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**“Minimizing Blood Culture False Positive Rate by
Educational Intervention on Proper Collection Techniques
at Caritas Baby Hospital”**

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M.Sc. Thesis

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Minimizing Blood Culture False Positive Rate by
Educational Intervention on Proper Collection
Techniques at Caritas Baby Hospital

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Jerusalem- Palestine

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Dedication

To all Palestinian children who deserve to have good health for healthy
Palestinian Society

"Children, I love you so much"

To my parents who supported me

To my husband who carried a lot of stress

To my children who I will never forget

Declaration

I certify that this thesis submitted for the degree of master is the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:

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Date:

Acknowledgment

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Title: Minimizing Blood Culture False Positive Rate by Educational Intervention on Proper Collection Techniques at Caritas Baby Hospital

Prepared by: Suhair Qumsiyeh

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Abstract

Hospitals have a problem that is the rate with which bacteria external to the patient contaminate blood cultures (BCs). If specimen collectors use poor collection technique, they can introduce organisms into BC bottles that mislead physicians into thinking that patients have bacteremias. The results can add more cost for treatment, lead to unnecessary antibiotic therapy, prolonged hospital stay, and monitor the patients with more tests. Thus the practice of aseptic technique in the collection should be emphasized. The goal of this study was to determine the effectiveness of the education intervention program on the proper procedure of blood collection in minimizing false positive (F+) rates of BC samples collected by nurses ward 'A' at Caritas Baby Hospital (CBH).

The aim of the study was to determine the effect of the educational intervention on nurses' ward 'A' knowledge, attitudes, and practices (KAP). And To determine the effect of the educational intervention in minimizing and making the move towards zero BC F+ rates for the intervention ward.

A hospital based quasi-experimental study with intervention and control group modalities was carried out in two pediatric wards at CBH in southern West Bank-Palestine.

The study targeted two populations, nurses working in the pediatric wards and BC sets.

A 51-items questionnaire developed by the researcher was given to 41 participants nurses in ward 'A' as intervention group and ward 'B' as control group before (pretest) and one month after (posttest) the educational intervention. The questionnaire included items related to updated BC practices and procedures, was pre-tested for validity and reliability in addition to pilot testing prior to data collection.

A total of 1117 BC samples were obtained from patients admitted at ward 'A and B' from May till July 2009, three months pre-intervention, and from September-October till November-December 2009, three months post-intervention. The BC F+ rates for the intervention and control wards were compared between the two periods.

The findings showed that the majority of the participants were PN (83%) with long experience and assessment for the intervention nurses revealed lack of knowledge and poor practices regarding BC collection technique. The findings of the study illustrated that the mean grades in the pretest for nurses' ward 'A' and 'B' was similar, and there was no significant difference between the two mean grades ($p= 0.51$). Thus the need for educational intervention emerged.

Comparing the posttest mean grades for the intervention (92.8) and the control nurses (50.3), the findings illustrated that there was significant difference between the two groups ($p=0$).

Pre-test and post-test grades for the control group were the same, while for the intervention group showed significant difference ($p=0$) with mean grades of 48.4 VS 92.8 respectively indicating that their knowledge and practice improved post-intervention. The clinical findings of this study indicated changes in nurses ward 'A' intended behaviors on-the-job concerning BC collection technique that been noted by the observation.

The BC findings revealed that the intervention ward 'A' had a baseline average F+ rate of (1.9%) and the control ward 'B' had a rate of (3%) from a total of 555 BC specimens collected pre-intervention. There were no significant differences in F+ rate for both wards from the baseline data ($p= 0.37$).

The average F+ rate decreased from 1.9% pre-intervention to 0.3% post-intervention for the intervention ward and from 3% to 1.5% for the control ward. Although there were no significant differences between the two wards post-intervention ($p= 0.07$) from 562 BCs drawn, however; a significant reduction in the BC F+ rate ($p=0.04$) was achieved in the intervention ward using new protocol for BC procedure. This indicates the effectiveness of the educational intervention program.

The recommendations for the Ministry of Health, to adopt polices to ensure Laboratory Information System to calculate the BC F+ rates are initiated in each laboratory of the different health settings to keep track on the contamination rates.

For the nursing academic institutions, to add the BC collection technique in the curriculum, and to emphasize on training in the clinical field as well as teaching the theoretical context of the process.

For the managers of the hospitals in general and CBH in specific, to consider the utilization of standard protocol for drawing BCs including use of proven disinfectants as skin prep. Adopt variety of strategies as continuously educating staff members on the correct procedure and provision of appropriate resources.

العنوان: تقليل نسبة الاحتمال الايجابي الخاطئ لزراعة الدم عبر التدخل في التعليم حسب مجموعة تقنيات مناسبة في مستشفى الكريetas للأطفال.

اعداد: سهير قمصية

المشرفة: الدكتورة سمية الصايح

ملخص الدراسة

تعرض المستشفيات الى مشكلة. وهي نسبة تواجد البكتيريا الخارجية التي تفسد زراعة الدم. فاذا استخدم جامع العينة تقنية جمع غير صحيحة فستدخل الكائنات الحية في زجاجات زراعة الدم والتي تضلل الأطباء الى الاعتقاد بأن ذلك المريض لديه بكتيريا في الدم. ويمكن أن تضيف هذه النتيجة المزيد من تكاليف العلاج، والتي تؤدي الى العلاج بالمضاد الحيوي الغير الضروري واطالة مدة بقائه في المستشفى ومتابعته بفحوصات أكثر. وبالتالي يجب أن يتم التركيز على تقنية التعقيم في عملية جمع الدم.

هدفت الدراسة لتحديد تأثير برنامج تعليمي وتدريبى للجراءات المناسبة في عملية جمع الدم من الطفل المريض لتقليل نسبة الاحتمال الايجابي الخاطئ في عينات زراعة الدم التي جمعتها ممرضات قسم (أ) في مستشفى الكريetas للأطفال.

- تحديد تأثير التدخل في التعليم على المعرفة والسلوك و الممارسة لممرضات قسم (أ).
- تحديد تأثير التدخل في التعليم في تقليل وتحريك نسبة الاحتمال الايجابي الخاطئ لزراعة الدم باتجاه معدل الصفر.

تستند الدراسة شبه التجريبية في مستشفى الكريetas للأطفال على نماذج مجموعة التدخل والتحكم التي تم تنفيذها في قسمين للأطفال في هذا المستشفى. استهدفت الدراسة ممرضات قسم الأطفال (أ و ب) وعينات زراعة الدم. طورت الباحثة نموذج استطلاع والمكون من ٥١ فقرة حيث شاركت في تعبئته ٤١ ممرضة يعملن في قسم (أ) كمجموعة تدخل وفي قسم (ب) كمجموعة تحكم. وتمت تعبئة النموذج على مرحلتين: الاولى شهر أي الفحص القبلي وشهر بعد التدخل في التعليم (الاختبار البعدي، أي ما بعد التدخل). وتضمن الاستطلاع فقرات لها علاقة بجراءات محدثة لجمع عينات زراعة الدم، وقد تم اختبارها لتحديد المصدقية والمعولية، بالإضافة الى تجربتها قبل جمع المعلومات.

تم الحصول على ما مجموعه ١١١٧ عينة لزراعة الدم من المرضى الذين تم ادخالهم الى قسمي (أ و ب) من أيار الى تموز ٢٠٠٩، أي ٣ شهور قبل التدخل، ومن أيلول-تشرين أول الى تشرين ثاني-كانون أول ٢٠٠٩، أي ٣ شهور بعد التدخل. وفقد تم مقارنة المعدل الايجابي الخاطئ لزراعة الدم لأقسام التدخل والتحكم بين الفترتين.

وكشفت النتائج بأن أغلب المشاركين بالدراسة ٨٣% هم من الممرضات العملييات (PN) وذات خبرات طويلة. وأن ممرضات التدخل ينقصهم المعرفة والممارسة الصحيحة لجمع عينات زراعة الدم.

أظهرت الدراسة بأن متوسط علامات الممرضات في القسمين (أ و ب) كانت متشابهة ولا يوجد دلالة احصائية بينهما ($P=0,51$) قبل اعطاء البرنامج التعليمي والتدريبى. وبالتالي انبثقت الحاجة الى التدخل في التعليم. ولقد تمت مقارنات عدة بعد التدخل وقد كانت النتائج التالية:

- لقد ارتفعت نسبة معدل العلامات لممرضات التدخل الى (٩٢,٨) وبقيت علامات ممرضات التحكم (٥٠,٣)، وهذا الفارق كان واضحا بين المتوسطان وهو ($P=0$).

- كانت نتائج ما قبل التدخل وما بعده لمجموعة التحكم متساوية. ولكن أظهرت مجموعة التدخل فرق واضح ($P=0$) مع متوسط الدرجات ٤٨,٤ مقابل ٩٢,٨ والتي بينت ان معرفتهم وممارستهم تحسنت بعد التدخل.

أظهرت النتائج العملية لهذه الدراسة تغيير واضح في السلوك فيما يتعلق بتقنيات تجميع زراعة الدم على العمل الذي لوحظ من قبل المتابعة والمراقبة.

- أما بالنسبة للمقارنة بين عينات الدم لنسبة احتمال الايجابية الخاطئة وقد كانت النتائج التالية:
- كشفت نتائج زراعة الدم بأن قسم التدخل (أ) لديه معدل خط اساس متوسط الايجابية الخاطئة (٩, ١%) وقسم التحكم (ب) من مجموع ٥٥٥ عينة تجميع زراعة الدم قبل التدخل. ولم يكن هنالك اي تغيير ملحوظ من البيانات الاساسية ($P=0,3$)
 - انخفضت نسبة متوسط الايجابية الخاطئة من ١,٩% قبل التدخل الى ٠,٣% بعد التدخل لقسم التدخل و من ٣% الى ١,٥% لقسم التحكم. بالرغم من انه لم يكن هنالك فرق واضح بين القسمين قبل التدخل ($P=0,07$) من ٥٦٢ عينة زراعة دم مسحوبة , بينما حققت النتائج تخفيض واضح في معدل الايجابية الخاطئة لزراعة الدم ($P=0,04$) في قسم التدخل باستخدام نظام جديد لتجميع زراعة الدم. وهذا يوضح مدى تأثير برنامج التدخل في التعليم.

توصي الدراسة بأن تتبنى وزارة الصحة سياسات لضمان مختبر نظام المعلومات لحساب معدل الايجابية الخاطئة لزراعة الدم على ان تبدأ في كل مختبر في مختلف الاماكن الصحية لتتبع مسار معدلات التلوث.

على مؤسسات التمريض الاكاديمية أن تضيف تقنيات جمع زراعة الدم الى مناهجها التعليمية والتدريبية في جمع عينات زراعة الدم

لمدراء المستشفيات بصفة عامة وبصفة خاصة في مستشفى الكريetas للأطفال، النظر في استخدام نظام موحد لسحب عينات الدم بما في ذلك استخدام المطهرات.

اعتماد مجموعة من الاستراتيجيات مثل تعليم وتدريب الموظفين المعنيين بالاجراء الصحيح على جمع عينات زراعة الدم وتوفير الموارد المناسبة لهم لجمعها بالطريقة الصحيحة.

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List of Abbreviations

BC	Blood culture
BCC	Blood Culture Contamination
BCT	Blood Culture Team
CBH	Caritas baby hospital
CE	Continuous Education
CLSI	Clinical and Laboratory Standards Institute
Dr	Doctor
ET-CH	Ethanol-Chlorhexidine
F+	False positive
KAP	Knowledge, Attitude, and Practice
MOH	Ministry Of Health
NGOs	Non Governmental Organizations
P/N	Practical Nurse
QA	Quality Assurance
RN	Registered Nurse
SPS	Sodium polyanetholsulfonate
SUHT	Southampton University Hospitals NHS Trust
SUMC	Soroka University Medical Center
VS	Versus
WB	West Bank

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Chapter I

Introduction

1.1 Introduction

Caritas baby hospital (CBH) in Bethlehem-Palestine is a medical pediatric hospital for patients aged 16 years and younger that has a blood culture obtained as part of their care. According to the Clinical and Laboratory Standards Institute CLSI (2006) blood culture is a specimen of blood that is submitted for bacterial or fungal culture. For blood cultures, false positive is a culture that yields a microbial isolates that is determined not to be the cause of sepsis.

CBH as other hospitals has a frustrating problem that is the rate with which bacteria external to the patient contaminate blood cultures. According to Ernst (2004) if specimen collectors use poor collection technique, they can introduce organisms into blood culture bottles that mislead laboratory technicians and physicians into thinking that patients have potentially life threatening bacteremias when in fact they do not, yielding misleading findings in terms of financial and human. Ernst clarified further; in financial terms: it can add more cost for treatment by more hospital stay, and in human terms: it leads to unnecessary antibiotic therapy, prolonged hospital stay that keeps patients from rejoining their families, and monitors the patients with more tests.

CBH is the only medical pediatric hospital in Bethlehem which serves the southern area in Palestine. It has three wards with 82 beds; ward 'A', ward 'B' for general pediatrics and the third ward for neonate and premature babies, beside an outpatient clinic. The occupancy rate is 87%. Blood culture specimens can be drawn from the all ward patients according to the need and by many health care workers including physicians, laboratory technicians, phlebotomists, and nurses. Eskira et al (2006) reported that health care providers can help introduce exogenous bacteria to blood culture samples through patient's skin, their hands and contaminated fomites; needle, syringe, or culture bottle. To maintain a good quality and best practice of the care given for the pediatric patients and combat this problem, this quasi-experimental study aims to teach nurses' ward 'A' at CBH about the practice of aseptic

technique in blood culture collection in attempt to reduce the contamination or false-positive rates of blood culture.

Murray et al (1999) stated that blood culture specimen is one of the most important specimens received by the laboratory. Because a wide variety of microorganisms can be involved in bloodstream-related infections, the methods used to recover organisms from the blood should be capable of supporting a range of microorganisms. There have been many improvements in the broth media and technology for culturing blood during the past decade, resulting in highly reliable manual and automated systems. Automated systems use instrumentation to detect microbial growth in broth media by monitoring byproducts of bacterial or fungal metabolism.

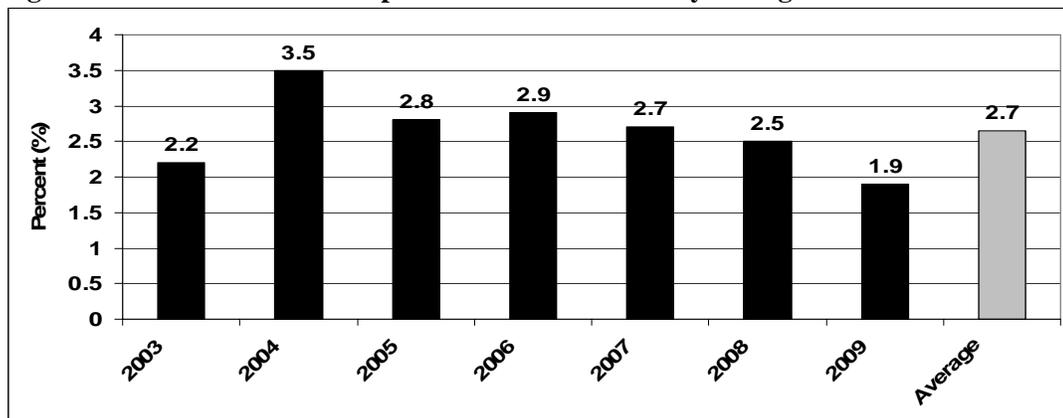
In CLSI (2006) guideline, blood cultures that are compromised by inattentive specimen-collection practices are costly to the hospital, the laboratory, and the patient. Reporting positive blood cultures which are not consistent with patient's condition, diagnosis, or clinical symptoms put physicians in a quandary. In addition, because the morbidity and mortality rates are attributable to sepsis is high, prompt and accurate detection of bacteremia and fungemia is important for improving patient care. Since the cross-training for health care professionals started, it has never been more difficult to control blood-culture contamination rates.

For this purpose, one strategy the researcher followed to decrease contamination rate was by educational intervention for the nurses ward "A" at CBH as intervention group that provided new protocol for drawing blood culture to help control health care costs, since costs of contaminants from blood cultures are high. The information cover sound collection practices as well as a review of recent studies findings that will arm nurses with specific strategies to prevent the expensive and unfortunate consequences of poor phlebotomy technique. Also it will give the physicians and the laboratory workers a way to combat the problem. This study is conducted to determine the effectiveness of the educational intervention in reducing blood culture contamination or false positive rates.

1.2 Problem statement

According to CLSI (2006), as example of quality assurance indicator, the goal for blood culture contamination rate, whether analyzed overall or stratified by location, phlebotomist, etc., should be below 2%. Even when the best blood collection protocols are used, it may not be possible to reduce the contamination rate below 2%. Despite a steady decline in the percentage rate of false-positive in blood culture at CBH, the false positive rates for six years (2003-2008) ranging from 2.2 - 3.5% (overall 2.9%) continue to exist. Figure 1.1 illustrates the blood culture false positive rate at CBH from (2003-2009) including the year of study (2009) which represents an explicit decline resulting from the intervention.

Figure 1.1: Blood culture false positive rate in the seven years ago at CBH.



Blood culture is important for the diagnosis of sepsis, but the interpretation of a positive blood culture may pose a difficult problem since not all cultures are clinically significant. Misinterpretation of a false positive blood culture result may lead to unnecessary antibiotics therapy, drawing other diagnostic tests, prolonged hospital stay, and added expense (Little et al, 1999). Because the mortality associated with bacteremia may be influenced by whether or not prompt and appropriate antimicrobial therapy is given, it is important that proper technique in the collection of blood for culture be employed. Thus the practice of aseptic technique in blood culture collection is the responsibility of the nurses who draw the blood specimens at CBH.

Only limited data are available concerning the association between the expertise of staff members and the risk of blood culture contamination. Previous studies have shown that trained phlebotomists are associated with lower blood culture contamination rates than resident physicians. Eskira et al (2006) reported that there is still a need to continuously

educate house staff on proper procedure of collecting routine laboratory examination such as that of blood culture.

The present study aims to examine the effect of an educational intervention on the proper procedure of blood collection in minimizing false-positive rates of blood culture samples collected by the intervention group at CBH. The intervention program which implemented by the study investigator aims to track nurses in ward 'A' as intervention group. This intervention entails 3 hours class room session complemented with video show and modeling behavior for the target group.

1.3 Significance of the study

Blood cultures provide very useful information if the blood is taken correctly from the patient. Because physicians depend on blood culture results to diagnose and monitor febrile patients, few results can have such a deep effect on patient care as an erroneous blood-culture report (Ernst, 2004). False-positive blood cultures arise due to contamination that occurs when organisms that are not actually present in a blood sample are grown in culture. Preventing blood culture contamination is important in order to reduce undesirable clinical outcomes including the inappropriate use of antibiotics, additional laboratory testing and associated costs laboratory and pharmacy expenditure (Thompson and Madeo, 2009).

Most blood cultures are drawn by venipuncture. In order to minimize the risk of contamination with skin flora, the venipuncture site requires disinfection (CLSI, 2006). So the practice of aseptic technique in the blood culture collection should be emphasized. For this purpose, educational intervention for the nurses ward 'A' at CBH on proper technique for blood culture collection conducted in an attempt to minimize false-positive rates of blood culture. This intervention is expected to influence the nurse's knowledge, attitude, and practice to control the contamination rate of the blood culture samples.

Unfortunately, CBH does not have the resources of maintaining a dedicated team of phlebotomists to keep a steady false positive rate of less than 2% as CLSI recommended in 2006 to assure high quality of care. Also there is no continuous education on the collection of blood culture planning for nurses who perform this procedure. For this reason it is critically important to continuously monitor and educate the health care providers who collect blood cultures, to keep contamination rates as low as possible. Thus, nurses'

education plays a central role in blood culture contamination prevention and improving patient care. As Thompson and Madeo (2009) concluded that a multidisciplinary approach is required along with the need to adopt a variety of strategies such as sufficiently educating clinicians on the correct techniques, provision of appropriate resources/equipment, and monitoring of contamination rates. They add, by maintaining vigilance with preparation, appropriate utilization of equipment and sampling techniques and feedback regarding contamination rates it is possible to make the move towards zero false-positives.

To date there is lack of data on morbidity and mortality attributable to sepsis in general and to false positive rates in specific. In Palestine, no studies concerning blood cultures false positive rates have been reported. The Ministry of Health (MOH) medical director of Palestine Laboratories was consulted and he assured the study investigator that no documentations were available for positive or negative blood culture rates at national level. He recommended to have such studies, and encouraged the researcher to continue this study to be a pioneer in this field. In addition, because of the clinical importance of bacteremia and fungemia, and therefore the importance of blood cultures, standard protocols are needed to help control health care costs, since the costs of contaminated blood cultures are high.

1.4 Purpose of the study

The purpose of this quasi-experimental study was to examine the effectiveness of education intervention program on the proper procedure of blood collection in minimizing the false-positive rates of blood culture samples collected by the intervention group (nurse's ward 'A') at CBH.

To achieve this purpose, the following measurable objectives were set.

Objectives

1. To have pretest assessment for the knowledge, attitudes, and practices (KAP) of nurses working in pediatric wards 'A' and 'B' on the proper procedure of blood collection for culture at CBH.
2. To assess through records the percentage of false positive blood culture rates for wards 'A' and 'B' three months prior to educational intervention.
3. To implement an educational program on the proper procedure of blood collection based on the assessed needs of nurses in ward 'A' as intervention group.

4. To compare pretests with posttests for both the intervention and the control groups.
5. To compare posttests for both the intervention and the control groups (nurses' ward A and B).
6. To compare pre-intervention with post-intervention false positive rates for both the intervention and control wards A and B.
7. To compare the false positive rates for both wards post-intervention as intervention and control wards.
8. To determine the effectiveness of the educational intervention on the proper procedure of blood culture collection in minimizing and make the move towards zero false-positive rates at CBH.

1.5 Research questions

This study will answer the following questions:

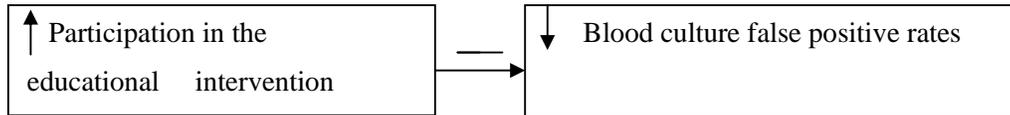
1. What are the common pitfalls and errors of blood culture collection currently implemented in the intervention ward 'A'?
2. Do educational intervention program has an impact on the (KAP) of the intervention group on the proper technique of blood culture collection?
3. Do educational intervention program make differences between the (KAP) of the intervention and the control groups?
4. Does the educational intervention on the proper procedure of blood culture collection for ward 'A' nurses reduce blood culture false-positive rates collected by them at CBH?
5. Does the educational intervention make difference in the blood culture false positive rates between the intervention and the control wards at CBH?

1.6 Hypotheses

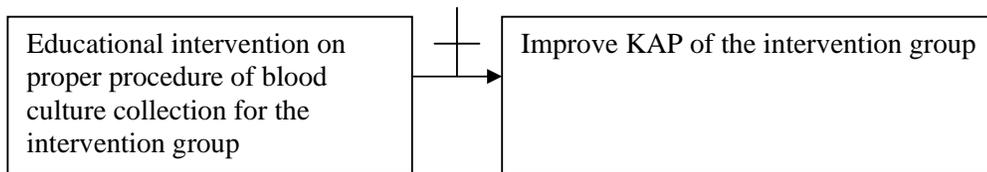
Hypothesis is defined by Burns and Grove (2007) as a formal statement of the expected relationship(s) between two or more variables in a specified population. The hypothesis translates the research problem and purpose into a clear explanation or prediction of the expected results or outcomes of the study. Hypothesis can be described using four categories: (1) associative versus causal, (2) simple versus complex, (3) non-directional versus directional and (4) null versus research.

In the present study, a simple hypothesis is used which states the associative or causal relationship between the two study variables:

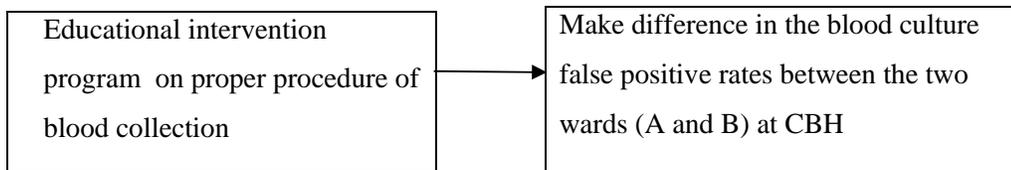
Hypothesis 1: Minimizing false-positive rates of blood cultures will be influenced by nurses who will participate in an educational intervention on proper collection of blood culture.



Hypothesis 2: Nurses who will participate in the educational intervention on proper blood culture collection at CBH will improve their knowledge, attitude, and practice for better care.



Hypothesis 3: The educational intervention program will make difference in the blood culture false positive rates between the two wards (A and B) at CBH?



1.7 Feasibility of the study

Researcher expertise- The researcher of this study has a Baccalaureate degree in nursing (20 years experience), post graduate Diploma in "clinical supervision" (12 years experience), and currently studying for Master Degree "Management in Nursing". She is a "Head Ward Sister" and a member of the "continuous education committee" at CBH, who participates in training the nurses on some nursing skills.

The study was carried out as a requirement for the Master's degree in nursing management at Al-Quds University and to enhance proper practice strategy for better care since it complies with CBH strategy to have a multi-skilled workforce to raise quality of service.

Money Commitment- The study is funded by the CBH, where it was implemented. Financial assistance from the Executive committee at CBH was provided.

Availability of subjects, facilities, and equipments- The study was conducted in partially controlled setting (CBH-pediatric hospital, Ward 'A' and 'B', nursing school, and the Laboratory) so it was easy to contact and obtain the subjects, facilities, and equipments.

The educational intervention was implemented in the Nursing School at CBH, where facilities and equipment for teaching are available.

Ethical Considerations- The title and the research methods were approved by the Higher Studies Nursing Committee which allowed passing the first part of the thesis.

A consent form was signed by nurses who participated in the study (please refer to annex 2). All nurses ward 'A + B' accepted to participate in the study after informing them about the potentiality to decrease the contamination rate of the blood culture to improve patients' care. Formal permission letter were written to make an appointment to explain the aim of the study in details (please refer to annex 5). This letter was sent to CBH 'Continuous Education Committee' to get their approval about the study.

1.8 Background of the study

Blood culture (BC) is a laboratory test in which blood is injected into bottles with culture media to determine whether microorganisms have invaded the patient's bloodstream or not. Such cultures are ordered as a set, which consist of 2 bottles; 1 aerobic bottle and 1 anaerobic bottle. If the skin is not adequately cleaned before drawing blood for culture, bacteria on the skin will be injected into the bottle, producing a false positive BC which results from the growth of contaminants. It is sometime difficult for the physician to determine; whether the bacteria growing in the BC is a real pathogen causing bloodstream infection or whether bacteria on the skin have contaminated the culture. This can lead to excess use of antibiotics and prolongation of hospital stay (Virginia Commonwealth University- VCU Medical Center, 1993).

Dowling et al (2008) pointed that patients with high fever may have small numbers of bacteria responsible for infection circulating in the bloodstream. To identify these bacteria, a sample must be taken carefully to avoid contamination by skin flora. Since bacteria are not normally present in the blood, any growth from the bottle is usually significant, and a gram-stain will be performed when there is evidence of bacterial growth in the bottle. They further added that early positive results provide valuable diagnostic information on which appropriate antimicrobial therapy can be based. And faulty technique during the collection may result in inadequate, misleading or delayed laboratory reports, which may affect the patient's treatment, including management of infection.

No microbiologic test is more important for the clinician than the blood culture. Finding of pathogenic microorganisms in the bloodstream often provides critical clinical information that in turn leads to specific, often life-saving therapy (Reller and Sexton, 2008). Ward-based staff should be encouraged to take the blood culture samples since this ensures familiarity with the procedure and increase the amount of clinical interests and information (Hawkey and Lewis, 1989).

One approach to reducing patient care costs is to decrease the rate of false positive blood culture by use of a dedicated team for blood collections and track the contamination rate for each team member (Murray et al, 1999). Because a designed team of phlebotomists is one of the factors that can significantly reduce a facility's blood culture contamination rate, the researcher challenge was to educate health-care personnel to use good collection technique. This educational intervention was based on guidelines from the CLSI (2006) to prepare collection sites aseptically when performing phlebotomy in their patients at CBH aiming to decrease the suffering of the sick children and reduction of the costs.

Few studies at international level and none at national level have addressed the effects of a training team of phlebotomists' intervention on the outcomes of false positive BC rates. The purpose of this study was of two-folds: First, attempted to determine whether knowledge, attitude, and practices of CBH nurse's ward 'A' could be improved by educational intervention on the proper procedure of BC collection and second, the study attempted to determine if the rate of false positive BC could be reduced by as a result of this intervention.

1.8.1 Background of study setting

The current study was carried out in CBH, the only medical pediatric hospital in Bethlehem, who serves the southern area in Palestine. The Palestine Occupied Territories consist of Gaza Strip and West Bank (WB) including Jerusalem. The WB is divided into four main regions; the northern region includes Nablus, Jenin and Tulkarem, the central region includes Jerusalem and Ramallah, the southern region includes Hebron and Bethlehem, and the region of Jordan Valley including Jericho (Ministry Of Health-MOH, 2001).

