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Assessing Blood Culture Contamination

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ASSESSING BLOOD CULTURE CONTAMINATION

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CHAPTER I

INTRODUCTION

The determination of bacteria actively growing in a patient's bloodstream is a serious medical finding with life threatening implications. The collection of blood cultures to make this determination is a significant test in the clinical laboratory. Positive blood cultures are causes of considerable morbidity and mortality; such findings are alarming to clinicians and may warrant aggressive treatment regimes.

Blood cultures which become contaminated are false positive reactions and a major problem for microbiologists, clinicians and healthcare organizations. Such cultures are costly for healthcare institutions in several ways. Among the reasons are prolonged hospital stays and additional laboratory and radiologic testing. Patients may be treated with antimicrobial therapy which may, at a minimum, be inappropriate for their care. Additionally, the unnecessary prescribed therapy may have contraindications which could be detrimental to patients' well being; many antimicrobial agents cause side effects in susceptible patients. Uncertainty over the interpretation of conflicting findings leads to increased consultations. Finally, the overuse of antimicrobials has been found to be a contributing factor in emerging antimicrobial resistance.

Laboratories often use dedicated phlebotomy teams to collect blood for laboratory tests, including blood cultures. Phlebotomists are trained in the proper technique for obtaining blood in a manner in which the normal microbes of the skin will not be introduced into the blood culture. Research has found that it is virtually impossible to have a contamination free rate (0%) in the modern clinical setting (Weinstein, 2003). Due to the significant impact on patient care and hospital costs, each laboratory is required to

determine its monthly blood culture contamination rate. Actual rates vary between institutions, from as little as 0.65% to over 6% (Hall & Lyman, 2006). According to standards produced by the American Society of Microbiology, the rate of blood culture contamination should not exceed 3% (Ernst, 2004).

At the study hospital the blood culture contamination rates are inconsistently high. Despite numerous attempts to decrease the rate, the hospital seems unable to sustain an adequate contamination rate.

STATEMENT OF THE PROBLEM

The problem of this study was to evaluate blood culture collection procedures utilized at the study hospital to determine the cause of the high contamination rates.

RESEARCH QUESTIONS

To provide a framework, answers to the following questions will guide this study:

RQ_1: What are the recommendations of the College of American Pathologists?

RQ_2 : Is there consistent protocol compliance for aseptic technique among personnel collecting blood for culture?

RQ_3: Is the contamination rate significantly higher for nursing personnel than for phlebotomy?

RQ_4: Does the study hospital provide collaboration and feedback to individuals and departments regarding contamination rates?

BACKGROUND AND SIGNIFICANCE

Blood cultures are widely accepted as an important tool to detect serious bloodstream infections, including endocarditis. Bacteremia or septicemia is among the most serious of clinical infections. Emerging pathogens for certain patient demographics

has led to more sensitive methods to isolate and identify causative agents. One method of increasing the sensitivity of blood cultures is to enhance nutrients in the blood culture bottles in order to grow fastidious organisms. Although the ability to grow these organisms is advantageous, the downside is that the enhancements will also grow minute amounts of skin flora when present. Another reason for the increase in contamination is that newer, continuous monitoring blood culture systems have the ability to detect very small amounts of bacteria in the bottles. While increasing sensitivity for pathogens is favorable, the detection of contamination is confusing for the clinician. Contamination may occur during blood culture collection, during inoculation of media, while subculturing or from other events of processing specimens. Another reason given for the increase in contamination is due to the increased use of central venous access catheters. When these access lines are used to obtain blood for culture, studies have shown an increase in contamination (Weinstein, 2003).

Many of the organisms associated with contamination, or false positive reactions, may also be significant pathogens. This leads to difficult situations for physicians who are attempting to determine diagnostic and therapeutic strategies. Despite the fact that physicians are aware of the common agents of contamination, nearly half of patients with contaminated blood cultures are still treated with antibiotics (Robert, 2011).

The financial consequences of blood culture contamination have been described in several studies. A study conducted by Bates et al. compared the costs of charges of patients with contaminated blood cultures to patients with cultures which were true negatives. Individuals in both study groups had comparable health issues. The study found that contamination led to a 20% increase in laboratory charges and a 39% increase

in intravenous antibiotic charges (Bates, Goldman & Lee, 1991). In a subsequent study of

blood cultures shown to be contaminated with coagulase-negative staphylococci, almost

half the patients were treated with antimicrobial therapy. The estimated cost of this

unnecessary treatment was $100 per patient (Souvenir, 1998). More recent studies show

that contaminated blood cultures can increase a patient's hospital stay by as much as 4.5

days and add more than $5000 to the cost of treatment (Ernst, 2004). In 2004, another

study found that the estimated expense of a single positive blood culture was $5506 per

patient. Moreover, an institution that processes blood cultures on ten new patients per day

could free up 82 bed-days and reduce expenses by $100,500 per year if the contamination

rate is reduced by 0.5% (Berkeris, Twoerk, Walsh & Valenstein, 2005). A study was

conducted at a 968-bed tertiary care hospital in Dallas, Texas, for a 13 month period from

December 2006 to December 2007. Comparison of median patient charges between

negative cultures and false positive episodes showed $8,720 in additional charges per

contamination event. The researchers concluded that with contamination rates from 5.6%

to 7.4%, the additional charges for evaluation of patients would range from $6.7 million

to $8.9 million annually (Gander et al., 2009). Those with contaminated blood cultures

have been found to incur a median cost of $874 for intravenous antibiotics, versus $492

for negative cultures. Total lab costs for contamination yielded a median of $2056 versus

$1426 for negative findings (Robert, 2011). A study conducted primarily to determine the

financial impact of contaminated blood cultures was performed over a 13 month period

(July 2007 to July 2008). Conducted in Northern Ireland at a 426 bed teaching hospital,

the research concluded that 254 bottles classified as contaminated added 1372 extra

hospital days and incurred additional hospital costs of $1,905,572 per year (Alahmadi et al., 2011).

