BLOOD CULTURE CONTAMINATION IN THE DEPARTMENT OF PAEDIATRICS OF UNIVERSITAS- AND PELONOMI HOSPITALS

BY

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DEDICATION

This study is wholeheartedly dedicated to Craven, Ronél, Petri, Ezra and Kana who have been my source of inspiration and gave me strength when I thought of giving up.
And most especially to the Almighty Lord my God for providing me with the opportunity to work with the most special of creation: children.

DECLARATION OF AUTHORSHIP

I, Dr R.C. Krause, declare that the coursework Master's Degree mini-dissertation and interrelated publishable article that I herewith submit for the degree in MMed (Paediatrics and Child Health) at the University of the Free State are my own independent work and that I have not previously submitted it for a qualification at another institution of higher education. Where help was sought, it has been acknowledged.

I, Dr R.C. Krause, hereby declare that I am aware that copyright of this mini-dissertation is vested in the University of the Free State.

I, Dr R.C. Krause, hereby declare that all royalties in relation to intellectual property that was developed during the course of and/or in connection with the study at the University of the Free State will accrue to the University.

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DR R.C. KRAUSE **DATE**

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ABSTRACT

Background: Sepsis and septic shock are one of the most important risk factors for mortality in children. Blood cultures remain the gold standard to identify the causative organisms of sepsis and to obtain the antibiotic sensitivity profile. The shortcoming of blood cultures is that only 5 to 13% of cultures will turn out to be positive and roughly 20 to 56% of these will represent contaminants. The South African Society for Clinical Microbiology (SASCM) endorses the blood culture sampling technique as described by Ntusi *et al*. (2010). Abrahams *et al*. (2015) described that there was poor adherence to these standards which contributes to a high blood culture contamination rate. There is a shortage of South African studies addressing the problem of blood culture contamination.

Objective: To determine the blood culture contamination rates in the Department of Paediatrics at Pelonomi- and Universitas Hospital for the month of May to 27 August 2019 by reviewing blood culture results. To assess blood culture sampling technique amongst clinicians by means of anonymous questionnaires.

Methods: This is a descriptive study. The blood culture contamination rate for 1 May 2019 to 27 August 2019 was determined by analysing NHLS data. Clinician blood culture sampling practices were described by using information from anonymous questionnaires which were handed out to clinicians working in the Department of Paediatrics during the same period.

Results: Of the 244 blood cultures reviewed, 61 (25%) had positive growth, 36 (15%) grew contaminants and 7 (3%) grew more than one organism. The blood culture contamination rate was 15%. Thirty-two percent of clinicians were aware of the SASCM guidelines regarding blood culture sampling technique, but only 3% indicated that they complied with the guidelines.

Conclusion: This study found a blood culture contamination rate which is almost five times higher than internationally accepted rate. It also found that clinicians were not aware of blood culture sampling guidelines and in the few cases where clinicians were aware of these guidelines, compliance with these guidelines was not met. Recommendations made, include quarterly review of blood culture contamination rate at these institutions and making clinicians aware of correct technique or optimising technique within the limited circumstances by putting together guidelines on blood sampling techniques for blood cultures for local use.

KEYWORDS: Sepsis, blood culture, paediatric sepsis, blood culture contamination rates, blood culture contaminants

ABBREVIATIONS AND DEFINITIONS

SIRS - Systemic inflammatory response syndrome

SIRS is a non-specific process that occurs in response to an infection or an injury. To diagnose SIRS, at least two of the following should be present (one of which must be an abnormal temperature or leucocyte count):

- core temperature of >38.5 ˚C or <36˚C
- tachycardia – heart rate of > 2SD above the normal for age or bradycardia
- respiratory rate >2SD above the normal for age
- white cell count elevated or depressed for age[5, 6].

Sepsis

The Third International Consensus Definitions for Sepsis has defined sepsis as a dysregulated host response (such as SIRS) to infection followed by life threatening organ dysfunction[7]. Sepsis is a medical emergency which requires immediate and appropriate medical attention[8, 9].

Blood culture

A specimen of blood inoculated in a growth medium with the purpose of growing pathogenic bacteria and or fungi to identify causative organisms of infection and its sensitivity profile to antibiotics[6] or antimycotics.

Contaminants

In blood cultures a contaminant can be defined as an organism which is not present in the patient's bloodstream, but is grown in the culture[10]. In certain clinical scenarios, organisms which are classified as contaminants can cause sepsis.

Pre-analytical factors

With regards to blood cultures, pre-analytical factors are factors which influence the result of a blood culture prior to the specimen arriving at the laboratory. These include: volume of blood inoculated in specimen medium, site of blood collection, skin preparation, elapsed time from specimen being taken until arrival at laboratory and clinician knowledge regarding correct blood culture sampling technique[4].

Department of Paediatrics at Pelonomi and Universitas Hospitals

The Department encompasses the following units and wards:

- At Pelonomi Hospital:
  Neonatal High Care Unit
  Paediatric Intensive Care Unit
  Wards 3A, 4A and 4B
- At Universitas Hospital:
  Neonatal Intensive Care Unit
  Neonatal High Care Unit (abbreviated as SSE)
  Paediatric Intensive Care Unit
  Paediatric Cardiology Suite
  Ward 10A and 10B

BLOOD CULTURE CONTAMINATION IN THE DEPARTMENT OF PAEDIATRICS OF UNIVERSITAS- AND PELONOMI HOSPITALS

CHAPTER 1

BACKGROUND

1.1 LITERATURE REVIEW

In both industrialised and developing countries, severe sepsis and septic shock are one of the most important risk factors for mortality in children[1]. Statistics South Africa confirms that the global trend is also relevant to South Africa with an estimated 20% of child deaths attributable to sepsis during the 2013 to 2015 period[11]. Despite the fact that one in five child deaths in South Africa are caused by sepsis, data on the causative organisms and prevalence of sepsis in children in South Africa are scarce[12,13].

To guide the recognition of sepsis in children, consensus definitions have been published [5]. Sepsis can be defined as a systemic inflammatory response syndrome (SIRS) in the presence of or resulting from a suspected or proven infection. The Third International Consensus Definitions for Sepsis is defined has defined sepsis as a dysregulated host response (such as SIRS) to infection followed by life threatening organ dysfunction[7]. Sepsis is considered to be severe when it is associated with organ hypo-perfusion or dysfunction characterised by one or more of the following:

- prolonged capillary refill time;
- increased lactate;
- oliguria or acute kidney injury;
- altered mental state;
- acute respiratory distress syndrome;
- disseminated intravascular coagulation; and/or
- hypotension[5].

Sepsis is a medical emergency which requires immediate and appropriate medical attention, of which appropriate antibiotics and supportive management are essential[8, 9].

In an attempt to improve the mortality rate of patients who are diagnosed with sepsis an

international expert panel was assembled in 2004: the Surviving Sepsis Campaign (SSC). In the latest guidelines (2020) for the management of sepsis, SSC recommends that it is best practice to do blood cultures prior to administration of antibiotics, to optimise identification of infective organisms. However, SSC also states that antibiotic therapy should not be delayed whilst waiting for a blood culture to be done[8,9,14]. This is important to take note off as not all district hospitals and local clinics in the Free State are equipped with blood culture facilities and they do not have laboratory support to process blood cultures. At these hospitals and clinics; prior to referral, antibiotics are administered to patients diagnosed with sepsis according to syndromic case management guidelines. This influences the true results of blood cultures collected at receiving hospitals[15].

Blood culture currently remains the mainstay of identification of causative organisms of sepsis as well as the organism's antimicrobial susceptibility test (AST) result despite advances in molecular techniques and biomarkers[2,3,14,16]. It guides physicians to use appropriate antibiotics and to de-escalate from broad spectrum antibiotics to specific antibiotic therapy and reduce the time period of antibiotic use which forms the cornerstone of antibiotic stewardship. For this reason, blood culture remains essential in high quality management of sepsis[8,15]. The World Health Organization currently recognises blood culture as a priority specimen for surveillance of antimicrobial resistance because of its clinical importance as well as accurate and uncomplicated methods of detection[17].

The process of collecting a blood culture is important as it affects the quality of the specimen[4]. Ombelet *et al*. (2019) summarised the procedure of blood collection for blood cultures as follows:

- a tourniquet is applied to the patient's arm which is also a shortcoming in methodology of collecting specimen in neonates, infants and children;
- a vein is identified and palpated followed by appropriate antiseptics being applied at the place of sampling (the vein should not be retouched after disinfecting);
- the selected vein is then pierced with a needle and syringe; and
- a sufficient volume of blood is divided into blood culture bottles[16].

The shortcomings of blood cultures are:

- only 5 to 13% of cultures will turn out to be positive and roughly 20 to 56% of these will represent contaminants.

- a three to four day waiting period from collection of blood culture specimen to identification of organism and its AST results[4,18].

These two shortcomings as listed above will now be discussed in further detail.

1.2 IMPACT OF BLOOD CULTURE CONTAMINANTS ON CLINICAL PRACTICE

Organisms commonly accepted as contaminants include: *Coagulase negative staphylococci*, *Corynebacterium* species, *Bacillus* species, *Clostridium perfringens*, *Micrococcus* species and *Viridans streptococci*[10,15] because these are normal skin commensals. The College of American Pathologists defines a contaminant as the presence of aforementioned organisms in only one of a series of blood culture specimens[19] in a specific patient. Contaminant organisms are most often cultured when sterility during sample collection is jeopardised. Blood culture contamination can occur at any stage during collection, which includes: skin preparation, blood culture bottle top preparation, blood collection method and blood culture inoculation site[20].

It may happen that organisms which are classified as contaminants cause infections. Contaminants are suspected to be causative of sepsis when:

- two different blood culture samples culture the same contaminant organism;
- a patient deteriorates and persistently cultures the same organism;
- certain diagnoses are made such as infective endocarditis; or
- in clinically deteriorating premature infants where contaminant organisms commonly are causative organisms of sepsis[7, 16, 20].

In clinical practice, to differentiate whether a contaminant organism is truly the causative organism of sepsis remains difficult. In most instances, when there is doubt as to whether a contaminant organism can truly be causing sepsis in a specific patient, help of a medical microbiologist is often needed. Difficulty in distinguishing between contaminants and true bacteraemia leads to increased admissions of patients who could have been managed as outpatients, increased length of stay in hospital by one to five days, unnecessary additional laboratory testing with an up to 80% increase in microbiology charges and approximately 40% increase in inappropriate antibiotic exposure which may contribute to the emergence of drug resistant organisms[19,20]. It is also clear from literature that improvement in specifically blood culture specimen quality (and thus implying decreased contamination rate) will greatly improve patient outcome with sepsis in terms of patient survival, hospital

infection control, antibiotic stewardship, patient length of stay, hospital costs, laboratory costs and laboratory efficiency[2,12,20–23]. Avoiding contamination is vital, even more so in a resource limited setting[16].