Bethlehem is the birthplace of the Jesus Christ and is one of the world's great shrines. It is located approximately 10 kilometers to the south of Jerusalem in an area of about 659 km², and the population is about 176, 235 (7.5% of the WB population). The estimated number of children (under the age of 18 years) in the Palestinian Territory in mid 2009 totaled 1.9 million; this represents about 49.4% of the total population, distributed 47.3% in the West Bank and 52.5% in the Gaza Strip. The age structure of the Palestinian society in general and of children in particular indicates that the Palestinian society is young. Children aged less than five years constitute 14.8% of the total population living in the Palestinian Territory, children aged (5-9 years) constitute 13.9%, children aged (10-14 years) constitute 13.3%, and while children aged (15-17 years) constitute about 7.4%. The total number of hospital beds is 645 divided between nine hospitals (Palestinian Central Bureau of Statistics PCBS, 2008).

Based on MOH in (2008), the main leading cause of infant mortality in the WB was respiratory system infections with 32.3%, followed by congenital anomalies with 16.8%. Infectious diseases were the cause for 13.5% of infant mortality and 12.7% for premature and low birth weight.

1.8.2 Short portray about CBH

Children's Relief Bethlehem's Media Kit (2009) reported the following short portray. Caritas Baby Hospital (CBH) is a Christian charitable institution, the only one for young children in Palestine, which ensures basic medical services for all children. It includes social services, a mothers' school, and a nursing college.

In Bethlehem, Christmas Eve 1952, on his way to the Church of Nativity, Father Ernst Schnydrig sees a desperate man burying his dead child in the mud near a Palestinian refugee camp. The farmer's son from the Swiss canton of Valais is deeply shocked, and he takes action. He rents a house, equips it with 14 beds, and calls it " Caritas Baby Hospital". He wins the support of the Palestinian doctor Dr. Antoine Dabdoub and the Swiss Hedwig Vetter for his project. Never again shall children at the birthplace of Jesus be refused medical help. In his native country, Schnydrig founds the organization "Children's Relief Bethlehem", an independent association with members from different countries, to financially secure the work in Bethlehem.

Up to today, the CBH has remained the only hospital in Palestine treating young children. There are 105'000 children of less than 4 years of age in the closer surroundings of Bethlehem and Hebron alone.

The initial makeshift institution developed into a modern children's hospital. In 1978, a new building with 82 beds was inaugurated. Father Schnydrig didn't live to celebrate this day. He died a few days before. His legacy is engraved in the foundation stone of the new building: We help the poorest as best we can, and in doing so never care about nationality or religion.

With the operation of its hospital, CBH doesn't only ensure basic medical care for children in Palestine. It also runs a mothers school, and in the nursing college, young people are trained in nursing care. Social workers see to it that the poor are treated gratuitously, and help the young patients' families.

The independent and impartial work, which is recognized and appreciated by all parties, is financed by donors of Children's Relief Bethlehem in Switzerland, Germany, Italy, and Austria. The annual costs for the CBH, including all allocations and necessary reserves, amount to 5.3 million Euros.

In 2007, Children's Relief Bethlehem agreed on major extension and reconstruction projects, in favor of the mothers' school and of the outpatient clinic. The respective costs amount to an additional 1.75 million Euro.

On the one hand, children in Bethlehem suffer from typical poverty diseases. On the other hand, potentially harmless diseases like diarrhea often become life-threatening, since the children are presented to doctors too late, and the bad hygienic conditions heavily accelerate

the course of the disease. The most frequent diagnoses at CBH are: gastro-intestinal infections with diarrhea and vomiting, acute disease of the respiratory tract, and pneumonia.

1.8.3 Building and infrastructure

The location of CBH is in Bethlehem Area in Palestine. The hospital consists of four separated buildings:

Entrance: The doorman and visitors' waiting room, garages, and parking.

The annex building: Day nursery (ground floor), Social department (1st floor), and Sister's apartment (2nd floor), the Chapel (ground floor), Conference hall (basement).

The nursing school: is separate from the building and its role is to graduates practical nurses (PN) with two years study period.

The main building: Basement- Laundry, Maintenance department, Changing room, Pharmacy, Central store, Kitchen, Milk-kitchen, Sterilization, Physiotherapy room, and Cardiac Clinic.

Ground floor- Reception, Outpatient Clinics, two Wards' A and B (57 beds), X-ray room, Emergency room, Laboratory, Playing room.

First floor- Premature and neonate ward (25 cots and incubators), Ultrasound, Doctors offices, Mothers Department (a house for inpatients' mothers with a capacity for 40 mothers).

Second floor- Administration Department, Dr's apartment, and Meeting room.

The hospital has a capacity of 82 beds/incubators for sick children. The daily average bed occupancy, from total of 82 beds, was 55.3% in 2009. The total hospital days were 20,184 while the average hospitalization period (days) was 4.5 days /pt which means that the needed patients only were admitted to complete the 5 days I.V treatments. The admission numbers were 4,534, from them 39 patient died.

As other organization this hospital consist of employees whose total number is (203) and the number of temporary workers 'pool' are (6). This number includes administrators, nurses, doctors, clerks, technicians of different specialties; all are working and doing their defined roles to achieve the final outcome which is providing the services to sick people attending hospital to reach its ultimate goal. There is equity in the relative number of Registered Nurses (4 RN) in each ward, with (Baccalaureate degree and some with post graduate diploma) and the rest are Practical Nurses (PN). However, the relative total number of RN to

the total number of PN is low. We have a high rate of PN to RN, as soon as PN graduate; they have more practical experience than newly graduate RN. In the long run the RN has a deeper knowledge in nursing and she can complement her practical training on the job.

This study was conducted in pediatric wards A and B, with 57 beds covered by 41 nurses; 7 RNs, 29 PNs, and 5 pool nurses, in addition to a ward sister as head nurse in each ward. The physicians were 4 specialists and 8 general practitioners. It is worth to mention that Pool Nurses are temporary nurses, PN graduated from CBH nursing school, which are called to work either day or night in the pediatric or neonatal wards for covering the nursing needs of the hospital due to nursing shortage.

Chapter II

Review of Literature

Introduction

This chapter will present the definition of the key concepts of the study, clinical importance of blood culture (BC), indications for BC, specimen collection and transport, BC methods, contaminants, factors that have a critical bearing on drawing a blood-specimen, protective measures and quality assurance, and health education. The focus of this review is to identify factors that have an effect on drawing a blood-specimen, and draw current knowledge about what others study in this field. Review of international studies and relevant documents with the support of electronic search on studies related to false-positive blood culture (contamination) with specific notion of the common causes of contaminated blood culture was done.

The literature review was used as a guide for the development of the research tool and of the educational program that implemented by the researcher for the intervention group with a new blood culture collection protocol to be followed by them. The organization of the sources presented is according to each topic. The search mainly was from "Pub Med", "MEDLINE" and "Google". Key words: education intervention, blood culture, false-positive rate.

Many studies tried to address the problem, and the following review besides the accurate collection practice can arm health care professionals with necessary knowledge and skills to prevent the poor phlebotomy technique.

2.1 Definitions

Most of the following theoretical definitions are taken from the (CLSI Guideline, 2006, p. 2, 3) which stated that:

Antiseptic- a substance that inhibits the growth and development of microorganisms without necessarily killing them.

Automated blood culture system- a blood culture system that uses mechanical systems to incubate, agitate, and/ or monitor blood culture bottles for microbial growth.

Bacteremia- the presence of bacteria in the bloodstream; NOTE: Bacteria isolate from blood may be the cause of sepsis, indeterminate as a cause of sepsis, or contaminants.

Blood culture- BC is a specimen of blood that is submitted for bacterial or fungal culture; NOTE: This is irrespective of the number of bottles or tubes into which the specimen is divided or distributed.

Blood culture set- the combination of blood culture bottles or tubes into which a single blood specimen is inoculated.

Chlorhexidine gluconate- the digluconate salt of chlorhexidine; Note: It is used as a topical agent for cleansing and disinfecting the skin.

Contaminant- a microorganism isolated from a blood culture that was introduced into the culture during specimen collection or processing and that was not pathogenic for the patient from whom blood was collected (i.e., the isolates were not present in the patient's blood when the blood was sampled for culture).

False positive- a positive test result for a disease or condition when the disease or condition is not present; NOTE: *For blood cultures*, 1) a culture that yields a microbial isolate(s) that is determined not to be the cause of sepsis, or 2) a culture with objective evidence of microbial growth (i.e., an instrument signal that indicates microbial growth) but for which subcultures and stains are negative.

Inadequate blood volume- a blood culture bottle containing less than 80% of the recommended minimum volume indicated on the bottle label.

Sepsis- is systemic inflammatory response syndrome (SIRS) plus infection.

Tincture of iodine- an alcoholic solution of iodine and potassium iodide; Note: It is used as a topical agent for disinfecting the skin.

True positive- a positive test result for a disease or condition when the disease or condition is present; NOTE: *For blood cultures*, a culture that yields a microbial isolate(s) that is determined to be the cause of sepsis.

Venipuncture- puncture of a vein; Note: A method used to collect blood specimens for culture.

Educational intervention- A standard dictionary defines intervention as an influencing force or act that occurs in order to modify a given state of affairs. In the context of behavioral health, an intervention may be any outside process that has the effect of modifying an individual's behavior, cognition, or emotion state (Wikipedia, Encyclopedia).

Educational intervention is any attempt to persuade physicians (nurses) to modify their practice performance by communicating clinical information. The term *health education intervention strategy* is a heuristic device used to conceptualize and organize a large variety of activities (Steckler et al, 1994).

2.2 Clinical importance of blood cultures

According to the CLSI (2006), the presence of living microorganisms circulating in the blood stream of a patient has substantial diagnostic and prognostic importance. Diagnostic, the positive blood culture either establishes or confirms that there is an infectious etiology for the patient's illness. Moreover, it also provides the etiologic agent for antimicrobial susceptibility testing which, in turn, allows optimization of antibiotic therapy.

From a prognostic stand point, a blood culture that grows a clinically important pathogen indicates failure of the host's defenses to contain the infection at its primary location or failure of the physician to remove, claim, or eradicate that focus of infection. The type of pathogen recovered from blood also provides important prognostic information.

2.3 Indications for blood cultures

Chandrasekar et al (1994) stated that patients in whom BCs are appropriate include:

1. Patients with signs and symptoms suggestive of microorganisms in the blood like fever, chills, and tachycardia.
2. Patients with fever or hypotension not explained by non-infectious causes.
3. In the absence of fever:
 - Patients with focal infection such as pneumonia, meningitis, and acute osteomyelitis.
 - Elderly or children with sudden failure to thrive.
 - Elderly patients with deterioration from baseline status such as confusion and frequent falls.
 - Patients with renal insufficiency & unexplained leukocytosis or altered mentation.
 - Immunocompromised patients looking ill, or with unexplained pulmonary, renal, or hepatic dysfunction.

- Patients receiving antibiotic therapy for documented blood stream infection. (BC is needed to confirm clearance of microorganism from blood).

Clinically BCs should be obtained from individuals by dedicated venipunctures in the following scenarios: there is clinical suspicion of bacteraemia, prior to the use of systemic antimicrobial therapy in any hospitalized patient with equal or more than 2 Systemic Inflammatory Response Syndrome (SIRS); temperature greater than 38°C or less than 36°C, tachycardia, tachypnea, and white blood cell count greater than 12 x 10⁹ /L, systemic and localized bacterial infections or fever of unknown origin (Southampton University Hospitals NHS Trust SUHT 2007).

2.4 BC specimen collection and transport

This part will present timing of BC, number of BC, volume of BC, BC collection and transport, and BC specimen rejection criteria.

2.4.1 Timing of blood cultures

Murray et al. (1999, p.65) said that, blood specimens should be collected before antimicrobial agents are administered, although there are media available which contain substances designed to minimize the effect of these agents on bacterial growth. Optimally, the specimen should be collected just before a fever spike; however, practically, the specimen should be collected immediately after the spike.

A research shows that when blood cultures are obtained before and after initiation of antimicrobial agents, the post antibiotic cultures are less likely to yield microorganisms (Grace CJ et al, 2001).

Reller and Sexton (2008) reported that, it is optimal to obtain BCs at time intervals ranging from one to several hours. However, it is sufficient and appropriate to obtain BCs from two separate sites within minutes of each other from patients who are acutely ill or those in whom the likelihood of continuous bacteraemia is high. In comparison, it is advisable to obtain several sets of cultures 6 to 36 hours apart in patients with suspected intermittent bacteraemia or in those in whom infection with a possible contaminant such as coagulase-negative staphylococci is considered likely.

The timing of BCs in the continuous bacteraemia of endocarditis is probably not important, but in most other conditions the bacteraemia is intermittent and related to the fevers and rigors which follow the appearance of organisms in the body by 30- 60 min. Blood cultures should be taken as near to the onset of a spike of fever as possible (Hawkey and Lewis, 1989).

One study showed no difference in microbial recovery when blood specimens were drawn for culture simultaneously or at spaced intervals for up to 24 hours. Other study observed no significant differences in positivity rates of BCs obtained in relation to the fever spikes of patients. As a practical matter, BCs should be obtained simultaneously or over a short timeframe (CLSI, 2006).

2.4.2 Number of blood cultures

For adult patients, two sets of cultures should be collected per febrile episode to help distinguish probable pathogens from possible contaminants. Greater numbers of cultures are not necessary; no more than 4 sets should be submitted in a 24-h period (Murray et al., 1999). Single blood cultures should never be drawn from adult patients; this lead to inadequate volume of blood cultured and more difficult to interpret (CLSI, 2006). Avoid the sending of large numbers of BCs from the same patient, whether positive or negative, since they waste laboratory time. Single sets may be adequate in neonates, in whom the density of bacteremia is higher (Hawkey and Lewis, 1989).

As for adult patients, it is recommended in pediatric patients that two to three BCs should be collected within a 24 period. However, because in pediatric patients anaerobic bacteria are rarely recovered, use aerobic bottles only. Anaerobic bottles may be considered in high-risk groups that include neonates from mothers that have had prolonged rupture of membranes during childbirth or maternal chorioamnionitis; chronic oral or sinus infection; cellulites; abdominal signs and symptoms; bite wounds; septic phlebitis; and neutropenic patients receiving steroids (CLSI, 2006).

CLSI guideline (2006) stated that most patients with bacteremia or fungemia can be followed clinically and do not need follow-up BCs to document the clearance. BCs should not be repeated for 2-5 days, because the blood does not become sterile immediately following the start of antimicrobial therapy. There are two exceptions to this; first, for

patients with infective endocarditis, and second, for patients with *Staphylococcus aureus* bacteremia not related to infective endocarditis.

2.4.3 Volume of blood for culture

The total volume of blood cultured is one of the most important factors in the recovery of the bacterial pathogen. For adults, 20 to 30 ml of blood should be collected per venipuncture but less blood is required for children because there are more microorganisms per milliliter of blood. Periodically, BC volumes should be monitored to identify opportunities for educating the health care providers about optimal BC techniques (Murray et al, 1999).

Pediatric BCs differ from adult BCs primarily in the amount of blood obtained for culture. It has been common practice to draw the minimum amounts of blood because of the: 1) smaller volumes of blood in pediatric patients; 2) difficulty in phlebotomy; 3) potential for increased transfusions due to the amounts of blood drawn for all laboratory procedures; and 4) presumed high levels of bacteria in the blood in pediatric patients with bacteremia. For infants and younger children, the volume of blood to be drawn for culture should not exceed 1% of the patient's blood volume (CLSI, 2006).

On an individual basis, suggested BC volumes to be drawn have been based on other clinical parameters such as patient weight and hematocrit (Kellogg et al, 2000).

2.4.4 Blood culture collection and transport

Since arterial BCs are not associated with higher diagnostic yield than venous BCs, many studies mentioned that blood for culture should be drawn from veins, not arteries and are not recommended (Reller et al, 1982).

CLSI guideline (2006) reported that after the venipuncture site is identified, the rubber septum on the BC bottle(s) or tube(s) should be disinfected with 70% isopropyl alcohol and allowed to dry. The site of the venipuncture should then be disinfected; typically this means cleansing the site first with 70% isopropyl alcohol, allowing it to air dry, followed by application of the main disinfectant, then allowing that substance to sit for the recommended amount of time. Strict aseptic technique should be used throughout the procedure. The person drawing the culture should not palpate the vein after skin disinfection unless a sterile

glove is worn. It is recommended that blood be drawn into a sterile syringe and then transferred to the BC tube or bottle. Blood can be drawn directly into collection tubes containing sodium polyanetholsulfonate (SPS), but should never be drawn into tubes containing other anticoagulants. The blood from an SPS tube can then be transferred to BC medium. Drawing blood directly into BC vials (e.g., using a needle holder designed for collecting blood into tubes) is not recommended because of the risk of reflux of the broth media back into the vein and also because the volume of blood drawn into the bottle or tube cannot be controlled. Collection devices are available from some manufacturers; these should be used according to the manufacturer's recommendations. BC bottles should be kept upright when these devices are used. BC bottles/tubes should be inverted gently several times to prevent clotting.

It is suggested not to change the needle before inoculating BC bottles due to safety issues. If a blood is drawn at the time of placement of a new intravascular catheter, draw the sample through the catheter into a syringe. Using aseptic technique, place a sterile needle on the syringe and inoculate the culture bottles. Then dispose of the needle and syringe in the appropriate sharps bin (SUHT, 2007).

Where blood is taken at the same venesection for other tests (e.g. hemoglobin, white blood cell count) insist that the BC bottles are inoculated first. Ensure that the BC bottles have attained ambient temperature and are not chilled (Hawkey and Lewis, 1989).

BC sets should be sent to the laboratory immediately; delays in entering BC bottles into continuous-monitoring BC instruments may delay or impede detection of growth. Holding bottles at room temperature is not recommended for anything longer than a few hours. BC bottles should never be refrigerated or frozen after they have been inoculated (CLSI, 2006).

According to the length of incubation, Hawkey and Lewis (1989, p.26) indicated that complete clinical information will have an influence on the length of incubation. If the clinical diagnosis is septicemia, the broths should be incubated for 7- 10 days. All the common pathogens, such as staphylococci, coli forms and so on, will be isolated within the first 2-3 days. If endocarditis is suspected, the period should be prolonged to 3 weeks; pyrexia of unknown origin is treated likewise.

2.4.5 BC Specimen rejection criteria

CLSI in (2006, p.7) stated that BC specimens which meet the following criteria should be rejected and another specimen collected: 1) incorrectly labeled or unlabeled vials; 2) broken, damaged, or leaking bottles/tubes; 3) clotted tubes; or 4) tubes containing anticoagulants other than SPS.

2.5 Blood culture methods

BCs can be processed in the laboratory either by manual or by automated methods. The term 'manual BC techniques' refer to methods that do not employ instrumentation to monitor the growth of microorganisms. Manual BCs subdivided into visually monitored ('conventional') broth-based cultures, cultures using biphasic media, and the lysis-centrifugation technique. Automated Continuous Monitoring BC Systems (CMBCSs) use instrumentation to detect microbial growth in broth media by monitoring byproducts of bacterial or fungal metabolism (CLSI, 2006).

The fully automated (CMBCSs) are the newest type of systems developed for the detection of bacteria and fungi in blood. The systems available in the United States are the Bac T / Alert, BACTEC 9000, and ESP. In these systems, culture bottles are incubated in an instrument and continuously monitored for the production or consumption of gas. The data collected are transmitted to a computer and analyzed to allow rapid detection of microbial growth. These systems are a reliable and rapid alternative to conventional systems for the detection of bacteria and yeast in the blood (Murray et al, 1999).

2.6 Contamination

Contamination arises in three distinct ways. The first two mechanisms are ward-based and, therefore, not directly controlled by the laboratory. 1) *Cross-contamination*: can be result if BC bottles become cross-contaminated with saprophytic bacteria from non-sterile containers for other tests. BCs should either be performed as a separate procedure, or BC bottles always inoculated before any other containers. 2) *Skin organism- contamination*: may arise from the skin organisms of the patient. To minimize this, the necessity for good aseptic and antiseptic practice at the time of venipuncture should be stressed to the ward staff. When more than one set of BCs are to be taken separate venipuncture sites should be used. 3) *Laboratory-*

based contamination: this arises after the first, or subsequent, routine subculture (Hawkey and Lewis, 1989).

Contaminants: Microorganisms commonly associated with contaminated blood cultures are: *Bacillus* spp., *Corynebacterium* spp., *Propionibacterium* spp., coagulase-negative staphylococci, *Aerococcus* spp., *Micrococcus* spp., are also capable of causing systemic, blood-borne infection in the appropriate setting (CLSI, 2006).

Collection of samples by arterial puncture or lower extremity venipuncture may increase the risk of patient injury and of culture contamination. Specimens collected through lines also have a greater risk of contamination. Upper extremity venipuncture is recommended for the collection of samples for blood culture examination under most circumstances (CLSI, 2006).

2.7 Factors that have a critical bearing on drawing a blood-specimen

Ernst (2004) identified five factors affecting blood-culture collection; training of blood-collection, location of collection site, preparation of puncture site, blood-collection equipment, and collection volume. Ernst added, if facilities employ these factors individually or in combination, it is reasonable to expect that fewer patients will be subjected to the human and financial costs associated with contaminated cultures.

Personnel: training the personnel on proper blood-collection can minimize BC contamination (BCC) rate. One study on medical and surgical units in a teaching hospital in New York was conducted to determine whether the rate of BCC could be reduced by using a team of dedicated phlebotomists (BCT). Comparison was made between adult patients requiring blood cultures for suspected bacteremia before and after the introduction of a (BCT). From 956 cultures of blood collected by the BCT with a commercial skin prep kit, only 11 samples were contaminated, with significant reduction in BCC rate ($P < 0.001$). Calculations suggested that cost saving from reducing false-positive blood cultures were greater than cost of BCT. A reduction of BCC rate to 1.2% from 4.7% achieved with potential saving of \$1,200,000 / 2 years (Weinbaum et al, 1997).

Another study on the effectiveness of a showing a video on the proper procedure of blood collection in reducing BCC was conducted at the Philippine general hospital, Manila. A total of 2,056 blood cultures were obtained from patients admitted at the medical ward, by the

medical clerks, interns, and first year residents. A 26 items questionnaire was given to them before (pretest 1), immediately after (posttest 1) and 2 weeks to 2 months after (posttest 2) the video was shown. Even though BCC rate was not significantly ($P > 0.05$) affected with the showing of the video, significant improvements were shown in the scores of the pretest ($x = 13.34$) to posttest 1 ($x = 22.18$, $P < 0.05$). Conclusions were made that there is still a need to continuously educate house staff on proper procedures of blood culture by improved video and larger sample size (Marilou et al, 1997).

A College of American pathologist Q-tracks study of 356 institutions, Bekkeris et al (2005) conducted a program to provide contemporary bench mark data about blood culture contamination rates in a large number of clinical laboratories and used longitudinal Q-Trucks data set to elucidate factors associated with sustained improvement in performance. Data were collected from 1999 through 2003 (longitudinal cohort study) and a mixed linear model analysis of data set was used. They found that: (1) BC contamination was significantly higher in institutions that used non laboratory personnel (medical and paramedical staff) to collect BC ($P = 0.03$) and significantly lower in facilities that used a dedicated phlebotomy team ($P < 0.001$), (2) Higher volume of blood collection was significantly associated with lower contamination rates ($P < 0.001$), (3) Continued participation in the Q-tracks monitoring program was associated with significant and progressive reduction in BCC rates. By the fifth year of participation, the median institution had reduced its BCC rate by 0.67% ($P < 0.1$). They concluded that institutions that use decentralized patient-centered personnel rather than dedicated phlebotomy teams to collect blood cultures experience significantly higher BCC rates. Long-term monitoring of contamination is associated with sustained improvement in performance (Hawthorn effect). Blood cultures were processed by a variety of automated and manual methods.

In Israel, Soroka University medical Center (SUMC), a 1000-bed teaching hospital located in the city of Beer Sheva (456,000 inhabitants of whom 194,000 are children aged 0-18 years) conducted a study. The SUMC has a busy pediatric emergency department (PED) with more than 100 daily visits and 108 general pediatric inpatient beds. Blood cultures from pediatric patients throughout the hospital are drawn by physicians only and at their discretion. The aim of study was to assess the role played by the patient's age and the physician's experience in determining the pediatric BCC rates. The proportion of true-positive and false-positive results among blood cultures obtained by in-training physicians and experienced pediatricians from young children (aged 1-35 months) and older children

(> 36 months) and the value of a positive blood culture to predict a true-positive results were retrospectively determined. Computerized records of the SUMC laboratory and positive blood cultures from PED patients and inpatients collected in the 35-months period January 1, 2002 through November 30, 2004 were gathered. Collected data included organisms isolated, patient's age, and the name of the physician who collected the blood sample. A p value < 0.05 was considered statistically significant. The study has the limitation that organism were classified as pathogens or contaminants without review of patient chart and this could resulted in misclassification of some isolates. The odds of a positive BC to predict isolation of a true-pathogen was 0.366 only when the sample was obtained by an inexperienced physician and 0.523 when it was drawn by an experienced physician ($P < 0.001$), 0.419 when it was obtained from a young child and 0.429 when it was drawn from an older child ($P = 0.781$). The predictive value of a positive result for isolating a pathogen was significantly higher when experienced physicians draw the blood culture regardless of the patient's age. The conclusions were that patient's young age and lack of experience of the physician who draws the specimen increase the risk of BCC. These results strengthen the need to improve the technical skills of young physician (Pavlovsky et al, 2006).

Eskira et al (2006) in their study about the efficacy of an educational intervention to prevent BCC in internal medicine in two medical wards in a busy tertiary-care hospital "1000-bed" at Sourasky Medical Center in Tel-Aviv was conducted. Blood cultures were obtained by male physicians rather than dedicated phlebotomists. The intervention was performed by an infection control nurse in one ward selected randomly (ward 1) and (ward 2) selected also randomly served as a control. Proper technique was ensured via observation. Pre-intervention, 1420 blood cultures obtained from six wards, baseline BCC rates were 5.7% and 7.1% in intervention and control wards, respectively ($P 0.6$), compared with 1.95% and 6.7%, respectively, post-intervention ($P < 0.0001$). A sample of 814 blood cultures from each ward was required post intervention. They conclude that a protocol utilizing ET-CH (ethanol 70% plus chlorhexidine 0.5%) decreased the BCC rate significantly. Since each BCC episode results in additional costs of > 3300 euros (roughly the monthly salary of a nurse), appointment of a full-time infection control nurse may be cost-effective, even if only one BC contamination episode is prevented monthly. Thus simple educational intervention reduced BCC and was considered to be cost-effective. This study has limitations that no two wards are identical, and thus differences in practice could have influenced the results. Also the first set of cultures obtained from each patient was investigated may create a selection bias.

Site Location: The location of the collection site has effect on the potential for a culture to be contaminated. Draws from vascular-access devices, such as arterial lines, central venous catheters, and heparin locks, have been shown to result in high BCC rates. Because these ports pass through the skin and remain there for long periods of time, they are susceptible to bacterial colonization. Colonized bacteria multiply and accumulate in and around invasive ports, and can be pulled into blood specimens drawn from those sites (Ernest, 2004).

According to CLSI (2006), blood for cultures should be drawn from veins not arteries. And culture of blood from access devices should be paired with another culture obtained by venipuncture to assist in interpretation in the event of a positive result.

To compare contamination rates in blood culture specimens obtained from separate sites Vs through newly inserted intravenous catheters, a study conducted at a United States Children's hospital emergency department. It was observational study from January 1998 through December 1999 among patients aged 18 years or younger. All phlebotomy was performed by emergency department registered nurses. During the baseline phase, blood specimens for culture were obtained simultaneously with intravenous catheter insertion. During the post intervention phase, specimens were obtained by a separate, dedicated procedure. A total of 4108 blood cultures were evaluated, including 2108 during the baseline phase and 2000 in the post intervention phase. The false-positive blood culture rate decreased from 9.1% to 2.8% ($P < 0.001$). Young age was associated with increased contamination rate in both phases. BC contamination rates were lower when specimens were drawn from a separate site compared with when they were drawn through a newly inserted intravenous catheter (Nor berg et al, 2003).

McQuillen et al (1999) conducted a study to compare the BCC rate drawn by two methods: blood culture drawn through indwelling intravenous VS blood culture drawn at the time of Intravenous (IV) placement, and to determine if the collection of two blood cultures enhances pathogen recovery. The sample was Urban Pediatric Emergency department in the USA. The results were 1.9% of 3000 grew contaminants: 27 in the first and 30 in the second blood culture for contamination rates of 1.8% and 2%. From 3000 blood cultures, 1.3% grew pathogens: 24 represent 12 patients with growth in one out of two cultures. Pathogen rates were 1.1% with one blood culture per patient and 1.7% with two blood cultures per patient. As a conclusion there is no difference in the contamination rates of two blood cultures drawn

from the same site at two different times. The collection of two blood cultures per patient may enhance pathogen recovery.

Antecubital venipuncture is not associated with a high contamination rate, BC can be drawn at the same time but from different sites, and if at all possible BCs should draw from venipuncture not via lines (Ernst, 2004).

Site preparation: Ernst (2004) reported that the most important factor in collecting uncontaminated blood culture is the site preparation. Iodine-based antiseptics, sometimes used along with isopropyl alcohol, have become the industry standard for preparing puncture sites. Site preparation starts with a 30-60 seconds scrub with the antiseptic (use isopropyl alcohol first to remove skin contaminants, followed by the application of the antiseptic). When applying the antiseptic, cover the skin two inches or more in all directions, then complete the process by starting from the center and moving outward in circles of increasing diameter.