Additionally, contaminated blood cultures can affect patients' quality of life. Prolonged hospital stays prevent patients from rejoining their families and their jobs. Lost wages and time spent away from family keeps patients from reclaiming their lives and is difficult to quantify (Ernst, 2004).

Another serious consequence of contamination is the administration of inappropriate antibiotic therapy. The misuse of antibiotics can not only lead to the emergence of organisms which are multi-resistant, but also increases the risk of *Clostridium difficile* infection (Thompson & Madeo, 2009).

LIMITATIONS

The following limitations of this study are recognized by the researcher:

1. The primary purpose of this study is to determine which, if any, of the known causes may have led to fluctuating contamination rates at the study hospital. There may be factors, yet to be described in the literature, which may also contribute. It is beyond the scope of this study to determine if there is an additional factor other than those currently identified to effect contamination rates.

2. The research was conducted at the study hospital utilizing the standard operating procedures for blood culture collection at that facility. Varying procedures and demographics at other hospitals may result in substantially different results.

3. It is beyond the scope of this study to implement changes. Findings will be presented to the infection prevention, phlebotomy and microbiology departments overseeing the study laboratory.

ASSUMPTIONS

There were several assumptions in this study which the researcher assumed to true. The assumptions were as follows:

1. Since aseptic site preparation is the most important factor in collecting uncontaminated blood cultures (Ernst, 2004), they must be collected in a manner in which to prevent contamination. Any healthcare worker collecting blood for this purpose should be knowledgeable about aseptic techniques. In addition to a specific procedure for site preparation, the bottle tops should be cleaned prior to introducing blood into them. If an intravenous access line is used, the "scrub the hub" technique is required (Department of Health and Human Services, 2010). It is essential that personnel have an understanding of the importance of compliance to protocol for collection. This study assumes that those collecting blood for cultures have been educated regarding basic aseptic techniques and its significance.

2. Several commercial products are available for site preparation, and they are not all created equally. Each has differing contact times which should be strictly adhered to. This study is based on the assumption that those collecting blood for culture are aware of and adhere to the contact time requirement for the preparation used.

3. Collection of blood for culture from intravenous lines is discouraged, yet it is still performed in practice (Ernst, 2004). Institution policy states that if a specimen is collected in this manner, it should be so noted. For the purpose of this study, it is assumed that all blood is collected peripherally unless otherwise noted.

4. The volume of blood is crucial for culture. Volumes for adult blood cultures should not exceed 12 ml per bottle because overfilling can lead to false positive results (Ernst, 2004). Laboratory personnel are required to observe the bottles and make note of an improper fill. This study presumes that the bottles are properly filled unless otherwise noted.

5. Finally, the order of tubes filled is very important. If a patient is having other blood work ordered simultaneously, the blood culture bottles should be filled first to avoid contamination (Ernst, 2004). This study assumes that this procedure is being followed by all personnel.

PROCEDURES

This study began with a review of literature to determine the current position of the scientific world regarding blood culture contamination. These theories will be explored to see if known factors are the answer to an ongoing problem at the study hospital.

Prior to embarking on this research, the study hospital administered a survey when the contamination rates began to increase. Participants remained anonymous, but were asked to indicate if they were nursing or phlebotomy personnel. The purpose of the survey was to determine the extent of knowledge of protocol for collecting blood cultures

among those currently performing the procedure. The results of the survey are included in the findings, and will be used to determine if there is protocol compliance.

The modern laboratory utilizes a Laboratory Information System (LIS), which is a computer software system which receives, processes and stores data. The system also communicates, or is interfaced, with the Hospital Information System (HIS) and laboratory instruments. Patient data in HIS is transferred to all tests sent via LIS. All laboratory employees are issued a tech code which is added to each specimen that they access. A password is required to access the LIS system, which may be used to generate reports based on requested criteria. For microbiology, the data from all positive blood cultures for a specific time frame may be requested. The report may be generated and scrutinized for patterns. Data are available in LIS for those collecting, processing and reporting blood cultures.

The monthly blood culture contamination rates were calculated for the year by the clinical coordinator of the study hospital laboratory. The results were provided for study purposes.

The blood culture contamination rates will be generated and tabulated to confirm prior findings. Using the algorithm used most widely in microbiology laboratories (Gander et al., 2009), blood culture contamination rates will be generated. The data from phlebotomy workers and nursing will be compared to see if there is a significant difference in contamination rates between the two groups.