Other studies done on patients with sepsis and in some cases paediatric patients with sepsis describe factors that can contribute to an increase in false positive or negative blood culture results such as:

- Case management of sepsis with ceftriaxone at primary health care level. In South Africa all children who are identified with danger signs at primary health care facilities receive empiric ceftriaxone as part of the IMCI program.
- The small size of paediatric patients. Suboptimal blood volumes are collected. There are currently no consensus guidelines on the volume of blood that needs to be inoculated in paediatric blood culture bottles in paediatric patients. Needham *et al*. (2018) attempted to address this problem and designed a blood volume chart for blood culture sampling according to weight (Table 2). However, this does not form part of consensus guidelines as yet.
- Poor compliance with hand hygiene practices of the person collecting the blood specimen.
- Lack of use of sterile gloves.
- Inadequate patient skin preparation by the physician who is collecting the sample.
- Inadequate preparation of blood culture bottle-top with antiseptics.
- Collection of only one blood culture specimen due to financial or time constraints.
- General lack of knowledge amongst physicians regarding the importance of correct blood culture collection and the diagnostic as well as therapeutic implications of blood culture results.
- Lack of standardised policy with regards to when and how to collect blood cultures.
- Overcrowding of a unit, i.e. too many patients admitted to a specific ward and increased patient to doctor ratio[2,6,13,15,19,20,23,24].

The scenarios above are typical of low- and middle-income countries (LMIC). Financial, logistical and infrastructure related constraints, challenge clinicians in implementing routine blood culture collections[16]. South Africa is currently classified as an upper middle-income country by the World Bank.

Min *et al*. (2014) also describes other factors that can contribute to an increase in false

blood culture results. These include: the clinician's desire to prevent a pain inducing procedure such as a needle-stick injury in paediatric patients and lack of sterility to a procedure that needs to be performed sterile (i.e. blood culture sampling) in paediatric patients (it is difficult to sample blood on a crying/upset child, even more so to remain sterile)[19].

1.3 IMPACT OF AST RESULT WAITING PERIOD ON CLINICAL PRACTICE

It is well known that with every hour delay in appropriate antibiotic therapy, mortality rates in patients with sepsis increase. Due to this possible three to four day waiting period, situations in clinical practice do exist where sepsis is diagnosed and empiric antibiotics are administered as per SSC. However; these empiric antibiotics are not necessarily the same drugs as the definitive antibiotics[25]. Tabak *et al*. (2018) state that a decrease in time between blood culture specimen collection and the reportable AST results, leads to a decrease in time to optimal antibiotic therapy, a decrease in patient morbidity and mortality as well as a decrease in hospital and laboratory costs[26]. Survival of sepsis is thus inversely related to time to appropriate antibiotic therapy[27].

Antibiotics can be defined as appropriate when the bacteria identified in the blood culture are susceptible to at least one of the antibiotics administered within 24 hours of collecting the blood culture[25]. Yokota *et al*. (2014) described that broad spectrum antibiotics are not always appropriate antibiotics to manage sepsis, as causative organisms of sepsis in their study were not always susceptible to empiric antibiotics. Thus, when empiric antibiotics were used in cases where patients had sepsis due to organisms resistant to empiric antibiotics, patients essentially were undertreated, had an increased risk of mortality as well as increased risk of developing antibiotic side-effects, developing antibiotic resistance and developing *Clostridium difficile* infection[25].

A systematic review and meta-analysis done by Paul *et al*. (2010) stated that the odds ratio for all-cause mortality when the appropriate antibiotic was used within the first 48 hours for in patients with sepsis was 1.6 (95% CI, 1.37 to 1.86)[28]. The drive for appropriate antibiotic use in sepsis is thus clearly stated by this systematic review. Patient survival during sepsis depends on prompt initiation of appropriate antibiotics. Thus, one can understand the statement made by Rhodes *et al*. (2016) that blood cultures remain essential in high quality management of patients with sepsis.

According to Baron *et al*. (2013) the interpretation of the results of specimens submitted to microbiology for analysis depends entirely on the quality of the specimen that is submitted. Specific emphasis is made that the quality of the blood culture specimen is influenced by the specimen management. Optimal blood culture specimen management can be described in terms of so called pre-analytical factors; that is: volume of blood collected, timing of sample collection, sampling site, skin preparation and knowledge of the correct technique of blood culture sampling[3,20–22].

The South African Society for Clinical Microbiology (SASCM) endorses blood culture sampling technique as described by Ntusi *et al*. (2010). This guideline aims to: improve the quality of blood culture sampling, reduce the contamination of blood samples collected and thus improve the management and ultimately outcome of patients with sepsis (Table 1)[6].

Table 1. Blood culture standards[14]

1	BCs should be collected if there is a clinical suspicion of a blood stream infection.
2	Informed consent should be obtained prior to performing a BC.
3	BCs should be obtained prior to administration of antibiotics.
4	Hand washing should be performed prior to performing a BC.
5	Hands should be disinfected prior to performing a BC.
6	Sterile gloves should be used when performing a BC.
7	BCs should be drawn from peripheral sites.
8	BCs should be collected from separate venepuncture sites.
9	Puncture site should be sterilised using appropriate disinfectant.
10	Skin disinfectant should be allowed time to dry before inserting the needle.
11	BC bottle tops should be disinfected prior to inoculation.
12	Bottle-top disinfectant should be allowed time to dry prior to inoculation.
13	Needles should not be exchanged between BC collection and inoculation of BC bottles.
14	BC should be inoculated first, if blood is collected for other tests.
15	Minimum of two BCs should be drawn within 24 hours.
16	Aerobic BC bottles should be used in a resource-limited area.
17	Minimum of 20 mL of blood should be obtained for each BC. *(This is of relevance to adult medicine.)*
18	BC should be correctly labelled.
19	Laboratory request form should be correctly completed.
20	BC should be documented in the clinical notes.
21	BC bottles should be left at room temperature if there is a delay in transporting them to the laboratory.
22	BC bottles should be delivered to the laboratory as soon as possible.

BC: blood culture

In a study done by Ombelet *et al*. (2019), specific strategies are mentioned in an attempt to decrease blood culture contamination. These include amongst others: skin antisepsis, one-step vs. two-step procedure for skin antisepsis, sterile gloves, disinfecting the blood culture bottle top (septum) and phlebotomy teams[16]. These aforementioned four strategies will now be elaborated on.

- Skin antisepsis: a recent meta-analysis found no difference between povidone iodine or chlorhexidine alcohol being used as antiseptic agents[15,16]. In the light of alcohol having a quicker drying time and being less prone to be accidentally colonised with Gram-negative organisms, it might be more likely to be used correctly. However, the safety of chlorhexidine with alcohol in infants <2 months has not been established.
- One-step vs. two-step procedure for skin antisepsis: Ombelet *et al*. (2019) describes the one- step procedure for skin antisepsis as the single application of an antiseptic to the venepuncture site and the two-step method as consecutive application of one or more different antiseptics to the venepuncture site. Their study suggests that in LMIC the two-step antiseptic approach should be used. This is due to the fact that many patients have long travels, some being on dirt roads, to reach hospitals. Ideally isopropyl alcohol (alcohol swabs) needs to be used to clean the skin overlying the venepuncture site. Once the alcohol swabs are not stained by dust, then only should the clinician proceed with the second step of skin antisepsis by using for instance chlorhexidine-alcohol[16].
- Sterile gloves: the routine use of sterile gloves to sample blood culture specimens, might reduce blood culture contamination rate, but at the same times increases the cost of blood culture sampling. Ombelet *et al*. (2019) found that in LMIC where contamination is much more prevalent, centres which used sterile gloves when sampling blood culture specimens had lower baseline contamination rates. This benefit of decreasing the blood culture contamination rate and its implications on microbiology laboratory fees may outweigh the increased costs when sampling blood cultures with sterile gloves[16].
- Disinfecting the blood culture bottle top: In the light of higher environmental contamination being present in LMIC, disinfecting the blood culture bottle top with isopropyl-alcohol is a low cost strategy to reduce contamination[16]. South African literature suggests that this is not routinely done[15].
- Phlebotomy teams: Ombelet *et al*. (2019) and Rana *et al*. (2018) found that having dedicated phlebotomy teams being dedicated to sample blood cultures, lead to a decrease in blood culture contamination. This was due to sampling techniques being standardised and increased awareness amongst phlebotomy teams regarding the importance of correct blood culture sampling technique[16,20]. However, this option might not be feasible in many institutions, due to increased costs related to having dedicated phlebotomy teams.

Unfortunately, a study done in the Western Cape by Abrahams *et al*. (2015) found that

there was poor adherence to these standards and that this possibly could explain a higher than acceptable contamination rate in blood cultures done in their study[15]. Internationally accepted rates of blood culture contamination are 3%[22]. The results from Abrahams *et al*. (2015) are similar to results from studies done in Germany, the United States of America, Nigeria and Malaysia. All of these studies found that clinicians had deficits regarding blood culture related knowledge and sampling technique [23].

A recent study done by Rana *et al*. (2018) states that by reducing the contamination rate of blood cultures at their facility from 2.85% to 1.54% saved the hospital on average $49 998 per month (roughly R750 000). They achieved this reduction in blood culture contamination rate by the following interventions:

- Standardising blood culture sampling by means of a protocol for all paediatric and neonatal wards, paediatric intensive care units and neonatal intensive care units.
- Optimising blood volume collection by proposing a weight-based blood volume chart (Table 2). It should be mentioned that optimising blood volume inoculated in the blood culture bottle, directly correlates with an increase of detection rate[2]. To decrease the chances of missing sepsis caused by a low bacterial count in a patient's blood stream, it is recommended to sample as large a volume of blood as possible. This is difficult when sampling blood from small children, who might become anaemic due to an optimal blood volume sample. In some instances parents may also find it unacceptable that large volumes of blood are taken for samples from their child[16].
- Continual education of staff as well as staff cooperation in maintaining correct blood culture sampling technique remained pivotal in the reduction of the rate of contamination.

