. (13%), *Micrococcus sp.* and *Proteus* sp. (8.7%), *Salmonella, Staphylococcus aureus*and *Shigella*sp. (4.3%), *Streptococcus* sp., *Klebsiella*sp. and *Pseudomonas* sp. (2.2%). Other gram negative bacteria(17.4%) were still left identified.

Among the different areas of GTLMH, the emergency room yielded the most number of bacterial species namely *Bacillus* sp., *Proteus* sp., *Salmonella* sp., CONS, *Neisseria* sp., *Shigella* sp., and some other unidentified gram negative bacteria. The Neonatal Intensive Care Unit yielded the least number of identified bacteria which may be attributed to the sterility of the babies' respiratory tract. Between the connection tubing and collection bottle, the latter yielded the highest number of bacterial species. It is therefore evident that the collection bottles of the suction machines have the most number of bacterial species since it is where the secretions are collected after suctioning. This serves as a breeding ground for bacterial proliferation if left without cleaning. Therefore, collection bottles should be properly cleaned and sterilized and there should also be filters inside in order to prevent release of bacteria into the environment which can be a source of respiratory nosocomial infection. Not only the collection bottle but also the connection tubing should also be cleaned properly to reduce the risk of introducing bacteria with the suction catheter and prevents condensate and secretions from contaminating the environment. Since more diverse and more pathogenic species were isolated from the emergency room, a more vigorous

sterilization should be employed to keep the area infection-free. It is important for the health care workers to observe proper infection control through cleaning and disinfecting equipment, such as suction machines, every after use in order to prevent respiratory nosocomial infection.

Hospitals' infection-control committees must determine general and specific control measures. Given the prominence of cross-infection, hand hygiene is the single most important preventive measure in hospitals. Health care workers' rates of adherence to hand-hygiene recommendations are abysmally low (<50%). Reasons cited include inconvenience, time pressures, and skin damage from frequent washing. Sinkless alcohol rubs are quick and highly effective and actually improve hand condition since they contain emollients and allow the retention of natural protective oils that would be removed with repeated rinsing. Use of alcohol hand rubs between patient contacts is now recommended for all health care workers except when the hands are visibly soiled, in which case washing with soap and water is still required (Fauci*et* al., 2008). Other preventive strategies include prudent antimicrobial use, aseptic technique, short hospital stays, minimal use and early removal of invasive devices, adequate staffing and an active infection control program.

This study is highly recommended to the following:

- Hospital Administrators of Gregorio T. Lluch Memorial Hospital may implement guidelines that are directed toward the areas involved especially in the Emergency room wherein guidelines and standard protocols should established on proper handling and cleaning of hospital equipment, including other apparatus not involved in the study.
- Registered nurses should be reoriented and trained as to the procedure in cleaning and handling hospital equipment to protect clients from possible nosocomial infections.
- Infection Control Staff should employ the following measures:
    - Proper sterilization of the suction machine
    - Proper scheduling of cleaning the different devices and apparatuses of the hospital especially the suction machines.

- The use of appropriate if not the ideal disinfectant which will eradicate microorganisms that may contribute to nosocomial infection.

- Patients are encouraged to buy their own suction apparatus to reduce the risk of contracting nosocomial infection. When budget is a problem, patient can provide connection tubing and, clean and disinfect the collection bottle.
- Clinical instructors and student nurses should have proper education about the possible microorganisms that could be present in suction machines that could cause nosocomial infection. Being a health educator, student nurses are urged to provide health teaching to patients on proper cleaning and handling of suction machines.

There are limitations in this study that the researchers would like to recommend the following as a follow-up study:

1. Future studies can do antibiotic susceptibility testing to check for the emergence of resistant strains like MRSA (Methicillin-resistant *Staphylococcus aureus*).
2. Include the suction machine in the recovery room.
3. Correlate the identified bacteria to the nursing care provided by the hospital workers through giving of questionnaires wherein it will determine the frequency in cleaning and changing the suction machine's tubing and bottle.
4. It is also important to identify and compare suction machines depending on whether they have filters or not.
5. Increase the number of hospitals to be included in the study in which the study can be converted into a comparative, correlational study.
6. Do quantitative analysis.
7. Correlate results with the type of nosocomial infection prevalent in the hospital.
8. To identify the bacteria up to the species level.