DEFINITION OF TERMS

Following is a list of terms and definitions which are applicable to this study:

Aseptic technique – procedures taken to inhibit the growth of microorganisms

Bacteremia – presence of bacteria in the blood

Blood culture – laboratory test used to detect bacteria in the bloodstream

Blood culture medium – a liquid enrichment broth for the cultivation of bacteria in the diagnosis of blood infections

CAP – College of American Pathologists

Contamination – false positive blood culture resulting from normal skin organisms

ED – emergency department

Fastidious – organisms with complex nutritional requirements

FTE – full time equivalent; the number of hours that represent what a full time employee would work over a given time period

HIS – Hospital Information System- receives, stores and processes hospital data. HIS usually communicates with other computer systems within the institution

LIS – Laboratory Information System- receives, stores and processes laboratory data. LIS is usually interfaced with HIS

Multi-resistant organism – an organism in which growth is unaffected by many antimicrobial agents

Pathogen – disease causing microorganism

Phlebotomist – individual trained to draw blood from humans

Sensitive (susceptible) – organism in which growth will be inhibited by a particular antimicrobial agent; organism is said to be susceptible to that agent

Septicemia – systemic infection in which pathogenic bacteria are actively multiplying in the circulating bloodstream

Skin flora – microorganisms that live normally on skin to compete with pathogenic bacteria; they provide a natural immunity to some infections

Subculture – process in which an organism is transferred from one medium to another medium

Tertiary care – treatment given in a health care center that includes highly trained specialists and often advanced technology

OVERVIEW OF CHAPTERS

Chapter I introduced the concept of blood culture collection and the significance of collecting with attention to aseptic technique. The consequences of high contamination rates were discussed with emphasis on the tremendous financial impact it has on healthcare organizations. Contamination may also lead to unnecessary antimicrobial treatment, contributing to the emergence of multi-resistant organisms. Additional time in the hospital may adversely affect patients and their quality of life. Other factors, such as increased work load for microbiology technicians and the long term effects to patients are hard to quantify.

Chapter II will review the current literature pertaining to blood culture contamination and how it may be prevented. Chapter III will explain the methods and procedures used to evaluate this problem. Once data has been collected, findings will be revealed in Chapter IV. Finally, the summary, conclusion and recommendations will follow in Chapter V.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this research was to evaluate the practices used at the study hospital to determine how blood culture contamination rates might be decreased. The methods that were used previously may not be as effective in the modern hospital laboratory. A review of current literature was initiated. In this chapter, the literature will be reviewed on the following interventions to decrease contamination rates: 1) CAP recommendations, 2) compliance with hospital protocol for blood culture collection, 3) the use of dedicated phlebotomy teams for blood culture collection and, 4) providing collaboration, education and feedback to departments and individuals regarding contamination rates.

RECOMMENDATIONS OF THE COLLEGE OF AMERICAN PATHOLOGISTS

The College of American Pathologists (CAP) is a medical society providing laboratory quality improvement programs. As an accrediting agency for pathologists, it provides meetings, newsletters, publications, standards and reference material. The organization implemented a program entitled Q-tracks, which reaches beyond the testing phase. The purpose of the program was to evaluate the quality of processes both within and beyond the laboratory that potentially impact test results and patient outcomes. The results of a Q-track study (QT-02) to evaluate blood culture contamination were released in 2005. The purpose of this study was to measure contamination rates in institutions over time to reveal practice patterns and demographics which were associated with persistent reduction in contamination rates.

In the QT-02 study it was noted that several institutions reported an increase in contamination rates. The increase was attributed to the enhanced sensitivity of new blood culture systems. Data were collected from 1999 to 2003 for 356 participating institutions. Contamination rates were reported quarterly to the CAP. Any institution which neglected to submit data for two quarters was excluded from the study. The findings were:

1. The longer an institution participated in the study, the more the rate decreased. Participation in the study led to a progressive decline in contamination rates.

2. Contamination rates were lower in institutions that employed dedicated personnel for the collection of blood cultures. Institutions which did not use nursing staff to collect routine blood cultures had an average rate of 2.17%; institutions in which virtually all were collected by nursing personnel had an average contamination rate of 4.21%.

3. The overall contamination rate inversely correlated to blood volume; the larger the volume, the lower the rate of contamination.

The authors provided the following options for managers to consider in evaluating blood culture contamination:

1. Use either dedicated phlebotomists or medical technologists for obtaining blood for culture.

2. Use larger limit of blood volume in cultures.

3. Utilize a system of continual monitoring of employees to include feedback; subjects under observation perform better than unobserved subjects (Berkeris,Tworek, Walsh & Valenstein, 2005).

In 2007, a study was initiated to test the hypothesis that compliance with hospital protocol for collection of blood cultures is associated with decreased contamination rates. Participants in the study were healthcare workers who obtained blood cultures from adults. A questionnaire was administered to the participants in order to determine if there was a relationship between contamination and noncompliance. When protocol was followed the contamination rate was 2.6%. When protocol was not followed the contamination rate was significantly higher at 10.3%. Researchers concluded that compliance with hospital protocol in peripheral blood collection technique significantly reduces blood culture contamination (Qamruddin, 2008).

Madeo and his colleagues (2005) utilized a simple intervention to reduce contamination rates in a busy emergency department. The study showed how providing information on procedures for skin decontamination impacted contamination rates. Those collecting blood for culture were given a large, 62% alcohol wipe and pocketsize instructions on how to properly collect blood cultures. This simple intervention resulted in a reduction from 12% contamination before the intervention to 8% post intervention (Madeo, Jackson & Williams, 2005). In 2006, Hall and Lyman offered an updated review of blood culture contamination. The most common source of contamination is the patient's own skin flora; as many as 20% of these organisms may survive disinfection. Nevertheless, inadequate skin preparation is still considered to be a frequent cause of contamination. Studies on the effects of chlorhexidine versus povidone iodine antiseptic solutions were inconsistent; the authors concluded that the most important issue was not the type of antiseptic utilized. The key factor is that the minimum contact time for the

antiseptic be strictly adhered to. The authors also concluded that prepping the rubber stopper before inoculation significantly reduced rates of contamination (Hall & Lyman, 2006). This type of information should be readily available to anyone collecting blood for culture.