Table 2. Recommended blood culture volume by weight (Wt) [20]

Wt Range, kg	BD Bactec Peds Plus Blood Volume, mL	BD Bactec Plus Aerobic Blood Volume, mL	BD Bactec Plus Anaerobic Blood Volume, mL	Total Volume to be Drawn, mL
<5	1	N/A	N/A	1
5–10	2	N/A	N/A	2
10.1–20	3	N/A	3	6
20.1–40	N/A	5	5	10
>40	N/A	10	10	20

This study confirmed that it is possible to decrease the blood culture contamination rate, and thereby patient morbidity and hospital costs, by enforcing simple measures which are less expensive than phlebotomy teams or ready to use blood culture kits[20].

Selek *et al*. (2014) concluded that every laboratory should conduct a yearly determination of blood culture contamination rate. Should this rate be more than 3% measures should be taken to identify and correct the underlying problem as patient safety might be compromised.

To the candidate's knowledge, there are no studies which were undertaken at Universitas or Pelonomi Hospital examining the blood culture sampling methods used and the blood culture contamination rates. South African literature regarding the topic of paediatric sepsis, blood culture sampling techniques and contamination rates are scanty and scarce[29].

1.4 RESEARCH QUESTIONS

- What is the blood culture contamination rates at the Department of Paediatrics at Pelonomi- and Universitas Hospitals during the period 1 May 2019 to 27 August 2019?
- What are the blood culture sampling practices in the Department of Paediatrics at Pelonomi- and Universitas Hospitals during the period 1 May 2019 to 27 August 2019?

1.5 AIM OF STUDY

- To assess the blood culture contamination rates at the Department of Paediatrics at Pelonomi- and Universitas Hospitals.
- To determine blood culture sampling practices in the Department of Paediatrics at Pelonomi- and Universitas Hospitals.

1.6 STUDY OBJECTIVES

- To determine the blood culture contamination rates in the Department of Paediatrics at Pelonomi- and Universitas Hospitals for the period 1 May 2019 to 27 August 2019 by accessing data from the National Health Laboratory Services.
- To assess blood culture sampling practices amongst clinicians by means of anonymous questionnaires.

1.7 HYPOTHESIS

Blood culture contamination rate is higher than international standards. Blood culture sampling standards are not adhered to.

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CHAPTER 2

ARTICLE 1

The publishable article was prepared according to the journal submission guidelines for the *South African Medical Journal (SAMJ)* (cf. Appendix G).

ABSTRACT

Background: Sepsis and septic shock are one of the most important risk factors for mortality in children. Blood cultures remain the gold standard to identify the causative organisms of sepsis and to obtain the antibiotic sensitivity profile. The shortcoming of blood cultures is that only 5 to 13% of cultures will turn out to be positive and roughly 20 to 56% of these will represent contaminants. The South African Society for Clinical Microbiology (SASCM) endorses the blood culture sampling technique as described by Ntusi *et al*. (2010). Abrahams *et al*. (2015) described that there was poor adherence to these standards which contributes to a high blood culture contamination rate. There is a shortage of South African studies addressing the problem of blood culture contamination.

Objective: To determine the blood culture contamination rates in the Department of Paediatrics at Pelonomi- and Universitas Hospital for the month of May to 27 August 2019 by reviewing blood culture results. To assess blood culture sampling technique amongst clinicians by means of anonymous questionnaires.

Methods: This is a descriptive study. The blood culture contamination rate for 1 May 2019 to 27 August 2019 was determined by analysing NHLS data. Clinician blood culture sampling practices were described by using information from anonymous questionnaires which were handed out to clinicians working in the Department of Paediatrics during the same period.

Results: Of the 244 blood cultures reviewed, 61 (25%) had positive growth, 36 (15%) grew contaminants and 7 (3%) grew more than one organism. The blood culture contamination rate was 15%. Thirty-two percent of clinicians were aware of the SASCM guidelines regarding blood culture sampling technique, but only 3% indicated that they complied with the guidelines.

Conclusion: This study found a blood culture contamination rate which is almost five times higher than internationally accepted rate. It also found that clinicians were not aware of blood culture sampling guidelines and in the few cases where clinicians were aware of these guidelines, compliance with these guidelines was not met. Recommendations made, include quarterly review of blood culture contamination rate at these institutions and making clinicians aware of correct technique or optimising technique within the limited circumstances by putting together guidelines on blood sampling techniques for blood cultures for local use.

Word count: 371

INTRODUCTION

In both high- and lower income countries, severe sepsis and septic shock are the most important risk factors for mortality in children[1]. Statistics South Africa confirms that the global trend is also similar in South Africa with an estimated 20% of child deaths attributable to sepsis during the 2013 to 2015 period[2]. Blood culture currently is the mainstay of identification of causative organisms of sepsis as well as the organism's antimicrobial susceptibility test (AST) result despite advances in molecular techniques of identifying causative organisms of sepsis[3–5]. It guides physicians to use appropriate antibiotics and to de-escalate from broad spectrum antibiotics to specific antibiotic therapy which is the cornerstone of antibiotic stewardship. For this reason a blood culture remain essential in high quality management of sepsis[6,7]. The World Health Organization currently recognises blood culture as a priority specimen for surveillance of antimicrobial resistance because of its clinical importance as well as accurate and uncomplicated methods of detection[8].

Despite the fact that one in five children who die in South Africa, die of sepsis, data on the causative organisms and prevalence of sepsis in children in South Africa are scarce[9,10].

To the writer's knowledge, there are no previous studies done at paediatric departments of Pelonomi- and Universitas Hospitals examining the blood culture contamination with regard to the rate and blood culture sampling methods. South African literature regarding paediatric sepsis, blood culture sampling techniques and paediatric blood culture contamination rates or scanty[11].

AIM OF STUDY

- To assess the blood culture contamination rates at the Department of Paediatrics at Pelonomi- and Universitas Hospitals.
- To determine blood culture sampling practices in the Department of Paediatrics at Pelonomi- and Universitas Hospitals.

STUDY OBJECTIVES

- To determine the blood culture contamination rates in the Department of Paediatrics at Pelonomi- and Universitas Hospitals for the period 1 May 2019 to 27 August 2019

by accessing data from the National Health Laboratory Services and describing the contaminant organisms which were cultured.

- To assess blood culture sampling practices amongst clinicians working in the Department of Paediatrics of Pelonomi - and Universitas Hospitals by means of anonymous questionnaires.

METHODS

Type of study

This was a descriptive study conducted at the Department of Paediatrics of Pelonomi- and Universitas Hospitals.

Setting

Pelonomi Tertiary Hospital is a tertiary level hospital in the Free State with two general paediatric wards, an acute diarrhoea and severe acute malnutrition ward and a paediatric intensive care unit (PICU). Universitas Academic Hospital is a tertiary hospital which receives referrals from secondary hospitals in the Free State, Northern Cape and Lesotho. Universitas Hospital Paediatrics department consists of a general paediatrics ward, paediatric cardiology high care unit, paediatric oncology ward and a PICU.

Time Frame

The blood culture contamination rate for 1 May 2019 to 27 August 2019 was determined by means of NHLS data. The specific time frame 1 May 2019 to 27 August 2019 was used as intern doctors rotated on a four monthly basis through the Department of Paediatrics at these hospitals, these dates represent the first and last day of the interns' paediatric rotation.

In- and exclusion criteria

All blood cultures submitted for every patient who was admitted in paediatric wards were included in the study.

Neonatal units at both hospitals were excluded from this study, as well as blood cultures done on neonate patients (i.e. patients < 28 days of life) in the paediatric wards. Reasons for excluding neonatal patients include: clinical notes needed to be accessed to determine whether blood culture results were managed as contaminants or pathogens. Accessing clinical notes was beyond the scope of this study design. Furthermore, a study regarding

neonatal blood culture results was already underway in the Department of Neonatology at Pelonomi- and Universitas Hospitals and the researcher was instructed to focus on the Department of Paediatrics at Pelonomi- and Universitas Hospitals. Paediatric surgery and orthopaedic patients were also excluded from this study as clinicians rotating through these departments change on a monthly basis and not a two monthly basis such as in the Department of Paediatrics.

Criteria for determining contamination

It is difficult to differentiate between a pathogen and contaminant organism. There are two methods of differentiating between the two entities (i.e. pathogenic and contaminant organisms). Firstly, clinically by means of reviewing clinical assessment and secondly by the number of cultures that show growth for a particular organism. In this study, the second method was used. In cases where organisms were cultured which are traditionally labelled as contaminants (*Corynebacterium*, *Coagulase negative staphylococ*us, *Micrococcus* species, *Pantoea* species and *Streptococcus mitis*), these cultures were only regarded as clinically relevant if the organism was isolated from two different cultures. This is due to the fact that the odds of having contaminated both cultures with the same organism are small[(5)].

Method of collecting questionnaire data

Clinician blood culture sampling practices were obtained by means of an anonymous questionnaire which were handed out to clinicians working in the Department of Paediatrics during the same period. Questionnaires were based on the 22 SASCM guidelines on blood culture sampling technique.

At Pelonomi- and Universitas Hospitals, blood cultures are collected by clinicians and not nursing staff. Only clinicians who had taken blood cultures during the study period were eligible to complete an anonymous questionnaire. The questionnaire included 22 questions which attempted to describe clinician sampling techniques such as: blood culture sampling practices related to hand disinfecting, blood culture bottle top disinfecting and informed consent obtained prior to blood culture sampling were included in the questionnaire.
When referring to clinicians in this study, consultants, registrars, medical officers and intern doctors are all included.

Data analysis

Data was analysed by using Microsoft Excel charts and QI Macros 2020.

Ethics

Prior to data sampling, approval from the following institutions were obtained:

- The Health Sciences Research Ethics Committee (HSREC) at the Faculty of Health Sciences, University of the Free State (Ethics number: UFS-HSD2019/0377);
- The Free State Department of Health; and
- The National Health Laboratory Services (NHLS).

RESULTS

A total number of 350 blood cultures were performed over a period of four months at the Department of Paediatrics of Pelonomi- and Universitas Hospitals of which 244 of the 350 blood cultures were included in this study. Of the 106 blood cultures which were excluded; two did not have patient ages documented, 76 blood cultures were performed on patients < 28 days of life and 28 blood cultures were performed on paediatric patients admitted to wards other than the wards specified in this study (i.e. patients were admitted to paediatric surgery wards).

