



Variations in the system influencing venous blood specimen collection practices: sources of pre-analytical errors

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Abstract: Incorrect venous blood specimen collection (VBSC) practices might influence results from blood analyses and thus jeopardize patient safety. A large amount (60–80%) of important decisions in diagnosis, administration and medication are based on laboratory test results, therefore correct VBSC is of most importance. A harmonization of VBSC can lead to accurate collection procedures, rapid and correct diagnosis, and treatment. Correct test results contribute to increased patient safety and enhanced healthcare economy. VBSC errors might be consequences of both human mistakes and cultural factors in relation to the overall system. Variations in the system influencing VBSC practices might originate from international and national structures, local organizational and work cultures, and humans working in the frontline. In order to succeed in reducing sources of errors, it is of utmost importance that leaders and managers take the whole system into consideration when planning interventions in their mission to enhance practice. Thus, the aim of this article was to discuss variation in VBSC practices and how the variation might be a source of VBSC errors.

Keywords: Culture; errors; phlebotomy; systems theory

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Introduction

Venous blood specimen collection (VBSC) is one of the most common practical skill procedures in healthcare (1) and in nursing care (2). A large number of important decisions in diagnosis, administration and medication are based on blood test results (3), therefore correctly performed VBSC is of most importance. Unfortunately, errors are common due to incorrectly performed VBSC (4–8). VBSC is associated with the pre-analytical phase (i.e., the phase before the venous blood sample arrives at the laboratory), which previous research points out to be the most problematic and error-prone phase in the total testing process (9,10). Therefore, our discussion will focus on the pre-analytical phase.

VBSC errors identified in the pre-analytical phase are, for example, carelessness regarding preparation and identification procedures, venipuncture, specimen handling and information search procedures (4,5,11). The fact that the majority of VBSC errors occur in the pre-analytical phase is not surprising since this phase includes several steps performed by staff who, compared to laboratory equipment, are only completely accurate in theory. Moreover, VBSC performance is influenced by the surrounding factors such as the system (6) and cultures (12).

The human and the cultural factors in relation to the overall system as a source of VBSC errors have received little focus in the literature. Thus, this paper will discuss some of the variations within the system that might be a source of VBSC errors.

Variation in VBSC practices

In order to understand how to prevent VBSC errors it is important to assess the surrounding factors of the VBSC culture out of a system perspective. In 2012, Reason describes how the system influences various events in the organization (13). From a system perspective, errors occur due to situations within the system rather than to the individual human. Hence, the same type of situation leads to the same kind of errors regardless of the organization or the staff. The system can be divided into the following parts; *international and national structures, local organizational and work cultures, and humans working in the frontline*. It is reasonable to assume that these factors might cause variations in VBSC practices and hence are a source of errors. Each part must be developed to include safeguards for efficient protection against failure: When one security level is passed, the next must be activated and thus ensure safe care (13).

International and national structures

International and national structures are, for example, guidelines, professional affiliation, educational structures (7) and other structures whose purpose are to defend the system. The development of international guidelines aiming to harmonize VBSC practice is one example of an international structure to reduce VBSC errors. However, international guidelines developed in industrialized countries are probably difficult to implement and adhere to in developing countries. Lack of material, a weak economy, or other circumstances become barriers to comply with guidelines which might lead to consequences as VBSC errors. Those kinds of errors cannot be related to a human failure.

In Europe, there is a large variation of professionals that perform VBSC. For example administrative staff, laboratory staff, medical doctors, phlebotomists (14) and nurses (enrolled nurses, registered nurses, specialised nurses). It is reasonable to believe that the variation in professionals within the different countries might influence VBSC practices. However, the literature shows divergent results regarding if a specific professional category can be a source of errors compared to another professional category (4,5,7). Simundic and co-workers reported in 2015 that administrative staffs were most likely to be non-compliant with recommended practice (7). In 2009, Söderberg and colleagues reported that primary health

care staff (registered nurses, enrolled nurses & biomedical technicians) followed VBSC guidelines about checking the barcode number on the referral better compared to laboratory staff (biomedical technician & enrolled nurses); while a lower proportion of the primary health care staff reported correct practice regarding always asking for name and identification number, and always labeling the test tube prior to sampling compared to laboratory staff in the same study (5). In Wallin and co-workers' 2009 study, laboratory staff reported better VBSC practices compared to hospital ward staff (4). However, the number of participants in each professional group varied largely in all of these studies (4,5,7), which might have influenced the results. It is also reasonable to believe that the variation in educational level between the professionals might influence the VBSC performance (11).

Other examples of structures that might lead to variations in VBSC are the distance between the geographic location for blood sampling and the laboratory (7). Thus, it is important to further increase the knowledge and identify the weakness of the system to make it possible to develop and implement barriers that prevent VBSC errors (15).

Organizational and work cultures

The culture concept has been defined in numerous ways. It has been suggested to signify features such as cognitive beliefs, assumptions, attitudes and definitions which are shared among the members at a specific workplace or within a specific organization (16). Errors due to organizational or workplace cultures might be ascribed to phenomena within the organization. Reason (17) denotes latent conditions as one explanation for the origin of 'holes' (failures) in the Swiss cheese model of defence. Latent conditions are present in all systems and therefore inevitable parts of an organization. Since organizations change on a daily basis (18), it is reasonable to assume that organizational cultures do as well. Most changes occur unintentionally whereas some are forced by strategic efforts, for example, to enhance performance.