USE OF DEDICATED PHLEBOTOMY TEAMS FOR CULTURE COLLECTION

In November 1993, the phlebotomy team at St. Luke's Medical Center was eliminated in order to reduce costs. The phlebotomy team had an average contamination rate of 2.6%; the non-phlebotomists' rate averaged 5.6%. A study was instituted to determine the extent of resource utilization due to blood culture contamination. Length of stay, number of days on antibiotics and hospital costs for patients with a contaminated culture were compared with patients with negative cultures but similar health issues. There was a significant increase in resource utilization due to contaminated blood cultures. The post culture hospital cost for patients with negative cultures versus those with contaminated cultures was $4,213 and $10,515 respectively. The study concluded that reinstitution of dedicated phlebotomy could be a cost effective solution, saving between $950,000 and $1.5 million per year for this hospital (Surdulescu, Utamsingh & Shekar, 1998).

As early as 1998, the CAP sought to determine the effects of eliminating dedicated phlebotomy teams. A Q-probe study concluded that the use of these teams for the collection of blood cultures would decrease contamination rates (Q-probe studies differ from Q-track studies in that the former provides a snapshot perspective of the problem; the latter provides information over an extended period of time). The study identified the use of a multi-skilled workforce as the cause of significantly higher

contamination rates, as much as 77% higher than dedicated, trained phlebotomy teams (Schifman, Strand, Meier & Howanitz, 1998). In a more recent Q-probe study, there was a significantly lower contamination rate among cultures collected by the dedicated phlebotomy team. Institutions in which the majority of blood cultures were collected by nursing personnel doubled the rate of those collected by dedicated phlebotomy (Berkeris,Tworek, Walsh & Valenstein, 2005). Citing best practice guidance from the Department of Health, Thompson and Madeo (2009) agree that blood cultures should only be collected by trained members of staff who have proven competency.

Areas of the hospital such as the emergency department are especially challenging when attempting to reduce blood culture contamination. Factors which have an impact in such areas are: rapid staff turnover, understaffing, the critical state of the patients, and multiple simultaneous emergencies. Specimen integrity is an important preanalytical concern for laboratories. In 2008, a study was performed to improve the quality of care in an emergency department. The researchers noted that healthcare organizations are decreasing dedicated phlebotomy at a time when annual patient visits to emergency departments (ED) in the United States are on the rise. Despite past efforts to lower the contamination rate at this facility, the contamination rate had remained unchanged for years. Continuous in-service education to non-laboratory staff on proper technique was to no avail; researchers attributed this to high turnover rates in nursing personnel and the multi-tasking nature of their position. Researchers hypothesized that blood culture contamination rates, patient time spent in the ED and turnaround times for laboratory test results would decrease if specimens were drawn by dedicated phlebotomy instead of non-laboratory personnel. During a six month period, 2,986 blood cultures were collected in

the emergency department. The dedicated phlebotomy contamination rate was 1.1%, whereas the non-laboratory personnel contamination rate was 5.0%. This was found to be a significant difference; the researchers estimate that utilizing dedicated phlebotomy will save the hospital $5,765 per incident, or $445,523.80 annually. Despite the cost of providing coverage 24 hours per day, 7 days a week, the study realized a savings of more than $100,000 when phlebotomists were employed (Sheppard, Franks, Nolte & Frantz, 2008).

A 13-month study was conducted at a 968 bed hospital in Dallas, Texas, to evaluate the impact of utilizing trained phlebotomy teams instead of nursing staff for blood culture collections. A total of 5,432 blood cultures were collected from 2,642 adult patients. For the purpose of this study, there was a simultaneous comparison of contamination rates between phlebotomists and non-phlebotomists in the same area of the emergency department. The phlebotomists' rate was 3.1%, whereas the rate of the non-phlebotomy staff was 7.4%. If full time coverage had been by dedicated phlebotomy, researchers estimated that the reduced contamination rate would save this institution about $4.1 million in excess charges per year. Researchers advise that the quality improvement of hiring dedicated phlebotomy in the emergency department could counterbalance the cost of implementation. With an estimated cost of $8,720 for each patient with erroneous positive results, the prevention of just five false positive reports ($36,650) might fund the salary of one mid level phlebotomist (Gander et al., 2009).

COLLABORATION, EDUCATION AND FEEDBACK

From February to May of 2009, an intervention was implemented at Skane University Hospital in Sweden. The high contamination rate was attributed to the fact that phlebotomists did not always adhere to guidelines for skin disinfection. As a result, the researchers amended the guidelines, then provided education and feedback. Prior to intervention the contamination rates were 2.59%; post intervention rates were 2.23%. However, this study did not utilize dedicated phlebotomy teams; all collections were performed by nurses. Given the low rates, the researchers could not concur with previous findings which conclude that dedicated phlebotomy teams are necessary in order to obtain acceptable contamination rates (Roth et al., 2010).

Ruth Robert (2011) searched the literature and conducted research to elucidate an answer regarding the increasing blood culture contamination rates. Her study was performed in a teaching hospital where she had noticed that contamination rates had fallen during an intervention for nursing in 2006. In 2007, blood culture contamination rates increased for laboratory personnel; Robert decided to apply the same strategy used in the earlier intervention. The contamination rate plunged from 4.8% before the intervention to 3% post intervention. Robert concluded that contamination rates can be decreased by implementing a supervised training and evaluation program with collaborative efforts of nursing and non-nursing departments.