Although contamination may occur at any stage of BC processing, the continued predominance of skin flora organisms in false-positive cultures points to insufficient skin disinfection and poor phlebotomy technique as primary causes of pseudo-bacteremia (Correa and Pittet, 2000).

CLSI (2006) reported that tincture of iodine, chloride peroxide, and chlorhexidine gluconate are superior to povidone-iodine preparation. Tincture of iodine and chlorhexidine gluconate are properly equivalent. Iodine-containing preparation requires sufficient time to disinfect surfaces (30 seconds for tincture of iodine 1.5 to 2 minutes for iodophors). Chlorhexidine gluconate requires the same amount of time, but is not associated with allergic reaction. The primary disadvantage to Chlorhexidine gluconate is that it cannot be used to disinfect skin of infants less than two months of age. For Pediatric blood cultures- the same methods of skin antiseptics for adults apply to pediatrics, with the exception in neonates with the potential to develop subclinical hypothyroidism due to iodine. For all patients, topical iodine compounds must be completely removed after phlebotomy. Chlorhexidine gluconate as a skin antiseptic is approved for use in pediatric patients two months of age and older.

Generally, at least 30 seconds of contact is necessary before the puncture to assure proper site preparation. Blood culture contamination is most likely to occur during attempts to

relocate difficult-to- find veins by palpation after a site has been cleansed. This practice obviously reintroduces skin contaminants to the site, potentially, into the bottle. It is advisable before cleaning; making a mental note of a vein's location in relation to certain skin markers can reduce the urge to re-palpate. Cleaning the tip of the gloved index finger for population is not advised (Ernst, 2004).

Calfie and Farr (2002) conducted a study on the Department of Medicine University of Virginia Health System, conducted to compare the efficacy of four skins antiseptic in preventing blood culture contaminate. A randomized, crossover investigator-blinded study conducted in an emergency department in the patient wards of a university hospital. All patient groups were from whom blood samples obtained per-cutaneously for culture. Skin antiseptics was performed with 10% povidone-iodine, 70% isopropyl alcohol, and tincture of iodine or povidone- iodine with 70% Ethel alcohol. The BCC rate associated with each antiseptic was then determined. A total of 333 (2.62%) of 12,692 blood cultures were contaminated during the study period compared to 413 (3.21%) of 12,859 blood culture obtained during the previous 12-months period $P = 0.006$. The findings were no significant differences in blood culture contamination rates among these four antiseptics.

An additional factor that contributes to low contamination rates is the practice of decontaminating the top of the blood culture bottle before use. Some facilities cleanse the tops with alcohol; other use an iodine solution, allowing it to dry and remain in control with the stopper for 30 seconds before removing the iodine with a fresh alcohol prep (Ernst, 2004).

We can see that the important issue here is to teach the nurses how to clean the site correctly rather than thinking what type of antiseptics to use. Demonstration of a correct phlebotomy procedure in cleaning the site will help in minimizing the BC contamination.

Equipment: Depending on the type of blood-culture bottle in use, collectors will fill bottles either by using a winged infusion (butterfly) set and a vacuum tube adapter or by drawing blood directly into a syringe through a needle or butterfly set. After the puncture, the adapter should be positioned over the neck of the culture bottle and pressed downward so the interior needle punctures the bottle stopper. If both aerobic and anaerobic bottles are included in the set, the aerobic bottle should be inoculated first for two reasons: (1) Empty butterfly tubing can have up to 1 cc of dead-space volume. If this volume of air is pulled into anaerobic

bottles, it can be detrimental to some anaerobic organisms. (2) Ninety-eight percent of septicemias are caused by aerobic or anaerobic organisms that can tolerate aerobic environments (facultative anaerobes). If blood flow is interrupted and cannot be resumed before the anaerobic bottle is filled, most of the causative organisms of septicemia will still be detected (Ernst, 2004).

CLSI guideline (2006) suggested that when blood is collected into a syringe, either directly or through a butterfly set, the safety feature of the needle should be immediately activated upon removal from the vein, removed from the syringe, and carefully discarded into an approved sharps container. Attach a safety transfer device and inoculate the culture bottles. Blood should not be forcefully evacuated from a syringe into culture bottles or any specimen tubes. This risks exposure to blood borne pathogens if a specimen splatters.

Ernst (2004) recommended that the collector should allow the vacuum to pull the recommended volume of blood into the broth. Overfilling, however, can lead to false-positive results. To understand this consequence, one must understand how some automated systems detect growth. When bacteria multiply, they raise the concentration of C[O.sub.2] in the bottle's internal environment. Systems that measure changes in the C[O.sub.2] levels during incubation periodically monitor concentrations and compare them to the baseline levels taken when the bottle was initially loaded. When a threshold of change is exceeded, the instrument alerts the operator that a positive vial has been detected. White blood cells, however, produce minute amounts of C [O.sub.2]. If collectors become inattentive, and more than the maximum recommended volume is evacuated into a bottle, the excess of White Blood Counts can trigger alerts and force unnecessary confirmatory testing (p.5).

Collection volume: CLSI guideline (2006) suggested that for infants and younger children, the volume of blood to be drawn for culture should not exceed 1% of the patient's blood volume comparing with adult.

While many pediatric infections are characterized by high numbers of microorganisms in the blood, a small but significant number of infections have relatively low numbers of microorganisms. Processing large blood volumes increases the yield of recovery of pathogens, and decreases the time to detection (Isaacman et al, 1996).

Ernst (2004) stated that collecting volumes less than the required amount reduces the potential to harvest organisms causing septicemia. If the collection yields less than the minimum volume after drawing both aerobic and anaerobic bottles, evacuating up to the maximum recommended volume into the aerobic bottle is preferred over dividing lesser amounts between two bottles. If a second blood culture is ordered, it may be appropriate to collect it immediately after the first one if it can be drawn from another site. Otherwise, a 45-minute wait before collecting the second set from the same site is recommended. The rationale here is that sampling from two completely different bloodstreams increases the likelihood of capturing sparse and transient populations of microorganisms.

2.8 Protective measures and quality assurance

Collecting BC specimens using aseptic technique require protective measures and quality assurance (QA) from the health workers who draw these specimens. The 4 tenets of QA as mentioned by Brown (1991) are: 1) QA is oriented toward meeting the needs and expectations of the patient and the community. 2) QA focuses on systems and processes. 3) QA uses data to analyze service delivery processes. 4) QA encourages a team approach to problem solving and quality.

The following information was drawn from the CLSI guideline (2006):

Protective measures

Prevention of infection transmitted by samples submitted for BC examination depends on compliance with an effective control plan.

Hand Washing: Frequent hand washing is a critical component for preventing transmission of acquired infection. Hands, or other skin surfaces, must be washed immediately after direct contact with blood or any potentially infectious material. Hands should also be washed before donning gloves and after removal of gloves, after completion of work, and when leaving or moving into a clean area.

Barrier Protective: Gloves must be worn during the collection of samples for BC examination and changed between each patient contact. Gloves must be changed immediately if they become contaminated by blood or show any sign of breakage or loss of barrier function. Gloves should also be worn in areas where hands may come into contact

with infectious materials or contaminated surfaces. Gloves should be worn when handling and disposing of biohazardous waste.

Long-sleeved and closed-front protective clothing should be worn for activities related to BC processing. Protective clothing must be removed immediately if visibly contaminated. Contaminated protective clothing should be discarded as of biohazardous waste or laundered according to the institution's policy. Protective clothing must be removed before leaving or moving into a clean area.

Sterilization, Disinfection, and Decontamination: The collection and manipulation of samples for BC examination presents risks for contamination of equipment and environmental surfaces with infectious material. So, detailed instructions for the prevention and management of spills of infectious material must be provided.

In general, the response to spills includes the following components: 1) containment and absorption; 2) removal of residual material using an aqueous detergent; 3) decontamination by flooding the surface using an intermediate hospital disinfectant. Concentration and time of exposure will depend on the type of surface contaminated; 4) removal of disinfectant and rinse with water; 5) drying surface to prevent slipping; and 6) disposal of materials used for decontamination and all contaminated materials that could not be effectively decontaminated.

Standard Precautions: They provide engineering and work practice controls that will minimize the risk of contact with infectious materials or, in the case of accidental contact, minimize the duration of exposure. All employees must receive initial training in the basic principles and practice related to standard precautions. In addition, retraining related to the concepts of standard precautions should be incorporated into the hospital's continuing education program.

A critical component of standard precautions is the prevention of percutaneous exposure. Several strategies should be considered: 1) minimize the use of needles and other sharp instruments; 2) when needles must be used in the collection of BC samples, use safety devices and practices to minimize the chance of needle stick injury. Recapping needles when necessary; 3) if blood is collected by syringe, the needle used for collection should not be replaced before inoculation of BC bottles; 4) needles should be equipped with a mechanism

to minimize the risk of injury. The safety mechanism should be used, according to the manufacturer's instructions; 5) needles must be placed in an approved sharps container after use. The container should be close to the site of use with opening clearly visible. Sharp containers should not be overfilled; 6) a sharps container must be used if exposed needles or other sharps must be transported to or within the laboratory.

Quality assurance

Quality assurance as defined by A Dictionary of Nursing (2008) the process in which services are periodically reviewed and health-care provision assessed against benchmarks and other local or national reference points.

Brown in (1991) stated that the Quality Assurance Project (QAP) was initiated in 1990 to develop and implement sustainable approaches for improving the quality of health care in less developed countries. QA Project has two broad objectives: 1) to provide technical assistance in designing and implementing effective strategies for monitoring quality and correcting systemic deficiencies; and 2) to refine existing methods for ensuring optimal quality health care through an applied research program. In essence, quality assurance is that set of activities that are carried out to set standards and to monitor and improve performance so that the care provided is as effective and as safe as possible.

Pre-examination Process: this process for BC examination includes: patient evaluation; test selection and ordering; sample collection; sample transport; sample receipt and processing. Each of these components includes multiple procedures or processes for successful completion.

Patient evaluation- it is imperative that every organization develops guidelines to identify appropriate patients for BC analysis. Guidelines should also identify clinical scenarios with a low prior probability of bacteremia or fungemia where BC examination is not recommended. False-positive BC examination for such low-risk patients is likely to have a negative impact on the patient's outcome and the institution's cost of caring for the patient.

Test selection and ordering- the laboratory should work with the organization's health practitioners to ensure that clinical practice standards result in selection of the most appropriate use of BCs. Protocols for when to draw or not to draw BCs should be available

for all practitioners. Requests for BC examination must be submitted using a standardized process (paper or electronic) established by the organization in compliance with relevant local and federal regulations. All critical information must be included in the requisition in a legible form, including, but not limited to: unequivocal patient identifiers; unequivocal identification of the authorized healthcare provider requesting the examination; specimen type and detail; specific examination requested; patient diagnosis; and pertinent clinical information.

Sample collection- detailed protocols for collection of samples will minimize the medical errors that can occur with venipuncture (including misidentification of samples or patients, incorrect collection vessel, incorrect timing of collection, formation of hematomas, nosocomial anemia, and hemoconcentration). A training program with documentation of competence for trainees is essential for healthcare providers who will draw BCs. Such protocols should be designed with the goals of minimizing the risks for both the patient and phlebotomist, as well as ensuring the collection of a sample that will produce informative results from the BC examination. The use of a dedicated team for collection of BC samples should be considered.

The following information must be provided for all blood culture specimens- patient's first and last name; a unique identification number; date and time of collection; other information or label required by institution policy; and identification of the person collecting the specimen.

Sample transport- samples for blood culture should be transported to the laboratory as quickly as possible in a manner to ensure maintenance of sample integrity and compliance with applicable safety regulations. It is recommended that samples for blood culture examination be delivered to the laboratory within two hours of collection and transport.

Sample receipt and processing- samples for BC examination must be promptly received after delivery to the laboratory, assessed for acceptability, accessioned into laboratory records, processed with media inoculation, and transferred to the site of BC examination.

The status of samples for BC examination that is determined to be unacceptable at arrival in the laboratory must be communicated immediately to the ordering physician or patient location according to the laboratory's policy for reporting critical test results. BC specimens that meet the following criteria should be processed but the provider notified that the

specimen is not optimal: inadequately filled bottles; insufficient number of cultures; single BCs; and blood inoculated into only aerobic or anaerobic bottles.

Examination Process—this process for BCs includes the following components: procedures for the detection of microorganisms; identification of isolates; susceptibility testing of relevant isolates; verifying the reliability of test results. Each of these components includes multiple procedures or process for successful completion. Detailed laboratory protocols must be prepared for each process.

Post-Examination Process— this process for BCs examination includes the following components: result reporting and archiving; and sample management. Each of these components includes multiple procedures or process for successful completion.

2.9 Health education

Rassol (1998) stated that Health education is a component of health promotion activities where the goal is to enhance and promote health through the implementation of effective educational and training programs, taking into account the socio-political influences. Part of the goal of health education includes the process of enabling an individual to change his life-style and behavior. In the context of substances use and misuse, the goal of health education is to promote the health of the general population and prevent the use of psychoactive substances and minimize the harm (p. 84).

Tones and Green (2004) propose the following 'empirical' definition, which centers on the process of learning:

"Health education is any planned activity designed to produce health- or illness- related learning" (p. 24).

They also said that,

'Learning' has frequently been defined as a relatively permanent change in capability or disposition—that is, the change produced is not transitory and, after the educational intervention, people are capable of achieving what they were not capable of achieving before the intervention and/ or feel differently about ideas, people or events. Accordingly, effective health education may result in the development of cognitive capabilities such as the acquisition of factual information, understanding and insights. It may also provide skills in problem solving and decision making and the formation or development of beliefs. It might also result in the clarification of existing values and the creation of new values-and, quite frequently, in attitude change" (p. 24).

And they add that health education also aims to foster the acquisition of health –related interaction skills. It may bring about changes in behavior or create the conditions for the adoption of healthy public policy.

According to Noe et al (2006) training refers to a planned effort by a company to facilitate employees' learning of job-related competences. These competencies include knowledge, skills, or behaviors that are critical for successful job performance. The goal of training is for employees to master the knowledge, skill, and behaviors emphasized in training programs and to apply them to their day-to-day activities (p. 257).

A key characteristic of training activities that contribute to competitiveness is that they are designed according to the instructional design process. Training design process refers to a systemic approach for developing training programs. The six steps of this process, which emphasizes that effective training practices involve more than just choosing the most popular or colorful training method are: Step 1 is to assess needs to determine if training is needed, Step 2 involves ensuring that employees have the motivation and basic skills to master training content, Step 3 addresses whether the training session has the factors necessary for learning to occur, Step 4 is to ensure that trainees apply the content of training to their jobs, Step 5 involves choosing a training method that will provide the appropriate learning environment to achieve the training objectives, Step 6 is evaluation-that is, determining whether training achieved the desired learning outcomes and/or financial objectives (Noe et al, 2006).

The primary reason that organizations train the employees is to bring their knowledge, attitudes, and skill up to the level required for satisfactory performance. As a result of the training, employees may be even more effective on the job and may qualify for jobs at a higher level (San Francisco: Jossey-Bass, 1988) in Sherman and Bohlander Book.

Developing nursing practice in any area demands skills, knowledge, support and long term commitment to the achievement of best practice. It is easy to become overwhelmed by the competing demands for client care and service delivery. It is not always easy to see how good ideas, clinical concerns and professionally led objectives, can be realized in practice. Ongoing professional development activities, including formal educational programs can contribute to individual staff members' ability to take on practice development projects. Too often however, educational programs are seen as making little real difference to clinical

practice. Work-based learning approach contributes to integrating learning and developing practice in the field of medical care. The work-based learning approach can bring about tangible benefits for patients, practitioners and organizations, but only if the organizational and contextual factors which impact on practice and its development are properly considered and managed through effective partnerships (Clarke and Copeland, 2003).

A standard dictionary defines intervention as an influencing force or act that occurs in order to modify a given state of affairs. In the context of behavioral health, an intervention may be any outside process that has the effect of modifying an individual's behavior, cognition, or emotional (state.www.minddisorders.com/Flu-Inv). A nursing intervention is defined as a single nursing action - treatment, procedure or activity - designed to achieve an outcome to a diagnosis, nursing or medical, for which the nurse is accountable (Saba, 2007). (www.sabacare.com/Interventions/).

Summary

Blood culture is a laboratory test in which a specimen of blood is submitted for bacterial or fungal cultures. If the skin is not adequately cleaned before drawing blood for culture, bacteria on the skin will be injected into the bottle producing a false positive BC which yields a microbial isolates that is determined not to be the cause of sepsis. Contamination arises in three distinct ways: Cross-contamination of BC bottles from non-sterile containers for other tests, skin organisms of the patient, and Laboratory-based contamination. The presence of living microorganisms circulating in the blood stream of a patient has substantial diagnostic and prognostic importance. Studies illustrated the indication for BC that is appropriate in different patient diagnosis, either in the presence or absence of fever in addition to the diagnosis that are not explained by non-infectious causes. Clinically BCs should be obtained from patients by dedicated venipunctures.

BCs collection procedure or technique differ from one institution to another, however there are principles agreed upon them. This include: aseptic technique must be followed, Doctor's order must be obtained, appropriate verification of the patient's identity, cultures should be drawn before administration of antibiotics and via venipuncture not from lines, 2-3 aerobic cultures obtained at wide intervals within a 24hr period are sufficient, BC can be drawn at the same time but from different sites, draw adequate volume, disinfect the rubber top of BC bottle before inoculating the blood, send the specimen to the laboratory as soon as possible,

BC should not be repeated for 2-5 day, and chlorohexidine is as effective as iodine but iodine is not recommended in premature patients. The single most important factor in collecting uncontaminated BC is proper collection site preparation.

BCs can be processed in the laboratory either by manual or by automated methods. The fully automated are the newest type of systems developed for the detection of bacteria and fungi in blood. BC specimens which do not meet specific criteria should be rejected and another specimen collected. A designed team of phlebotomists, suitable site selection, correct site preparation, enough collection volume, and proper equipment can significantly reduce a facility's BCC rate. These factors lead to decrease the suffering to the human and reduce the costs. Components for preventing transmission of acquired infection during blood sample collection include: hand washing; gloves, Long-sleeved, and closed-front protective clothing; detailed instructions for the prevention and management of spills of infectious material must be provided; and training in the basic principles and practice related to standard precautions. To assure quality of care; it is imperative that every organization develops guidelines to identify appropriate procedures for each process; pre, examination, and post processes. Detailed protocols must be prepared for each process. Health education is a component of health promotion activities where the goal is to enhance and promote health through the implementation of effective educational and training programs.

Chapter III

Theoretical Framework

Introduction

This chapter presents the "Integrating Intervention Theory and strategy in culture sensitive health promotion programs" focused on interventions aimed at the prevention of behaviors and social conditions that put health at risk. Also, it illustrates how the theoretical framework and strategy help in the development and implementation of an educational intervention on the correct procedure of blood collection for the intervention group (nurses ward A). Further this chapter provides the definitions of concepts and the conceptual model 'Heuristic Framework' in addition to the definitions of the research variables.

3.1 Integrating intervention theory

Discipline use theories to organize their body of knowledge and to establish what is known about the phenomenon. Theory is defined as an integrated set of defined concepts and statements that present a view of a phenomenon and can be used to describe, explain, predict, and control that phenomenon. Sometimes nurses use theories developed in other disciplines, such as psychology or biology, and apply them to nursing situations (Burns and Grove, 2007).

Pick, Poorting, and Givaudan (2003, p. 422) in their theory "Integrating Intervention Theory and strategy in culture sensitive health promotion programs" focused on interventions aimed at the prevention of behaviors and social conditions that put health at risk. Their aim was to demonstrate how intervention programs can simultaneously be (a) rooted in the everyday context of a target population (b) informed by psychological theory and method, and (c) open to critical evaluation.

The following points are central to the approach in Pick et al study (2003):

First: intervention programs have to be need driven. Important parameters for intervention have to be identified, and psychologists' knowledge of previous findings, theory, and methodology can help in this process. Much of the necessary context specific knowledge is

with stakeholders in particular the clients of the program. The combination of real life expertise and academic perspectives is a potentially powerful way to create interventions that have a positive impact on individuals and communities (Kagicbasi in Pick et al. study, 1996).

Second: interventions tend to be directed either at the individual or at the social and cultural context in which people live. Successful interventions do not require changes in the behavior of the person but also an environment that facilitate the maintenance of newly acquired patterns of behavior.

Third: many interventions are meant to bring about change in characteristic features of the person. An alternative approach is to focus interventions more on communication and decision making skills, as well as on beliefs and knowledge. These can be seen as tools that enable the person to deal adequately with situations that are experienced as problematic, changes in broader characteristics of the person, like self-esteem and self-efficacy (Bandnra in Pick study, 1986, 1996), as seen as resulting from an accumulation of experiences of competence in a wide range of situations. The authors are in agreement with the view of Hamburg (1997) that opportunities for healthy practices must be combined with skills building, acquisition of knowledge, social supports, and a healthy environment.

Fourth: interventions require advocacy and dissemination, particularly at the context level. Advocacy is directed at policymakers and community leaders whose positive attitudes help in gaining permission to carry out a program, in creating a receptive atmosphere with health workers and teachers, and in processing financial support. Dissemination takes place through campaigns in the local media but also includes pamphlets and posters. Both advocacy and dissemination are needed in order to gain support for further distribution and implementation and ultimately for the "up scaling" of a program so it becomes available to large numbers of participants.

Finally: adequate information about the effectiveness of programs (or lack thereof) can be obtained if each step in program development is evaluated. It helps to diagnose the program's strong and weak points, and ultimately, its effectiveness.

3.2 A Heuristic Framework

Prior to describing this framework, Burns and Grove (2007) stated that,

"Conceptual models are similar to theories and sometimes are referred to as theories. However, conceptual models are even more abstract than theories. A conceptual model broadly explains phenomena of interest, expresses assumptions, and reflects a philosophical stance." (p. 167).

The Heuristic Framework as been described by Pick, Poorting, and Givaudan, (2003) entails four frames labeled; context, person, situation, and behavior (please refer to the illustration below).

Context: the first frame in the Heuristic Framework includes; economic factors, education, and socio cultural variables, and refers to the circumstances in which people are living. Central to the context are *economic factors* (Berry et al. in Pick et al. study, 2002). The members of a wealthy group or society have access to all kinds of material and nonmaterial resources that simply are not available in a poor society, such as reliable source of food, fresh water, good medical care, as well as information and education. Also problems are enhanced by unequal distribution of resources between different social groups.

Education is closely related to a country's economy. In poor societies the financial resources for formal education are limited, because of the actual costs of schooling and the economic loss of the time children spend in school and are not available for work. Education does not only provide factual knowledge but also know-how and skills, ultimately enhancing control over wider areas of life. Intervention programs are complementary to formal schooling, in that they are directed at target groups that fall outside the education system and/or address issues insufficiently in the curriculum.

Socio cultural variables- are shared within a society, such as values, norms, and beliefs. Through socialization and enculturation, individuals acquire the rules that are prevented in their social environment (Segall et al. in Pick et al study, 1999). One has to understand the rules that govern behavior, especially those rules with a normative character, in order to grasp the possible constraints on behavior changes (Marin in Pick et al study, 1993).

Person: the second frame includes; basic individual traits, norms, and socio-cognitive traits, and refers to characteristic that provide performance to the individual person. In psychology the person is usually considered to possess dispositions that have continuity over time and

situations. These can be conceptualized as trait dimensions. There are also formulations of dispositions resulting from self-development and external influences. Self-efficacy and self-esteem included.

Individual attitudes tend to be stable over time, unless the person is given reason to question them.

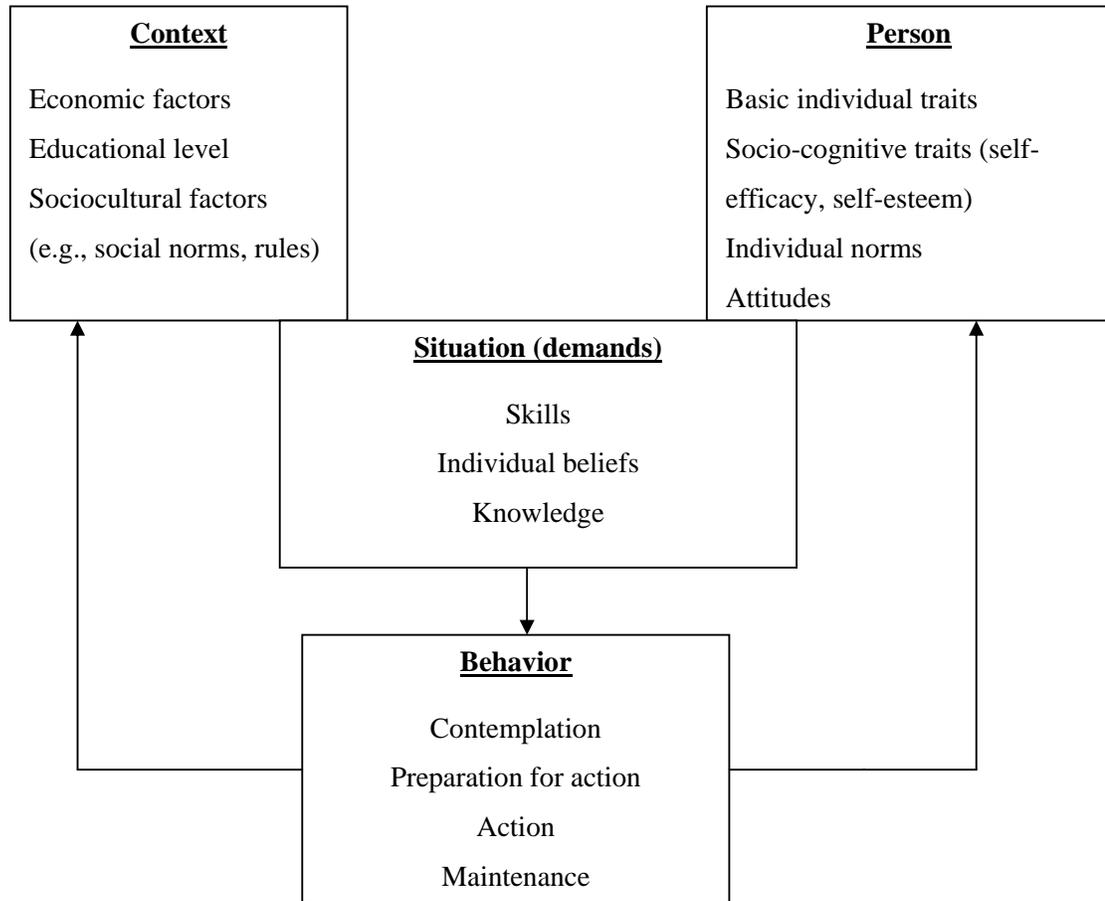
Individual norms which especially in cohesive or "tight" societies (Berry et al in Pick et al. study, 2002) tend to be consistent with those of important groups like one's village, church, etc.

Situation (demands): the third frame includes; skills, knowledge and individual beliefs, and refers to situations that an individual faces, especially with regard to demands to which one is required to respond. Appropriate skills allow the person to react optimally according to his/her own standards and desired outcomes. Examples of skills are the ability to make one's own decisions and the expression of feelings.

Knowledge concerns, for example, self-hygiene or how to prevent HIV. Beliefs include items of knowledge for which there is no empirical basis and that may even be demonstrably incorrect.

Behavior: the main outcomes of intervention programs at the individual level are changes in intentions and in actual behavior. The distinctions made in the frame are meant to reflect that target behaviors do not occur suddenly. The model authors borrowed from an earlier study (Prochaska & Diclemente in Pick et al. study, 1982) to emphasize that behavior changes occur in steps; from contemplating change, to preparing for change, to making the change, and to maintaining the new behavior.

Finally, there are two feedback arrows, indicating that changes in behavior patterns overtime lead to changes in more permanent characteristics of the person, as well as to changes in the context level, which becomes more conducive to the new patterns when more people are changing their behavior.



A Heuristic Framework for intervention programs

(Pick, Poorting, and Givaudan, 2003)

3.3 Stages in program development and implementation based on heuristic model

To structure the design and implementation of intervention programs, Pick et al distinguish five stages in the table below: from an initial plan to address certain needs in a target population to the upscaling of the final program. In most stages there are activities at both the context level and the individual level. At each stage there are three aspects that are to be addressed explicitly: goals; methods and activities; and evaluation.

A strategy for the development and implementation of intervention programs:

Goals	Methods and activities	Evaluation
<i>Stage 1: Identification of needs and definition of problem</i>		
Definition of problem domain Establishing scope for intervention (individual level and community) Establishing target behaviors for change (constrains and opportunities)	Context level Demographic information Surveys Ethnographic information Individual level Focus groups Interviews Questionnaires	Is the definition of need (domain to be addressed) comprehensive ? Is there a clear definition of the client population? What is the quality of the background data? Psychometric quality of exploratory research?
<i>Stage 2: Development of intervention program</i>		
Preparation of preliminary version of all program items	Context level Planning advocacy Construction of media messages Individual level Selection of program topics and contents Selection of didactic methods	Is there good content validity (in terms of defined needs and domain description)?
<i>Stage 3: Program piloting</i>		
Establishing applicability of contents and methods of delivery Preparation of final program version	Context level Tryouts Revisions Individual level Tryouts Revisions	Are clients open to the program? Is there good attendance? Are there observable effects (e.g., assessment with control group)
<i>Stage 4: Advocacy and dissemination</i>		
Facilitating contextual conditions for behavior change Facilitating program distribution	Context level Addressing institutions and administrative authorities Mass media campaigns	Have the important stakeholder groups all been addresses? Were advocacy and dissemination sufficient and successful?
<i>Stage 5: Upscaling</i>		
Maximizing the reach of the program	Setting up a system for distribution of materials Training for trainers	Are there long-term changes in behavior? Is the program efficient and effective?