Twenty-three percent (57/244) of blood cultures were sampled at Pelonomi Hospital and 77% (187/244) sampled at Universitas Hospital. Table 1 shows the organisms grown from blood cultures, excluded from this table are cultures which had polymicrobial results. Table 2 demonstrates the interpretation of the blood culture result as well as the blood culture contamination rate of 15% (37/244). Only one blood culture bottle was submitted per patient per blood culture request in all of the blood cultures. Seven blood cultures (3%) cultured more than one organism from the blood culture, i.e. polymicrobial blood cultures[12].

Table 1. Micro-organisms recovered from blood cultures

Pathogens	Isolates (n)
Acinetobacter baumannii	2
Coagulase negative staphylococcus (present in two separate blood cultures)	6
Enterococcus faecium	3
Escherichia coli	4
Klebsiella pneumoniae	1
Pseudomonas aeruginosa	1
Streptococcus pneumoniae	1
TOTAL	**18**
Contaminants	

Coagulase negative staphylococcus	31
Corynebacterium	2
Micrococcus species	1
Pantoea species	1
Streptococcus mitis	2
TOTAL	**37**

Table 2. Total number of, and proportion of, blood culture contaminants expressed in terms of number of blood cultures

	Pelonomi Hospital (N=57/244) *n* (%)	**Universitas Hospital (N=187/244) *n* (%)**	**Total (N=244) *n* (%)**
Positive blood cultures	11 (19)	51 (27)	62 (25)
True pathogens	2 (4)	16 (9)	18 (7)
Contaminants	8 (14)	29 (16)	37 (15)
Polymicrobial (more than one organism cultured)	1 (2)	6 (3)	7 (3)
No growth	46 (81)	136 (73)	182 (75)

Of the 42 questionnaires handed out to eligible clinicians (clinicians who were working in the Department of Paediatrics at Pelonomi- and Universitas Hospitals during the study period who also collect blood culture specimens), 34 were completed, that is a response rate of 80%. Eighteen percent (6/34) of participants were consultants, 50% (17/34) registrars, 6% (2/34) medical officers and 26% (9/34) interns. Consent was obtained by means of a disclaimer letter, which stated that participation in study was anonymous and voluntary. Standards which were evaluated are illustrated in Figure 1.

Eighteen of the 34 (53%) of participants reported to use chlorhexidine for skin disinfectant; 16/34 (47%) reported to use alcohol swabs for skin disinfectant. Thirty of the participants (88%) reported that they used 1 - 2 mL of blood to inoculate blood culture bottles, 1/34 (3%) used < 1 mL of blood frequently and 3/34 (9%) used > 2 mL of blood frequently. Forty-three percent (13/30) of participants reported to always inoculate 1 - 2 mL of blood, 47% (14/30) frequently inoculated 1 – 2 mL of blood and 10% (3/30) inoculated 1 – 2 mL of blood sometimes. Twelve of the participants (35%) reported to repalpate a vein after disinfecting a patient's skin. Twenty-two participants (65%), reported to not repalpate a vein after disinfecting a patient's skin. When asked whether participants still observe aseptic technique when sampling blood cultures during an abnormally busy day; 22 (65%) reported yes and 12 (35%) no.

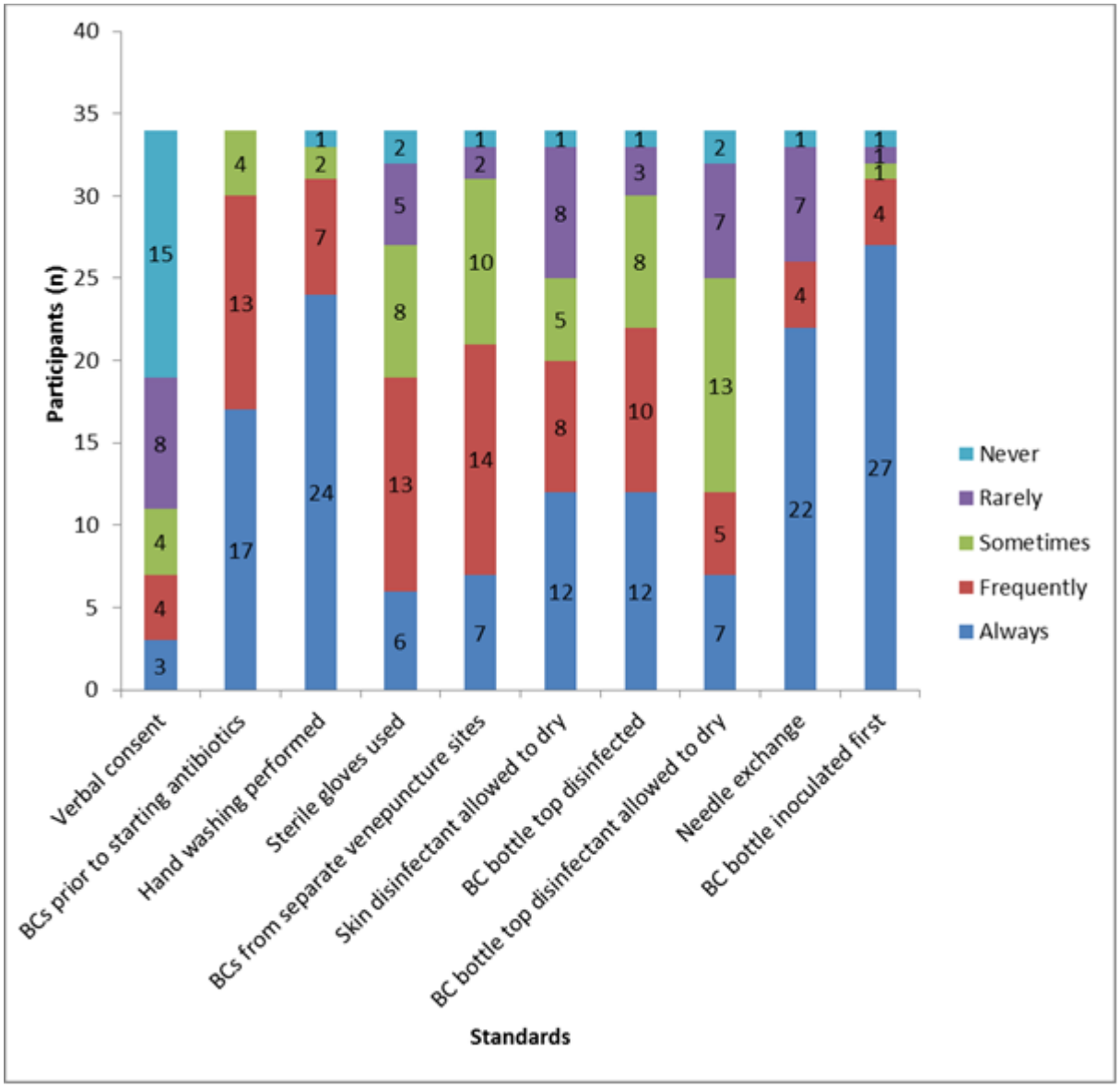

Figure 1. Standards evaluated and ranked by the clinician questionnaire

During days when there were delays in transporting blood cultures to the laboratory, 3 (9%) of the participants reported to not leave blood cultures at room temperature and 31 (91%) of participants reported to have left blood cultures at room temperature. All the blood cultures were submitted using a single blood culture bottle. Of the 34 participants, 8 (24%) had received a lecture on the importance of correct paediatric blood culture sampling whilst working in the Department of Paediatrics; four participants being registrars, one participant an intern and the other three participants, consultants. Eleven (32%) of the participants stated that they were aware of the SASCM guidelines on blood culture sampling technique, 23 (68%) were not aware of the SASCM guidelines. On overall analysis of questionnaires one (3%) of the participants responded to questions that suggest complete compliance with the 22 standards of the SASCM guidelines on blood culture sampling.

In this study it was noted that the highest blood culture contamination rate was in the age group > 28 days to < 24 months. When considering that 55% (135/244) of blood cultures were sampled in this age group, there seems to be a higher blood culture contamination rate of 20% (27/135) in this group of patients. Blood culture contamination rates at the different Paediatric Departments were: 14% (8/57) at Pelonomi Hospital and 15.5% (29/187) at Universitas Hospital.

DISCUSSION

An alarming finding from this study is the high blood culture contamination rate of 15%, almost three times the contamination rate at another hospital in the public health sector[7,13]. Internationally, accepted blood culture contamination rates are 3% or less[14]. Factors contributing to this contamination rate include poor compliance to blood culture sampling standards such as hand hygiene practices, inadequate skin and blood culture bottle top preparation, lack of use of sterile gloves and lack of sterile gloves (Figure 1)[7]. Adverse consequences related to a high blood culture contamination rate include (and are not limited by):

- increased hospitalisation time by one to five days;
- with an associated 20-39% increase in hospital fees;
- an 80% increase in microbiology laboratory charges; and
- a 40% increase in unnecessary antibiotic use with a resultant increase in antibiotic resistance, antibiotic associated side effects including allergic drug reactions[5,7,15]

It is thus clear that this blood culture contamination rate will have to be addressed so as not only to save money in a resource limited setting but also to optimise patient management. To quote Rana *et al*. (2019): "Blood culture contamination is a safety and quality concern in children's hospitals"[15].

In this study it was noted that the highest blood culture contamination rate was in the age group > 28 days to < 24 months. Seventy three percent (27/37) of contaminated blood cultures was noted to be in this age group. This might be due to the technical difficulty of sampling blood from a small child, a child who does not cooperate due to a lack of understanding and pain and other technical problems such as not having staff available to keep the patient in position whilst performing blood culture sampling. When considering

that 55% (135/244) of blood cultures were sampled in this age group, there seems to be a higher blood culture contamination rate of 20% (27/135) in this group of patients. To the author's best knowledge there is no South African data available regarding blood culture contamination in this age group.

Seven blood cultures cultured more than one organism (i.e. polymicrobial) and were excluded from the calculation involved when blood culture contamination rate was calculated. In a setting where the clinical information regarding a patient's condition is excluded from a study, it is almost impossible to differentiate between overt blood culture contamination and true polymicrobial septicaemia. Polymicrobial septicaemia most commonly occurs in patients who were admitted to hospital for at least 90 days, patients with malignancies, patients who previously had central venous lines and other immuno-compromised individuals[12]. In a systematic review done by Reddy *et al*. (2010) it was found that 1.2% of bloodstream infections in African countries were due to polymicrobial septicaemia.[9] In our institution this rate was found to be higher at 3%, this might be secondary to the high blood culture contamination rate, but this is purely speculation.