The results of a study conducted in 2009 were recently published. It was done in the emergency department of a 732-bed medical center in Taiwan. Data were collected for twelve weeks, from February 1, 2009 to April 30, 2009. The hospital averaged 1800 sets of blood cultures per month, with contamination rates reaching 11%. The

intervention included two phases. The first six week phase was to ensure that those collecting blood for culture were knowledgeable about the procedure. Training was provided for each nurse and competency was assessed. Education was continued in phase two, but feedback regarding contamination was provided to the emergency department. Moreover, the person collecting the contaminated culture was given one on one feedback. If an individual obtained a high contamination rate more than once per week, they were retrained. The pre-intervention contamination rate averaged 3.4%. During the educational phase of the intervention, the rate averaged 2.67%. When one to one feedback was added during the final six weeks, the contamination rate fell to 2.0 %. The research showed that an educational intervention including one to one feedback is a simple and cost effective way to reduce contamination rates (Lin et al., 2012).

A recent study was presented in June 2012 at the annual meeting of the Association for Professionals in Infection Control and Epidemiology (APIC). The findings indicated that a combination of interventions may be needed to reduce contamination rates. A Texas emergency department at Harlingen Medical Center had been experiencing contamination rates two to four times the national average. Administration did not feel that they had the volume to justify a dedicated phlebotomist, therefore the emergency department nurses and CNAs were responsible for phlebotomy. When evaluating the problem, researchers noted widespread variability in collection techniques. Subsequently, an in-service was created, focusing on the impact of contamination and the rationale for each step in the collection procedure. Individual technique was observed and real time feedback was provided directly to individuals when

a sample they drew resulted in contamination. Unfortunately, the contamination rate did not improve.

A second in-service was called in which researchers observing techniques noted that the skin prep was rarely being performed correctly. Participants were given another demonstration with emphasis on the need for a full 30 second prep with a full 30 seconds of drying time. This resulted in an impressive improvement of the contamination rate. Within the first four months of 2011, the contamination rate ranged from 6.6% to 8.6%. Post intervention, the rate was sustained from 2.1%- 3.3%. Researchers concluded that planning and oversight was needed to initiate change. Factors included understanding what motivates current behavior, persuading participants of the value of the change, reviewing literature to identify interventions which have proven successful, revising strategies if needed, and providing timely, individual performance feedback (Hodgins, 2012).

SUMMARY

In this chapter, it was evident that blood culture contamination had been a source of concern for many years. The implementation of a study by the CAP and the subsequent recommendations from the 2005 Q-probe study provided a great deal of insight into the blood culture contamination problem. Studies revealed that the use of a dedicated phlebotomy team was optimal. Studies also suggested that personnel who were well educated about the need for proper technique was essential to obtaining low contamination rates. Moreover, nursing personnel who were required to multitask in hectic critical care departments were more likely to collect contaminated cultures. Unfortunately, nursing personnel were being relied on more to collect blood from

catheter lines and other access devices, another contributing factor to increased contamination.

When dedicated phlebotomy teams are not an option, information on proper collection should be readily available for any personnel collecting blood for culture purposes. Because the use of aseptic technique was critical to obtaining an uncontaminated culture, the standard operating procedure for the institution should be strictly adhered to. Personnel who are performing multiple duties may not be competent to perform the venipuncture without a written procedure. Training sessions and periodic retraining was recommended, in addition to having written instructions readily available.

Finally, the Hawthorne effect should be utilized to positively impact contamination rates. Collaboration, education and continual feedback of contamination rates should be made available to all employees and supervisors of departments involved in culture collection. Moreover, one on one feedback to employees known to have collected a contaminated culture has been proven effective. This information is vital to the health of the patient and to the fiscal health of the institution. Chapter III will focus on the methods and procedures used to collect data to further research the problem which has been set forth.

CHAPTER III

METHODS AND PROCEDURES

This was a descriptive study to evaluate blood culture collection procedures utilized at an acute care hospital with about 100 beds. It sought to establish the significance of the following variables: 1) collection by dedicated phlebotomy teams versus collection by nursing personnel, 2) utilization of proper aseptic technique and 3) education, collaboration and feedback between nursing and laboratory regarding contamination rates. This chapter identifies methods and procedures used to collect and analyze data for this study. The researcher will identify the population used for the study and provide research variables, design of instruments and statistical analysis**.**

POPULATION

For study purposes, the population was the contaminated positive blood cultures collected at the study hospital from January 1, 2011 to December 31, 2011. The total number of blood cultures collected was 4794. During this time, 162 cultures were contaminated. This information was obtained from the LIS database at the study hospital.

RESEARCH VARIABLES

The dependent variable in this study was blood cultures assessed to be contaminated by current algorithms (Gander et al., 2009). Independent variable number one was the use of phlebotomy versus nursing personnel. Independent variable number two was to what extent those collecting blood were utilizing aseptic technique. Finally, independent variable number three was the continuous monitoring and collaborative feedback between nursing and laboratory personnel.

INSTRUMENT DESIGN

Prior to this research, the clinical coordinator attempted to analyze this problem by administering a questionnaire to personnel collecting blood for culture. The 23 employees who completed the survey were responsible for collecting blood for culture in the emergency department of the study hospital. The anonymous survey addresses the research goal of compliance to hospital protocol regarding aseptic techniques. Participants were asked to identify when proper aseptic technique was being followed in several scenarios. The survey content is provided in Appendix A.

METHODS OF DATA COLLECTION

The researcher used the existing hospital laboratory database to determine the quantity of blood cultures collected during 2011. The same database was utilized to determine how many blood cultures were contaminated. Based on employee codes, the laboratory clinical coordinator tabulated how many contaminated blood cultures were collected by nursing and phlebotomy.