3.4 Theoretical approach in the development of the educational intervention

The researcher adopted the integrated intervention theory and will illustrate how the theoretical approach and strategy discussed previously helped in the development and implementation of an educational intervention on the correct procedure of blood collection. The goal of this educational program was to enhance the behaviors of nurses (Ward A) on

the correct technique of blood culture collection to decrease the false-positive blood culture results.

To structure the design and implementation of the proper procedure of BC collection program, and referring to the matrix, researcher distinguishes the five stages; in each stage there are two aspects that are to be addressed: goals, and methods/ activities.

Stage 1: Context Analysis and identification of needs:

The first stage is the identification of needs and the definition of the problem, both the context and individual resources will be explored in order to arrive at inclusive description of the problem to be addressed. The main goal of this phase is to identify constraints that limit readiness for change and opportunity for intervention

The cost of the BC technique offered by CBH, nurses have access to all kinds of material and resources needed for proper BC collection. In addition, nurses were offered financial compensation for their participation in the educational program; hence, *economic factors* didn't appear to form a serious constraint and not further considered.

Education about how to perform blood culture procedure is often not included in the nursing school curriculum at CBH because it is not a due for nurses. But since it is traditionally in CBH that nurses do this job they learned these procedures from each other. Since the majority (83%) of the study participants are PN where most of them graduated from nursing school at CBH, so the intervention program was complementary to formal education, in that they directed at nurses that address issues insufficiently represented in the curriculum.

Socio cultural variables that are shared by nurses within a hospital, such as values, norms, and beliefs, they acquire the rules "of how to draw blood for culture" that are prevalent in their work environment. Since each nurse learns from the old one, she took the rules from that nurse and is not based on empirical basis. This has important effect on nurse's behavior- the possible constraints on behavior changes and thus the scope for this educational intervention program.

At the individual level, initial data were collected in a convenience sample of 41 nurses working in ward A and B at CBH. Ward A served as intervention group and ward B as a control group. A questionnaire (pretest), to measure the nurse's knowledge and practice

about the BC collection technique, distributed before the educational program to assess the needs for education and training.

Thus, the first stage served as inventory of needs. It was useful in establishing the level of knowledge, the pitfalls in practice, the willingness and reasons to learn more, and what kinds of contents should be included in the educational materials that nurse needs for their practice in BC collection.

Stage 2: Development and implementation of an educational program (intervention):

The second stage is the development of an educational intervention on proper collection of blood for culture. Having identified factors that affecting the blood culture collection and literatures reviewed concerning BC technique, educational materials were developed that focused on the concrete situation in which behavior was to be changed (in live with the theoretical approach). There were 5 components: knowledge concerning blood culture, new protocol (guideline) includes eleven steps as the correct way to draw blood specimen, skills to perform venipuncture, mistaken beliefs regarding specimen collection, and attitudes regarding procedure performance.

Power point presentation for the materials prepared about BC (please refer to annex 4), in addition, video show and modeling behavior by the researcher on the correct technique of blood culture collection were used. Training based on principles of best practice in the education; this method, chosen on the basis of previous research findings (Chickering and Gamson, 1987), was adopted. The authors indicated that the principles of best practices in education are:

- *Active learning*: Students learn content and basic skills as active participants in the learning process.
- *Prompt feedback*: information given the learner's response, the process by which the response is derived, or the learning strategy used to respond.
- *Time to task*: time used wisely to learn contents and basic skills.
- *Diverse talents and ways of learning*: many different ways offered to meet students' different learning needs.
- *Collaborative learning*: students learn with others.
- *High expectations*: good outcomes are anticipated from the students.
- *Faculty/student interaction*: there is contact between nurses and instructor during the learning process.

Roll-playing by nurses as a way of learning helped them to gain skills as active participants in the learning process, information was given the learner's response, time used wisely to learn contents and basic skills. Participants were assigned homework after the session as they were asked to keep by heart the materials provided about BC.

Nurses learned in a group, which becomes more conducive to the new procedure when more people are changing their behaviors. The complete version of the program required 3 hours of training at nursing school at CBH for one week period. Three groups each session 7 nurses were formed and the implementation of the educational intervention was one month duration (August, 2009).

Stage 3: Piloting of the program:

In the third stage, the pilot program is tried out and revised. After the implementation of the educational program and in order to assess the impact of the training, a questionnaire (posttest) distributed to check the knowledge and practice of both the intervention group and the control group. Also the actual behavior observed on-the- job for one month period (August-2009) to evaluate if changes in knowledge, skills, and in intended behaviors achieved or not. When mistakes noted, the need for more training or follow-up clearly emerged during that month.

The results of BC false positive rate also compared in both the intervention ward A and the control ward B to see if more training will be required. Feedback to each individual nurse in ward A as intervention group was given on their contamination rate in an attempt to reduce the BC false positive rates.

Stage 4: Advocacy and dissemination:

The fourth stage entails advocacy and dissemination. The distinction between the two terms mainly has to do with the target group addressed. Advocacy is directed at policymakers in the broadest sense. Dissemination is directed at the general public.

Throughout the study, the researcher communicated frequently with both the hospital continuous education administrator and nursing school staff at CBH, in an attempt to enhance conditions for acceptance of a program and its contents. The objectives for this attempt were: to make known the existence of the education program and the results obtained with it, and to "advocate" changes in BC technique and guideline that facilitate a

broader acceptance of the education program. After the completion of the study, the researcher will invite them and the Palestinian health institutions at different levels to participate in workshop including this educational program and comment, in this way making advocacy an ongoing process rather than an activity at the end of the study. The development of the project and the results will be presented at scientific meetings (workshops). Dissemination will be promoted through publishing the research, or press conference.

Stage 5: Up scaling:

The objective of the final stage is to have the largest possible participation in an intervention. After the completion of the study, all the staff of CBH in all wards (ward B, premature ward, and outpatient clinic) will be educated and trained on the proper procedure of BC collection in an attempt to move false positive rates toward zero-positives, because the changes in the context level, becomes more conducive to the new patters of the BC procedure when more people are changing their behaviors.

The educational program will may distribute to the health institutions, nursing schools, and universities of Palestine if it is effective and efficient at the end of the study.

3.5 Operational definitions of the research variables

Determination of contamination at CBH: (dependent variable) each positive blood culture bottle classified as either containing pathogen or contaminant (False-positive result). A pathogen considered to represent true bacteremia. Blood cultures considered contaminated (False-positive) if microorganisms derived from common skin flora are cultured. These include *Staphylococcus epidermidis* (*Coagulase Negative Staphylococcus*), *Bacillus* species, corynobacteriam, and *Micrococcus* species.

Educational intervention: (independent variable) the researcher implemented the educational intervention on the proper procedure of collecting blood culture samples based on revision of the literature and the CLSI guideline. It includes both: class room session about BC to add to the nurses' knowledge, video show as modeling behavior by the researcher, and training as role playing by nurses on the BC technique to gain skills on performance.

The educational intervention content through power point presentation included: a definition of both, the blood culture and the contamination or false positive BC; patients in whom BC are appropriate; the purpose of the BC; the cause of BC contamination; principles for BC collection; preparing materials needed for BC collection; protocol to follow when practicing BC collection consists of 11 steps; and common pitfalls encountered during BC technique. In addition, it featured a detailed procedure such as skin preparation, volume of blood to be collected, manner of inoculating blood into the bottle, site selection, and specimen handling.

The training session supported by Video show using "Modeling behavior" of the new protocol by the researcher that includes eleven steps of the BC collection technique (please refer to annex 4) and "Role playing" by the nurses on dolls available at CBH nursing school. The researcher divided the nurses into three groups, each group consist of 7 nurses who took 3hrs training session on the proper procedure of collecting a blood for culture at CBH Nursing School. The training session included one hour theory presented by power point, 15 minutes video show with discussion, 15 minutes modeling behavior, and one and a half hour role playing by each nurse. Each group attended the training session in different days during the first week of August 2009, one day each group. The period of the intervention was one month, August 2009.

Training based on principles of best practice in education, that mentioned before, was implemented. Nurses learned content and basic skills as active participants in the learning process through role-playing; information given the learner's response, the process by which the response is derived; time used wisely to learn contents and basic skills; many different ways offered to meet nurse's different learning needs (modeling behavior, role playing, video show, theory); nurses learned with others (group of nurses each session); good outcomes anticipated from nurses; and there was contact between nurses and instructor (researcher) during the learning process.

Nurses were offered financial compensation for their participation in the educational program. During the rest of the month, supervision was done by the researcher to follow nurses' performance of blood collection procedure. The actual behavior was observed on-the- job to evaluate if changes in intended behavior achieved or not. When mistakes noted, the need for more training or follow-up was clearly emerged during August 2009. Direct feedback of contamination rates to each individual in the intervention group was provided to increase both ownership and awareness.

Chapter IV

Research Methodology

Introduction

This chapter describes the research methodology used in this study including; study design, setting, population, period, participants eligibility criteria, sample size, sampling approach, sampling method, research tool, data collection and data analysis procedures. Moreover it presents the validity and reliability of the instrument that was constructed and used for the purpose of data collection, the methods of data analysis, and the limitations of the study, the ethical considerations and accessibility are also included in this chapter.

4.1 Study design

The researcher has used quasi-experimental design to examine causality among the dependent and the independent variables and used a structured instrument to collect information. This quasi-experimental study with intervention and control group modalities utilized multiple comparisons to detect the effectiveness of the educational intervention through pre- and post tests. As Burns and Grove (2007) stated that:

" Use of a quasi-experimental design facilitates the search for knowledge and examination of causality in situations in which complete control is not possible. This type of design was developed to control as many threats to validity as possible in a situation in which some of the components of true experimental design are lacking." (p. 255).

This study is a type of experimental research that lacks the random selection procedures since the sample selected for the study is convenient and confined to CBH BC laboratory results, and to nurses working in the two pediatric wards at CBH who perform BC collection. The untreated comparison group design was used with pretest and posttest in this study. With this design, the researcher has a group of subjects who receive the educational intervention (Nurses Ward A) at CBH and a comparison group of subjects who receive no educational intervention (Nurses Ward B) in the same hospital. The participants of the control group included 20 Nurses; 3 Registered nurses (RN), 15 Practical Nurses (PN), and 2 pool nurses, with 25 beds in Ward B. The participants of the intervention group were 21

Nurses; 4 RN, 14 PN, and 3 pool nurses, with 32 beds in Ward A. The design can be mapped as follows:

	Pretest	Treatment	Posttest
Intervention group (ward A)	01	T	02
Control group (ward B)	01		02

The education intervention program entailed a variety of training methods; classroom sessions with video show, modeling behavior by the researcher, and role-play.

To evaluate the effectiveness of the intervention on the blood culture results, the proportion of contamination (false-positive) results among blood cultures obtained by nurses in ward A and nurses in Ward B from patients aged 40 days-16 years were retrospectively identified for the percentage of its availability prior to pretest and intervention to be compared with results at post-intervention. In other words, all blood cultures drawn and assessed for the false positive rates from pediatric patients from Wards A and B from the beginning of May 2009-the end of July 2009 (3 months) were considered the pre-intervention stage and from the mid of September-the mid of December 2009 (3 months) were considered the post-intervention period.

Quantitative approach used in this study because it emphasizes objectivity in the collection of data and analysis of information. It also allows analyzing data using numerical information through statistical procedures.

Also this study complies with the requirements of this approach, when large enough sample of blood specimens were used to analyze the BC results for the differences at pre and post tests. The study sampling for participants and blood samples utilized convenient sampling approaches.

4.2 Study setting

The study was conducted at CBH with 82 beds where blood culture samples are traditionally collected by nurses rather than dedicated phlebotomists to avoid multiple separate invasive procedures. This private charitable medical pediatric hospital is located at Bethlehem,

servicing the population of the Southern region of Palestine. CBH has 3 wards; ward A, ward B, and neonate ward (premature) in addition to the outpatient clinic. Two of the wards at CBH; ward A" where the study was performed" and the place work for the intervention group, and ward B the work place for the control group were included in the study. The two wards are similar in terms of the staff skills, patients' volume ~ (1500/year), median stay of hospitalized patients (5.1) and daily patients' turnover (8.6), (generated from CBH inpatient monthly statistics, 2008). Ward A includes 32 beds, while ward B includes 25 beds.

One aerobic BC sample usually required by physician was drawn from the patients to identify the presence of bacteria in the blood. Evaluation of blood culture specimens occurs at CBH laboratory which have automated blood culture system "Becton Dickenson Bactec 9050 machine". This system allows for continuous automated monitoring of the patient blood specimens. All specimens that contain any type of bacteria are detected by the machine and an alarm is set off. The laboratory personnel evaluate the sample by performing a Gram Stain looking for the type of bacteria that grow from the patient blood. The result of the Gram Stain is reported to the hospital staff in that ward and a culture is performed on the blood sample. The organism that grows on the next day is identified.

4.3 Study population

The study aims to target two populations. First, a total of 41 nurses were included in the present study, all nurses in ward 'A' as intervention group and all nurses in ward 'B' as control group.

Second, all patients 40 days-16 years old admitted at" wards A and B" at CBH, from whom BCs were obtained based on the doctor's suspicion that the patient has bacteremia were included. The unit of evaluation for this aspect is the blood culture bottles. The patient units chosen for this study is ward A and B, where all patients on these wards requiring a blood culture samples for suspected bacteremia during the study period were included. One aerobic BC sample was drawn from patients to identify the presence of bacteria in the blood.

4.4 Study period

The study started in May 2009 after the approval of Al-Quds University Higher Studies Council. Pilot testing was conducted in June 2009 followed by distribution of the questionnaire as pretest for nurses in wards A and B in July 2009 were completed. At the

same time and at 3 months period all blood samples for false positive results were obtained retrospectively from the hospital record to be compared with the post test results. As a second step of the study, education intervention for nurses in ward A was implemented in August 2009. After one and a half month, posttest for both groups in wards A and B was done coupled with collection of blood sample results for 3 months and as post intervention for nurses in ward A were completed (September 15th-December 15th). Analysis and writing the final report continued till the middle of January 2010.

4.5 Eligibility criteria

Inclusion criteria: First- in a convenient sample all nurses working at CBH in wards A and B who draw blood samples for culture during their current practice in pediatric wards participated in the study.

Second- blood specimens for culture obtained from all sick children aged 40 days till 16 years old admitted at wards A & B of CBH, based on the doctor's suspicion that the patient has bacteremia were included. The unit of evaluation for this aspect is the blood culture bottles.

Exclusion criteria: First- all nurses work at CBH in ward premature and outpatient clinic who draw blood samples for culture in the current wards were excluded. Second- all patients admitted at ward premature and outpatient clinic of CBH, from whom blood specimens for culture were obtained based on the doctor's suspicion that the patient has bacterimia were excluded. Also the blood culture samples collected during the period of intervention August 2009 till mid of September in ward A and B were excluded.

4.6 Sampling method and approach

A non-probability sampling method utilizing convenience sampling, also called "Accidental sampling" approach for study participants are included in the study because they were working in the study setting at that time. As Burns and Grove (2007) stated that,

"Convenience sampling is considered a weak approach because it provides little opportunity to control for biases; subjects are included in the study merely because they happen to be in the right place at the right time. Patients hospitalized with specific medical diagnoses, and classroom of students are an example of convenience sample. Available subjects are simply entered into the study until the desired sample size is reached. Multiple biases may exist in the sample, some of which may be subtle and unrecognized. However, serious biases are not always present in convenience samples.

Convenience samples are inexpensive, accessible, and usually less time-consuming to obtain than other samples. This method commonly used in health care studies and most researchers conducting quasi-experimental studies in medicine and nursing use convenience sampling method" (p. 337, 338).

The researcher follows the 'random assignment to groups' as a design strategy, which does not alter the risk of biases resulting from convenience sampling but does strengthen the equivalence of the study groups.

4.7 Sample size

1. A total of 41 nurses, with 21 nurses working in ward A (intervention group) and 20 nurses working in ward B (control group) were included in the study.

2. All patients 40 days till 16 years old admitted at wards A and B in CBH, from whom blood cultures were obtained based on the doctor's suspicion that the patient has bacteremia were included. A total of 1117 blood culture bottles pre and post-intervention were collected from the CBH laboratory records and analyzed, 555 one during the pre intervention period and 562 samples were collected at post intervention period which total for a 6 months period.

4.8 Data collection

Data were collected by the researcher who works at CBH as the head nurse of ward A. In this study, data were collected by means of a structured questionnaire that was distributed among study participants at pre-and post test to evaluate the effectiveness of the intervention and pretesting strategies implemented for this study. The study design and study objectives required two data collection and two data analysis procedures: the pre-intervention data and the post-intervention data.

4.8.1 The Pre-intervention data collection

The first data (pre-test) was conducted in May 2009 after a letter of agreement offered by the Nursing Manager at CBH to justify the researcher permission. Then, the questionnaire was distributed to each nurse in ward A and B who was available on the duty in that day, until all participants reached. For each nurse the investigator described the purpose of the study and

the importance of the nurses' input in filling out the questionnaire. It was pointed to all nurses to have a free choice if they are willing to participate or not, and were asked to sign the informed consent form attached at the front page of the questionnaire. The nurses were promised for anonymity and confidentiality.

The questionnaire was administered individually and the time used for filling the questionnaire was 20-25 minutes. Explanation of the items offered by the researcher if there was need to fill out the questionnaire. All nurses were responsive, cooperative, and willing to participate in the study and motivated to know the correct answers of the items.

The first set of data analysis of the questionnaire was done at first of June 2009, and then analysis, interpretation and reporting of the results needed two weeks. Based on the results and the nurse's needs for further education on aseptic technique when drawing blood for culture, in addition to revision of literature related, a health education package was developed in July 2009. The health education intervention program was introduced first week of August 2009. A month and a half later, at the mid of September, the second data collection (post-test) was obtained. Then comparison between the intervention group and the control group was conducted. The scores of the intervention group compared with the scores of the control group to evaluate the effectiveness of the education program as well as the pretest on their knowledge, attitude, and practices regarding collecting BC as well as to assess the similarities and/or differences for the two groups.

In addition, the blood culture results of all specimens drawn from patients with suspected bacteremia in ward A during the pre-intervention period (May-June-July, 2009) were identified for each calendar month from routine reports generated from the Clinical Microbiology Laboratory of the CBH to determine the proportion of false positive to the total blood cultures. The blood cultures results were categorized into true-positive, false-positive, and negative categories based on criteria established by this laboratory. Then, the rates of contaminations (False-positive) results were compared between the specimens collected by the intervention group and those collected by the control group.

4.8.2 The post-intervention data collection

The post intervention data (post-test) was collected by the same pretest questionnaire in September 2009 after one month of the intervention. As the pre-test, data were obtained

from both, the intervention and control groups, then the mean grades of the intervention group compared with the mean grades of the control group to evaluate the effectiveness of the education program on the intervention group's knowledge, attitude and practices. Also comparisons of pretest-posttest mean grades were made to both groups to determine the effects of educational intervention.

The second step for evaluation of the effectiveness of the intervention program was the comparison of the rate of contamination or false-positive rates for three months prior to the intervention (May, June, July) and with the rate of contamination for three months post the intervention period (September-October, October-November, November-December) for children admitted in both wards A and B to determine the effectiveness of the intervention program.

4.9 Research instrument

The study instrument was structured questionnaire developed based on previous studies and the continuous education test on controlling BC contamination rates prepared by experts from the field, where some items adopted and other items were modified and mostly were structured by the researcher. The questionnaire was distributed on experts (two pediatricians working at CBH, two microbiology specialist doctors from CBH and Al-Quds University, and the thesis advisor) to assess for wording, adequacy, and coverage of items to the aspects of BC collection technique and take their recommendations. To evaluate item clarity and response variance and to estimate the questionnaire reliability, a pilot testing was conducted. Pilot testing the instrument on 20 nurses from the same pool (CBH premature ward) resulted in adding or eliminating some questions and rewording until reliability achieved. The researcher translated on the spot the questions in case the participants cannot understand the meaning. The pilot participants were not included in the study.

A questionnaire that tested the knowledge and practices of updated blood culture procedures was given to each study participant before (pretest) and after (posttest) the educational intervention. Also the questionnaire was given to the comparison/control group pre and posttest. The questions are designated to assess the nurses' knowledge and practice about BC technique conducted at CBH in wards A and B.

The questionnaire (please refer to annex 3) was self-report instrument with closed ended questions and through 'multiple-choice' items that offer 3 response alternatives: True (T), False (F), Not sure or not known (N). Graded alternatives are preferable for opinion or attitude questions because they give researchers more information and give respondents a chance to express a range of views (Polit and Beck, 2004). Summated rating scales used as a person's total score is determined by adding together individual item scores. The self-administered questionnaire contained quantitative data in a 51 item checklist.

The questionnaire was developed into subcategories covering the following areas:

- Personal and demographic data, including: age, sex, academic background, years of experience, and place work. In addition, information about if the participants collected blood for culture and if they followed CBH guideline for BC collection.
- Part 1, including 4 items focused on the participant's knowledge about the conditions in which blood for culture are ordered. Such as patients with fever, or absence of fever, patients receiving antibiotic therapy, and in immune-compromised patients.
- Part 2, assessed the participant's practice and knowledge concerning BC collection. Item 1, asked about the definition, item 2 asked about the timing of BC collection, item 3 and 4 asked about the number of blood culture bottles obtained.
- Part 3, including 2 items that aimed to assess the participant's knowledge of false-positive BC and when contamination occurs.
- Part 4, including 5 items aimed to identify the participant's practices and knowledge of the materials needed for drawing BC. Such as the type of: gauze, antiseptic, syringes and gloves use, and the manufactured name of the BC bottle used.
- Part 5, including 5 items assessed the participant's knowledge of the importance to practice aseptic technique in the collection of blood for culture. In addition to the consequences of practicing the aseptic technique.
- Part 6, asked about the single most important factor in collecting uncontaminated BC to assess the participant's knowledge.
- Part 7, including 3 items aimed to assess the participant's practices and knowledge concerning the disinfection of the venipuncture site.
- Part 8, including 3 items assessed the participant's practices and knowledge concerning the collection site; Item 1 asked about the selection of venipuncture site, item 2 asked about the preferable site, item 3 asked if BC can be drawn from different sites at the same time.

- Part 9, assessed the participant's knowledge of the effectiveness of the BC disinfectants; Item 1 asked if the Iodine is more effective than Chlorhexidine, item 2 asked if the two disinfectants are effective, item 3 asked if Alcohol is effective like Iodine, item 4 asked if iodine is recommended in premature patients.
- Part 10, focused to assess the participant's practices and knowledge concerning the optimal volume for BC collection from children; item 1 asked about the volume which can be cultured, item 2 asked if the volume depends on the patient's body weight, item 3 asked if the less volume is increasing the potential to harvest organisms causing septicemia.
- Part 11, aimed to assess the participant's practices of pitfalls in the collection of BC; such as palpating the vein even after disinfecting the site, drawn BC bottles second if other laboratory tests ordered, and usage of same syringe to collect BC and other laboratory tests.
- Part 12, 3 items asked when BC contamination is suggested, and the common source of it, to assess the participant's knowledge.
- Part 13, aimed to assess the participant's knowledge about the use of multiskilled phlebotomists. 3 items asked if the contamination rates decreased or increased when multiskilled phlebotomists used to draw Blood for culture and if feedback to each one lead to increase the contamination rates.
- Part 14, assessed the participant's practices after drawing the blood for culture. Item 1 asked if they disinfect the rubber tops of the bottle before inoculation, item 2 asked if they changed the needle before inoculation, item 3 asked if they remove the air from the syringe before inoculation, item 4 asked if they forcefully expel blood from the syringe, item 5 asked if they swirl the bottle after inoculation of blood.

4.10 Reliability and validity of the study instrument

Reliability is concerned with the consistency of the measurement technique. Reliability testing is a measure of the amount of random error in the measurement technique. It takes into account such characteristics as dependability, consistency, accuracy, and comparability. Cronbach's Alpha coefficient is the most commonly used measure of reliability (Burns and Grove, 2007). For the newly developed instrument that constructed by the researcher and used for the first time, a reliability statistics showed a Cronbach's Alpha of 0.805 for 51 items of the questionnaire, which considered high reliability value.

The validity of an instrument is a determination of how well the instrument reflects the abstract concept being examined. No instrument is completely valid (Burns and Grove, 2007). The instrument used in this study prepared with considerably high face validity. According to Cormack (2000) content validity is concerned with the extent to which the instrument covers the various dimensions of the concept under investigation. Face validity involves forming a subjective impression of whether "on the face of it" the research instrument appears to measure what it is supposed to measure, and this can be approached by asking for experts' opinion and/or searching the literature for information against which to compare the contents of the instrument.

Content validity was established by distributing the questionnaire on five experts including the research advisor; others were two pediatricians working at CBH and two specialist doctors in microbiology from CBH and Al-Quds University, to examine the instrument and evaluate the initial contents. After revising the feedback from experts, the investigator of the study made the changes required where rewording, adding or deleting some items was needed. The tool was developed in English language and the English version was revised and modified by the advisor and then corrected according to his comments received.

4.11 Ethical matters and procedures

The title and the research methods were approved by the Higher Studies Nursing Committee which allowed passing the first part of the thesis. Then as a second step the Higher Studies Council at Al-Quds University approved it.

CBH administration was approached regarding study steps where they informed of the research to give permission of involving nurses 'ward A and B' in the study and to allow implementing the educational program at CBH nursing school. They encouraged the researcher for this step she took and promised to support the project financially. Also approval from the laboratory chief was taken to check the computerized blood culture results. In addition, CBH "Research Committee" was informed (please refer to annex 5) and the approval was received to implement the study (please refer to annex 6).

For the purpose of maintaining ethical and legal standards, every participant in the study received an explanation about the purpose of the study, confidentiality, and sponsorship of the study through an informed consent attached with each questionnaire (please refer to

annex 2). The letter of agreement includes information about the nature of the study, why it is to be conducted and a statement assuring voluntary participation. Participants were assured that anonymity and confidentiality will be maintained at all stages of data collection.

4.12 Statistical analysis

The quantitative data was entered and analyzed using the SPSS (Statistical Package for Social Sciences Version 17). The methods used to analyze the questionnaires are:

1. Descriptive Statistics- represented by graphs, mean, variance, frequencies.
2. Inferential Statistics- represented by paired sample T-test and independent sample T-test

The data analysis was carried out according to the following stages:

- Reviewing the questionnaires.
- Grading the papers.
- Deciding on what statistical methods to use.
- Cleaning the data.
- Formulating frequency tables for the study variables.
- Statistical testing of the responses of the participants using paired sample T-test for comparing two means, and independent sample T-test to see if there is a statistical difference between the variables according to the study objectives.

Statistical level of significance used was 0.05.

4.13 Response rate

The study population who approved to participate was 41 nurses at CBH of whom, 21 nurse from ward A and 20 nurses from ward B. A total of 41 nurses received the questionnaire by personal distribution and participated in the study. The response rate was controlled by having the nurses fill the questionnaire in their work field, which is often inexpensive and efficient and likely to yield a high rate of completed questionnaires (Polit and Beck, 2004).

All the questionnaires were completely filled and thus the response rate was 100%, and no any question was omitted from the analysis. As Polit and Beck (2004, p. 366) stated that personal contact with respondents has a positive effect on response rates for self

administered questionnaires (SAQs). Furthermore, researchers can help explain or clarify particular items or the study purpose.

4.14 Limitations of the study

The support from the managers in the study locations decreased the difficulties in data collection and access to the participants. Where the main limitations included the following:

- One of the most important limitations of this study worth mentioning was limited access to local and regional studies, since in the local area there was no any study related to this study. In addition, the main access that contained related literature provided by Al-Quds University was the Toronto University access which provided a limited number of literatures.
- As mentioned before, Convenience sampling is considered weak approach because it provides little opportunity to control for biases; subjects are included in the study merely because they happen to be in the right place at the right time. Multiple biases may exist in the sample, some of which may be subtle and unrecognized. However, serious biases are not always present in convenience samples. In addition, Low sample size of the population of the study who fill the questionnaire because this number is found in the study place.
- Health education requires time, resources, and consistency in education to affect the learners (Kiger, 1995). The education program implemented in this study was designed to fit the structure of the continuous education (CE) program at CBH and according to the time allowed from the head of the CE. This may have posed some limitation on the quantity and thus quality of the information given. Also since the researcher is the educator could increase the bias toward group A.
- Both groups (intervention and control) are very close in terms of their work settings and their life experiences could have increased the contamination among them, even this contamination was positive.
- Data collection was completed through a self-administered questionnaire in which information obtained what is asked, so there is always possibility that important unknown dimensions can be overlooked. In addition, the data collection of the questionnaire was lengthy, since self-administered questionnaires have taken time from both the researcher and the participants.