Coagulase negative staphylococci (CoNS) were classified as being pathogenic when they were isolated from two different blood cultures on the same patient. In 2% (6/244) of the blood cultures that were analysed CoNS were pathogenic and classified as contaminants in 13% (31/244) of the blood cultures. In all 6 cases where CoNS were pathogenic, patients were noted to be < 24 months of age. In a Western Cape district hospital, Abrahams *et al*. (2015) described that contamination rate due to CoNS was only 3%[7]. This difference might be due to hospital supplies difference between these two studies and or due to sampling practice differences.

The South African standards on blood culture sampling recommends using alcohol or povidone to disinfect the skin puncture site[16]. At the Pelonomi- and Universitas Hospitals, chlorhexidine with alcohol or alcohol swabs are readily available and thus used. A recent meta-analysis study confirmed that there is no significant difference between using chlorhexidine-alcohol and povidone iodine solutions for skin antisepsis. Using alcohol swabs for skin disinfection is not ideal practice, as each swab needs to be opened individually, with the outside surface of the wrapper not being sterile. Ombelet *et al*. (2019), describe a technique where alcohol swabs are used multiple times until dirt is removed from a patient's skin and then only applying a different antiseptic agent to venepuncture site[5]. Forty-seven

percent (16/34) of participants reported using alcohol swabs for skin antisepsis.

Although 88% of participants indicated that they use 1 - 2 mL of blood when inoculating blood cultures bottles, only 43% of this subgroup indicated to always use this blood volume, 47% frequently and 10% sometimes. In a quality improved initiative study done by Needham *et al*. (2019) it was noted that nursing staff routinely sample 1 – 3 mL of blood, irrespective of a patient's body weight. As conclusion as to why this specific volume of blood is used, it is stated that there was no optimized blood volume charts available in their setting[15]. This is also true for our centre. This possibly explains the different frequency at which clinicians sample different blood volumes for paediatric blood cultures. Multiple authors agree that by optimising the blood volume which is inoculated in blood culture bottles, one significantly improves the blood culture yield[4,10,15,17].

Roughly a third of participants were aware of the SASCM guidelines on blood culture sampling but only 3% of participants completed the questionnaires in a manner which indicated compliance with these guidelines.

The strengths of our study were that we attempted to evaluate blood culture sampling practices and not only the blood culture contamination rates. We differentiated between results which were contaminants and pathogens and lastly we identified errors in blood culture sampling practices.

The limitations of our study were that we did not evaluate the availability of equipment for performing blood cultures such as sterile gowns, sterile gloves, chlorhexidine-alcohol solution and sterile gauze. Furthermore; we did not evaluate the clinical indications for blood culture sampling, nor whether contaminant organisms were on clinical grounds treated as pathogens or not. Blood culture request forms were not audited. Sites from which blood cultures were sampled were not described. We did not evaluate the volume of blood inoculated in each blood culture bottle and lastly, timing of antibiotic administration and blood culture sampling was not assessed.

RECOMMENDATIONS

- Pictorial wall charts should be applied to procedure rooms in Paediatric Wards at Pelonomi- and Universitas Hospitals, indicating the correct blood culture sampling techniques.

- In the younger aged child, assistance with restraining a child whilst sampling blood culture specimen might aid in decreasing the blood culture contamination rate.
- Weight based blood culture volume charts should also be applied to walls of the procedure rooms in Paediatric Wards[15].
- Weekly antibiotic stewardship rounds to be used as an opportunity to educate clinicians on the best practice when sampling blood culture specimens could be done on every post-intake round.
- This study can be used as motivation for hospital management at the Pelonomi- and Universitas Hospitals to address possible shortages of consumable that are required when sampling a blood culture specimen.
- Quarterly refreshing of culture sampling guidelines/techniques for all clinicians working in Paediatric Departments of Pelonomi- and Universitas Hospitals.
- Pre-packed blood culture kits and procedural checklists to be used.
- Quarterly review of blood culture contamination rates at these institutions following implementation of these recommendations.
- Future studies to be done in these institutions to assess blood volume and blood culture yield.
- Future studies to be done in these institutions to assess indications for blood culture sampling.

CONCLUSION

In conclusion, our study found a blood culture contamination rate which is higher than an internationally accepted rate. It also demonstrated that clinicians were not aware of blood culture sampling guidelines and in the few cases where clinicians were aware of these guidelines, compliance with these guidelines were not met.

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APPENDIX A

UFS ETHICAL APPROVAL LETTER

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

06-Sep-2019

Dear **Dr Roelof Krause**

Ethics Clearance: **Blood culture contamination rate and sampling practices in the Department of Paediatrics of Universitas- and Pelonomi Hospitals.**

Principal Investigator: **Dr Roelof Krause**

Department: **Paediatrics and Child Health Department (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2019/0377/0110**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa

APPENDIX B

DEPT. OF HEALTH ETHICAL APPROVAL LETTER

health
Department of Health
FREE STATE PROVINCE

12 July 2019

Dr R Krause
Dept. of Paediatrics and Child Health
UFS

Dear Dr R Krause

Subject: A quality improvement initiative: reducing blood culture contamination in the Department of Paediatrics of Universitas- and Pelonomi Hospital.

- Please ensure that you read the whole document, Permission is hereby granted for the above – mentioned research on the following conditions:
- Participation in the study must be voluntary.
- A written consent by each participant must be obtained.
- Serious Adverse events to be reported to the Free State department of health and/ or termination of the study
- Ascertain that your data collection exercise neither interferes with the day to day running of the **Pelonomi and Universitas Hospital** nor the performance of duties by the respondents or health care workers.
- Confidentiality of information will be ensured and please do not obtain information regarding the identity of the participants.
- **Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).**
- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of Free State and to Free State Department of Health.
- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the Free State and to Free State Department of Health.
- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to** sebeelats@fshealth.gov.za / koekoeel@fshealth.gov.za **before you commence with the study**
- No financial liability will be placed on the Free State Department of Health
- **Please discuss your study with Institutions Managers on commencement for logistical arrangements see 2nd page for contact details.**
- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study
- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)
- You are encouraged to present your study findings/results at the Free State Provincial health research day

Trust you find the above in order.
Kind Regards

Dr D Motau
HEAD: HEALTH
Date: 11/07/19

Head : Health
PO Box 227, Bloemfotein, 9300
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health
Department of Health
FREE STATE PROVINCE

12 July 2019

Dr R Krause
Dept. of Paediatrics and Child Health
UFS

Dear Dr R Krause

Subject: A quality improvement initiative: Reducing blood culture contamination in the Department of Paediatrics of Universitas- and Pelonomi Hospital.

Please find below the contact details of CEO's for logistical arrangements.

Universitas Academic Hospital	
Name: Dr M Molokomme **Email**: molokommm@universitas.fs.gov.za **Tel**: 051 405 3557	**PA**: Me M Van Der Berg **Email**: vdbergsu@universitas.fs.gov.za
Pelonomi Hospital	
Name: Mrs. BS Ramodula **Email**: ramodulabs@fshealth.gov.za **Tel**: 051 405 3634	**PA**: Me C Ntlhokoa **Email**: ntlhokc@fshealth.gov.za

Trust you find the above in order.

Kind Regards

Head : Health
PO Box 227, Bloemfotein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfotein
Tel: (051) 408 1646 Fax: (051) 408 1556 e-mail:khusemj@fshealth.gov.za@fshealth.gov.za/chikobvup@fshealth.gov.za

APPENDIX C

APPROVAL TO ACCESS NATIONAL HEALTH LABORATORY SERVICE (NHLS) DATA

NATIONAL HEALTH LABORATORY SERVICE

Academic Affairs and Research
Modderfontein Road, Sandringham, 2031
Tel: +27 (0)11 386 6142
Fax: +27 (0)11 386 6296
Email: babatyi.kgokong@nhls.ac.za
Web: www.nhls.ac.za

21 November 2019

Applicant: Reolof Krause
Institution: University of Free State
Department: Paediatrics and Child Health Department
Email: rckrause6@gmail.com
Cell: 072 329 1632

Re: Approval to access National Health Laboratory Service (NHLS) Data

Your application to undertake a research project **"Blood culture contamination rate and sampling practices in the Department of Paediatrics of Universitas- and Pelonomi Hospitals"** using data from the NHLS database has been reviewed. This letter serves to advise that the application has been approved and the required data will be made available to you ***without patient names*** to conduct the proposed study as outlined in the submitted application. Submissions should be made annually on the AARMS system – https://aarms.nhls.ac.za.

Please note that approval is granted on your compliance with the NHLS conditions of service and that the study can only be undertaken provided that the following conditions have been met.

- Processes are discussed with the relevant NHLS departments (i.e. Information Management Unit and Operations Office) and are agreed upon.
- Confidentiality is maintained at participant and institutional level and there is no disclosure of personal information or confidential information as described by the NHLS policy.
- NHLS Data cannot be used to track patients as no pre-approval/consent is obtained from Patients.
- CDW form is to be completed for the request with clear indications of the data required.
- All data requested should be in accordance with the research protocol submitted and approved by the relevant Ethics Committee.
- Request for the inclusion of the NHLS as a source of data in the original protocol to be approved by Ethics as NHLS does not have a Human Research Ethics Committee.
- A final report of the research study and any published paper resulting from this study are submitted and addressed to the NHLS Academic Affairs and Research office and the NHLS has been acknowledged appropriately.

Please note that this letter constitutes approval by the NHLS Academic Affairs and Research Office. Any data related queries may be directed to NHLS Corporate Data Warehouse, contact number: 011 386 6074 email: zarina.sabat@nhls.ac.za

Dr Babatyi Malope-Kgokong
National Manager: Academic Affairs and Research

NATIONAL HEALTH LABORATORY SERVICE HELPDESK
Tel: (011) 386-6125/6/7/9 Fax: (011) 386-6308 email: helpdesk6@nhls.ac.za

ACCESS TO DATA FROM CDW FMI0069

Each application will be approved or rejected subject to the ability to extract this data and the availability of the data, and subject to the intended usage of the requested data. Applications that are incomplete and/or do not contain supporting documentation, will be rejected.