STATISTICAL ANALYSIS

LIS data was analyzed to determine the total monthly contamination rates. The results of the data were formatted into appropriate tables illustrating the results in accordance with the research goals of this study. The data collected from LIS was also analyzed to determine the relationships between contaminated blood cultures and the collector (phlebotomy versus nursing). These data were also formatted into tables, which show the mean contamination rate for each personnel group. A *t*-test calculation was applied to these research tests to determine if there was a significant difference between contamination rates of phlebotomy and nursing personnel.

The questionnaires were evaluated to determine correct responses. Scenarios one and two included incorrect techniques and represented an incorrect response. Only scenario number three described the correct procedure from start to finish. These data were then analyzed to determine the percentage of personnel that provided the correct response.

SUMMARY

Chapter III discussed the methods and procedures used to collect data that was pertinent to answering the problem of this study. The population is all of the contaminated blood cultures collected at the study hospital from January 1, 2011 to December 31, 2011. Samples were taken from this population to determine which departments were most often responsible for contamination. A survey to determine competency regarding aseptic technique was also given. Chapter IV will explain the findings.

CHAPTER IV

FINDINGS

The purpose of this study was to determine the cause of fluctuating blood culture contamination rates at the study hospital. This chapter presents the statistical analysis of the data collected for the study. Information in the existing LIS database was accessed to determine contamination rates and observe trends. Findings are divided into two sections. One section reveals the findings from the survey, while the second section describes findings from the LIS database.

Prior to this research, a survey was administered to those collecting blood for culture. Once completed, the surveys were collected and data recorded to determine the competency and training needs of the participants. Chapter IV will consist of a description of the response rate and an analysis of the data collected from each survey question.

This chapter will also contain statistical analysis of the contamination rate information retrieved from the study hospital database. This will include data as it pertained to nursing collections and phlebotomy collections. The data will be analyzed to determine if there is a significant difference between contamination rates of the two groups.

SURVEY ANALYSIS

The survey was administered to 23 employees who were responsible for collection of blood cultures. Of these employees, 21 were registered nurses and two were phlebotomy technicians in the emergency department. Fifty-seven percent (13) of those surveyed worked 7 am to 7 pm, while 26% (6) worked 7 pm to 7 am. The remaining

17% participants worked eight hour shifts from 7am to 3pm (14%) or 3pm to 11pm (13%). None of the participants worked 11pm to 7 am.

The questionnaire included three detailed scenarios of blood culture collection. Although the survey was administered to 23 employees, only 22 provided a response for items 1 and 3 (participation rate of 95.7%). There were 20 responses to item 2, or 86.9% participation.

Response number three represented the correct response. Forty-one percent of respondents indicated that item 1 was correct and 10% indicated that item 2 was correct. Item number three was accurately identified as the correct procedure by 86% of respondents. Data collected from this survey is provided in Table 1. There were eleven incorrect responses, reducing the amount of absolute correct responses to eleven or 50%.

CONTAMINATION RATES

The study period was from January 1, 2011, to December 31, 2011. During this period, total blood culture contamination rates ranged from 2.1% to 5.3% with a mean of 3.4%. Institution blood cultures for the year totaled 4803. The blood culture collections were divided into two groups; those drawn by phlebotomists and those collected by nursing. The nursing group collected 3826 sets, or 79.7% of the total. The monthly contamination rates ranged from 2.7% to 5.9% among the nursing group, with a mean of 4.03%. Data for this group is provided in Table 2.

Phlebotomists drew a total of 977 blood cultures during the same period, with monthly contamination rates ranging from 0% to 1.8%. The mean contamination rate for phlebotomy was 0.80%. Phlebotomy collected 20.3% of the total blood cultures drawn during the period. Data for this group is provided in Table 3.

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Table 1

Blood Culture Collection Survey Analysis

Responses Items 1-3	Scenario 1		Scenario 2		Scenario 3	
	Amount	Percentage	Amount	Percentage	Amount	Percentage
This is the correct procedure for drawing blood cultures	9	41%	2	10%	19	86%
This is not the correct procedure for drawing blood cultures	13	59%	18	90%	3	14%
Total respondents	22		20		22	

Title of Respondents

Response Item 4	Registered nurse	Licensed practical nurse	ED (phlebotomy) tech	Nursing assistant
Amount	21	0	2	0
Percentage	91%	0%	9%	0%

Primary Shift of Respondents

Item 5	7am - 7 pm	7pm -7am	7am-3pm	3pm-11pm	11pm-7am
Amount	13	6	1	3	0
Percentage	57%	26%	4%	13%	0%

Table 2
Nursing Collections Data

Month	Nursing Collections	Total Collections	Percentage of Total Collections	Number Contaminated	Percentage Contaminated
January	332	409	81.2	13	3.92
February	392	506	77.5	20	5.10
March	330	422	78.1	9	2.72
April	275	375	73.3	10	3.63
May	298	382	78.0	11	3.69
June	300	405	74.1	9	3.00
July	275	358	76.8	14	5.09
August	312	366	85.2	15	4.81
September	290	354	81.9	9	3.10
October	301	354	85.0	18	5.98
November	330	403	81.9	14	4.24
December	391	469	83.4	12	3.07
Total	3826	4803	79.7	154	
Mean					**4.03 %**

Table 3

Phlebotomy Collections Data

Month	Phlebotomy Collections	Total Collections	Percentage of Total Collections	Number Contaminated	Percentage Contaminated
January	77	409	18.8	1	1.29
February	114	506	22.5	2	1.75
March	92	422	21.8	0	0
April	100	375	26.6	0	0
May	84	382	22.0	1	1.19
June	105	405	25.9	2	1.90
July	83	358	23.2	0	0
August	54	366	14.8	0	0
September	64	354	18.1	1	1.56
October	53	354	15.0	1	1.89
November	73	403	18.1	0	0
December	78	469	16.6	0	0
Total	977	4803	20.3	8	
Mean					**0.80 %**