- Difficult access to the whole population (nurses) in the different shifts and duty days, which took about 30 days to fill the questionnaire for the whole participants including those who were in their annual leaves.
- The study confined to CBH. Thus results obtained cannot be generalized to other hospitals that did not take part in the study.

Summary

The research design for this study is quasi-experimental design to examine causality among the dependent variable and the independent variable. The "untreated comparison group design" was used with pretest (3 months before intervention) and posttest (3 months after).

The study aims to target two populations. First, all patients 40 days till 16 years old admitted at "ward A and B" of CBH, from whom blood cultures were obtained. The unit of evaluation for this aspect is the blood culture bottles. Second, a total of 41 nurses were included in the present study, all nurses in ward A as intervention group and all nurses in ward B as comparison group and the response rate was 100%.

The participants eligible for participation were all the nurses' work at CBH in ward A and B who draw blood samples for culture in the current pediatric wards. The total is 41 nurses. And all patients 40 days till 16 years old admitted at "Ward A & B" of CBH, from whom blood specimens for culture were obtained based on the doctor's suspicion that the patient has bacteremia were included.

The instrument was constructed by the researcher and used for the first time, distributed on experts in the field including the research advisor; two pediatricians working at CBH and two specialist doctors in microbiology from CBH and Al-Quds University for validity. A reliability statistics showed a Cronbach's Alpha of 0.805 for 51 items of the questionnaire, which considered high reliability value.

Pilot testing the instrument on 20 nurses from the same pool (CBH premature ward) resulted in adding or eliminating some questions and wording until reliability achieved. The pilot respondents were not added to the sample. Ethically, after approval by the Nursing Higher Studies Committee, the Higher Studies Council at the Faculty of Nursing Management allowed to pass the first part of the thesis. Then it was approved by the Higher Studies Council at Al-Quds University.

The researcher collected the data by means of a structured questionnaire that distributed among study participants pre-and post test to determine the knowledge and practice of the study participants' pre-and post intervention. The study design and study objectives required

two data collection and two data analysis: the pre-intervention data and the post-intervention data. The statistical analysis of the quantitative data done using SPSS system, and statistical testing done using paired sample T-test and independent sample T-test at the 0.05 significance level.

Limitation of the study included library access limitation, weakness of the convenience sample, Low sample size of the population who fill the questionnaire, and results obtained cannot be generalized, in addition to time limitation.

Chapter V

Findings

Introduction

This chapter presents the main findings of the study using descriptive and inferential analysis. The study targeted two populations; the first study population consisted of 41 participants (nurses) working at CBH in wards 'A' and 'B', the second population was all patients 40 days till 16 years old admitted in wards A and B at CBH, from whom blood cultures were obtained based on the doctor's suspicion that the patient has bacteremia were included. The unit of evaluation for this aspect is the blood culture bottles.

The descriptive statistics used to represent the sociodemographic characteristics and variations among participants, and presented by tables and graphs. The questionnaire items are ranked in ordinal measure of frequency, percentages, means, and variances, and presented in tables, graphs, and figures.

The inferential statistics used to test hypothesis about the population; paired sample T-test for comparing two means, and independent sample T-test to analyze the questionnaire pre and post-test which aimed to measure the participants' grades or scores pre and post test for both the intervention group (ward A) and the control group (ward B). According to Polit and Beck (2004) the parametric procedure for testing differences in group means is the T-test (sometimes referred to as student's T). The T-test can be used when there are two independent groups (e.g., experimental VS control), and when the sample is paired or dependent (e.g., when pretreatment and post-treatment scores are compared for a single group).

The rates of false-positive, true-positive, and negative BCs three months pre and three months post intervention were collected, calculated and presented in tables and figures for the number and percentages. To compare the two proportions (percents) of BC false-positive rates between the two study periods for the two groups, Z-test was used.

5.1 Description of sociodemographic data

This section will present the characteristics of the participants, description of the intervention group, and description of the control or comparison group.

Table (5.1.) represents the participants' distribution according to age, sex, occupation, job experience, experience in collecting blood for culture, and in following CBH blood culture collection guideline.

Table 5.1: Summary of the demographic characteristics of the participants (Total 41 participants)

Variable	Group	Number	Percent
Age	Less than 30 yrs	11	26.83
	30- 40 yrs	11	26.83
	More than 41 yrs	19	46.34
Sex	Female	38	92.68
	Male	3	7.32
Occupation	RN	7	17.10
	PN	29	70.70
	Pool	5	12.20
Job experience	Less than 5 yrs	10	24.39
	5- 10 yrs	8	19.51
	More than 10 yrs	23	56.10
Have you collected blood for culture	Yes	41	100
Do you follow CBH blood culture collection guideline	yes	41	100

As it is clear in table (5.1.) the participants aged less than 40 years were around 54% and who aged more than 40 years were 46%, that's mean nearly half of the participants were at young age group and the other half of them were at old age group, with a majority of females 92.7% VS 7.3% males.

The findings indicated that the majority (83%) of nurses are practical nurses (PNs); 71% with permanent job and 12% are pool. Only 17% are registered nurses (RNs) which indicated poor educational background of drawing blood for culture since it is not included in their academic curriculum.

The distribution of the participants based on their total years of experience as shown in table (5.1.) illustrates that 56% worked more than 10 years, followed by 24% worked less than 5 years, and 20% have experience of 5-10 years. Although the majorities are PNs, however half of them have high job experience in the pediatric wards at CBH.

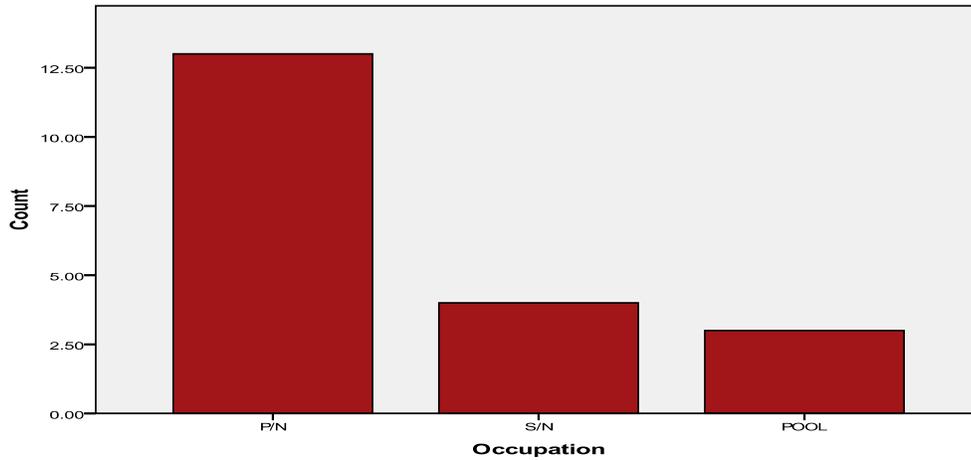
All participants respond positively (100%) to the following two questions; have you collected blood for culture? and do you follow CBH blood culture collection guideline? This means they all have the same experience in collecting BC since they follow CBH guideline.

5.1.1 Description of the intervention group

There were 41 participants (nurses) included in the study, 21 (nurses ward A) were pretested, given the educational intervention about BC collection technique, and then given the post-test to serve as intervention group. The other 20 (nurses ward B) were pretested, not given the educational intervention, but were given the post-test to serve as a control group. Both groups were given the tests at the same time and the duration between the pretest and posttest was 31 days. Only 20 participants were included in the analysis from ward 'A' so that both samples will be of equal size as recommended by the statistician. One participant was randomly chosen and excluded from the analysis. So, the sample size was 20 from ward 'A' (who took the training and education) and 20 from ward 'B' (who did not take any training or education).

The findings showed that the intervention group (ward A) has 18 female and 2 male nurses, of those 70% (13 nurses) were PNs and 20% (4) were RNs while the rest 10% (3) were Pool, and this was evident in figure 5.1.

Figure 5.1: The intervention participants' occupation

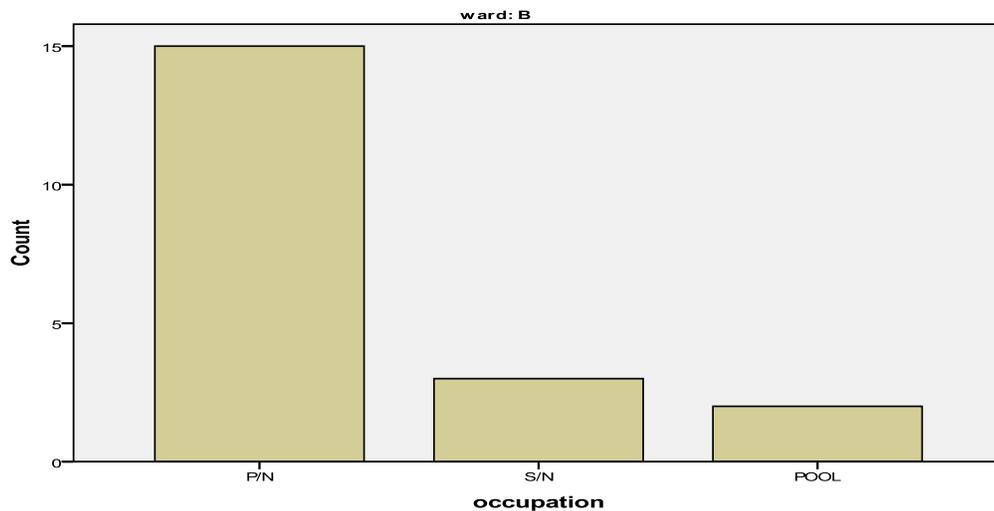


The oldest participant was 59 years old and the youngest was 22 years. The average age of the intervention group was 39.4 years, and on average, the participants in ward 'A' had 16.7 years of experience, where the minimum job experience was less than 1 year and the maximum was 38 years of experience.

5.1.2 Description of the control group

The findings showed that the control group (ward 'B') was all females except one, of those 75% (15 nurses) were PN and 15% (3) were RN while the rest 10% (2) were Pool, and this was evident in figure 5.2.

Figure 5.2: The control participants' occupation.



The oldest participant in ward 'B' was again 58 years old and the youngest was 21 years old. The average age was 37.4 years. And, on average those in ward 'B' had 15.9 years of experience; the least experience was 1 year and the most was 35 years. These findings were similar in the intervention group, which indicate that the two study groups were similar in their distribution according to age, sex, occupation, and job experience.

5.1.3 Comparison between characteristics of the control and intervention group

To compare the characteristics of the participants between the control and intervention group, table (5.2.) represents comparison between the two groups' distribution according to age, sex, occupation, job experience, experience in collecting blood for culture, and in following CBH blood culture collection guideline. The findings indicate that the two study groups were similar in their distribution according to age, sex, occupation, and job experience. All participants from the two have the same experience in collecting BC since they follow CBH guideline.

Table 5.1.3: Comparison of the demographic characteristics of the participants (20 nurses each group)

Variable	The intervention participants'	The control participants'
Age	Oldest participants: 59 yrs	58 yrs
	Youngest: 22 yrs	21 yrs
	Average age: 39.4 yrs	37.4 yrs
Sex	Female: 18 nurse	19 nurse
	Male- 2 nurse	1 nurse
Occupation	RN: 4	3
	PN: 13	15
	Pool: 3	2
Job experience	Average: 16.7 yrs	15.9 yrs
	Minimum: less than 1 yr	1 yr
	Maximum: 38 yrs	35 yrs
Collected blood for culture	20 nurse	20 nurse
Follow CBH BC collection guideline	20	20

5.2. The pre-test data analysis of the questionnaire

This section includes: comparison of the pre-tests between the intervention and the control groups, and needs assessment of the pre-test for the intervention group.

As aforementioned the first experimental step was the assessment of the knowledge, attitudes, and practices (KAP) of nurses in wards 'A and B' on the proper procedure of blood collection for culture at CBH. The assessment obtained through the pre-test for ward 'A' helped the investigator to design an educational program based on the identified needs and concerns.

5.2.1 Comparing pre-tests for the intervention and control groups

To compare the pre-test for the intervention group (ward A) with the pre-test for the control group (ward B); the questionnaires were evaluated and given grades (scores). The grade was the grade for each nurse (number of correct answers/ 51) made out of 100. The total mean grades was the sum of grades over the number of nurses (20 each group). Then the total mean grades for both groups were evaluated (sum of grades/ number of nurses) and the findings presented in Table 5.2.

Table 5.2: The total mean grades for the intervention (ward A) and control group (ward B) at pre-test

	ward	N	Mean	Std. Deviation	Std. Error Mean
Pre-intervention grade means	A	20	48.43	8.100	1.811
	B	20	50.20	8.639	1.932

The mean grade for ward 'A' was 48.4 and the mean grade for ward 'B' was 50.2, which is low means for both wards and indicated the need for educational intervention on proper BC collection procedure. To see if there was a significant difference, the two mean grades from pretest subjected to independent sample t-test and the results showed that the grades for the two groups are not significantly different (at a 0.05 significance level) as showed a test

statistic of -0.666 with a p-value of 0.509. This indicated that the two groups lack knowledge regarding BC and have poor practices related to BC collection technique.

5.2.2 Findings of the pre-test for the intervention group

The questionnaire includes questions that are designated to assess the nurses' knowledge and practice about BC technique conducted at CBH. The self-administered questionnaire contained quantitative data in a 51 item checklist (please refer to annex 3).

Structured self-report instrument was closed ended questions. The type of these closed-ended questions was 'multiple-choice' questions that offer 3 response alternatives: True (T), False (F), Not sure or not known (N). Graded alternatives are preferable for opinion or attitude questions because they give researchers more information and give respondents a chance to express a range of views (Polit and Beck, 2004). Summated rating scales used as a person's total score is determined by adding together individual item scores. True or false responses may be wrong or right answers depend on the way how the question asked, however the not sure responses considered wrong answers because that information is not known for them.

The findings of the pre-test data analysis have met the first objective of the study (To assess the knowledge, attitudes, and practices (KAP) of nurses ward 'A' on the proper procedure of blood collection for culture at CBH). The analysis provided an opportunity to assess participants' needs for education and to answer the study question (What are the common pitfalls and errors of blood culture collection currently implemented in ward 'A'?).

Table 5.3 presents the analysis of the questions 1 and 2 reflecting ward 'A' participants' knowledge about the conditions in which BC are ordered, what is BC, and information like when to draw BC and how many at wide intervals.

Table 5.3: Ward 'A' participants responses to question 1, 2 reflecting their knowledge toward BC. (Total 20 participants)

1- Blood culture are ordered in the following condition:	T		F		N	
	No	%	No	%	No	%
a. Patients with fever, or hypotension not explained by non- infectious causes.	13	65	4	20	3	15
b. In the absence of fever, patients with focal infection such as pneumonia, meningitis, acute osteomyelitis and Coma.	17	85	2	10	1	5
c. Patients receiving antibiotic therapy for documented blood stream infection.	12	60	8	40	0	0
d. Immuno-compromised patients with unexplained pulmonary, renal, and hepatic dysfunction.	8	40	5	25	7	35
2- Blood culture:						
a. Is a lab. Test in which blood is injected into bottles without culture media to determine whether microorganisms have invaded the patient's blood stream.	10	50	5	25	5	25
b. Should not draw half an hour before rising fever.	6	30	6	30	8	40
c. For total of 2-3 aerobic cultures obtained at wide intervals within a 24 hrs are sufficient to diagnose most cases of septicemia.	6	30	6	30	8	40
d. Blood cultures should obtain once because it is more cost-effective.	8	40	8	40	4	20

Related to question 1, the findings indicated that 40% from the participants respond wrongly to the third item because BC are ordered in case patients receiving antibiotic therapy for documented blood stream infection to confirm clearance of microorganism from blood, also 60% respond wrongly to the fourth item because BC can be ordered in case of immuno-compromised patients with unexplained pulmonary, renal, and hepatic dysfunction. While 65% knew that BC are ordered in case patients with fever or hypotension not explained by non-infectious causes, and 85% knew that BC can be drawn in the absence of fever, and in case patients with focal infection such as pneumonia, meningitis, acute osteomyelitis and coma. This information indicates that ward 'A' participants had lack of knowledge to some conditions in which BC are ordered.

Related to question 2, the findings illustrated that 75% of the participants have wrong answers related to what is BC test, because the blood is injected into bottles with culture media. Also, 70% respond wrongly to the second item because BC should be drawn half an hour before rising fever and 70% respond wrongly to the third item because 2-3 aerobic

cultures should be obtained at wide intervals within a 24 hrs to diagnose most cases of septicemia. More than half (60%) respond wrongly to the third item because BC should not be obtained once for the cost effective reason. This indicated lack of knowledge toward what is BC and information like when to draw BC and how many at wide intervals.

Table 5.4 presents the analysis of the questions 3, 12, and 13 reflecting ward 'A' participants' knowledge about what is false positive BC means, when BC contamination suggested, and if the contamination rates increased or decreased when the hospitals use multiskilled phlebotomists to draw blood specimens.

Table 5.4: Ward 'A' participants responses to question 3, 12, and 13 reflecting their knowledge toward false positive rate and contamination. (Total 20 participants)

3- False positive blood culture means:	T		F		N	
	No	%	No	%	No	%
a.False positive is a positive test result for a disease or condition when the disease or condition is not present.	9	45	3	15	8	40
b. Contamination not occurs during blood drawing if the skin is not cleaned well.	4	20	15	75	1	5
12- Blood-culture contamination:						
a. Is suggested when bacterial growth is present in all cultures collected from the patient.	9	45	5	25	6	30
b. Should automatically be considered if gram stains from positive blood cultures indicate the presence of normal skin flora.	9	45	6	30	5	25
c. The common source of blood culture contamination is the skin flora.	12	60	3	15	5	25
13- Use of multiskilled phlebotomists to draw blood specimens :						
a. Increased blood-culture contamination rates.	1	5	18	90	1	5
b. Decreased blood-culture contamination rates.	17	85	1	5	2	10
c. Feedback to each individual phlebotomist on their personal contamination rate lead to increase in contamination rates.	2	10	9	45	9	45

The findings related to question 3 showed that around half of the participants (55%) did not know (respond wrongly to item one) the meaning of false positive BC which is a positive test result for a disease or condition when the disease or condition is not present. This indicates knowledge lack related to the meaning of BC false positive.

Although 75% knew that contaminations occurs during blood drawing if the skin is not cleaned well, but 25% did not know.

Related to question 12, the findings indicated that 75% of the participants did not know that contamination is not suggested when bacterial growth is present in all cultures collected from the patient, also around half of them (55%) respond wrongly to the second item because contamination should be considered if gram stains from positive blood cultures indicate the presence of normal skin flora. Also 40% respond wrongly or did not know that skin flora is the common source of contamination, while it is the common source.

The findings related to question 13 showed that the majority (85%) of the participants had the right answer that the use of phlebotomists decreased BC contamination rate. And 55% respond wrongly to the third item because researches found that feedback to each individual phlebotomist on their personal contamination rate decrease (not increase) false positive rates.

Table 5.5 presents the analysis of the questions 5, 6, and 9 reflecting ward 'A' participants' knowledge about the importance of practicing aseptic technique, disinfectants used, and the most important factor in collecting uncontaminated BC.

The findings related to question 5 indicated that although 85% of the participants knew that practicing aseptic technique in BC collection result in isolating the bacteria that is usually significant (right answer), but half of them (50%) had wrong answer because they did not know that aseptic practice reduce the cost of hospitalization for the patients. Although 35% respond wrongly because aseptic practice not lead to time loss for health practitioner; however, 85% had right answer because they knew that practicing aseptic technique decrease stress over the family. Also, 45% respond wrongly that aseptic practice result in adding expense for the hospital while it decreases expenses.

Table 5.5: Ward 'A' participants responses to question 5, 6, and 9 reflecting their knowledge toward the importance of practicing aseptic technique, disinfectants used, and the most important factor in collecting uncontaminated BC. (Total 20)

5- It is important to practice aseptic technique in the collection of blood for culture because this will result in:	T		F		N	
	No	%	No	%	No	%
a. Isolation of bacteria that is usually significant.	17	85	2	10	1	5
b. Reduce cost of hospitalization.	10	50	7	35	3	15
c. Loss of time for technician, Drs, and nurses.	6	30	13	65	1	5
d. Increase stress over the family.	3	15	17	85	0	0
e. Add expense for the hospital.	7	35	11	55	2	10
6- The single most important factor in collecting uncontaminated blood cultures is:						
a. Use of fresh antiseptics.	3	15	9	45	8	40
b. Skilled personnel.	6	30	7	35	7	35
c. Proper collection site preparation.	8	40	6	30	6	30
9- Blood culture disinfectants:						
a. Iodine is more effective as a site preparation antiseptic than Chlorhexidine .	15	75	0	0	5	25
b. Chlorhexidine is as effective as iodine.	3	15	6	30	11	55
c. Research showed that using Chlorhexidine is not effective like iodine.	8	40	2	10	10	50
d. The use of iodine is recommended in premature patient.	3	15	6	30	11	55

Question 6 on the most important factor in collecting uncontaminated blood cultures which should be 'the proper collection site preparation' received scattered responses, the findings illustrated that 60% of the participants did not know that the proper collection site preparation is the single most important factor in collecting uncontaminated blood cultures.

Regarding question 9 on BC disinfectants, the findings indicated that all participants answered wrong because 75% said that iodine is more effective as a site preparation antiseptic than Chlorhexidine while it is not, and the rest were not sure. Also, 90% answered wrong to the third item because they did not know or not sure that using Chlorhexidine is effective like iodine as research showed. In addition, 70% of the participants did not know and not sure that the use of iodine is not recommended in premature patient.

Table 5.6 presents the analysis of questions 4, 7, and 8 related to ward 'A' participants' knowledge and practices concerning BC procedure; like preparing materials needed, disinfecting of the venipuncture site, and selecting collection site..

Table 5.6: Ward 'A' participants responses to questions 4, 7, and 8 reflecting their knowledge and practice toward preparing: materials for BC procedure, venipuncture site, and selecting collection site. (Total 20 participants)

4- Materials needed for drawing blood culture include:	T		F		N	
	No	%	No	%	No	%
a. Sterile gauze.	19	95	1	5	0	0
b. Alcohol and tincture of iodine.	20	100	0	0	0	0
c. Sterile syringes 2cc, sterile needles (butterfly and standard needle)	15	75	5	25	0	0
d. Must be sterile gloves	8	40	9	45	3	15
e. Culture bottle: 'BACTEC' brand vial & patient's labels.	16	80	0	0	4	20
7- In the disinfection of the venipuncture site:						
a. Clean site with alcohol swabs for 20 seconds.	4	20	7	35	9	45
b. Clean site in a circular manner from the periphery to center for at least 30 seconds.	10	50	6	30	4	20
c. Clean with alcohol first, then clean with tincture of iodine and allow to dry, then clean site with alcohol swab and let it to dry.	12	60	5	25	3	15
8- The collection site:						
a. Antecubital venipuncture is associated with a high contamination rate.	5	25	2	10	13	65
b. If at all possible, blood cultures should draw from lines, not via venipuncture.	3	15	14	70	3	15
c. Blood culture can be drawn at the same time but from different sites.	7	35	4	20	9	45

The aim of question 4 was to assess the participants' preparation of materials needed for drawing BC. The findings revealed that only 5% of the participants did not prepare and use sterile gauze for drawing blood for culture while the rest use it. All of them prepare and use alcohol and tincture of iodine which should be used together. Also 75% use only sterile 2cc syringes while 5cc is more suitable for the volume and only 25% of them prepare the two syringes according to volume. Although 40% of them used sterile gloves, but 60% did not use sterile gloves in some conditions needed. And 20% of the participants were not sure about the name of the BC bottle that used in CBH which is the BACTEC' brand vial, while 80% of them knew that.

The aim from question 7 was to assess the participants' practices toward preparing the venipuncture site. The findings showed that 20% of the participants were cleaning the venipuncture site with alcohol swabs for only 20 seconds, and 45% were not sure for how many seconds to clean the venipuncture site which means that 65% had wrong answer. Also half of them (50%) cleaned venipuncture site in a circular manner from the periphery to center for at least 30 seconds which is a wrong practice, in addition 20% of them were not sure in which way to clean or for how many seconds, and only 30% of them used the right practice (from center to periphery). Whereas 60% of the participants used to clean the venipuncture site with alcohol first, then clean with tincture of iodine and allow it to dry, then cleaned site with alcohol swab and let it to dry which it is the right way, but 25% of them did not use this way for cleaning the site, and 15% of them were not sure that this way is healthy.

The aim from question 8 was to assess the participants' practices toward selecting the collection site. Researches showed that antecubital venipuncture is not associated with a high contamination rate, however 25% of the participants thought that it is associated with a high contamination rate and thus did not select it, in addition 65% of them were not sure of that information, and only 10% of them selected antecubital site. Although blood cultures should be drawn via venipuncture and not from lines, the findings indicated that 70% of the participants did that, however 15% still draw blood via lines and the other 15% also were not sure that BC should be drawn via venipuncture site. It is true that BC can be drawn at the same time but from different sites, but only 30% of the participants did that and 20% thought it is false practice in addition 45% of them were not sure if it is a right practice.

Table 5.7 presents the analysis of the questions 10, 11 and 14 which related to ward 'A' participants' knowledge and practices concerning BC collection technique, like optimal volume to be drawn, aspiration and post withdrawal technique to maintain sterility.

The aim of question 10 was to assess the participants' knowledge and practices related to the optimal volume for blood-culture collection from children. The findings indicated that 20% of the participants did not know the volume of blood that can be cultured from children patients, so they can inject more or less than the required volume in addition to the 5% who were not sure and considered wrong responses. Although the blood volume required to be drawn depends on the patient's body weight, 20% of the participants did not draw blood volume according to patients' weight plus 20% were not sure that blood volume depends on the weight, while the rest (60%) drew blood volume according to patients' weight. BC

optimum results are obtained with 1-3ml; however the findings showed that 80% of the participants did not draw that required amount, in addition to 10% of them were not sure of the required amount to obtain good results. Research showed that collecting volume less than the required amount decrease the potential to harvest organisms causing septicemia, but 60% of the participants were not sure of that information, plus 10% of them did not aware and may collect less amount that revealed poor diagnosis.

Table 5.7: Ward 'A' participants responses to questions 10, 11, and 14 reflective their practice concerning BC collection. (Total 20 participants)

10- The optimal volume for blood-culture collection from children:	T		F		N	
	No	%	No	%	No	%
a. The blood volume which can be cultured is 0.5—5.0 ml.	15	75	4	20	1	5
b. Depends on the patient's body weight.	12	60	4	20	4	20
c. Optimum results are obtained with 1.0- 2.0 ml.	16	80	2	10	2	10
d. Collecting volume less than the required amount increase the potential to harvest organisms causing septicemia.	2	10	6	30	12	60
11- In the collection of blood cultures:						
a. Palpating the vein even after disinfecting the site can be done.	3	15	17	85	0	0
b. It is recommended that the blood-culture bottles are drawn second if other lab. tests ordered.	14	70	4	20	2	10
c. One may use same syringe to collect blood culture and other tests but to use sterile technique.	5	25	13	65	2	10
14- After drawing the blood, it is important to:						
a. Disinfect the rubber tops of the bottle before inoculation into the culture bottle and let dry.	17	85	2	10	1	5
b. Change needle before inoculating blood into the culture bottle.	14	70	3	15	3	15
c. Remove the air from the syringe that containing blood before expel into the blood-culture bottle to maximize finding bacteria.	8	40	1	5	11	55
d. It is best practice to forcefully expel blood from the syringe.	6	30	7	35	7	35
d. Don't swirl the bottle after inoculation of blood, but shake well.	10	50	4	20	6	30

The aim of question 11 was to assess the participants' practices during BC collection technique. It is known that palpating the vein with unsterile gloves after the site has already been disinfected is one of the pitfalls of BC collection, however the findings illustrated that 15% of the participants still practicing that and 85% of them were aware that it is bad practice. It is recommended through literature review that the blood-culture bottles are drawn first if other laboratory tests ordered, however the findings showed that 70% of the participants drew blood second if other laboratory tests ordered, plus 10% of them were not

sure of the best practice and only 20% of them drew blood cultures sample first in the order of multiple tubes. Also, literatures recommended not using same syringe to collect blood for culture and other lab tests, but 25% of the participants used same syringe plus 10% of them did not know the best practice and 65% of them used different syringes.

The aim of question 14 was to assess the participants' practices after drawing the blood for culture and preparation of culture bottles. CLSI guideline (2006) reported that after the venipuncture site is identified, the rubber septum on the BC bottle(s) or tube(s) should be disinfected with 70% isopropyl alcohol and allowed to dry. The findings illustrated that 10% of the participants did not disinfect the rubber tops of the bottle before inoculation plus 5% of them were not sure doing that, but 85% of them disinfect the rubber tops of the BC bottle and let dry. One of the pitfalls in BC collection is to change the needle before inoculating the blood into the culture bottle. It is suggested not to change the needle before inoculating BC bottles due to safety issues. The findings indicated that 70% of the participants did that pitfall plus 15% of them were not sure if it is pitfall or not and only 15% of them did not change the needle. It is recommended to inoculate the blood into the bottle after removing the air from the syringe that containing blood before expel into BC bottle to maximize finding bacteria. If this volume of air is pulled into anaerobic bottles, it can be detrimental to some anaerobic organisms. The findings showed that 55% of the participants were not sure to remove or not the air plus 5% of them did not remove the air and 40% of them removed the air from the syringe that containing blood before expel into BC bottle. Also it is recommended to expel blood from the syringe by gravity for safety issue; however the findings showed that 30% of the participants forcefully expelled blood from the syringe, in addition 35% of them were not sure and only 35% expelled blood from the syringe by gravity. CLSI guideline (2006) reported that BC bottles should be inverted gently several times to prevent clotting and to mix the blood with the broth. The findings illustrated that 50% of the participants did not swirl the BC bottle but shack it well, in addition 30% of them were not sure to swirl or shack, and only 20% of them gently swirled the BC bottle.