APPLICANT DETAILS			
Applicant's Name and Surname	RC Krause	**Telephone Number**	( )
Email Address	rckrause6@gmail.com	**Cell Phone Number**	072 329 1632
Business Role / Designation	Doctor Postgraduate student Registrar: Paediatrics	**Laboratory/ Department/ Branch / Region or External Organisation**	
Supervisor Name	DR S Simmons	**Telephone Number**	( )
Supervisor Designation	Paediatrician	**Email Address**	

TERMS AND CONDITIONS

- **Data / Information is not to be used in contravention of Sections 14, 15, 16 and 17 of the National Health Act 61 of 2004 and the Promotions of Access to Information Act 2 of 2000.**
- **The applicant undertakes to ensure that the data supplied to it by the NHLS is used ethically and solely for the purposes for which it is provided as detailed in this application, and further acknowledges that it shall remain liable for any breaches of this clause by the end user.**
- **If the purpose for the data requested in this application is for research, or if patient identity linked data is required, ethics approval and the full protocol must be attached to this application form. It is the responsibility of the applicant to ensure that their institutions' Human Ethics approval includes explicit authorisation to access the requested NHLS data.**
- **The applicant undertakes to store the NHLS data in a confidential manner by separating patient identifying details from laboratory data and storing the master list that links patient identifying details to study patient identifiers in a separate, secure location.**
- **The information is for the private use of the applicant only, unless further approval is obtained from the NHLS. In the event of this, the applicant shall give due credit, including affiliation, of the participation of the NHLS in any such publications or presentations.**
- **The applicant undertakes to provide the Manager: Academic Affairs and Research at the NHLS with a copy of any report, presentation or publication emanating from the use of this data, if for research purposes.**

ACCEPTANCE OF CONDITIONS			
By signing this document we accept the conditions as stated above.			
Applicant Signature	RC Krause	**Date**	11/10/2019
Supervisor Signature	pp. Dr Simmons	**Date**	11/10/2019

NATIONAL HEALTH LABORATORY SERVICE HELPDESK
Tel: (011) 386-6125/6/7/9 Fax: (011) 386-6308 email: helpdesk6@nhls.ac.za

ACCESS TO DATA FROM CDW FMI0069

Note: All fields in this section must be completed

DATA REQUEST DETAILS					
Request Type (Tick)	☒ New ☐ Modify (Provide previous request details)	**Data Format (Tick)**	☒ Excel ☐ CSV	**Data Delivery (Tick)**	☐ CD / DVD ☒ Email
Frequency of Extract (Tick)	☒ Once ☐ Repeat	**If Repeat, specify frequency (Tick)**	☐ Daily ☐ Weekly		☐ Monthly ☐ Annually

DESCRIPTION OF REQUIRED DATA EXTRACT	
Details of Data required	Blood culture results
Region (For data extract, e.g. Province, Laboratory or Facility etc)	Pelonomi Hospital: Ward 3A, 4A + 4B + PICU Universitas Hosp: Ward 10A, 10B, PICU + paediatric cardiology
Date range of extract (Period for which data is required)	1 May 2019 – 27 August 2019
Fields required (e.g. Patient name, Date of Birth, etc)	date of birth, organisms cleared, hospital number, time to positivity, time of sample collection and time upon arrival at NHLS

ADDITIONAL INFORMATION

DESCRIPTION OF INTENDED USE OF DATA EXTRACT (e.g. research, epidemiology study, cost analysis of service, drug effectiveness, disease surveillance
research

LIST WHO WILL HAVE ACCESS TO THIS DATA
DR RC Krause

PROJECT NAME AND REGISTRATION NUMBER (If data is required for a registered research project. Please attach the Ethics Approval and full Protocol.)
Blood culture contamination rate and sampling practices in the Department of Paediatrics of Universitas and Pelonomi Hospitals

NATIONAL HEALTH LABORATORY SERVICE HELPDESK
Tel: (011) 386-6125/6/7/9 Fax: (011) 386-6308 email: helpdesk6@nhls.ac.za

ACCESS TO DATA FROM CDW FMI0069

NHLS RESPONSIBILITIES
The NHLS will: • **Ascertain if it is possible to extract the required data.** • **Register the application and issue a registration number.** • **Only release the requested data to the applicant whose name is specified on this application form.**
After this application has been completed and approved, please raise a service request with the NHLS IT Service Desk (Contact Number: (011) 386-6125/6/7/9): • **Send an email to helpdesk6@nhls.ac.za,** • **Scan this application form and attach it to the email, or fax it to (011) 386-6308.**

FOR OFFICE USE					
APPROVAL BY RESEARCH OFFICE (Research data requests only)					
Check List	☐ Signed by Supervisor ☐ Ethics Approval attached ☐ Research Protocol attached				
Executive **Manager: Academic Affairs and Research & Quality Assurance**	PROF K.P MLISANA	**Signature**		**Date**	29/11/2019
CEO APPROVAL (Only for non-research data requests requiring sensitive data)					
Chief Executive Officer	Dr K. Chetty	**Signature**	KChetty	**Date**	2/12/20 19
CDW APPROVAL					
CDW Manager		**Signature**		**Date**	/ /20

APPROVED

Name: Dr Babatyi Malope-Kgokong

National Manager: Academic Affairs and Research

Date: 29/11/19 Sign: .....

PROTOCOL OF STUDY APPROVAL

DEPARTMENT: **Paediatrics and Child Health**

This is to certify that the Departmental Evaluation Committee approved of the following MMed research protocol:

CANDIDATE: **Dr RC Krause**

SUPERVISOR: **Dr S Simmons**

DATE OF THE MEETING: **1 March 2019**

TITLE OF THE RESEARCH PROJECT:

A quality improvement initiative: reducing blood culture contamination in the Department of Paediatrics of Universitas and Pelonomi Hospitals.

RESEARCH CHAMPION — DATE: 5/03/2019

SUPERVISOR — DATE: 06/03/2019

HEAD OF THE DEPARTMENT — DATE: 5/3/2019

A quality improvement initiative: reducing blood culture contamination in the Department of Paediatrics of Universitas- and Pelonomi Hospitals

Protocol for a mini-dissertation submitted in fulfilment of the requirements for the degree Master of Medicine in Paediatrics

Department of Paediatrics and Child Health
Faculty of Health Sciences at the University of the Free State

CANDIDATE

Dr RC Krause
Registrar: Department of Paediatrics and Child Health Faculty of Health Sciences
University of the Free State Student number: 2008005989

STUDY LEADER

Dr S Simmons
Consultant: Department of Paediatrics and Child Health Faculty of Health Sciences
University of the Free State

Table of contents

1. INTRODUCTION TO PROTOCOL

In both industrialised and developing countries, severe sepsis and septic shock is one of the most important risk factors for mortality in children. In this research project, the researcher will determine the contamination rate of blood cultures done in the Department of Paediatrics at Pelonomi- and Universitas Hospitals during May and July 2019 and compare it to the international accepted contamination ratio. The study will then also attempt to explain factors contributing to the contamination rate.

Clinician related factors which contribute to blood culture contamination will be identified by means of anonymous questionnaires which will be circulated to all the clinicians working in the Department of Paediatrics of Pelonomi- and Universitas Hospital during a monthly morbidity and mortality meeting in June 2019.

Problems which are identified will then be corrected by means of physician education during June 2019 at weekly academic meetings. To see if this intervention improved the blood culture contamination rate, the blood culture contamination rate for July 2019 will be determined.

There is a significant shortage of studies addressing the problem of blood culture contamination rates in South African literature. This study will contribute to South African literature regarding blood culture contamination rates.

2. BACKGROUND TO THE RESEARCH PROBLEM

2.1 DEFINITIONS

2.1.1 Systemic inflammatory response syndrome (SIRS)

SIRS is a non-specific process that occurs in response to an infection or other injury. To diagnose SIRS, at least two of the following should be present (one of which must be an abnormal temperature or leucocyte count):

- Core temperature of >38.5 ˚C or <36˚C
- Tachycardia – heart rate of > 2SD above the normal for age or bradycardia
- Respiratory rate >2SD above the normal for age
- White cell count elevated or depressed for age.[1][2]

2.1.2 Sepsis

The Third International Consensus Definitions for Sepsis is defined as a dysregulated host response (such as SIRS) to infection followed by life threatening organ dysfunction.[3] Sepsis is a medical emergency which requires immediate and appropriate medical attention.[4][5]

2.1.3 Blood culture

A specimen of blood inoculated in a growth medium with the purpose of growing pathogenic bacteria and or fungi to identify causative organisms of infection and its sensitivity profile to antibiotics.[2]

2.1.4 Contaminants

In blood cultures a contaminant can be defined as an organism which is not present in the patient's bloodstream, but is grown in the culture.[6] In certain clinical scenarios, organisms which are classified as contaminants can cause sepsis.

2.1.5 Pre-analytical factors

With regards to blood cultures, pre-analytical factors are factors which influence the result of a blood culture prior to the specimen arriving at the laboratory. These include: volume of blood inoculated in specimen medium, site of blood collection, skin preparation, elapsed time from specimen being taken until arrival at laboratory and clinician knowledge regarding correct blood culture sampling technique.[7]

2.1.6 Department of Paediatrics at Pelonomi and Universitas Hospitals

The Department encompasses the following units and wards:

- At Pelonomi Hospital: Paediatric Intensive Care Unit Wards 3A, 4A and 4B
- At Universitas Hospital: Paediatric Intensive Care Unit Paediatric Cardiology Suite Ward 10A and 10B

2.2 LITERATURE REVIEW

In both industrialised and developing countries, severe sepsis and septic shock is one of the most important risk factors for mortality in children.[8] Statistics South Africa confirms that the global trend is also relevant to South Africa with an estimated 20% of child deaths attributable to sepsis during the 2013 to 2015 period.[9] Despite the fact that one in five children in South Africa demise due to sepsis, data on the causative organisms and prevalence of sepsis in children in South Africa are scarce.[10][11]

To guide the recognition of sepsis in children; consensus definitions have been published.[1] Sepsis can be defined as a systemic inflammatory response syndrome (SIRS) in the presence of or resulting from a suspected or proven infection. The Third International Consensus Definitions for Sepsis is defined as a dysregulated host response (such as SIRS) to infection followed by life threatening organ dysfunction.[3] Sepsis is considered to be severe when it is associated with organ hypo-perfusion or dysfunction characterised by one or more of the following:

- prolonged capillary refill time,
- increased lactate,
- oliguria or acute kidney injury,
- altered mental state,
- acute respiratory distress syndrome,
- disseminated intravascular coagulation
- and or hypotension.[1]

Sepsis is a medical emergency which requires immediate and appropriate medical attention.[4][5]

In attempt to improve the mortality rate of patients who are diagnosed with sepsis an international expert panel was assembled in 2004: the Surviving Sepsis Campaign (SSC). In the latest guidelines (2016) for the management of sepsis, SSC recommends that it is best practice to do blood cultures prior to administration of antibiotics, to optimise

identification of infective organisms. However, SSC also states that antibiotic therapy should not be delayed whilst waiting for a blood culture to be done.[4][5] This is important to take note of as district hospitals in the Free State are not equipped with blood culture facilities. At these hospitals; prior to referral, antibiotics are administered to patients diagnosed with sepsis. This influences the true results of blood cultures collected at receiving hospitals.