Variation in VBSC practices jeopardizes patient safety and originates from, for example, latent conditions. When organizational cultures change, latent conditions also change. Studies in healthcare contexts show that culture most certainly impacts on performance. For instance, by using a culture index to examine the impact of cultural attributes, high-performing cultures outperformed low-performing cultures in domains such as employee

engagement, physician engagement and patient experience with statistical significance (19).

In one of our studies, we found associations between workplace affiliation and VBSC practice performance among staff working at primary healthcare centres (12). Phlebotomists working at a specific centre reported similar practices as their co-workers, regardless the level of adherence to VBSC guidelines. Hence, the staffs were equally adherent/non-adherent to the protocol as the rest of the staff at the site. This finding might be interpreted as a sign of shared cognitive beliefs, assumptions, attitudes and definitions between the members at the specific workplace or within a specific organization (16). The consequences from “doing as everybody else does” impact workplace culture by moving the whole workgroup in a certain direction. At sites where staff adhere to the VBSC protocol, new co-workers tend to follow their example—they too adhere, whereas at sites where staff do not, neither will new staff. Similar results were found among physicians where department affiliation predicted guideline adherence regarding the ordering of blood culture (20).

Studies on the organizational and work cultures’ impact on VBSC performance are to our knowledge few, although the issue has been highlighted in terms of the need for establishing and disseminating a good ‘VBSC culture’ in order to achieve quality targets (11,21). Hence, leaders should pay attention to culture, since the cultural attributes can serve as a master lever to steer organizational performance.

Humans working in the frontline

Errors are frequently occurring. However, according to the human error theory, intentional failures by humans are rare (22). Human mistakes are often undetected which makes them difficult to deal with (23). Human factors/mistakes can be viewed in relation to work/organizational cultures and in relation to national/international structures. Although healthcare staffs are expected to be aware of the content in guidelines and protocols they still deviate from best practice, also regarding VBSC performance (4-6,24,25). One example of human mistakes is deviations from recommended practice such as incorrect preparation of the patient prior to phlebotomy, i.e., non-compliance to fasting when fasting is urged. This leads to unreliable test results which in turn mean incomparable results (26) and most likely a patient subjected to unnecessary re-sampling (6).

VBSC errors have been shown to consist of incorrect procedures regarding patient identification, patient

preparation, request handling, use of stasis, blood drawing technique etc. which all might impact on test results and consequently also on diagnosis, treatment evaluation and hence on patient safety. Since human errors seldom are intentional but rather a result of numerous minor deviations over a long period of time, suboptimal VBSC guideline adherence practice probably develops without staff even noticing. Healthcare staffs’ attitudes towards VBSC guidelines are sparsely studied. In a recent German study on blood culture sampling guidelines, the procedure was considered an important tool for diagnosis but adherence to guidelines was low (20). Since human mistakes are difficult to detect (23), the possibility to identify VBSC errors relies on proper assessments to identify near-misses (25) rather than a low number of filled in incident reports (27). In studies among university student nurses, reported VBSC guideline adherence decreased with every completed semester. At the time of graduation, the students reported comparable levels of those reported by healthcare staff (28,29), which in turn might reflect a socialization process—a student is unwilling to provoke and question practice at the clinical placement (30), they rather just follow the lead of others although they are often aware of the risks with deviation from guideline content.

In order to continue the implementation of a safety culture regarding VBSC practice, the human factor needs to be considered. Moreover, the socialization process which is an inevitable part of the interaction between co-workers.

Conclusions

Sources of variations in VBSC might originate from *international and national structures, local organizational and work cultures, and humans working in the frontline*. In order to succeed in reducing VBSC errors, it is of utmost importance that leaders and managers take the whole system into consideration when planning for interventions in their mission to enhance practice. By addressing the system variations there are possibilities to also impact the VBSC staff. In order to change the common perception regarding VBSC practice to harmonize with guideline content, it is crucial to develop and test models that intend to spread accuracy among VBSC staff. The goal is to create a work culture where patient safety is highlighted, where staff are aware of the risks of not adhering to guidelines and where it comes naturally to search for information in guidelines and standard precautions whenever questions on “how” arise. The challenge consists of incorporating all aspects

individually, but also the way they relate to each other. For example, the national structure of laws, statutes and guidelines in relation to the variety of occupations/levels of education performing VBSC. Moreover, different countries infrastructures' impact on transportation issues of test tubes, or the mere fact that some countries do not have financial resources to ensure certain safety procedures such as always using disposable gloves. The attempts to harmonize VBSC can also be improved by the way guidelines are implemented in each country, each organization and all the way down to the local structure. Continued efforts to increase patient safety awareness regarding VBSC practice are still warranted. It seems reasonable to assume that a holistic approach including all three parts (*international and national structures, local organizational and work cultures, and humans working in the frontline*) might be successful in the ambition to homogenize guidelines.

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