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Update Review to Reduce Blood Culture Contamination

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THE incidence and mortality rate of sepsis is increasing worldwide. Rapid and accurate detection of bacteremia and fungemia is essential to improve the patient's condition. Health care providers, nurses, and possibly many laboratory staff are usually not well trained in proper blood culture techniques.

The present guideline addresses the clinical importance of blood culture, its applications, and the correct technique for detecting pathogenic microorganisms that cause sepsis, and attempts to explain the place of blood culture in the management of sepsis and the appropriate method for obtaining a blood sample for culture. Describe false positives to reduce.

Detection of bacteremia or fungi by blood culture is very important and vital in the management of patients with infection and can lead to the selection of appropriate antibiotics. Blood cultures (BCs) are important routine tests that are conducted in the clinical microbiology laboratory. Unfortunately, the common rate of BCs contamination is high which led to many clinical and economic consequences. The phlebotomy teams of blood sampling are very important to effectively reduce BCs contamination rate. Therefore, we conducted the current study to update our knowledge about the phlebotomy performances.

Keywords: Sepsis, Phlebotomy, Blood culture, Contamination.

Introduction

Blood cultures (BCs) are important diagnostic tests by providing valuable information about microorganisms causing bloodstream infections (BSIs) [1, 2]. However, BCs are commonly contaminated by commensal microorganisms [3]. Subsequently, contaminated BCs not only led to increased unnecessary laboratory workflow, they resulted in a physician's misdiagnosis, prolongation of hospital-stay, costs and also antibiotic consumption [3-5]. Although the Clinical and Laboratory Standards Institute (CLSI) recommended the overall BC contamination rate must be less than 3%, most clinical settings unfortunately cannot meet the current threshold [6]. So, Surdulescu et al., showed that blood samples drawn by the professional phlebotomy team (with 2.6% contamination rate) had a lower contamination rate in comparison to those drawn by non-phlebotomists (with 5.6% contamination rate) [7]. Therefore, we planned current review to describe several important performances to decrease contamination rate in BCs by emphasizing on the phlebotomy stage.

Multidisciplinary change phlebotomy team

An important note to achieve continued success in a planned program to reduce BCs contamination is the development of a multidisciplinary change team with an executive leader. The leader must be an instructor with enough knowledge about

the clinical setting and related technical details, the ability to motivate and support the team, understand processes, etc. [8].

Education of phlebotomy team

Education is a simple and effective solution to reduce BCs contamination [9]. Moreover, surveillance and feedback when combined with education is more effective than education alone. Halstead et al. [10] reported that although different intervention options are necessary to reduce BC contamination rate, a successful program is achieved by continuous education and feedback [8]. The education course follow by feedback conducted by Thong et al., led to reduce the rate of BCs contamination from 7% to less than 3% after the education [11].

Use of a defined protocol

If a single standard protocol for all blood sampling teams is determined, BCs contamination rate would be effectively reduced [9]. Doronjski *et al.*, reported that performances according to specific checklists have better outcomes [12].

Wearing sterile gloves

Kim et al. (2011) reported that an approximate 50% reduction in rate of BC contamination due to the routine use of sterile gloves. However, some BC contamination reported by use of non-sterile gloves that cause BC contamination through *Bacillus* species [4].

Hand hygiene

Hand hygiene compliance may also impact on BCs contamination (BCC) rate. Chraiti et al. (2013) studied the association between this action and BCs contamination. Their results showed a significant association between hand hygiene and BCs contamination in the intensive care unit (ICU) [13].

Sampling Site

It is preferable to blood collection from venipuncture rather than intravascular catheters (ICs), unless these devices are the source of infection [10, 14]. However, health care staff unfortunately often tends to sample from intravenous catheters. The contamination rate of BCs created from venipuncture samples have been significantly lower than the intravenous catheter BCs [9].

Disinfection of sampling site: The main cause of BCs contamination is normal skin flora from non-aseptic collection sites [15]. Guidelines recommend from the use of 2% alcoholic chlorhexidine and 70% isopropyl alcohol. The duration of cleaning and drying time is important, but this process commonly is insufficient [16]. Also, to reduce commensal microorganism load, the back-and-forth friction method of the area prior to blood drawing is more beneficial than the concentric method [17].

Disinfection of BC bottle top

Interestingly, some staff believed that the top of the BC bottle is sterile. For disinfection of the BC bottle top commonly used from 2% chlorhexidine in 70% isopropyl alcohol or 70% isopropyl alcohol alone. The structure of the BC bottle top is rubber, thus, we never use iodine alone, because it leads to erosion of rubber and subsequently contamination of BCs [10, 18].

Blood samples inoculation into culture bottles

There is not a unit protocol, and practices between staff members are commonly varied [16]. Although recommended needles should never recap, some staff routinely changes needles before blood inoculation to bottles. The results of Leisure and et al. (1990) study demonstrated that change needles are not necessary during BCs and the difference between these situations is not statistically significant. In addition, needle change has been discouraged due to the risk of needle-stick injury and infection by the blood-borne pathogens *e.g.* HIV [19].