Blood cultures remain the mainstay of identification of causative organisms of sepsis as well as the organism's sensitivity profile to certain antibiotics.[12][13] Blood culture results guide physicians to use appropriate antibiotics and to de-escalate from broad spectrum antibiotics to specific antibiotic therapy which forms the cornerstone of antibiotic stewardship.[14] Blood cultures remain essential in high quality management of sepsis.[5] Patient survival during sepsis depends on prompt initiation of appropriate antibiotics.

The shortcoming of blood cultures is that only 5 to 13% of cultures will turn out to be positive and roughly 20 to 56% of these will represent contaminants.[7] Organisms generally accepted as contaminants include: coagulase negative staphylococci, Corynebacterium species, Bacillus species, Clostridium perfringens, micrococcus species and Viridans streptococci.[6][14] The College of American Pathologists defines a contaminant as the presence of aforementioned organisms in only one of a series of blood culture specimens.[15] Contaminant organisms are most often cultured when sterility during sample collection is jeopardised. It may happen that organisms which are classified as contaminants sometimes cause infections. Contaminants are suspected to be causative of sepsis when:

- two different blood culture samples culture the same contaminant organism
- a patient deteriorates and persistently cultures the same organism
- certain diagnoses are made such as infective endocarditis or
- in clinically deteriorating premature infants where contaminant organisms commonly are causative organisms of sepsis.[3][16]

In clinical practice, to differentiate whether a contaminant organism is truly the causative organism of sepsis remains difficult. Most often the help of medical microbiologists are required to assist clinicians in making the right decisions regarding antibiotic treatment of contaminant organisms.

Difficulty in distinguishing between contaminants and true bacteraemia leads to increased admissions of patients who could have been managed as outpatients, increased length of stay in hospital, unnecessary additional laboratory testing and inappropriate antibiotic exposure which may cause the emergence of drug resistant organisms.[15][16]

Studies done in paediatrics reveal factors that can contribute to an increase in false blood culture results such as:

- Syndromic case management with ceftriaxone at primary care level. In South Africa all children who are identified with danger signs at primary level clinics receive empiric ceftriaxone.
- The diminutive size of paediatric patients. Suboptimal blood volumes are collected. There are currently no consensus guidelines on the volume of blood that needs to be inoculated in blood culture bottles in paediatric patients.
- Poor compliance with hand hygiene practices.
- Lack of use of sterile gloves.
- Inadequate patient skin preparation by the physician who is collecting the sample.
- Inadequate preparation of blood culture bottle-top with antiseptics.
- Collection of only one blood culture specimen due to financial restraints.

- General lack of knowledge amongst physicians regarding the importance of correct blood culture collection and the diagnostic as well as therapeutic implications of blood culture results.
- Lack of standardised policy with regards to when and how to collect blood cultures.
- Overcrowding of a unit, i.e. too many patients admitted to a specific ward and increased patient to doctor ratio.[2][11][12][14][15][16][17][18]

Baron *et al*. (2013) state that the interpretation of specimens submitted to microbiology for analysis depends entirely on the quality of the specimen that is submitted. Specific emphasis is made that the quality of the blood culture specimen is influenced by the specimen management. Optimal blood culture specimen management can be described in terms of so called pre-analytical factors; that is: volume of blood collected, timing of sample collection, sampling site, skin preparation and knowledge of the correct technique of blood culture sampling.[19][13][20][16]

It is also clear from literature that improvement in specifically blood culture specimen quality will greatly improve patient outcome with sepsis in terms of patient survival, hospital infection control, antibiotic stewardship, patient length of stay, hospital costs, laboratory costs and laboratory efficiency.[19][10][12][20][16][17]

The South African Society for Clinical Microbiology (SASCM) endorses blood culture sampling technique as described by Ntusi *et al*. (2010). This guideline aims to: improve the quality of blood culture sampling, reduce the contamination of blood samples collected and thus improve the management and ultimately outcome of patients with sepsis.[2] Unfortunately, in a study done by Abrahams *et al*. (2015) it was found that there was poor adherence to these standards and that this possibly could explain a higher than acceptable contamination rate in blood cultures done in their study.[14] Contamination rate of blood cultures is obtained from the following equation: (contaminated blood cultures divided by the total amount of cultures done within the same period) X100 and is reported as a percentage.[16] Internationally accepted rates of blood culture contamination are 3%.[20]

A recent study done by Needham *et al*. (2018) states that by reducing the contamination rate of blood cultures at their facility from 2.85% to 1.54% saved the hospital on average $49 998 per month (roughly R750 000). They achieved this reduction in blood culture contamination rate by the following interventions:

- Standardising blood culture sampling by means of a protocol for all paediatric and neonatal wards, paediatric intensive care units and neonatal intensive care units
- Optimising blood volume collection by proposing a weight-based blood volume chart (Addendum A). It should be mentioned that optimising blood volume inoculated in the blood culture bottle, directly correlates with an increase of detection rate.[12]
- Education of staff with regards to the importance of blood culture results and confidentially providing feedback to members of staff regarding contamination of blood cultures.

This study confirmed that it is possible to decrease the blood culture contamination rate, and thereby patient morbidity and hospital costs, by enforcing simple measures which are less expensive than phlebotomy teams or ready to use blood culture kits.[16]

Selek *et al*. (2014) concluded that every laboratory should conduct a yearly determination of blood culture contamination rate. Should this rate be more than 3% measures should be taken to identify and correct the underlying problem as patient safety might be compromised.

To the candidate's knowledge, there are no studies previously done at Paediatric Departments of Pelonomi- and Universitas Hospitals with regards to identifying the blood culture contamination rate.

3. PROBLEM STATEMENT

Sepsis is a major cause of morbidity and mortality in South African paediatrics. The cornerstone of sepsis management remains identification of the causative organism and appropriate antibiotic therapy. Blood cultures are currently still the gold standard by which causative organisms and their sensitivity profile can be identified. However, blood culture sampling is often left to be done by less experienced clinicians or done in suboptimal circumstances (such as not using sterile gloves).

4. STUDY QUESTIONS

- What is the blood culture contamination rate at the Department of Paediatrics at Pelonomi- and Universitas Hospitals for the months of May – and July 2019?
- What are the blood culture sampling practices in the Department of Paediatrics at Pelonomi- and Universitas Hospitals?

5. AIM OF STUDY

- To assess the blood culture contamination rate at the Department of Paediatrics at Pelonomi- and Universitas Hospital for the months of May and June 2019.
- To determine the practices of blood culture sampling amongst clinicians in the Department of Paediatrics in June 2019 by means of anonymous questionnaires.

6. STUDY OBJECTIVES

- To determine the blood culture contamination rate in the Department of Paediatrics at Pelonomi- and Universitas Hospital for the months of May and June 2019 by means of the NHLS database.
- To describe blood culture sampling practices amongst clinicians by means of analysing anonymous questionnaires.
- To give feedback to the Department of Paediatrics at Pelonomi- and Universitas Hospitals regarding clinician practice of blood culture sampling.

7. METHODOLOGY

7.1 Study design

This study will be designed as a descriptive study. Blood culture contamination rates for May and June 2019 will be determined by means of NHLS data. Clinician blood culture

sampling practices will be described by means of questionnaires.

7.2 Study population

The study population will include the following:

- All the clinicians (interns, medical officers, registrars and consultants) working in the Department of Paediatrics of Pelonomi and Universitas Hospitals during May 2019 to August 2019. Currently the department has roughly 70 employed clinicians. Clinicians will be recruited during a compulsory weekly Departmental Meeting. During this meeting the researcher will hand out a questionnaire to all the clinicians present. After the meeting, questionnaires will be dropped off in a box. Data collected from questionnaires will be used to describe blood culture sampling practices amongst clinicians.
- Admission blood culture results performed in the Department of Paediatrics of Pelonomi and Universitas Hospitals during the months of May 2019 to August 2019 as obtained from the NHLS. This will allow the researcher to calculate the blood culture contamination rate for the months 1 May 2019 to 27 August 2019.

7.3 Sampling

No sampling will be used for the questionnaires as all the clinicians working in the Department of Paediatrics will be included. Data regarding the blood culture sampling practices will be obtained from anonymous questionnaires. Estimated 70 questionnaires will be printed.

Data regarding admission blood cultures done during May 2019 to August 2019 at the Department of Paediatrics of Pelonomi-and Universitas Hospitals will be obtained from the National Health Laboratory Services (NHLS) database. Estimated 300 blood culture results will be received.

7.4 Measurement

All the admission blood cultures that are collected in the Department of Paediatrics at Pelonomi- and Universitas Hospitals for May to August 2019 will be analysed. The NHLS database will be used to supply all the blood culture results which were performed during this period. This will allow the researcher to determine the blood culture contamination rates for 1 May to 27 August 2019.

During these four months (1 May – 27 August 2019), once final approval has been received; questionnaires will be handed out to all the clinicians working in the Department of Paediatrics during the months of May to August 2019. These questionnaires will be handed out during a weekly Departmental meeting. The researcher will explain to clinicians how to correctly complete the questionnaires, reassure them that it is a voluntary and anonymous questionnaire. Time will be set apart during two of these meetings to complete a questionnaire. Completed questionnaires will be dropped off by clinicians in a box, so as to aid in anonymity. Analysis of completed questionnaires will aid the researcher in describing blood culture collection practices at the Department of Paediatrics of Pelonomi- and Universitas Hospitals.

It is important to note that intern medical officers rotate on a four monthly basis through

the Department of Paediatrics; hence the specific timespan of this study. A new group of intern medical officers will start working in the Department of Paediatrics on 30 April 2019 and finish their paediatrics rotation on 27 August 2019.

7.5 Errors in methodology

Questionnaires that will be circulated to clinicians might not be completed thoroughly or honestly. In attempt to minimise this error in data collection, instructions on how to complete the questionnaire will be attached to the questionnaire handed out and a pilot study done.

Not all the clinicians will be able to attend lectures.