The conclusion from these finding is that the intervention nurses' knowledge and practice regarding BC collection in different area need improvements and thus the educational intervention is deemed necessary.

5.3 Pre-intervention data analysis of the BC false positive (F+) rates

As mentioned before, the study targeted two populations, the first population was nurses working at ward A and B, while the second was all patients 40 days-16 years old admitted at wards A and B, from whom BCs were obtained based on the doctor's suspicion that the patient has bacteremia, were included in the analysis. The unit of evaluation for this aspect is the BC bottles. One aerobic BC sample was drawn from patients to identify the presence of bacteria in the blood. The evaluation of the BC specimens was performed at CBH laboratory which has an automated blood culture system (Becton Dickenson Bactec 9050 machine). All specimens that contained any type of bacteria were detected by the machine and an alarm is set off. The laboratory personnel evaluated the sample by performing a Gram Stain looking for the type of bacteria that grew from the patient's blood. The result of the Gram Stain was reported to the wards and a culture was performed on the blood sample bottle. The organism that grows on the next day was identified.

The BC results of all specimens drawn from patients with suspected bacteremia in ward A and B during the pre- and post-intervention period were identified for each calendar month from routine reports generated from the Clinical Microbiology Laboratory at CBH to determine the proportion of false positive from the total blood cultures. The BCs results were categorized into true-positive, false-positive, and negative categories based on criteria established by CBH laboratory.

A total of 1117 BC bottles during the pre- and post-intervention period were collected and analyzed. Of the 1117 BC bottles, 555 samples were collected during the pre- intervention period (May, June, July), while 562 samples were collected during post- intervention period (September-October, October-November, November-December) which total for a 6 months period.

The rates of true-positive and negative BCs during the three months pre-intervention for the two wards were collected and calculated based on numbers only, and the rates of false-positive (F+) BC were collected and calculated for the numbers and percentages. The findings are presented in table 5.8 and displayed graphically in figure 5.3.

There were a total of 555 BCs obtained from patients admitted at the medical pediatric wards A and B at CBH from May to July 2009, pre-intervention. Of the 555 BCs analyzed, 324 (58.4%) specimens from ward A, while 231 (41.6%) specimens from ward B. There was an

increase rate in the number of BCs done in ward A; this was thought to be due to the higher occupancy rate in ward 'A' (32 beds) when compared to ward B (25 beds). Thus, ward 'A' had more admissions than ward 'B'.

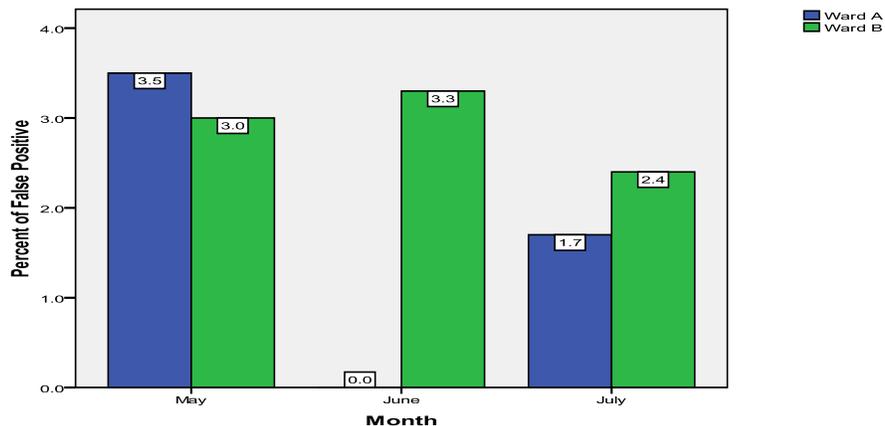
The F+ rates in May for ward A and B were 3.5%, 3% respectively, whereas in June were 0%, 3.3% respectively, and in July were 1.7%, 2.4% respectively. The high F+ rate was in May for ward 'A' (3.5%) while it was in June for ward 'B' (3.3%), and the low one was in June for ward 'A' (0%) while it was in July for ward 'B' (2.4%).

Table 5.8: Comparison of BC results between ward A and B prior to intervention.

	Ward A					Ward B				
	Total specimen	No growth	True positive	False positive		Total specimen	No growth	True positive	False positive	
				No	%				No	%
May-09	114	107	3	4	3.5	100	96	1	3	3
Jun-09	95	94	1	0	0	90	85	2	3	3.3
Jul-09	115	112	1	2	1.7	41	39	1	1	2.4
overall	324	313	5	6	1.9	231	220	4	7	3

The number of the true positive BCs for ward 'A' from May-July were 3, 1, and 1 (5 overall) whereas for ward 'B' was 1, 2, and 1 (4 overall). The rest of specimens were negative BCs, from them 313 for ward A and 220 for ward B.

Figure 5.3.: Comparing of BC F+ rates in ward A and ward B prior to intervention.



To compare the BC false positive rates (F+) for the two wards, the F+ average rates of the three months pre-intervention were calculated for the intervention and control wards and presented in table 5.9.

Table 5.9: BC F+ rates for ward A and B.

	F+ rates		Testing that F+ rates are the same in both wards	
	Ward A	Ward B	Test Statistic	P-Value
May	3.5%	3%	0.21	0.83
June	0%	3.3%	-1.78	0.08
July	1.7%	2.4%	-0.28	0.78
Overall (3 months)	1.9%	3%	-0.90	0.37

The average false positive rate for ward 'A' was 1.9%, while it was 3% for ward 'B'. The average false positive rate was higher in the control ward. To compare the two proportions, the F+ average rates pre-intervention for the two wards were subjected to a Z test (a test for comparing two proportions), and the findings showed that there was no significant difference (at the 0.05 significance level) in the F+ rates between the two wards p-value (0.37) during the pre-intervention period.

5.4 The education intervention program

The experimental step was the development of the educational program (proper procedure of collecting blood culture samples) for nurses in ward A, based on needs assessment of knowledge and practices indicated by the findings of pretest data and literature reviewed regarding this issue. The researcher reviewed CLSI guideline and literature related to educational intervention, then the program was developed and implemented. The pre-test analysis provide an opportunity to look at the lack of knowledge and poor practices of the nurses' ward 'A' and the results (records) of the BC false positive rates.

The objectives for intervention was to raise the knowledge through information, improve the practice by role modeling, and thus change the attitudes of nurses' ward A regarding BC collection. To achieve these objectives a theory session gave detailed information about BC collection procedure such as skin preparation, volume of blood to be collected, manner of

inoculating blood into the bottle, site selection, and specimen handling, common practices and mistakes encountered by "ward A" nurses in doing a BC discussed in details (please refer to annex 4). The training session was supported by a video show presented by the researcher that included the eleven steps (will be discussed in the new protocol) of the correct BC technique. The researcher used "Modeling behavior" to show the practicing of the proper BC technique and then "Role playing" by the nurses to improve their skills.

There were 21 nurses in ward 'A' (intervention group) who received the educational program. These were divided into 3 groups, 7 nurses in each group where education program was given separately. The educational program included 3 hours of teaching and training in the nursing school at CBH for one week period. Training based on principles of best practice in education was implemented: nurses learned content and basic skills as active participants in the learning process through role-playing; information given the learner's response (theory), the process by which the response is derived; time used wisely to learn contents and basic skills; many different ways offered to meet nurse's different learning needs (modeling behavior, role playing, video show); nurses learned with others (group of nurses each session); good outcomes anticipated from nurses; and there was contact between nurses and instructor during the learning process (the researcher directly responded to participant's questions related to theory and practicing BC collection technique) .

The educational content was: a definition of both, the blood culture and the contamination or false positive BC; patients in whom BC are appropriate; the purpose of the BC; the cause of BC contamination; principles for BC collection; preparing materials needed for BC collection; protocol to follow when practicing BC collection consisting of 11 steps; and common pitfalls encountered during BC technique. In addition, it featured a detailed procedure such as skin preparation, volume of blood to be collected, manner of inoculating blood into the bottle, site selection, and specimen handling.

The old protocol developed by the chief of the CBH laboratory which all nurses were following prior to the new protocol, was replaced by a new one to help intervention nurses to change their practice and attitude. According to the old protocol BC collection would have been done in the following way:

1. Recommended volume:
 - a) Infant and children: 0.5 to 3 ml of blood
 - b) Adults: 5 to 10 ml of blood
2. Skin antisepsis and venipuncture

- a) Site selection: Avoid drawing blood through indwelling intravenous or intra-arterial catheter unless blood cannot be obtained by venipuncture.
 - b) Select a different site if more than one blood culture is ordered.
3. Site preparation:
- a) Cleanse the venipuncture site with 70% ethyl alcohol.
 - b) Clean the skin twice with iodine by swabbing the site. For the third iodine cleaning, starting at the center of the site and moving in a circular motion, clean the skin for 10 seconds.
 - c) Allow the venipuncture site to dry (Please DO NOT blow on it).
 - d) Do not touch the venipuncture site after preparation of the skin and prior to drawing the blood. In case you have to touch the skin again, make sure to vigorously clean your finger with iodine and allow it to dry.
4. Disinfecting blood culture bottles
- a) Disinfect top of bottle with 70% ethyl alcohol, and allow it to dry.
 - b) Please DO NOT hook the vacuette to the bottle before finding the vein. This will lead to the loss of the blood bottle vacuum.
5. Insert the needle into the vein, and withdraw blood. Do not change needles before injecting the blood into the culture bottle.
- a) Do not touch the needle when drawing the blood.
 - b) Do not stick the patient twice with the same needle
 - c) Mix the blood well after adding it to the blood bottle to avoid blood clotting.

The new protocol developed and presented as video show by the researcher was based on the needs assessment, and is done in the following way:

Step 1- Check order,

- Identify patient by checking the arm band,
- Prepare labels

Step 2- Explain the procedure to the patients or parents (if possible with dolls or puppets).

- Explain need of second attempt if required.
- Assess parental ability to participate or assist you
- Decide whether parent should be present or not.

Step 3- Wash hands with soap & water with friction for 15 sec.

Or use Alcohol based hand rub.

Step 4- Prep the rubber cap of the BC bottle with iodine pad in a circular motion. Then with an alcohol pad and allow the alcohol to dry.

Step 5- Prep the puncture site

- Select appropriate site (preferably antecubital), apply tourniquet, & palpate for venous access.
- Prep (wipe) the puncture site with alcohol swab for at least 30 sec (30-60 sec.) in a circular manner from the center to periphery vigorously.
- Then clean with tincture of iodine & allow drying.
- Then clean again with alcohol swab & let it to dry,

(Note- don't wipe the site after cleansing the skin to reduce contamination)

Step 6- Apply gloves: If palpation of site prior to puncture is anticipated, wear __sterile gloves. If palpation is not anticipated, wear no sterile gloves.

Step 7- Draw Blood

1. Perform venipuncture using cannula with connection line / butterfly needle.
2. Draw the blood volume into sterile syringe
Pediatric: 2.5-5ml (don't overfill bottle). Infant: 0.5-1ml.
From 0.5ml-5ml can be cultured, depends on the pt body weight (no more than 1% of pt's total blood volume). Optimum results are obtained with 1-3ml.
3. Draw blood for culture first, then for other lab test second.
4. Remove the syringe first, and then remove the butterfly needle second.
5. Engage safety sheath.
6. Apply pressure to the site with gauze.
7. Dispose butterfly needle into sharps container.
8. Attach the syringe with sterile needle using aseptic technique.
9. Inoculate the blood into the bottle after removing the air from the syringe containing blood before expelling into BC bottle to maximize finding bacteria.
10. Don't forcefully expel blood from the syringe. Let it be drawn by gravity.

Step 8- Mix

- Gently swirl (rotate) the bottle to mix the blood & the broth.
- Don't shake vigorously.

Step 9- Place the pt label on the bottle & attach the lab requisition after filling with appropriate information. Remove & dispose gloves, wash hands.

Step 10- Send the BC bottle to the lab as soon as possible.

Step 11- Document the following in the nursing progress notes:

- Date & Time specimen obtained
- Site of specimen collection

The intervention participants' skills on drawing blood was observed on-the-job for one month period (August, 2009) to evaluate if changes in intended skills by the intervention group were achieved or not. When mistakes noted, the need for more training or follow-up clearly emerged during that month. Also feedback to each individual from the intervention group was given on their personal contamination rates in an attempt to decrease the false positive rates. Direct feedback of contamination rates to each individual increase both ownership and awareness.

Changes in nurses ward 'A' intended behavior were clinically significant since the laboratory technicians reported that.

5.5 Post-intervention data analysis of the questionnaire

For the second experimental step was the collection of the posttest data and post false positive rates for the two wards. The second data analysis, forty one questionnaires were collected from the intervention group (nurses ward A) and the control group (nurses ward B) to assess their knowledge and practice regarding BC collection technique post intervention. Again one questionnaire was deleted randomly from ward 'A' to fit the paired test analysis, so 20 questionnaire from ward 'A' and 20 questionnaire from ward 'B' were analyzed. The duration between the pretest and posttest was 31 days.

The mean grade at pre- and post-test for each category in the questionnaire were extracted based on this formula, ($m = \frac{\text{sum of all scores}}{\text{total number of scores}}$) for the intervention and control groups. Then the mean grades at posttest compared with the mean grades at pre-test to check the differences for the impact of the intervention.

5.5.1 Post-test data analysis for the intervention group

To answer the study question (Do educational intervention has an impact on the KAP of ward 'A' nurses?), comparison between the mean grades at pre and post tests in each category (question) was done for the intervention nurses' ward A to check the differences for the impact of the intervention. The findings presented in table 5.10, and displayed graphically in figure 5.4.

In question 1 (Blood cultures are ordered in the following condition) there was an increase in the mean grades from 63 (pre-intervention) to 98 (post-intervention), and from 30 to 90 in question 2 (what is BC?), and so on.

The pre-test analysis indicated that the minimum mean grades was 13 in question 9 related to the knowledge about BC disinfectant, and the maximum mean grades was 73 in question 13 related to the knowledge about individual phlebotomist. However, the minimum mean grades in the posttest was 87 in questions 6 related to the knowledge about the important factor in collecting uncontaminated blood cultures and in question 12 that related to when BC contamination suggested.

Table 5.10: Comparison between the mean grades at pre- and post-test for ward 'A'

Question	PRE-INTERVENTION			POST-INTERVENTION		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
q1 Blood cultures are ordered in the following condition:	25	100	63	75	100	98
q2 What is Blood culture:	0	75	30	75	100	90
q3 False positive BC means	0	100	60	50	100	88
q4 Materials needed to drawing BC	40	100	69	80	100	94
q5 It is important to practice aseptic technique because:	20	100	68	80	100	95
q6 important factor in collecting uncontaminated BC is	0	100	38	0	100	87
q7 In the disinfection of the venipuncture site:	0	100	42	67	100	95
q8 The collection site:	0	67	38	67	100	97
q9 Blood culture disinfectants:	0	75	13	50	100	91
q10 The optimal volume BC collection from children:	0	75	44	75	100	89
q11 In the collection of blood cultures:	0	100	57	67	100	98
q12 Blood-culture contamination:	0	100	43	33	100	87
q13 Use of multiskilled phlebotomists to draw BC	0	100	73	100	100	100
q14 After drawing the blood, it is important to:	0	60	39	60	100	88.5

The maximum mean grade in the posttest was 100 in question 13 related to the knowledge about individual phlebotomist, compared to 73 in the pretest. Also in the posttest the mean

grades was 98 in questions 1 and 11 related to the knowledge about the conditions BC ordered and the practice during BC collection, compared to 63 and 57 respectively in the pretest. This indicates that there was improvement in the mean grades at the posttest.

Figure 5.4: Comparison between ward 'A' mean grades at pre-and post-tests.

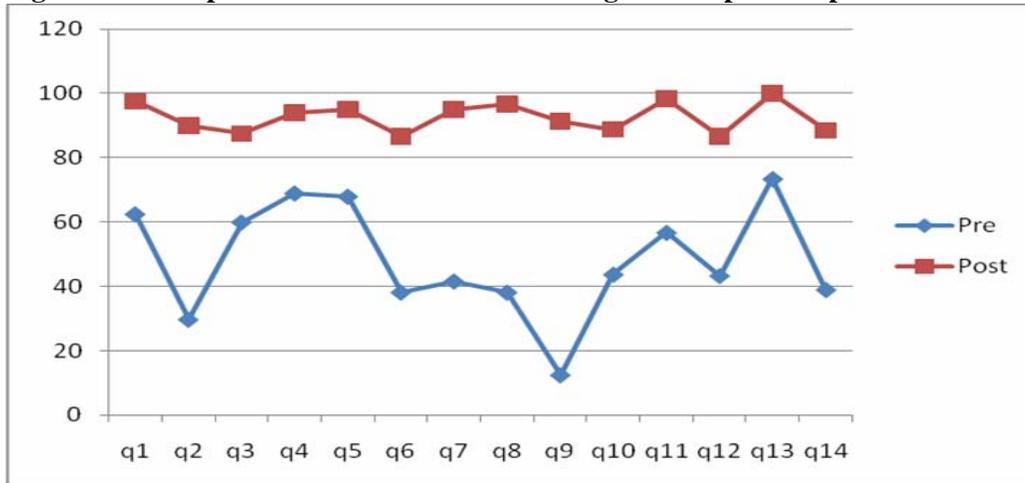


Figure 5.4 represents the mean grades for each question in pre and posttest for the intervention group. The posttest mean grades fall between 87- 100, while the pretest mean grades fall between 13-73. It is clear that the line of the posttest is higher than the line of the pre-test and thus there seems to be differences in the mean grades of the two tests.

To compare the total mean grades of the 14 questions in the questionnaire at the pretest with the posttest for the intervention group, the total mean and standard deviation of the grades for the pre- test and the post- test were calculated, and presented in table 5.11.

Table 5.11: Comparison between the total mean grades at pre and post-tests for Ward A.

Test	Mean	N	Std. Deviation	Std. Error Mean
Post Test	92.75	20	4.636	1.037
Pre Test	48.43	20	8.100	1.811

The findings showed that the total mean grades in the post-test for the intervention group were much higher than the total mean grades in the pre-test. The average grade after the

educational intervention was 92.75 which is really much higher than 48.4 before the educational intervention. This indicates that the grades of the intervention group were improved in the posttest which means that their knowledge, practice, and attitude improved post-intervention.

To test the hypothesis that the knowledge, practice, and attitude improved post-intervention for the intervention group, grades from pretest and posttest subjected to paired sample t-test. The findings showed a *T-test* of 22.061 and a p-value close to zero which means that the post-intervention test grades are significantly higher than the pre-intervention test grades. Here the significance level of alpha 0.05 was used. This approval indicates that the knowledge, practice, and thus their attitude improved post-intervention.

5.5.2 Post-test data analysis for the control group

To identify the differences in the control group (ward B) mean grades for pre and post test, comparison between the two tests was done, and the findings presented in table 5.12, and displayed graphically in figure 5.5.

The findings indicated that the mean grades for the control group in each category in the posttest stay nearly the same in the pretest. In question 1 (Blood cultures are ordered in the following conditions) the mean grades was 63 in the pre-test and 66 in the post-test. In question 2 (what is BC?) the mean grades was 44 in the pre-test and 39 in the posttest, and so on.

The pre-test analysis indicated that the minimum mean grades was 15 in question 9 related to the knowledge about BC disinfectant, and the maximum mean grade was 75 in question 13 related to the knowledge about individual phlebotomist (similar to ward A). The minimum mean grade in the posttest was 23 again in questions 9 and the maximum mean grade was 69 in question 4 related to materials needed to draw BC. This indicates that there was no improvement in the mean grades at the posttest for the control group.

Table 5.12: Comparison between the mean grades at pre and post-test for ward B.

Question	PRE -TEST			POST-TEST		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
q1 Blood cultures are ordered in the following condition:	25	100	69	50	100	66
q2 What is Blood culture:	0	75	44	0	100	39
q3 False positive BC means	0	100	48	0	100	63
q4 Materials needed to drawing BC	40	100	67	40	100	69
q5 It is important to practice aseptic technique because:	20	100	66	40	100	65
q6 important factor in collecting uncontaminated BC is	0	100	60	0	100	57
q7 In the disinfection of the venipuncture site:	0	100	55	0	100	43
q8 The collection site:	0	67	33	0	100	40
q9 Blood culture disinfectants:	0	75	15	0	100	23
q10 The optimal volume BC collection from children:	0	75	34	0	80	28
q11 In the collection of blood cultures:	0	100	53	0	100	62
q12 Blood-culture contamination:	0	100	50	0	100	42
q13 Use of multiskilled phlebotomists to draw BC	0	100	75	0	100	68
q14 After drawing the blood, it is important to:	0	80	40	0	80	43

Figure 5.5: Comparison between ward 'B' mean grades at pre-and post-tests.

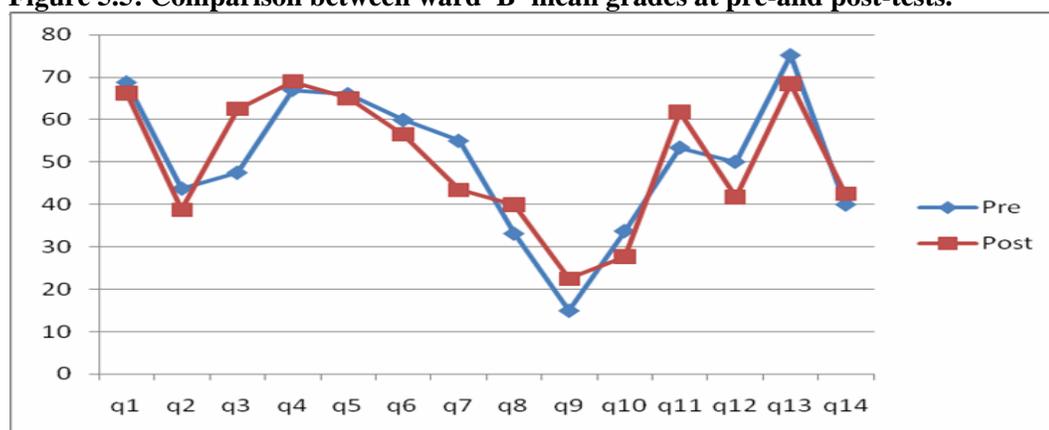


Figure 5.5 represents the average grade for each question in pre and posttest for the control group who has no intervention. It is clear that the lines are close to each other and thus there

seems to be no difference in the mean grades of the two tests. This indicates that no improvement in the knowledge, practice, and attitude (KAP) of the control group as there was no educational intervention done.

To compare the total mean (average) grades of the 14 questions in the questionnaire in the pretest with the posttest for the control group, the total mean and standard deviation of the grades for the pre- test and the post- test were calculated, and presented in table 5.13.

Table 5.13: Comparison between the total mean grades of the control group pre and post-test.

Test	Mean	N	Std. Deviation	Std. Error Mean
Post Test	50.29	20	8.798	1.967
Pre Test	50.20	20	8.639	1.932

The findings showed that the total mean grades in the post-test for the control group were 50.3 which are almost the same as the mean grades of the pre-test (50.2), consecutively indicating no differences. This could be expected since they did not receive educational intervention.

To test if there was significant difference between the two tests for the control group, a t-test used, and the findings indicated a test statistic of 0.048 and a p-value of .962 which means that there was no significant difference between the average grades for the pre and post tests since the p-value is more than 0.05.

5.5.3. Comparing the post-tests for the intervention and control groups

To answer the research question (Do educational intervention program make differences between the (KAP) of the intervention and the control groups), comparison made between the posttests for the two groups, and the total mean grades (average) presented in table 5.14. The table illustrates that the intervention group (ward A) has 92.75 mean grades compared with 50.29 for the control group (ward B). This means that the intervention group had higher mean grades, which indicates that the educational intervention program make differences between the (KAP) of the intervention and the control groups.

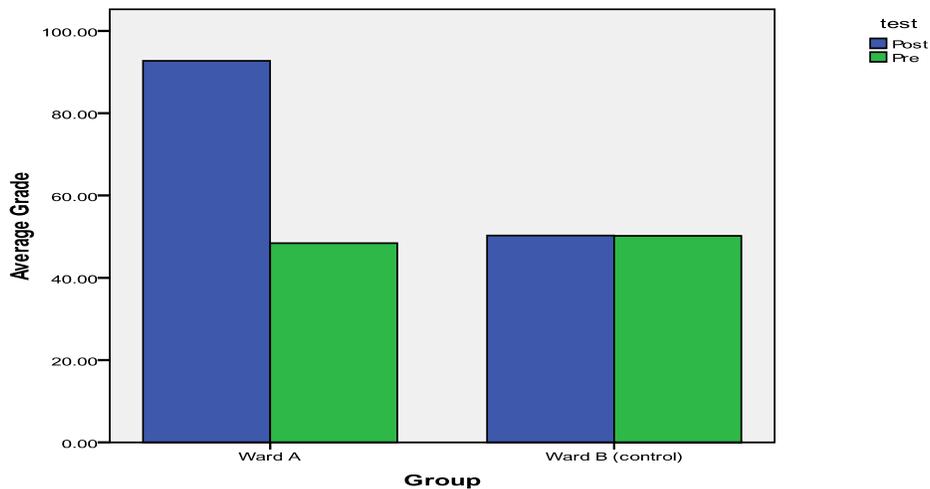
Table 5.14: Comparison between posttest mean grades for the control and intervention group (ward A and B).

	ward	N	Mean	Std. Deviation	Std. Error Mean
Post-intervention grade means	'A'	20	92.75	4.636	1.037
	'B'	20	50.29	8.798	1.967

And testing that the mean grades of the posttest were greater for ward A, we get a T-test of 19.09 with a p-value close to zero which is significant at the 0.05 significance level. This shows that the post-test grades for ward 'A' (intervention group) were significantly higher than those in ward B (control group). This means that the educational intervention for the intervention group was effective and can improve their KAP.

The average grades for the intervention and control groups pretest and posttest were displayed graphically in figure 5.6.

Figure 5.6: Comparison between posttest mean grades for the control and intervention groups.



The pretest mean grades for the intervention group was 48.43 compared with 50.20 for the control group, while the post test mean grades for the intervention group was 92.75 vs. 50.29 for the control group. The findings showed that the mean grades for the two groups at pretests were nearly same, while the mean grades for the intervention group were much higher than the mean grades for the control group at posttest. This indicates the effectiveness of the educational intervention done for ward A. Although there were no differences between the mean grades for the control group at the pre and post tests, however there were

significant differences between the mean grades for the intervention group at pre and post tests.

5.6 Post-intervention data analysis of the BC F+ rates

This section includes: analysis of the BC F+ rates at post-intervention for the intervention ward A and the control ward B, comparison between the rates of contamination (F+) results of the specimens collected by the intervention group and those which collected by the control group, in addition to the inpatient F+ rates at CBH during the year 2009. The aim was to identify if the educational intervention with the new protocol including the eleven steps on the proper procedure of BC collection had the effect to minimize the BC F+ rates at post-intervention period for the intervention ward.

The number of true-positive and negative BCs three months post intervention were calculated, and the rates of F+ calculated for number and percentages for the two wards. The results of studies examining the rates of the false-positive for the blood cultures post-intervention for the two wards are presented in table 5.15.

Table 5.15: Post-intervention BC results in ward A and ward B.

2009	Ward A				Ward B			
	Total specimen	No growth	True positive	False positive No %	Total specimen	No growth	True positive	False positive No %
Mid Sep- Mid Oct.	95	94	1	0 0	72	70	1	1 1.4
Mid Oct. Mid Nov.	118	116	1	1 0.8	109	103	5	1 0.9
Mid Nov. Mid Dec.	82	82	0	0 0	86	83	1	2 2.3
Overall	295	292	2	1 0.3	267	256	7	4 1.5

There were a total of 562 BCs drawn from patients admitted to wards A and B during post-intervention period, from September 15th-December 15th 2009. Of the 562 BCs, 295 (52.5%) specimens were collected from patients' admitted to ward A, while 267 (47.5%) specimens collected from patients' admitted to ward B. There was an increase in the number of BC drawn from ward 'A' on the second study period, which thought as mentioned before, due to the higher occupancy rate for ward A. The F+ rates in September-October for ward A and B were 0%, 1.4% respectively, whereas in October-November were 0.8%, 0.9% respectively, and in November-December were 0%, 2.3% respectively. The high F+ rate for

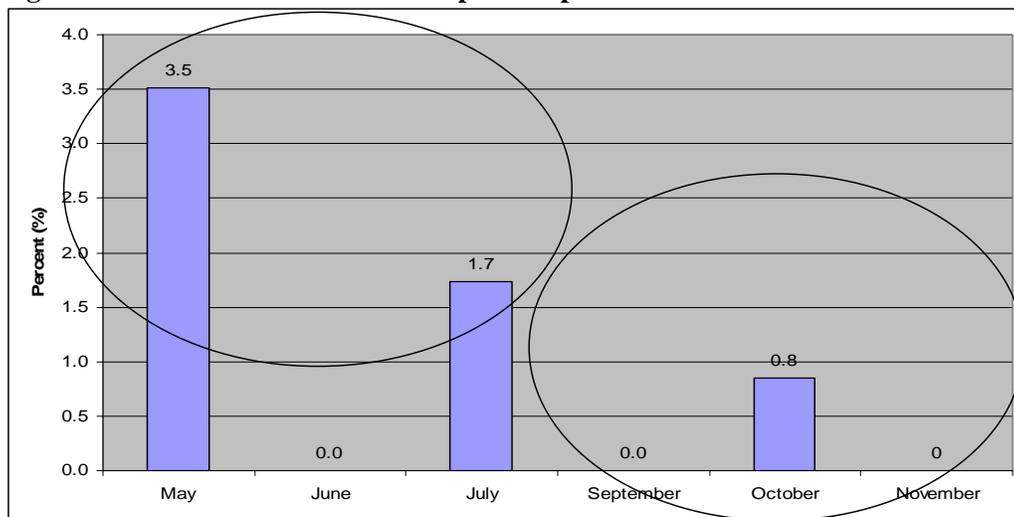
ward A was in October-November (0.8%) while for ward B was in November-December (2.3%). And the low one was in September-October and November-December (0%) for ward A while it was (0.9%) in October-November for ward B.