Selected References

Books

Baron, E., L. Peterson and S. Finegold. 1994. *Bailey and Scott's Diagnostic Microbiology,* 9th ed. St. Louis: Mosby Von Hoffmann Press, Inc.

Brooks, G., J. Butel and S. Morse. 2007. *Jawetz, Melnick, & Adelberg's Medical Microbiology*, 24th ed. New York: McGraw-Hill Companies, Inc.

Fauci, A., D. Kasper and D. Longo. 2008. *Harrison's Principles of Internal Medicine*, 17th ed. New York: McGraw-Hill Companies, Inc.

Isenberg, H.D. 1995. *Essential Procedures for Clinical Microbiology.* Washington, D.C.: American Society for Microbiology Press.

Leboffe, M. and P. Burton. 2006. *Microbiology Laboratory Theory and Application*, 2nd ed. Colorado: Morton Publishing Company.

Journals

Frago, C., A. Lopez, X. Fabay, D. Cua, and C. Untalan. "A cross-sectional study comparing the nosocomial infection rates before and after the implementation of cohorting among pediatric patients admitted in the wards." *PIDSP Journal*, vol. 7, no. 1, 2003 pp. 3-8.

Jarvis, W. and C. McDonald. "Linking Antimicrobial Use to Nosocomial Infections: The Role of a Combined Laboratory Epidemiology Approach." *Annals of Internal Medicine*, vol. 129 no3, 2008, pp. 245-247.

Meyer, E., M. Dettenkofe, W. Ebner, E. Meyer and M. Schuhmacher. "Experimental Contamination of a Closed Endotracheal Suction System: 24 h vs 72 h." *Infection,* vol. 37, no 1, 2008 pp. 49-51.

Internet

Africa-Purino, F., R. Coronel and E. Dy. 2000. *Stethoscopes: A potential source of nosocomial infections.* Retrieved from http://www.psmid. org.ph/vol29/vol29num1topic2.pdf on May 28, 2009

Austin, L. 2008. *Triple Sugar Iron.* Retrieved from http://www.austincc.edu/microbugz/triple_sugar_iron_agar.php on January 13, 2010.

Bruckner, M. 2008. *Gram Stain.* Retrieved from http://www.medchem.com/producedures/granstain.pdf on May 26, 2009

Collin, E. 2001. *Eosin Methylene Blue.* Retrieved from Http://Ftp.Ccccd.Edu/Dcain/CCCCD%20Micro/Embagar.Htm on Feb. 2, 2010

D'agata, E., M. Dupont-Rouzeyro, P. Magal, d. Olivier and S. Ruan. 2008. *The Impact of Different Antibiotic Regimens on the Emergence of Antimicrobial-Resistant Bacteria.* Retrieved from Http://Www.Ncbi.Nlm.Nih.Gov/Pubmed/19112501 On Feb. 4, 2010

Deep, A., Ghildiyal, R. 2000. Outbreak of MSRA in the Pediatric Intensive Care Unit of a Developing Country. Retrieved from http://www.iapindia.org/files/abstracts2007/IC.doc on Jan. 29, 2010

Faydil, Y., A Hamdan, M. Shtayeh and S. Al-Khalil. 1995. *Microbiological Screening of the Environments of Two Hospitals in Nablus.* Retrieved from http://www.najah.edu/researches/530.pdf on May 28, 2009

Freytag, F., W. Thies, König and T. Welte. 2003. *Prolonged Application of Closed In Line Suction Catheters Increases Microbial Colonization of the Lower Respiratory Tract and Bacterial Growth on Catheter Surface.* Retrieved from http://www.spingerlink.com/content/uqnv8v31tfmbba89/on May 28, 2009

Hurlbert, E. 1999. *Blood Agar Plates.* Retrieved from http://www.slic2.wsu.edu:82/hurlbert/micro101/pages/101hmpg.html on Ja. 15, 2010.

Nosocomial Infections Surveillance System. 2001. Retrieved from http://www.cdc.gov.tw/public/Data/o11r14193371.pdf on Feb. 4, 2010