Data from the questionnaires will only be used to assess blood culture practices during the study period in the study population. The goal of these questionnaires is to get an idea of the practices of blood culture sampling in the study population. Data from these questionnaires will be used to identify problem areas during the blood culture sampling procedure. Data from the questionnaires cannot be used to explain individual blood culture contaminants as this is not the study objectives.

During this study period intern doctors will rotate from Neonatal Unit to Paediatrics and vice versa. This will mean that not all the doctors who collected blood cultures in May 2019 will be the same doctors who collect blood culture samples in July 2019. However all of the doctors, irrespective of this rotation will be able to complete the questionnaires during a weekly Departmental Meeting, once final approval has been received.

7.6 Exclusion criteria

All blood cultures that were not performed upon admission of patients with sepsis will be excluded. This is to prevent bias. It can happen that once a patient has a positive blood culture that following cultures can remain positive for a prolonged period of time. Should this be included in the study it will skew the results so as to decrease the true contamination rate.

All cultures than on patients less than 30 days of age will be excluded as neonates can have sepsis due to organisms that are otherwise classified as contaminants.

7.7 Pilot study

Two clinicians in the Department of Paediatrics of Pelonomi and Universitas Hospital will be identified and asked to complete a questionnaire (cf. Addendum B). After completing the questionnaire, feedback will be obtained from them and questionnaire adjusted accordingly. Should no adjustments be made, these two questionnaires will be included in the study population.

7.8 Data analysis

Descriptive statistics namely means and standard deviations or medians and percentiles will be calculated for continuous data. Frequencies and percentages will be calculated for categorical data. The analysis will be done by the Department of Biostatistics.

7.9 Implementation of findings

Once this study is completed and an article written; feedback of findings will be given via a presentation to the Department of Paediatrics at Pelonomi- and Universitas Hospitals as well as the Department of Health of the Free State. Guidelines regarding blood culture sampling will be suggested. This study will also aim to be published in a peer review journal.

7.10 Budget

Printing of questionnaires, protocol and article	R250
Preparation for tutorials (whiteboard markers)	R50
Transport costs	R200
Total	**R500**

8. ETHICS

Prior to data sampling and pilot study; the following procedure will be followed:

- The study protocol will be submitted to the Health Sciences Research Ethics Committee (HSREC) at the Medical Faculty of the University of the Free State for review and approval.
- Consent will be obtained from the Department of Health in the Free State and the National Health Laboratory Services (NHLS).

Whilst the study is underway; data will be managed as follows:

- NHLS data and patient records will be managed with confidentiality. Patient records will not leave Pelonomi- or Universitas Hospital grounds.
- Data will be saved on the researcher's personal computer (which is password protected) and only be shared with the Department of Biostatistics at the University of the Free State.
- Questionnaires will be completed anonymously and by self-determination.
- Completed questionnaires will be placed in a box by the participants.

9. TIME SCHEDULE

Submission for HSREC approval	March 2019
Approval from NHLS and Free State Department of Health	July 2019
Pilot study	July 2019
Questionnaires to all doctors in the Department of Paediatrics	June/July/August 2019
Data collection: blood culture results	End of August 2019
Data analysis, writing of article and feedback	November 2019

10. Addendums

ADDENDUM A

PROPOSED BLOOD VOLUME CHART REVEALING THE OPTIMAL VOLUME RECOMMENDED BASED ON PATIENT'S WEIGHT

Recommended Blood Culture Volume by Wt (per Blood Culture Set Collected)					
Wt Range, kg	**Wt Range, lb**	**BD Bactec Peds Plus Blood Volume, mL**	**BD Bactec Plus Aerobic Blood Volume, mL**	**BD Bactect Plus Anaerobic Blood Volume, mL**	**Total Volume to Be Drawn, mL**
<5	<11	1[a]	N/A	N/A	1
5–10	11–22	2[a]	N/A	N/A	2
10.1–20	22.1–44	3[a]	N/A	3[b]	6
20.1–40	44.1–88	N/A	5[c]	5[b]	10
>40	>88	N/A	10[c]	10[b]	20

Table extracted from Needham *et al.* (2018)[16]

ADDENDUM B

GUIDELINES FOR COLLECTING BLOOD CULTURE SPECIMENS AS PER SASCM STANDARDS[14]

1. Blood cultures (BC) should be collected if there is a clinical suspicion of a blood stream infection.
2. Informed consent should be obtained prior to performing a BC.
3. BCs should be obtained prior to administration of antibiotics.
4. Hand washing should be performed prior to performing a BC.
5. Hands should be disinfected prior to performing a BC.
6. Sterile gloves should be used when performing a BC.
7. BCs should be drawn from peripheral sites.
8. BCs should be collected from separate venepuncture sites.
9. Puncture site should be sterilised using appropriate disinfectant.
10. Skin disinfectant should be allowed time to dry before inserting the needle.
11. BC bottle tops should be disinfected prior to inoculation.
12. Bottle-top disinfectant should be allowed time to dry prior to inoculation.
13. Needles should not be exchanged between BC collection and inoculation of BC bottles.
14. BC should be inoculated first, if blood is collected for other tests.
15. Minimum of two BCs should be drawn within 24 hours.
16. Aerobic BC bottles should be used in a resource-limited area.
17. Minimum of 20 mL of blood should be obtained for each BC. *(Please note: this is of relevance to adult medicine.)*
18. BC should be correctly labelled.
19. Laboratory request form should include patient identifiers, site, date and time of collection, clinical information regarding suspected diagnosis, and contact details of requesting doctors.
20. BC should be documented in the clinical notes.
21. BC bottles should be left at room temperature if there is a delay in transporting them to the laboratory.
22. BC bottles should be delivered to the laboratory as soon as possible. Number 1 to 22 is extracted from Abrahams *et al*. (2015). (14)

ADDENDUM C

QUESTIONNAIRE

Cover letter and questionnaire will be stapled into one document.

Dear Colleague,

Blood cultures form an integral part of sepsis management and antibiotic stewardship. Research done by Abrahams *et al*. (2015) confirmed that there is poor compliance with blood culture specimen collection standards which negatively impact blood culture results.[14]

In attempt to improve management of paediatric patients with sepsis at Pelonomi- and Universitas Hospitals, I have designed a research study to assess the technique in which blood cultures are collected from paediatric patients.

By completing a questionnaire; you are consenting that it was done out of free will and also aiding me with data collection.

The questionnaire is anonymous; please give an honest answer by giving one answer per question. This study has been approved by the University of the Free State's Health Sciences Research Ethics Committee (HSREC). Please note that these results might also be published in an academic journal.

Kind regards,

Dr RC Krause
072 329 1632

Dear Colleague,

Thank you for taking time to complete a questionnaire. For this study to be a true reflection of what happens in clinical practice, kindly adhere to the following:

- Honestly Indicate the most correct answer (as applicable to your clinical practice) with a cross (X).
- Mark only one answer per question.
- Complete the entire questionnaire**.**

Should any question be unclear: raise your hand and I will explain the question.

Regards,
Dr Krause.

1. **Please indicate your gender (for demographic use only):**

Male	Female

2. **At which level you are currently employed:**

Intern	Medical officer	Registrar	Consultant

3. **Are you aware of the South African Society for Clinical Microbiology guidelines for blood culture specimen collection?**

Yes	No

4. **Since starting working in the Department of Paediatrics, have you ever had a lecture about the importance of blood cultures?**

Yes	No

5. **Since starting working in the Department of Paediatrics, have you ever had a lecture about the correct collection technique of blood cultures?**

Yes	No

6. **How often do you obtain informed consent prior to collecting blood culture specimen?**

Always	Frequently	Sometimes	Rarely	Never

7. **Do you collect blood culture specimen prior to antibiotic administration?**

Always	Frequently	Sometimes	Rarely	Never

8. **Do you wash your hands prior to blood culture sample collection?**

Always	Frequently	Sometimes	Rarely	Never

9. **How often do you wear sterile gloves when performing a blood culture?**

Always	Frequently	Sometimes	Rarely	Never

10. **How often do you collect a blood culture specimen from a separate venepuncture site, i.e. a site other than a newly inserted drip site?**

Always	Frequently	Sometimes	Rarely	Never

11. **When you have inserted a new drip, how often do you collect a blood culture sample from the drip?**

Always	Frequently	Sometimes	Rarely	Never

12. **How often do you allow time for skin disinfectant to dry prior to inserting the needle?**

Always	Frequently	Sometimes	Rarely	Never

13. **How often do you disinfect blood culture specimen bottle top prior to collection?**

Always	Frequently	Sometimes	Rarely	Never

14. **How often do you allow time for blood culture specimen bottle top to dry prior to inoculation?**

Always	Frequently	Sometimes	Rarely	Never

15. **How often do you change needles between specimen sampling and inoculation of blood culture bottle?**

Always	Frequently	Sometimes	Rarely	Never

16. **When sampling blood for other tests as well as a blood culture, do you inoculate blood culture bottle first?**

Always	Frequently	Sometimes	Rarely	Never

17. **When there is a delay in blood culture transport to laboratory, do you leave blood culture bottle at room temperature?**

Yes	No

18. **Generally, what volume of blood do you inoculate into paediatric blood culture bottles?**

<1 mL	1-2mL	>2mL	Uncertain

19. **Referring to question 18, how often do you inoculate this volume?**

Always	Frequently	Sometimes	Rarely	Never

20. **Generally, what antiseptic do you use when cleaning the venepuncture site?**

Chlorhexidine with alcohol	Povidone tincture	Alcohol swabs	Iodine	Uncertain

21. **When a patient presents with a clinically diagnosable focus of infection and is being admitted to hospital, is it necessary to do a blood culture?**

Yes	No

22. **On a day that is busier than normal; do you still observe aseptic technique whilst collecting a blood culture?**

Yes	No

23. **After disinfecting a patient's skin, do you repalpate the vein?**

Yes	No

24. **With specific reference to uncooperative patients, do you ask for assistance to aid in restraining the patient whilst collecting a blood culture sample?**

Yes	No

25. **Please name 4 factors that is required to improve the true yield of blood cultures and to reduce the risk of contamination.**

ADDENDUM D

DATA SHEET

Identifier	Name of organism cultured	Organism cultured		
		Yes	Contaminant Yes (Y) or No (N) determined by clinical notes	No growth
Totals:				

Identifier: Episode number as per NHLS data. BC: Blood culture.

Indication: Reason for blood culture being requested indicated on NHLS requisition form.

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