Optimize sample volume in culture bottles

The volume of blood collected from patients is an important factor to diagnose pathogens. The initial sampling volume has been determined by the American Society for Microbiology (ASM) and also the Infectious Diseases Society of America (IDSA) for different patients [20]. The blood volume that must be inoculated into BCs bottles is determined by the manufacturer's instruction, and commonly recommends about 10 ml or less [21]. Notably, very low blood volumes inoculation may be led to BC contamination through (I) higher concentrations of contaminant organism in comparison to adequate-blood-volume inoculation; (II) low blood samples commonly related to cases who have poor peripheral venous accessibility which led to a decreased ability to maintain a sterile site during their blood draw [22]. In addition, the role of overfilled BC bottles in BC contamination is under discussion [23].

Sterile Kits (SKs)

Each sterile kit often includes different sterile devices for blood sampling such as gloves,

antisepsis solution, syringe, a fenestrated drape, and butterfly needle. Notably, use of sterile kit technique significantly led to a reduced rate of BC contamination as well as costs in comparison to usual methods [24].

Initial specimen diversion device (ISDD)

The ISDD device significantly reduces BCs contamination by excluding contaminants from the first portion of blood samples [25, 26]. Because, most BCs are contaminated by skin commensal organisms during blood sampling, first 1.5–2 mL of the initial culture specimens commonly consists of commensal organisms. The function of ISDDs is to divert initial blood volume and the rest of the sample directly inoculated into BCs bottles. Use of the ISDDs was associated with significant decreases in BCs contamination (27). For instance, Binkhamis and Forward (2014) reported 30.34% reduction in BC contaminants by use of ISDD [28].

Blood Culture App (BCA)

This device firstly developed in touch phones for different purposes such as monitoring of phlebotomist staff and process of blood sampling *e.g.* sampling site, sampling volume, time of sampling and also samplers' names. The BCA could increase users' safety and improve BCs

quality. For instance, BCA facilitated monitoring and surveillance of BC process, possibility of appropriate feedback and reeducate staff with relatively frequent errors [29].

Central venous catheter disinfection caps (CVCDCs)

The CDC currently recommended to disinfection of the central venous catheter (CVC) with an approved antiseptic such as 70% alcohol, chlorhexidine, iodophor, povidone and iodine. In addition, the routine use of CVC disinfection caps is recommended as an efficacy intervention for the catheter care and also reducing BCs contamination [30].

Workload of staff

Some studies have found an association between BCs contamination with increased departmental activity. Therefore, reducing staff's workload by rapid turnover or increasing their numbers can reduce the rate of BCs contamination. In contrast, the findings of Robertson *et al.,* had not found any mention of association and proposed future studies to investigate association of BCs contamination and departmental activity [31].
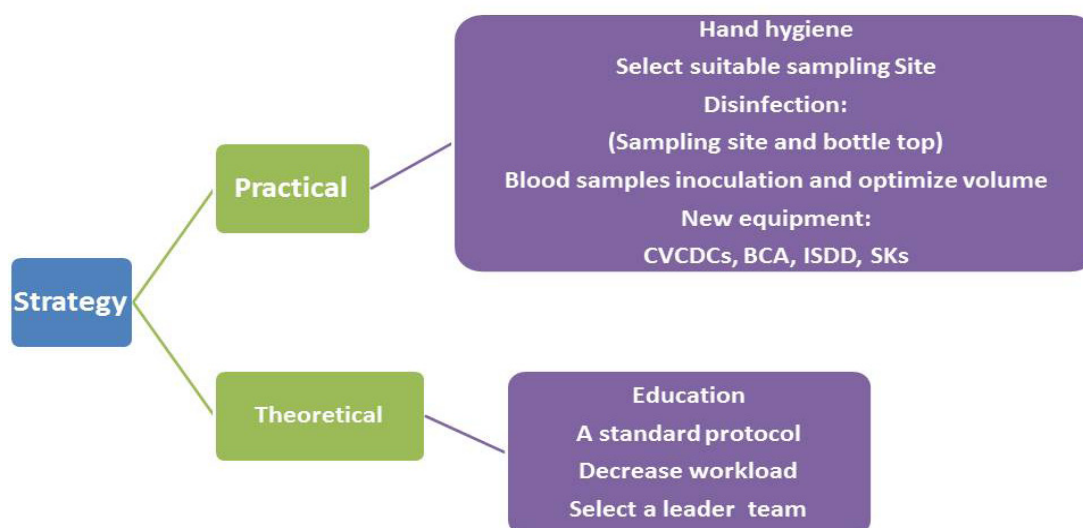

Fig. 1. Different strategies to reduce BCs contamination

Conclusion

Updating knowledge about different phlebotomy stages of blood culture as well as use of new equipment are efficacy strategies to reduce clinical and economic consequences of BCs contamination (Fig. 1).

Conflict of interest

No conflict of interest.

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