The number of the true positive BCs for ward 'A' from May-July were 1, 1, and 0 (2 overall); whereas it was 1, 5, and 1 (7 overall) for ward 'B': The rest of the specimens were negative BCs, of which 292 from ward A and 256 from ward B.

5.6.1 BC F+ rates pre and post-intervention for the intervention ward 'A'

The results of studies examining the effects of the educational intervention on the rates of the F+ for the blood cultures obtained by the intervention group pre- and post-intervention were displayed graphically in figure 5.7. For ward A, the pre-intervention F+ rates were 3.5%, 0%, 1.7% from May till July, while the post-intervention F+ rates were 0%, 0.8%, 0% from September-December. The high F+ rate of BC (3.5%) was in May during the pre-intervention period; while it was only (0.8%) in October-November during the post-intervention period.

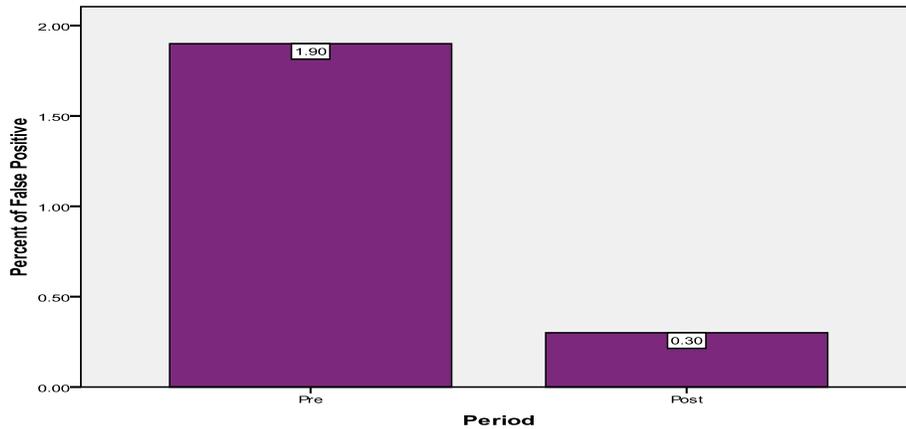
Figure 5.7: BC F+ rates for ward 'A' pre and post-intervention.



To answer the study question (Does the educational intervention for ward A nurses on the proper procedure of blood culture collection reduce blood culture false-positive rate at CBH?), a comparison between the BC F+ average rates in the pre-intervention period (May, June, July) and the post-intervention period (September-October, October-November,

November-December) for the intervention ward was done. Figure 5.8 represents the F+ average rates for the intervention ward pre- and post-intervention.

Figure 5.8: Comparison of BC F+ average rates for the intervention ward pre- and post-intervention.



Calculating the average F+ rates pre and post-intervention, the findings showed that it was 1.9% pre-intervention (May, June, July), while it was 0.3% post-intervention (September 15th-December 15th). After the introduction of the new protocol on the proper procedure of BC collection, the F+ rates decreased in average from 1.9% pre-intervention to 0.3% post-intervention. Table 5.16 presents a comparison between the average F+ rates pre- and post-intervention for the intervention ward.

Table 5.16: Comparing BC F+ average rates for the intervention ward pre and post-intervention.

	False positive rates		Testing that FP rates are lower in the post period	
	Pre-intervention	Post-intervention	Test Statistic (pre-post)	P-Value
Overall Percentage	1.9%	0.3%	1.78	0.04

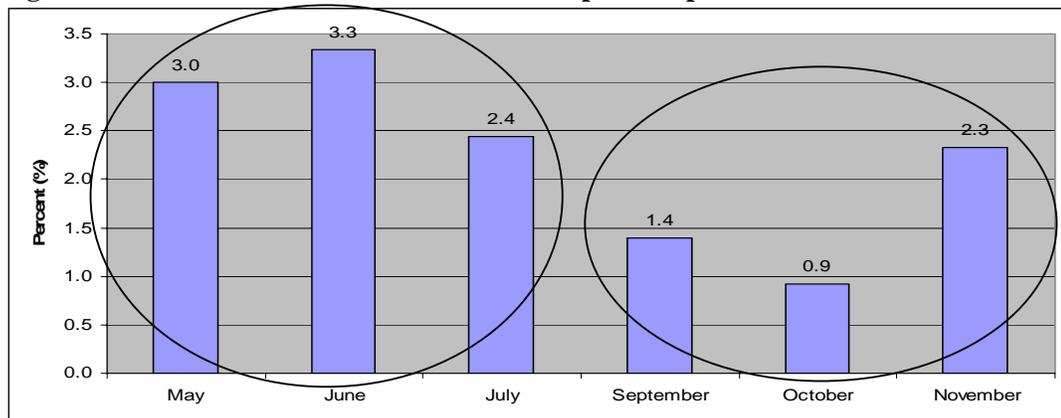
Testing that the F+ rates were lower in the post period for ward 'A', the findings indicated that the p-value was 0.04 which is less than alpha (0.05) thus there is enough evidence to show that the post period had lower overall F+ rates than the pre-period. This interesting result means that the educational intervention for ward 'A' nurses on the proper procedure of blood culture collection had the effect to reduce BC F+ rates.

5.6.2 BC F+ rates pre and post-intervention for the control ward 'B'

For ward B, the pre-intervention BC false positive rates were 3%, 3.3%, 2.4% from May-July, and the post-intervention BC F+ rates were 1.4%, 0.9%, and 2.3% from September 15th-December 15th. The higher percentage rate of BC contamination (2.3%) in November-December post-intervention period; while, the lower rate (0.9%) was in October-November. Calculating the average F+ rates pre- and post-intervention, the findings showed that it was 3% pre-intervention (May, June, July), while it was only 1.5% post-intervention (September 15th-December 15th).

Comparing the rates between pre- and post-intervention periods, the findings showed that the F+ rates surprisingly decreased during post-intervention period. This is thought to be due to the transfer of the educational guideline (new protocol) to nurses' ward B when both wards were mixed in the mid of August till the mid of September 2009. Ward B nurses came to work in ward A due to the decreased number of the admissions in the Pediatric wards, so their behavior towards the BC collection may have been influenced by the intervention group (nurses' ward A). This may have been reflected positively in the BC F+ rates of ward B. Figure 5.9 presents the BC F+ rates at pre- and post-intervention periods for ward 'B'.

Figure 5.9: BC F+ rates for the control ward B pre-and post-intervention.



5.6.3 BC F+ rates post-intervention for the intervention and control wards

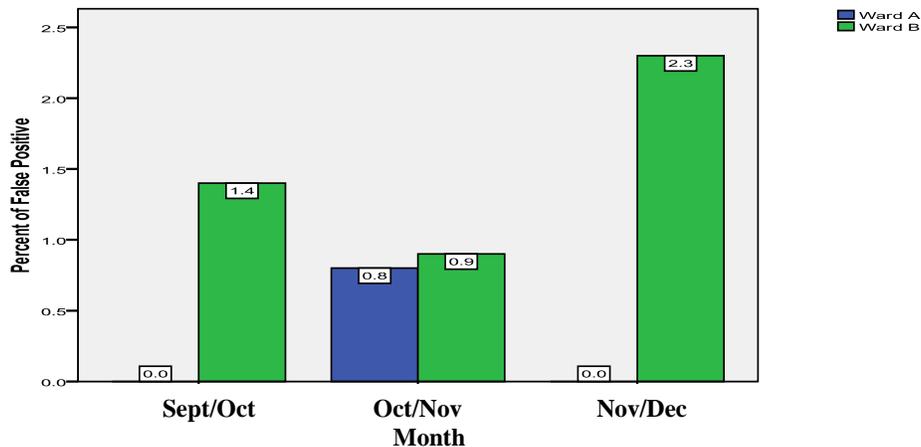
To answer the study question (Does the educational intervention make difference in the blood culture false positive rates between the two wards at CBH?), a comparison was made between the F+ average rates post-intervention for ward A and B. The F+ rates for each ward were summated and the overall average rates of the 3 months were obtained. The findings are presented in table 5.17 and displayed graphically in figure 5.10.

5.17: BC F+ average rates for ward 'A' and 'B' post-intervention.

	False positive rates		Testing that FP rates are lower in Ward A	
	Ward A	Ward B	Test Statistic	P-Value
September-October	0%	1.4%	-1.16	0.12
October-November	0.8%	0.9%	-0.08	0.47
November-December	0%	2.3%	-1.38	0.08
Overall (3 months)	0.3%	1.5%	-1.46	0.07

The overall average BC F+ rates post-intervention for ward 'A' was 0.3%; however it was 1.5% for ward 'B', both average F+ rates were less than 2%. The F+ rates were decreased post-intervention for the two wards; from 1.9%-0.3% for the intervention ward A and from 3%-1.5% for the control ward B. The reason was thought to be that ward 'B' benefited from the training and education about the BC collection technique in some way and thus during the post period they improved as well.

Figure 5.10: Comparison between the BC F+ rates for ward 'A and B' post-intervention.



To examine the differences in the BC F+ rates between the two wards, a Z test was used for comparing the two proportions. Table 5.19 shows no significant difference (at the 0.05 significance level) since the P-value= 0.07. Although there were no significant differences in the F+ rates between the two groups (ward 'A' and 'B') post-intervention, however there were

significant differences in the F+ rates for ward 'A' between the pre and post-intervention period.

5.6.4 BC F+ rates for inpatients at CBH during the year 2009

To have a clearer picture of the BC F+ rates at CBH and to identify the effects of the educational intervention, another step of further BC F+ rates analysis was made. As aforementioned, the inpatient at CBH includes three wards: ward A, ward B, and neonate ward. The BC F+ rates for inpatients at CBH during the year 2009 were registered in the laboratory computer, collected, and displayed graphically in figure 5.11.

Figure 5.11: Comparing BC F+ rates for inpatients at CBH during the year 2009.

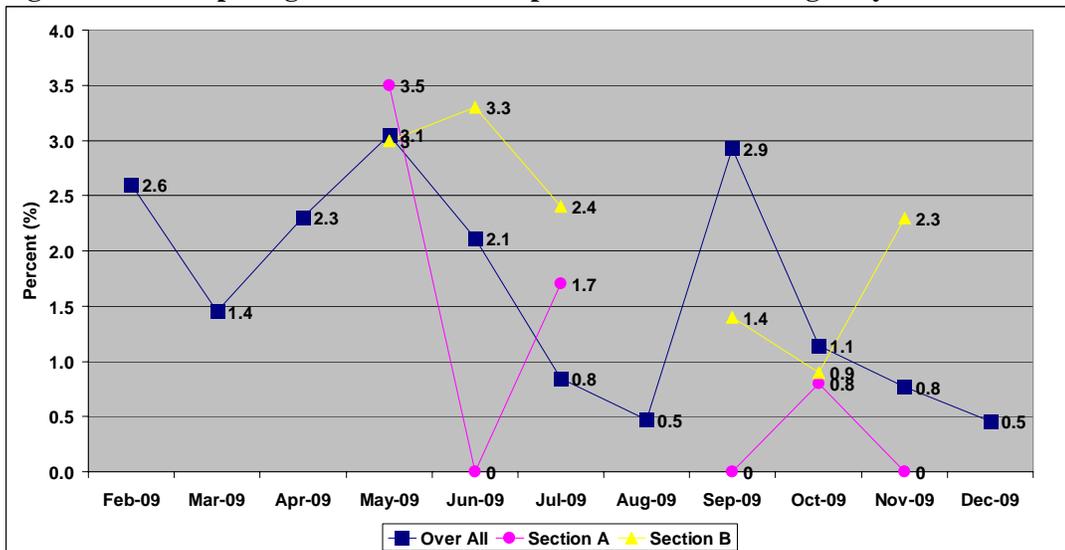


Figure 5.11 illustrates the overall inpatient BCs F+ rates over the year 2009 during each month from February 2009 till January 2010 in blue colors. The F+ rates ranged between 0.5%- 3.1%. The yellow colors represent ward 'B' (control group) F+ rates pre-intervention (May- July) and post-intervention (mid of September-mid of December) periods. The pink colors represent ward 'A' (intervention group) F+ rates during pre- and post-intervention periods. It is obvious that the minimum false positive rates were in the post-period for ward 'A' that had the educational intervention on the proper BC collection procedure. This indicates the effectiveness of the intervention program in decreasing the BCs F+ rates for the experimental group and can touch the control group as well.

Summary

The study targeted two populations; first, the total number of participants was 41 nurses distributed on wards 'A' and 'B', 21 of them were in (ward A) and given the test before and after the intervention and the other 20 (ward B) were given the test twice to serve as a control group without intervention. The duration between the pretest and posttest was 31 days. Only 20 participants were included in the analysis from the intervention group (ward A) so that both samples will be of equal size. One participant was randomly excluded from the sample as been recommended by the statistician. The second population was all patients 40 days-16 years old admitted at wards A and B, from whom BCs were obtained based on the doctor's suspicion that the patient has bacteremia. A total of 1117 BC bottles pre and post-intervention; of them 555 samples during the pre-intervention period, and 562 samples during the post-intervention period were collected and analyzed, which total for a 6 months period.

Nearly half of the participants were in a young age group and the other half were in an old age group. Where, the majority of the participants are females 92.68% VS 7.32% males. Although the majority of the participants were P/N, however half of them have highest job experience in the pediatric wards at CBH, and all the participant's 100% had collected blood for culture and were following CBH blood culture collection guideline.

For the first data analysis, forty one questionnaires were given to nurses' wards 'A' and 'B' to assess their knowledge about BC and their practices regarding to the BC collection technique pre-intervention. The findings indicated that ward 'A' participants have lack of knowledge related to BC and poor practice related to BC collection technique. The mean grade for ward 'A' was 48.43 and the mean grade for ward 'B' was 50.20 which are low means for both wards and indicated the need for educational intervention on proper BC collection procedure. The pre-intervention results showed that the mean grades for the two groups were not significantly different ($p=0.51$). And the BC F+ average rates for the intervention ward A was 1.9%, while it was 3% for the control ward B and there was no significant difference between the two wards ($p=0.37$).

The second experimental step was the implementation of the educational program (proper procedure of collecting blood culture samples) by the researcher after reviewing the

literature and the CLSI guideline, and based on the results obtained from the pre-intervention data.

For the third experimental step and the second data analysis, the findings showed that the mean grades of the intervention group (nurses ward A) in the post-test were 92.75 which is much higher than the mean grades in the pre-test (48.43). The post-intervention test grades were significantly higher than the pre-intervention test grades ($p= 0$); this approval indicates that the knowledge, practice, and thus their attitude improved post-intervention. For the control group (nurses ward B), the mean grade for the posttest is 50.29 which was almost the same as the mean grade of the pre-test (50.20), that is to be expected since their knowledge and practice not changed as there was no educational intervention done. Comparing the posttest for nurses ward A and B, the findings illustrated that the intervention group has 92.75 mean grades which is much higher than 50.29 for the control group. And there was significant difference between the two mean grades ($p= 0$). Although there was no significant difference between the mean grades pre- and post-tests for the control group ($p= 0.96$); however, the post-test grades for the intervention group were significantly higher than those of the control group. This is thought to be due to the educational intervention for the intervention group.

The overall BC F+ rates post-intervention for the intervention ward 'A' was 0.3% compared to 1.5% for the control ward 'B'. there were no significant differences in the BC F+ rates between the two groups (ward 'A' and 'B') post-intervention ($p=0.07$) which was thought to be due to the fact that ward 'B' benefited from the training and education about the BC collection technique in some way and thus their contamination rate decreased as well. However, there were significant differences in the BC F+ rates for ward 'A' between the pre and post-intervention period 1.9%, 0.3% respectively ($p=0.04$).

Chapter VI

Discussion and policy implications

Introduction

The study design was quasi-experimental targeted nurses and BC samples, and compared results at pre and post-intervention. The purpose of this study was to examine the effect of an educational intervention on the proper procedure of blood culture collection on the false-positive rates of blood samples collected at CBH.

The study was selected because despite a steady decline in the false-positive rates of blood culture at CBH, the false positive rates for six years (2003-2008) has ranged from 2.2 - 3.5% (overall 2.9%) continue to exist. To assure quality indicator, the goal for blood culture contamination rate, should be below 2% (CLSI, 2006). In addition to the fact that there is no documented studies targeted this subject in the Palestinian occupied territories, knowing that these studies have been established for more than three decades at international level.

This chapter will discuss the study findings highlighting the effectiveness of educational intervention and comparing with other studies that support study hypothesis as well as emerging implications of these findings will be drawn and reported. The education program attempted to reduce BC false positive rates for possible quality improvement and best care for Pediatric patients. It is worth to remind that the discussion presented well the objectives and research questions which were measured through the questionnaire items and the results of false positive rates.

6.1 The study populations

The study targeted two populations for assessing the educational intervention. The first study population consisted of 41 participant nurses working at CBH distributed in wards A and B. Where, these pediatric wards are delivering inpatient care for the acute and chronic pediatric cases. The second population was 1117 blood culture bottles drawn from patients 40 days-16 years old admitted to CBH wards 'A and B' pre and post-intervention who required this test.

For the first population, 20 participants as intervention group and 20 as control group were included in the analysis so that both samples will be of equal size to fit the paired analysis test. The findings illustrated that the sample was heterogeneous in terms of age, sex, occupation, and years of job experience, whereas it was homogeneous in terms of experience

in collecting blood for culture and follow CBH BC collection guideline. The participants were 83% PN and 17% RN, which reflects the fact that those workers were not prepared academically or trained well to draw blood for culture locally. Further this picture should track the attention of the decision makers to educate and train those nurses who traditionally draw blood for culture in the different health institutions.

The intervention group and the control group were selected from nurses working in the same pool (pediatric wards at CBH). The findings illustrated that the two groups were homogeneous in terms of experience in collecting blood for culture and follow CBH guideline. These findings is consistent with what was mentioned in the literature discussed this issue. Burns and Grove (2006) indicated that in most quasi-experimental studies, experimental and comparison subjects are selected from the same pool of potential subjects, this design strategy, does not alter the risk of biases resulting from convenience sampling but does strengthen the equivalence of the study groups.

6.2 Pre-intervention data

This section will discuss findings related to the pre-test for the intervention VS control group (nurses ward A VS nurses ward B), pre-test findings for the intervention nurses, and pre-intervention BC false positive rates (F+).

6.2.1 Pre-tests for the intervention VS control groups

Comparing the pre-test mean grades for the intervention group (ward 'A') with the control group (ward 'B'), findings revealed a low mean grades with 48.4 VS 50.2 respectively and there was no significant difference between the two mean grades ($p= 0.51$). This means that the two groups were having a low level of knowledge and poor practice regarding to BC collection technique used in the two pediatric wards at CBH.

These findings were consistent with the findings of the study of Marilou K. et al (1997) on the effectiveness of showing a video on the proper procedure of blood collection in reducing BC contamination. This study reported that the mean scores of the pre-test for 17 medical clerks, 77 medical interns and 15 first year medical residents on 26-item questionnaire was 13.34, which indicate that those medical staff at Philippine General Hospital performed no better in the pre-test than nurses at CBH.

The conclusion from these findings is that there is a need for education regarding the knowledge about BC and training on the BC collection procedure for both wards.

6.2.2 Pre-test for the intervention group

In this section, the most significant findings from the pre-test for the intervention group will be discussed. The findings on the participants' knowledge about the conditions in which BCs are ordered in the pre-test revealed that around 60% of the participants did not know that BC can be ordered in case of immuno-compromised patients with unexplained pulmonary, renal, and hepatic dysfunction. This is inconsistent with the publication of Chandrasekar et al (1994) who reported that BC are appropriate in immuno-compromised patients looking ill, or with unexplained pulmonary, renal, or hepatic dysfunction.

The findings of this study indicated that 75% of the participants did not know that the blood is injected into bottles with culture media, and 70% of them said that BC should not be drawn before a fever spike. This is not consistent with Murray et al (1999) who said that, blood specimens should be collected before antimicrobial agents are administered, although there are media available which contain substances designed to minimize the effect of these agents on bacterial growth. Optimally, the specimen should be collected just before a fever spike.

In the present study, findings showed that 55% of the participants define false positive as a positive test result for a disease or condition when the disease or condition is present, moreover, 45% of them said that BC contamination is suggested when bacterial growth is present in all cultures collected from the patient. This is not consistent with the publication of CLSI guideline (2006) define false positive as a positive test result for a disease or condition when the disease or condition is not present. Also it mentioned that, in many instance, a potential contaminant is recovered from one or both bottles of a single BC set. Without a second BC for comparison, it is virtually impossible to assign significance to a questionable isolate. This indicates nurses' need to educational intervention on contamination.

A study published in the Archives of Pathology and Laboratory Medicine showed that almost a 50% reduction in contaminated BCs occurred when the contamination rates of each

collector was monitored and individual collectors were informed of their rates (Gibb P et al, 1997). In the present study, 55% of the participants did not know that feedback to each individual phlebotomist on their personal contamination rate decrease false positive rates.

The publication of Ernst (2004) reported that aseptic site preparation is without question the single most important factor in collecting uncontaminated BCs. In this study, 60% of the participants did not have knowledge that proper collection site preparation is the single most important factor in collecting uncontaminated BCs. This reflects the fact that nurses did not give more attention to the site preparation when collecting blood for culture.

The findings of the present study show that all the participants did not know that iodine is effective as Chlorhexidine as skin disinfectant, also 70% of the participants did not know or not sure that the use of iodine is not recommended in neonate patients. Whereas the publication of CLSI guideline (2006) recommended that Tincture of iodine and chlorhexidine gluconate are properly equivalent. For Pediatric blood cultures- the same methods of skin antiseptics for adults apply to pediatrics, with the exception in neonates with the potential to develop subclinical hypothyroidism due to iodine. For all patients, topical iodine compounds must be completely removed after phlebotomy.

As a conclusion, these information reflect the facts that nurses from the experimental group lack knowledge concerning the following concepts: what is BC and contaminated BCs, appropriate conditions to draw BC, the importance of practicing aseptic technique, the most important factor in collecting uncontaminated BCs, the result of feedback to each individual phlebotomist on their personal contamination rate, and information about disinfectants used in BC collection. Thus the need for educational intervention emerged.

Participant's responses on their practices toward BC collection technique, the findings indicated that 75% used only 2cc sterile syringe that are not suitable for the blood volume in all pediatric patients and 60% did not use sterile gloves in some conditions needed. Moreover, 75% of them did not clean the site with alcohol swabs for 30 second, and 70% clean the site from periphery to center which indicating poor practices toward collecting blood for culture.

However, the publication of Virginia Commonwealth University (2003) regarding instruction on BC collection suggested two 5cc sterile syringes to be prepared for pediatric patients. If palpation of site prior to puncture is anticipated, wear sterile gloves. And prep

(wipe) the puncture site with alcohol swab for at least 30 second (30-60) in a circular manner from the center to periphery vigorously, then clean with tincture of iodine and allow to dry, then clean again with alcohol swab and let it to dry.

As mentioned before, antecubital venipuncture is not associated with a high contamination rate, BC can be drawn at the same time but from different sites, and if at all possible BCs should draw from venipuncture not via lines (Ernst, 2004). However, the findings showed that 90% did not know that antecubital venipuncture is not associated with a high contamination rate, and 65% did not know that BC can be drawn at the same time but from different sites. This indicates that nurses did not select antecubital venipuncture to draw BC and select same site if two BCs needed.

The findings of this study revealed that 30% of the intervention nurses drawn BCs via intravenous catheters. However, in a 2-years observational study comparing contamination rates for culture specimens drawn via venipuncture vs. via intravenous catheters in children, Norberg et al (2003) found a large statistically significant decrease in the rate of false positive BCs (9.1%- 2.8%) after their institution adopted a policy eliminating the use of intravenous catheters for this purpose.

Ernst (2004) stated that research showed that collecting volume less than the required amount decrease the potential to harvest organisms causing septicemia. It is recommended that the blood-culture bottles are drawn first if other laboratory tests ordered, and to inoculate the blood into the bottle after removing the air from the syringe that containing blood before expel into BC bottle to maximize finding bacteria. If this volume of air is pulled into anaerobic bottles, it can be detrimental to some anaerobic organisms. CLSI guideline (2006) reported that BC bottles should be inverted gently several times to prevent clotting and to mix the blood with the broth. However, the findings illustrated that 70% of the participants were not aware that collecting less blood volume reveal poor diagnosis and 80% draw blood culture second if other laboratory tests ordered. In addition, 60% were not removing the air from the syringe that containing blood before expels into BC bottle to maximize finding bacteria, and 80% did not swirl the BC bottle but shake it well.

The conclusion from these findings reflect the facts that nurses from the experimental group have poor practices concerning BC technique: collecting inappropriate blood volume, collecting blood for culture second if other laboratory tests are ordered, inoculating the air

from the syringe to the culture bottle that minimize finding bacteria, and shaking the culture bottle that may damage the broth. Thus training on BC technique is deemed necessary.

6.2.3 Pre-intervention BC F+ rates

A total of 1117 blood culture bottles pre and post-intervention were collected from the CBH laboratory records and analyzed. According to the pre-intervention false positive rates of BC specimens collected from patients from May-July 2009, findings of the present study revealed that a baseline average rate of BC contamination was (1.9%) for the intervention ward 'A' and (3%) for the control ward 'B' from a total of 555 BC specimens collected. From them, 324 specimens for ward 'A' and 231 for ward 'B'. Although the control ward 'B' had a higher baseline average false positive rates than the intervention ward 'A'; however these findings indicated that differences from the baseline data were not statistically significant with ($p=0.37$) at a significant level of 0.05.

These findings were consistent with the study of Eskira et al (2006) which indicated a baseline BC contamination rates of 5.7% and 7.1% in intervention and control wards respectively ($p=0.6$). Although the baseline contamination rates were higher than the present study; however it showed that the control ward had higher contamination rates than the intervention ward which is consistent with this study.

The findings of this study were inconsistent with the result of the pilot study of Weinstein (2003) that monitored phlebotomists' contamination rates on a monthly basis. Those results revealed a contamination rate of 3% for phlebotomists compared with nearly 11% for BCs obtained by resident physicians, non-degree nursing assistants, and nurses. This indicated that the baseline contamination rates for CBH nurses were much lower than the baseline contamination rates for Weinstein nurses.

6.3 Intervention period

Burns and Grove (2007) stated that the findings of the study can have statistical significance but not clinical significance. Clinical significance is related to the practical importance of the findings. There is no common agreement in nursing about how to evaluate the clinical significance of a finding. In studies testing the effectiveness of a treatment, clinical

significance may be demonstrated by the proportion of subjects who showed improvement or the extent to which subjects returned to normal functioning (p.439).

There were clinically significant improvements among nurses ward 'A' intended behaviors concerning BC collection technique as been noticed by the researcher on-the-job and as been reported by the laboratory technicians who accompanies the drawing of blood for culture by nurses at CBH.

This indicates that the intervention program was effective to change nurses' knowledge and skills on BC collection technique. And this is consistent with the study of Pick, Poorting, and Givaudan (2003) which indicated that the main outcomes of intervention programs at the individual level are changes in intentions and in actual behavior.

6.4 Post- intervention data

This section will discuss findings related to the comparison between pre and post tests for the intervention group, pre and post tests for the control group, comparing the posttests for the intervention and the control groups, and the post-intervention data of the BC false positive rates.

6.4.1 Comparing pre-with post-tests for the intervention group

Comparing the pre-tests with the post-tests for the intervention group , the findings showed that the mean grades in the post-test were much higher than the mean grades in the pre-test, 92.75 VS 48.4. The findings showed a p-value close to zero which means that the post-intervention test grades are significantly higher than the pre-intervention test grades. This approval indicates that the knowledge gain, attitude change and skills development for the intervention group (nurses ward A) ensured post-intervention.

These findings were consistent with the findings of the study of Marilou K. et al (1997) which aimed to determine the knowledge, attitude, and practice of 109 participants from medical clerks, interns and first year residents on the proper procedure of BC collection. A 26-item questionnaire was given to the participants before (pre-test), immediately after post-test 1 and two weeks to two months after (post-test 2) the video on the proper procedure of

BC collection was shown. Results showed significant improvements in the scores of pre-test ($x= 13.34$) to post-test 1 ($x= 22.18$, $p< 0.05$).