Table 4

Comparison of Phlebotomy and Nursing Contamination Rates

	cont. rate	d	d^2	Phlebotomy $M_1=0.80$ cont. rate	Nursing $M_2=4.03$ d	d^2
Jan	1.29	0.49	0.24	3.92	0.11	0.12
Feb	1.75	0.95	0.90	5.10	1.07	1.15
Mar	0	-0.80	0.64	2.72	-1.31	1.72
Apr	0	-0.80	0.64	3.63	-0.4	0.16
May	1.19	0.39	0.15	3.69	-0.34	0.12
Jun	1.90	1.1	1.21	3.00	-1.03	1.06
Jul	0	-0.80	.64	5.09	1.06	1.12
Aug	0	-0.80	.64	4.81	0.78	0.61
Sep	1.56	0.76	0.58	3.10	-0.93	0.86
Oct	1.89	1.09	1.18	5.98	1.95	3.80
Nov	0	-0.80	.64	4.24	0.21	0.04
Dec	0	-0.80	.64	3.07	-0.96	0.92
Sums	9.58		8.1			11.68

Degrees of freedom *(df)= **22***

This is a one-tailed test, predicting that there is a statistically significant difference between contamination rates of the two groups.

t-table predictors for *p* < 0.010 at *df* of 22 is 2.508. Since the observed ratio of 12.5 exceeds 2.508 for a sample size of 12 for each group, we can assume that the observed difference between the means is significant at the p< 0.01 level.

A t-test was utilized to determine if a statistical difference existed between the rates of the two groups. The *t*-value was 12.5; *t*-table predictors for p< 0.01 at *df* of 22 is 2.51. Data used for this calculation are provided in Table 4.

SUMMARY

The results of data collected during this study have been presented in this chapter. This included the results of a survey which were administered to twenty-three of the employees who collect blood for culture at the study institution. It also included data collected from the laboratory computer database of the study hospital. This information was used to determine contamination rates of the two groups responsible for blood culture collection.

The survey data indicated that 86% of the respondents recognized the correct collection procedure. However, 41% erroneously identified scenario number one as a correct response, and 10% inaccurately identified scenario number two as a correct response. Contamination rates were subjected to a t-test which determined that the rates between phlebotomists and nursing were significantly different.

Chapter V will supply a summary, conclusions, and recommendations for improvement. Conclusions will be drawn from the data collected and analyzed.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this research was to examine the processes at the study hospital to delineate any cause of fluctuating blood culture contamination rates. The summary, conclusions and recommendations for improvement will be included in this chapter.

SUMMARY

The problem of this study was to evaluate blood culture collection procedures utilized at the study hospital to determine the cause of its high contamination rates. The following research questions were addressed during this research:

RQ_1: What are the recommendations of the College of American Pathologists?

RQ_2: Is there consistent protocol compliance for aseptic technique among personnel collecting blood for culture?

RQ_3: Is the contamination rate significantly higher for nursing personnel than for phlebotomy?

RQ_4: Does the study hospital provide collaboration and feedback to individuals and departments regarding contamination rates?

The significance of the study was that high blood culture contamination rates lead to increased costs for the hospital and the patient. Patients often receive unnecessary antimicrobial therapy due to misleading contaminated blood cultures. This treatment can lead to side effects in patients, multi-resistant organisms, prolonged hospital stays and *Clostridium difficile* infections. Studies have shown that the costs associated with increased contamination are substantial. Long term effects to patient quality of life are

hard to quantify. The American Society of Microbiology recommends that monthly contamination rates should not exceed 3%.

This research was limited to the collection procedures and demographics of the study hospital; differing procedures and different patient demographics may have significantly different results. Additionally, only known factors which have been delineated in the literature were investigated during this research; other factors, yet to be described, may also affect contamination rates. The inability to implement changes in the hospital is another limitation to this study.

The population for this research was the contaminated positive blood cultures collected at the study hospital from January 1, 2011, to December 31, 2011. The total number of blood cultures collected was 4803. During this time, 162 cultures were contaminated. Monthly contamination rates ranged from 2.1% to 5.3% during the year.

An anonymous survey was used to address the issue of protocol compliance. It was administered to phlebotomists and nursing personnel who obtain blood for culture. The survey described three slightly different scenarios for proper blood collection; respondents were asked to identify the correct answer. The respondents indicated their primary occupation and the shift they worked.

Data from the study hospital's LIS was utilized to determine monthly contamination rates. Each blood culture collected was logged into the laboratory information system and included the code of the person entering it into the system. When a blood culture became positive, standard criteria was used to determine if it was likely contamination. The researcher was provided data regarding total blood cultures and contaminated cultures for each month. The data also identified the collector as

phlebotomy or nursing personnel. The survey results were tabulated to determine how many of the respondents chose the single correct scenario for blood culture collection. A *t*-test analysis was used to compare the contamination rates of phlebotomists and nursing personnel. This was done to determine if there was a significant difference between the rates of the two groups.

CONCLUSIONS

Research Question 1 was to determine the recommendations of the College of American Pathology regarding blood culture contamination. The recommendations are:

1. Use either dedicated phlebotomists or medical technologists for obtaining blood for culture.

2. Use larger limit of blood volume in cultures.

3. Utilize a system of continual monitoring of employees to include feedback; subjects under observation perform better than unobserved subjects (Berkeris,Tworek, Walsh & Valenstein, 2005).