The conclusion from these findings is that the educational program had good effect on the nurses' knowledge and practice concerning BC collection procedure.

6.4.2 Comparing pre-with post-tests for the control group

Comparing the pre-tests with the post-tests for the control group, the findings revealed that the mean grades for the control group in each category in the posttest stay nearly the same in the pretest. The mean grade for the posttest is (50.3) which are almost the same as the mean grade of the pre-test (50.2) that is to be expected since their knowledge, practice, and their attitude had not changed as there was no educational intervention done. And there was no significant difference between the mean grades for the pre and post tests of the control group with a p-value of (0.96).

The conclusion from these finding should track the attention of the local health agencies toward the importance that there is a need to continuously educate nurses on proper BC collection who traditionally collected blood for culture in the health institutions.

6.4.3 Comparing the post-tests for the intervention and control groups

Comparing the posttest for the nurses ward A and B, the findings illustrated that the intervention group (ward A) who had educational intervention has 92.75 mean scores which is much higher than 50.29 for the control group (ward B) who had no educational intervention. And testing that the grades of the posttest were greater for ward A, the findings revealed a test statistic of 19.09 with a p-value close to zero which indicated that the post-test grades for ward 'A' were significantly higher than those in ward B. This is thought to be due to the educational intervention for the intervention group.

These findings are consistent with the best practice guidance issued by the DH in London (2007) that BCs should only be collected by members of staffs who have been trained in the procedure and whose competence in BC collection has been assessed.

These findings are also consistent with the study of Clarke and Copeland (2003) which stated that developing nursing practice in any area demands skills, knowledge, support and long term commitment to the achievement of best practice. Ongoing professional development activities, including formal educational programs can contribute to individual staff members' ability to take on practice development projects. Too often however, educational programs are seen as making little real difference to clinical practice. Work-based learning approach contributes to integrating learning and developing practice in the field of medical care. The work-based learning approach can bring about tangible benefits for patients, practitioners and organizations, but only if the organizational and contextual factors which impact on practice and its development are properly considered and managed through effective partnerships.

Although there were no differences between the average grades for the control group in the pre and post tests, however there were differences between the average grades for the intervention group in the pre and post tests. The conclusion from these finding is that the educational intervention with work-based learning approach done for ward 'A' was so effective to make these differences.

6.4.4 Post-intervention data of the BC F+ rates

During the post-intervention period (September-October till November-December), the findings of this study showed that the average F+ rate for BCs drawn by the intervention ward nurses was 0.3% compared with 1.5% for the control ward. The average BC F+ rate decreased from 1.9% pre-intervention to 0.3% post-intervention for the intervention ward and from 3% to 1.5% for the control ward. Although there was no significant difference in the F+ rates between the two groups (ward 'A' and 'B') post-intervention, however; a significant reduction in the BC F+ rate was achieved in the intervention ward using new protocol for BC procedure ($p= 0.04$) post-intervention.

These interesting results mean that the educational intervention for ward 'A' nurses on the proper procedure of blood culture collection have been effective to reduce BC false positive rates.

Only limited data are available concerning the association between the expertise of staff member and the risk of BC contamination. Previous studies have shown that trained

phlebotomists or BC teams are associated with lower BC contamination rates and this is consistent with the findings of the present study which indicated that trained nurses on the proper procedure for BC collection are associated with lower F+ rates.

The findings of this study are consistent with the study of Weinbaum (1997) at a community teaching hospital where BCs drawn by a dedicated BC team using a commercially available kit that had a contamination rate of 1%, as opposed to cultures drawn by resident physicians, which had a contamination rate of 4.8% using the same kit. The results showed that a significant reduction in the contaminant BC rate was achieved by the BC team ($p < 0.001$).

In A College of American pathologist Q-tracks study of 356 institutions, Bekeris et al (2005) conducted a program to provide contemporary bench mark data about blood culture contamination rates in a large number of clinical laboratories over time and to elucidate practice patterns and demographic factors associated with sustained reduction in contamination rates. Data were collected from 1999 through 2003 (longitudinal cohort study) and a mixed linear model analysis of data set was used. The findings of this study showed that there was a statistically significant difference in contamination rates between institutions that utilized dedicated phlebotomists versus other staff for culture collection. Institutions in which the large majority of cultures were drawn by nursing staff had a contamination rate of 4.21%, while those institutions in which those same individuals did not collect any culture specimens had a contamination rate of 2.17%. In the present study, the contamination rate achieved (0.3%) is even more less than 2.17%.

This achievement should track the attention of the health institutions to utilize dedicated phlebotomists and to start thinking on training and creating BC team in an attempt to decrease the contamination rate.

The findings of this study are inconsistent with the study of Marilou K. et al (1997) on the effectiveness of a showing a video on the proper procedure of blood collection in reducing BC contamination conducted at the Philippine general hospital. The findings of their study showed no significant difference in the contamination rate between the two periods (before and after showing video on proper procedure of BC collection), although there were a significant results for the scores between pretest and posttest (2). However, in the present study there were significant results for the scores between pretest and posttest, and this was reflected in the reduced contamination rate between pre and post intervention.

Further, the efficacy of an educational intervention to prevent BC contamination in internal medicine was studied by Eskira S. (2006) in two medical wards in a busy tertiary-care hospital in which BCs were obtained by physicians rather than dedicated phlebotomists. Simple educational intervention reduced BC contamination rates from 5.7% and 7.1% in intervention and control wards, respectively ($p = 0.6$), compared with 1.95% and 6.7%, respectively, post intervention ($p < 0.001$). The protocol used included: hand-rubs for 15 second with ethanol 70% plus chlorhexidine 0.5% (ET-CH); use of disposable gloves; vein palpation before disinfection; skin disinfection with ET-CH for more than three; disinfection of bottle injection ports with (ET-CH); introduction of 10 ml of blood into bottles without needle exchange; and hand-rubs with (ET-CH) following glove disposal. In this study, providing educational intervention with the new protocol used decreased the contamination rate to 0.3% compared to 1.95% in Eskira S. study. Thus, providing an educational intervention is an important factor in reducing contamination rates.

The conclusion is that the new protocol for the educational program including eleven steps aforementioned in this study, should be considered for use when BC contamination rates are significant in setting that do not employ dedicated phlebotomists.

Chapter VII

Conclusions and Recommendations

Conclusions

In an attempt to minimize the false-positive rates of blood culture samples by educational intervention on the proper procedure of blood culture collection, the current quasi-experimental study was conducted in the pediatric hospital CBH in Bethlehem. The study included two populations; the first population consisted of 41 nurses working in wards 'A' and 'B', the second population was all patients 40 days till 16 years old admitted at wards A and B, from whom blood cultures were obtained based on the Dr's suspicion that the patient has bacteremia. In this study, the KAP of the intervention group (nurses ward A) and the control group (nurses ward B) were assessed using the same questionnaire pre and post intervention. The F+ rates for the intervention and control wards were compared between the pre (May, June, and July) and post intervention period (September-October, October-November, and November-December).

The findings indicated that the majority (83%) of nurses are practical nurses (P/Ns); 71% with permanent job and 12% are pool. Only 17% are registered nurses (R/Ns) which indicated poor educational background of drawing blood for culture since it is not included in their academic curriculum.

The findings of the study showed that the mean grades for ward 'A' was 48.4 and 50.2 for ward 'B' and there was no significant difference between the two mean grades ($p=0.51$). The low mean grades for the two groups reflect the lack of knowledge and poor practice of nurses regarding BC collection.

The findings of the study revealed that nurses from the intervention group lack knowledge on the following aspects; what is BC and contaminated BCs, appropriate conditions to draw BC, the importance of practicing aseptic technique, the most important factor in collecting uncontaminated BCs, the result of feedback to each individual phlebotomist on their personal contamination rate, and information about disinfectants used in BC collection. Moreover, findings indicated poor practice concerning BC technique: collecting inappropriate blood volume, collecting blood for culture second if other laboratory tests are

ordered, inoculating the air from the syringe to the culture bottle that minimize finding bacteria, and shaking the culture bottle that may damage the broth. Thus the need for educational intervention emerged.

Comparing the pre-tests with the post-tests for the intervention group, the findings showed that the mean grades post educational intervention was 92.75 which are really much higher than 48.4 pre-intervention, and there was significant difference between the two mean grades ($p= 0$). This approval indicates that the knowledge, practice, and thus the attitude of the experimental group (nurses ward A) improved post-intervention.

Comparing the pre-tests with the post-tests for the control group, the findings indicated that the mean grade for the posttest is (50.3) which are almost the same as the mean grade of the pre-test (50.2) that is to be expected since their knowledge, practice, and their attitude had not changed. There was no significant difference between the mean grades for the pre and post tests of the control group ($p= 0.96$).

Comparing the posttest for nurses ward A and B, the findings illustrated that the intervention group has 92.75 mean scores which is much higher than 50.29 for the control group. And there was significant difference between the two mean grades ($p= 0$).

The clinical findings of this study indicated changes in nurses ward 'A' intended behaviors concerning BC collection technique on-the-job that been noted by observation. There were clinically significant improvements in the intended behaviors since the laboratory technicians reported that.

From 1137 blood culture bottles collected pre and post-intervention, the findings revealed that the intervention ward 'A' had a baseline average false positive (F+) rate (1.9%) and the control ward 'B' had (3%) from a total of 555 BC specimens collected pre-intervention. The differences from the baseline data were not statistically significant ($p= 0.37$).

In the post-intervention period, 562 BCs done and the findings showed that the average F+ rate for BCs drawn by the intervention ward was 0.3% compared with 1.5% for the control ward. The average BC F+ rate decreased from 1.9% pre-intervention to 0.3% post-intervention for the intervention ward and from 3% to 1.5% for the control ward. Although there were no significant differences ($p= 0.07$) in the F+ rates between the two groups (ward 'A' and 'B') post-intervention, however; a significant reduction ($p= 0.04$) in the BC F+ rate was achieved in the intervention ward using new protocol for BC procedure.

To summarize, these interesting results means that the educational intervention for ward 'A' nurses on the proper procedure of blood culture collection was effective to reduce BC F+ rates and improve the knowledge, attitude, and practice, of the intervention group.

Recommendations

Recommendations to the Ministry of Health

These recommendations can be achieved through the MOH with the cooperation of the different stakeholders including the Non-Governmental Organizations (NGOs) and private sectors. In an attempt to achieve a statistically significant reduction in the blood culture contamination rates and move towards zero false positives, MOH officials can contribute to:

- Adopt polices to ensure Laboratory Information System to calculate the blood culture false positive rates are initiated in each laboratory of the different health settings.
- Imply these policies on the private and the NGOs sector.
- Requiring multidisciplinary approach from the health institutions along with the need to adopt a variety of strategies; to educate staff on the correct techniques, to use phlebotomists to draw blood for culture, and to provide appropriate resources/equipments.
- Standardize the process for drawing blood for cultures across the health institutions.
- Enforce quality improvements in the health settings, regardless of cost, by designing systems to reduce the contamination rates.
- Long-term monitoring of the BC F+ rates among different health settings to keep sustained improvements in the performance.
- Enhance the utilization of standard protocol in the settings where blood culture contamination rates are significant.
- Enforce the health institutions awareness of the study results through workshops or scientific meetings and disseminate the findings through a press conference, TV, radio and so on.

Recommendations to the academic institutions and teaching hospitals

- To add the blood culture collection technique in the academic curriculum at CBH since all its graduates are drawing blood for culture.
- To emphasize training on the proper blood culture collection technique in the clinical field as well as teaching the theoretical context of the process.
- Teaching hospitals must continuously educate house staff on the proper procedure of blood culture collection.
- Teaching and emphasizing the skills regarding blood culture collection through continuous education and on-the-job training for the personnel who draw blood for culture.
- Familiarize nursing schools and universities with the study results.

Recommendations for the decision makers and managers of the hospitals

- Revise the available process for drawing blood cultures in different departments across the organization.
- Consider the utilization of standard protocol for drawing blood cultures including use of proven disinfectants as skin preparation.
- Adopt variety of strategies as continuously educating staff members on the correct procedure, or use a dedicated phlebotomist, and provision of appropriate resources (providing enclosing advisory leaflets, and BC kit) may also be effective strategy.
- Initiate a policy to make Laboratory Information System to calculate BC F+ rates in the laboratories to keep track on the contamination rates.
- Follow-up monitoring BC contamination rates by utilization of the Laboratory Information System to create tech codes for each nurse or Dr who is collecting specimens so that the contamination problems can be addressed quickly.
- Encourage communications and coordination between the laboratory technicians and staff members to fight the problem by initiating regular meetings.
- Strive to reach a statistically significant reduction in the BC false positive rates in the setting where the contamination rates are significant.

Recommendations for future research

- Further studies on decreasing BC false positive rates with an improved educational programs and larger sample size should be done to fully assess the trends in the contamination rates.
- Studies that evaluate the significant benefits result from improved methods of skin preparation.
- Studies that target the estimates of the cost saving achieved by reduction in the BC contamination rates.
- Studies that focus on the association between the expertise of staff members and the risk of BC contamination.
- Studies that evaluate the reduction of BC contamination rates by providing direct feedback of contaminant rates to those who perform BCs.
- Establish clinical studies to investigate the effect of the BC educational programs on the quality of care and patient's satisfaction.

Chapter VIII

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Annexes

Annex 1: The picture of Caritas Baby Hospital



Annex 2 Informed Consent

**Consent Form
For Nurses in Ward A and B at CBH**

Agreement to take part in a research study

I _____ have had the study explained to me by the investigator Suhair Qumsiyeh; I understand the study will assess the knowledge, attitude, and practice of nurses ward A and B for collecting blood culture.

I am willing to participate in this study and I understand that all information recorded will be completely confidential and anonymous.

Signature _____.

Date _____.

Annex 3 The Questionnaire

Questionnaire

Thank you for your time and assistance.

This questionnaire is designated to assess nurses' knowledge and practice about blood culture technique conducted at CBH in wards A&B.

Age: _____.

Sex: Female _____ Male _____.

Occupation: S/N _____ P/N _____ POOL _____.

Job experience (years): _____.

Ward: A _____ B _____.

Have you collected blood for culture? Yes _____ No _____.

Do you follow CBH blood culture collection guideline? Yes _____ No _____ .

Please check all statements that apply: **True (T) or False (F) or not sure (not known) (N).**

1- Blood cultures are ordered in the following condition:	T	F	N
a. Patients with fever, or hypotension not explained by non-infectious causes.			
b. In the absence of fever, patients with focal infection such as pneumonia, meningitis, acute osteomyelitis and coma.			
c. Patients receiving antibiotic therapy for documented blood stream infection.			
d. Immuno-compromised patients with unexplained pulmonary, renal, and hepatic dysfunction.			
2- Blood culture:			
a. Is a lab. test in which blood is injected into bottles without culture media to determine whether microorganisms have invaded the patient's blood stream.			
b. Should not draw half an hour before rising fever.			
c. For total of 2-3 aerobic cultures obtained at wide intervals within a 24 hrs are sufficient to diagnose most cases of septicemia.			
d. Blood cultures should obtain once because it is more cost-effective.			
3- False positive blood culture means:			
a. False positive is a positive test result for a disease or condition when the disease or condition is not present.			
b. Contamination not occurs during blood drawing if the skin is not cleaned well.			

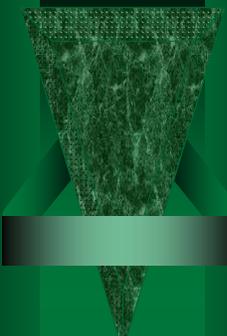
4- Materials needed for drawing blood culture include:	T	F	N
a. Sterile gauze.			
b. Alcohol and tincture of iodine.			
c. Sterile syringes 2cc, sterile needles (butterfly and standard needle)			
d. Must be sterile gloves			
e. Culture bottle:' BACTEC' brand vial & patient's labels.			
5- It is important to practice aseptic technique in the collection of blood for culture because this will result in:			
a. Isolation of bacteria that is usually significant.			
b. Reduce cost of hospitalization.			
c. Loss of time for technician, Drs, and nurses.			
d. Increase stress over the family.			
e. Add expense for the hospital.			
6- The single most important factor in collecting uncontaminated blood cultures is:			
a. Use of fresh antiseptics.			
b. Skilled personnel.			
c. Proper collection site preparation.			
7- In the disinfection of the venipuncture site:			
a. Clean site with alcohol swabs for 20 seconds.			
b. Clean site in a circular manner from the periphery to center for at least 30 seconds.			
c. Clean with alcohol first, then clean with tincture of iodine and allow to dry, then clean site with alcohol swab and let it to dry.			
8- The collection site:			
a. Antecubital venipuncture is associated with a high contamination rate.			
b. If at all possible, blood cultures should draw from lines, not via venipuncture.			
c. Blood culture can be drawn at the same time but from different sites.			
9- Blood culture disinfectants:			
a. Iodine is more effective as a site preparation antiseptic than Chlorhexidine.			
b. Chlorhexidine is as effective as iodine.			
c. Research showed that using alcohol is not effective like iodine.			
d. The use of iodine is recommended in premature patient.			
10- The optimal volume for blood-culture collection from children:			

a. The blood volume which can be cultured is 0.5- 5.0 ml.			
b. Depends on the patient's body weight.			
c. Optimum results are obtained with 1.0- 2.0 ml.			
d. Collecting volume less than the required amount increase the potential to harvest organisms causing septicemia.			
11- In the collection of blood cultures:			
a. Palpating the vein even after disinfecting the site can be done.			
b. It is recommended that the blood-culture bottles are drawn second if other lab. tests ordered.			
c. One may use same syringe to collect blood culture and other tests but to use sterile technique.			
12- Blood-culture contamination:			
a. Is suggested when bacterial growth is present in all cultures collected from the patient.			
b. Should automatically be considered if gram stains from positive blood cultures indicate the presence of normal skin flora.			
c. The common source of blood culture contamination is the skin flora.			
13- Use of multiskilled phlebotomists to draw blood specimens:			
a. Increased blood-culture contamination rates.			
b. Decreased blood-culture contamination rates.			
c. Feedback to each individual phlebotomist on their personal contamination rate lead to increase in contamination rates.			
14- After drawing the blood, it is important to:			
b. Disinfect the rubber tops of the bottle before inoculation into the culture bottle and let dry.			
b. Change needle before inoculating blood into the culture bottle.			
e. Remove the air from the syringe that containing blood before expel into the blood-culture bottle to maximize finding bacteria.			
d. It is best practice to forcefully expel blood from the syringe.			
e. Don't swirl the bottle after inoculation of blood, but shake well.			

Thanks very much for your cooperation
Done by: Suhair Qumsiyeh RN, Master Candidate

Annex 4 The Education Intervention Session presented by power point

3/29/2010 BCC-SUHAIR Q. 1



Blood Culture Collection

Suhair Qumsiyeh

Objectives

At the end of this session, experimental group nurses will be able to:

1. Demonstrate understanding of blood culture & its collection process (Blood culture collection, BCC).
2. Know patients in whom BC are appropriate.
3. Know the purpose of BC.
4. Know what BC contamination cause.
5. Memorize the principles for collection.
6. Prepare materials needed for BCC.
7. Practice aseptic technique when perform BCC.
8. Avoid blood culture contamination & decrease false positive results.

3/29/2010 BCC-SUHAIR Q. 2

3/29/2010 BCC-SUHAIR Q. 3



Introduction (BCC)

- ✓ Patient with high fever may have small numbers of bacteria responsible for infection circulating in the bloodstream.
- ✓ To identify this bacteria, a sample must be taken carefully to avoid contamination by skin flora.
- ✓ Any growth from the bottle is significant.
- ✓ A gram-stain will be performed when there is evidence of bacterial growth in the bottle.
- ✓ Dennis (2004) identified 5 factors affecting BBC, were: training personal on proper BBC; location of collection site; preparation of puncture site; BC equipment; & collection volume.

3/29/2010 BCC-SUHAIR Q. 4



What is blood culture (BC)

- ✓ Is a specimen of blood that is submitted for bacterial or fungal cultures (CLSI, 2006). It is one of the most important specimens received by the lab.
- ✓ Is a laboratory test in which blood is injected into bottles with culture media to determine whether microorganisms have invaded the pts bloodstream.
- ✓ Blood culture are ordered as a set -the combination of blood culture bottles into which a single blood specimen is inoculated.





Pts in Whom BC Is Appropriate

1. Pts with signs & symptoms suggestive of microorganisms in the blood like fever, chills, & tachycardia.
2. Pts with fever or hypotension not explained by non-infectious causes.
3. In the absence of fever:
 - Pts with focal infection such as pneumonia, meningitis, & acute osteomyelitis.
 - Elderly or children with sudden FTT.
 - Elderly pts with deterioration from baseline status such as confusion & frequent falls.

3/29/2010 BCC-SUHAIR Q. 6



Contaminated BC

If the skin is not adequately cleaned before drawing blood for ✓ culture, bacteria on the skin will be injected into the bottle, producing a false positive BC (result from BC growth of contaminants).

False positive (FP) is a positive test result for a disease or ✓ condition when the disease or condition is not present. collection errors can result in (FP) or BCC (CLSI,2006).

It is difficult for the Dr to determine whether the bacteria growing ✓ in the BC is a real pathogen causing bloodstream infection or whether bacteria on the skin have contaminated the culture.

3/29/2010 BCC-SUHAIR Q. 5



Pts in Whom BC Is Appropriate

- Pts with renal insufficiency & unexplained leukocytosis or altered mentation.
- Immunocompromised pts looking ill, or with unexplained pulmonary, renal, or hepatic dysfunction.
- Pts receiving antibiotic for documented blood stream infection. (BC is needed to confirm clearance of microorganism from blood. (Chandrasekar, et al 1994)

3/29/2010 BCC-SUHAIR Q. 7



Importance (Purpose) of BC

✓Diagnostic Importance-

The positive BC either establishes or confirms that there is an infectious etiology for the pt's illness.

✓Prognostic Importance-

A BC that grows a clinically important pathogen indicates failure of the host's defenses to contain the infection at its primary location. The type of pathogen recovered from blood also provides important prognostic info.

3/29/2010 BCC-SUHAIR Q. 8



BC Contaminants Lead To:

1. A serious delay in Rx,
2. Unnecessary antibiotic therapy,
3. Add expense,
4. Increase stress over family,
5. Loss of time for health professionals.

- ✓ So it is important to practice aseptic technique in the collection of blood for culture to decrease risk of contamination.

4/4/2010 BCC-SUHAIR Q. 9



Principles for Collection

- ✓ Gloves will be worn in accordance with standard precautions.
- ✓ A Dr's order must be obtained for specimen collection.
- ✓ Appropriate verification of the pt's identity: by means of armband confirmed with the child's chart prior to specimen collection.
- ✓ Draw BC specimen first, then draw other lab tests.
- ✓ Culture should be drawn before administration of antibiotics, if possible & ½-1 hr before rising fever.
- ✓ If at all possible, BC should not be drawn from lines, but should be drawn via venipuncture.
- ✓ It is important to understand that antecubital venipuncture is not associated with a high contamination rate.

4/4/2010 BCC-SUHAIR Q. 10



Principles for Collection-con...

- ✓ In most instances, 2-3 aerobic cultures obtained at wide intervals within a 24 hr period are sufficient & shouldn't be drawn more frequently than less than ½ hr apart.
- ✓ Blood can be drawn at the same time but from different sites.
- ✓ BC shouldn't be repeated for 2-5 days, because blood doesn't become sterile immediately after antimicrobial Rx.
- ✓ The single most important factor in collecting uncontaminated BC is proper collection site preparation.
- ✓ Chlorhexidine (Isopropyl alcohol) is as effective as iodine but iodine is not recommended in premature pt (potential to develop subclinical hypothyroidism).

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Contaminants

- ✓ Microorganisms commonly associated with contaminated BC:
 Bacillus spp., Corynebacterium spp.,
 Propionibacterium spp., Coagulase-negative staphylococci (CNS), Aerococcus spp.,
 Micrococcus spp.
- ✓ The goal for BC contamination rate should be below 2%.

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Materials needed

1. Pt labels
2. BC bottle (BACTEC brand vial)
3. Sterile gauze
4. Chlorhexidine
5. Tincture of iodine
6. Gloves
7. Tourniquet
8. Sterile needles
9. Sterile cannula (butterfly needle) with connection line
10. Sterile syringes, 2 and 5ml according to blood volume
11. Adhesive tape (plaster)



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Materials needed



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BCC Technique- Step 1-2

- ✓ Step 1- check order,
 - identify pt by checking the arm band,
 - prepare labels
- ✓ Step 2-
 - Explain the procedure to the pt or parents (if possible with dolls or puppets).
 - Explain need of second attempt if required.
 - Assess parental ability to participate or assist you
 - Decide whether parent should be present or not.

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Step 2- Explain the procedure to the pt or parents-con...

- ✓ How to relieve anxiety & fear:
 1. Collect blood away from other patients in a special room. Never in the hospital bed. This is a comfort zone.
 2. Area should be child friendly. Uniforms should be colorful.
 3. Keep equipment out of site.
 4. Ask child's preference of hand.
 5. Allow child to select comfort object.
 6. Stop procedure if child combative.
 7. Try later or another person.

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Step 3-

- Step 3- Wash hands with soap & water with friction for 15 sec. or use Alcohol based hand rub.



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Step 4- Prep Cap.

- Prep the rubber cap of the BC bottle with iodine pad in a circular motion. Then with an alcohol pad and allow the alcohol to dry.



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Step 5- Prep the puncture site

- Select appropriate site (preferably antecubital), apply tourniquet, & palpate for venous access.
- Prep (wipe) the puncture site with alcohol swab for at least 30 sec (30-60 sec.) in a circular manner from the center to periphery vigorously.
- Then clean with tincture of iodine & allow to dry.
- Then clean again with alcohol swab & let it to dry, (Note- don't wipe the site after cleansing the skin to reduce contamination)

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Step 6- Gloves

- Apply gloves:
 - If palpation of site prior to puncture is anticipated, wear sterile gloves.
 - If palpation of site prior to puncture is not anticipated, wear no sterile gloves.



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Step 7- Draw Blood

1. Perform venipuncture using cannula with connection line or butterfly needle.
2. Draw the blood volume into sterile syringe
 Pediatric : 2.5-5ml (don't overfill bottle)
 Infant : 0.5-1ml
 From 0.5ml-5ml can be cultured, depends on the pt body weight (no more than 1% of pt's total blood volume).
 Optimum results are obtained with 1-3ml.
3. Draw blood for culture first, then for other lab test second.
4. Remove the syringe first, then remove the butterfly needle second.

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Step 7- Draw Blood-con...

5. Engage safety sheath.
6. Apply pressure to the site with gauze.
7. Dispose butterfly needle into sharps container.
8. Attach the syringe with sterile needle using aseptic technique.
9. Inoculate the blood into the bottle after removing the air from the syringe that containing blood before expel into BC bottle to maximize finding bacteria.
10. Don't forcefully expel blood from the syringe. Let it drawn by gravity.

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Step 8- Mix

- ✓ Gently swirl (rotate) the bottle to mix the blood & the broth.
- ✓ Don't shake vigorously.



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Step 9 & 10- Label & Send

- ✓ Step 9- Place the pt label on the bottle & attach the lab requisition after filled with appropriate information.
 Remove & dispose gloves, wash hands.
- ✓ Step 10- Send the BC bottle to the lab as soon as possible.

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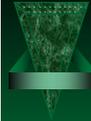
Other Pitfalls

- ✓ Using "waste" specimen
- ✓ Not drawing culture as 1st specimen
- ✓ Covering bar code of the BC bottle with label
- ✓ Failure to indicate time of draw
- ✓ Using wrong bottles
- ✓ Changing the needle before inoculating the blood into the culture bottle.
- ✓ Palpating the vein with unsterile gloves after the site has already been disinfected

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Any Question?

- ✓ Thanks for Listening.

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Annex 5 Permission to implement this study

Permission to implement research

From: Suhair Qumsieh R/N
To: C E committee

I would like to inform you about the research that I will implement at CBH and to please your agreement.

The title of the research is: "The effect of educational intervention for Nurses on the proper procedure of collecting blood culture in decreasing false-positive result at CBH". The research is one of the requirements to graduate for Master Degree in "Nursing management". For this purpose, training session for nurses' ward "A" (treatment group) on the proper technique of collecting blood culture will be implemented by the researcher. This training session is a 2hr classroom with video show, modeling behavior, role playing, and class presentation on the proper procedure of blood collection at nursing school. The researcher plan to have this session in February-first week, 2009, divided into 3days chosen by the CE responsible, each session will be provided for 7 nurses from ward "A" including S/N, P/N, and Pool nurses. Then the nurses will be followed by the researcher on-the-job. Also a questionnaire developed by the researcher will give to nurses' ward "A" and "B" pre-intervention and post-intervention. The guideline and the questionnaire will be send for you when it is available.

Thanks for any cooperation you can offer.

Suhair Qumsieh R/N

Suhair.Qumsieh R.N

15/01/09

Annex 6 CBH continuous education approval



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To: Suhair Qumsich (Sec. A)
Subject: Permission to implementing research
From: Sister Donatella (C.E.C.)
Date: 15/01/2009

I accept your research request (*The effect of educational intervention for Nurses on the proper procedure of collecting blood culture in decreasing false-positive result in CBI*) for training sessions for the nurses of Sec A.

I hope that your effort will help the section achieve a good result.

Do not hesitate to contact me for any request.

Sister Donatella
(Director of Continued Education)