Research Question 2 was to determine if there was consistent protocol compliance among personnel collecting blood for culture. Although 86% of the respondents correctly identified the proper procedure for collection of blood culture, 51% also chose an incorrect procedure as acceptable.

Research Question 3 was to determine if a significant difference existed between the contamination rates of phlebotomy and nursing personnel. This question was answered by applying a statistical t-test to the means of both sets of contamination rates. Since the obtained t-ratio of 12.50 exceeds 2.51 for a sample size of 12 for each group, one can assume that the observed difference between the means was statistically significant at the $p<0.01$ level. Therefore, the researcher can conclude that there was a

significant difference between the contamination rates of the phlebotomists and those of nursing personnel.

Finally, Research Question 4 was to determine if there exists a program of collaboration and feedback to individuals and departments regarding contamination rates. Currently, the laboratory coordinator provides the monthly contamination rates to the nursing supervisor, with limited success in decreasing contamination. The month with the lowest rate of 2.1% (March 2011) coincided with the delivery of an informative email to nursing regarding the need for strict attention to procedures for collection.

RECOMMENDATIONS

The results reached in this study were obtained from data taken from the study hospital. Based on the findings, the researcher makes the following recommendations to the study hospital:

1. Administration should consider hiring at least one well trained phlebotomist with proven efficacy to collect blood cultures for a specified time period. At the end of that time frame, contamination rates should be compared with the nursing rates which may justify the need for additional phlebotomists.

2. All employees collecting blood for culture should be required to attend an in-service for the purpose of retraining, highlighting the importance of blood volume, contact time of antiseptic and any other techniques specific for the product used. Proper technique should be demonstrated by a facilitator. The training should also emphasize the tremendous financial impact of contamination to the healthcare organization. This training should be mandatory and scheduled at least annually.

3. Pocketsize, easily accessible instructions should be produced and make available for quick reference during hectic times.

4. An aggressive program of collaboration and feedback should be provided. This would solicit input from other departments, such as Infection Prevention. Data regarding contamination rates should be provided not only to each department, but to each individual who has a high contamination rate (as determined by collaboration). Individuals or the entire emergency department nursing staff may be retrained if the contamination rates so warrant. Facilitators should ensure that everyone realizes that the rates are being scrutinized.

5. The contamination rates should be publicized with posters or flyers as constant, visible reminders of the need for quality improvement. These may be posted in lounges or offices initially. As rates improve, the contamination rates may be posted in more public areas.

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APPENDIX A

Blood Culture Collection Survey

Instructions:
For items 1-3, read the procedures for blood culture collection. Indicate whether the procedure is a correct (response 1) **or** an incorrect (response 2).
For items 4-5, please circle your title and primary shift.

1. Blood culture collection process:
   a. Positively identify the patient by asking them to state their name and DOB. Compare this to the written order.
   b. Blood culture bottles are to be drawn prior to any other ordered labs.
   c. Remove the plastic flip top from the blood culture bottle and disinfect with 70% Isopropanol prep.
   d. Cleanse skin with ChloroPrep® sponge for adults or Enturia ®Prep on children less than two months.
   e. Pinch wings of ChloroPrep® sponge to release cleansing solution.
   f. Using a circular motion, clean draw site for 30 seconds.
   g. Allow the site to air dry for 30 seconds. Do not touch the site during this time.
   h. Draw 8-10 ml of blood into each adult bottle or 1-3 ml of blood in each pediatric bottle.

This is the correct procedure for drawing blood cultures   _____
This is **not** the correct procedure for drawing blood cultures   _____

2. Blood culture collection process:
   a. Positively identify the patient by asking them to state their name and DOB. Compare this to the written order.
   b. Blood culture bottles are to be drawn prior to any other ordered labs.
   c. Remove the plastic flip top from the blood culture bottle .
   d. Cleanse skin with ChloroPrep® sponge for adults or Enturia® Prep on children less than two months.
   e. Pinch wings of ChloroPrep® sponge to release cleansing solution.
   f. Place the tip of the foam cushion onto draw site and utilize a back and forth motion to clean draw site for 30 seconds.
   g. Allow the site to air dry for 20 seconds. Do not touch the site during this time.
   h. Draw 8-10 ml of blood into each adult bottle or 1-3 ml of blood in each pediatric bottle.

This is the correct procedure for drawing blood cultures   _____
This is **not** the correct procedure for drawing blood cultures   _____

3. Blood culture collection process:
    a. Positively identify the patient by asking them to state their name and DOB. Compare this to the written order.
    b. Blood culture bottles are to be drawn prior to any other ordered labs.
    c. Remove the plastic flip top from the blood culture bottle and disinfect with 70% Isopropanol prep.
    d. Cleanse skin with ChloroPrep® sponge for adults or Enturia® Prep on children less than two months.
    e. Pinch wings of ChloroPrep® sponge to release cleansing solution.
    f. Place the tip of the foam cushion onto draw site and utilize a back and forth motion to clean draw site for 30 seconds.
    g. Allow the site to air dry for 30 seconds. Do not touch the site during this time.
    h. Draw 8-10 ml of blood into each adult bottle or 1-3 ml of blood in each pediatric bottle.

This is the correct procedure for drawing blood cultures   _____
This is **not** the correct procedure for drawing blood cultures   _____

4. What is your title?
    a. Registered nurse
    b. Licensed practical nurse
    c. ED tech (phlebotomy)
    d. Nursing assistant

5. What is your primary shift?
    a. 7am to 7 pm
    b. 7pm to 7am
    c. 7am to 3pm
    d. 3pm to 11pm
    e. 11pm to 7am