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Opinion Paper

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Recommendations for blood sampling in emergency departments from the European Society for Emergency Medicine (EUSEM), European Society for Emergency Nursing (EuSEN), and European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for the Preanalytical Phase. Executive summary

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Abstract

Aim: Blood Sampling Guidelines have been developed to target European emergency medicine-related professionals involved in the blood sampling process (e.g. physicians, nurses, phlebotomists working in the ED), as well as laboratory physicians and other related professionals. The guidelines population focus on adult patients. The development of these blood sampling guidelines for the ED setting is based on the collaboration of three European

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scientific societies that have a role to play in the preanalytical phase process: EuSEN, EFLM, and EUSEM. The elaboration of the questions was done using the PICO procedure, literature search and appraisal was based on the GRADE methodology. The final recommendations were reviewed by an international multidisciplinary external review group.

Results: The document includes the elaborated recommendations for the selected sixteen questions. Three in pre-sampling, eight regarding sampling, three post-sampling, and two focus on quality assurance. In general, the quality of the evidence is very low, and the strength of the recommendation in all the questions has been rated as weak. The working group in four questions elaborate the recommendations, based mainly on group experience, rating as good practice.

Conclusions: The multidisciplinary working group was considered one of the major contributors to this guideline. The lack of quality information highlights the need for research in this area of the patient care process. The peculiarities of the emergency medical areas need specific considerations to minimise the possibility of errors in the preanalytical phase.

Keywords: blood sampling; haemolysis; preanalytical errors; venipuncture; emergency department; blood tests

Introduction

Blood sampling prior to performing laboratory measurements is one of the most frequent interventions performed in managed care. In the emergency department (ED) [1], obtaining rapid, high-quality test results to inform patient management is a mainstay [2]. However, it is noteworthy that the majority of errors associated with laboratory testing are not analytical in nature, but occur in the preanalytical phase, particularly during blood sample collections (herein referred as “phlebotomy” or “venipuncture”) [3].

Three European scientific societies – European Society for Emergency Medicine (EUSEM), European Society for Emergency Nursing (EuSEN) and the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM), participate in the actual project. Blood Sampling Guidelines have been developed to target European emergency medicine-related professionals involved in the blood sampling process (e.g., physicians, nurses, phlebotomists working in the ED), as well as laboratory physicians and other related professionals. The general purpose of this document is to provide recommendations about the preanalytical phase process (PPP) in the ED in the European context. The guidelines population focus on adult patients in which a venous blood test is requested in the process of clinical care during ED management.

Design

The three European scientific societies – EUSEM, EuSEN, and the EFLM – have jointly collaborated to produce these recommendations for the preanalytical phase.

The GRADE methodology was used for the identification of important questions [4], as well as for literature searches, appraisals of the literature and elaboration of the recommendations [5]. Sixteen questions were developed [6], based on the PICO methodology, and corresponding recommendations produced. These constitute the core of this document. The results have been organised into four sections: pre-sampling, sampling, post-sampling and quality assurance, structure previously used by the EFLM Preanalytical working group for Preanalytical Phase (WG-PRE) [7]. The recommendations for each question, along with the level of evidence and the strength of the elaborated recommendation, was elaborated by the multidisciplinary panel working group. A final external review was performed by the external review group, including patients’ representation. The final reworked version constitutes the actual document.

Recommendations

Pre-sampling phase

1. Effect of prehospital blood sampling on the emergency care process

Background

Approximately 16 % of all patients seen in typical hospital EDs arrive by ambulance [8]. Sixty per cent of patients brought to EDs meet emergency medical services (EMS) protocols for intravenous access [9]. Whenever a patient is taken care by EMS before admission to the ED and venous access has been established, there is an opportunity to secure blood specimens.

Question 1: Do patients who are transported to hospital ED by ambulance and in whom prehospital phlebotomy is performed have shorter blood sample transport times to

the laboratory, shorter time to diagnosis and shorter ED length of stay (LOS), and do these effects decrease ED crowding compared with patients in whom phlebotomy was performed after arrival at the ED (typical care).

Recommendation
There is limited evidence to prove that pre-hospital blood sampling reduces the time taken for specimens to reach the laboratory, the turnaround time, or the patient's LOS. However, the group does not recommend against pre-hospital blood sampling, since this can benefit the flow of samples to the hospital laboratory, provided that sampling time and storage conditions are standardised and fulfil minimum quality criteria.

Quality of the evidence
Overall quality of evidence for the endpoint "turnaround time": VERY LOW.
Overall quality of evidence for the endpoint "blood sample arrival time": VERY LOW.
Overall quality of evidence for the endpoint "ED LOS": VERY LOW.

Strength of the recommendation
For turnaround time, weak strength of the recommendation; 2D GRADE.
For blood sample arrival time, weak strength of the recommendation; 2D GRADE.
For ED LOS weak strength of the recommendation; 2D GRADE.

2. Effect of tube labelling time

Background

Poor patient identification in the ED setting is a recognised safety risk [10]. It is plausible that errors in identification are more likely to occur in a busy ED environment where the sample collector is managing multiple tasks and patients [11]. Care is negatively impacted by poor patient identification during blood collection [12].

Question 2: Is there a difference in the rate of identification errors when blood tubes are labelled either before or after sampling in patients visiting the ED?

Recommendation
The guidelines group suggests that blood sampling tubes should be labelled in the presence of the patient prior to phlebotomy to reduce the rate of identification errors.

Quality of the evidence
Overall quality of evidence for the endpoint "identification errors" is VERY LOW.

Strength of the recommendation
A weak recommendation, with very low-quality evidence;2D GRADE.

3. Status of patient preparation

Background

Blood tests modifying results factors including fasting and position during sampling have been extensively analysed [13]. Consumption of a variety of substances can affect test results, including alcohol, over-the-counter (OTC) [14] drugs and dietary supplements. Fasting status, and food or medications that the patient has consumed previously cannot be modified in the emergency setting, and position recommendations are sometimes difficult to follow, so a practical approach must focus on recognising and interpreting these factors.

Question 3: In adult patients at the ED with indication for a blood test, does patient's preparation (posture, or fasting status) affect the test results?

Recommendation
For the posture component
The guidelines group recommends that the sampling posture should not be changed. If the patient has been lying for some time, blood should be collected again in a lying position.

Quality of the evidence
Overall quality of evidence for the "posture" component is VERY LOW.

Level of recommendation
Good practice.

For the fasting status component
The guidelines group suggests always verifying and registering the patient's fasting status, along with previous alcohol consumption.

Quality of the evidence
Overall quality of evidence for the "fasting" component is VERY LOW.

Level of recommendation
Good practice.

For previous exercise component
The guidelines group suggests that previous exceptional exercise should always be verified and registered.

Quality of the evidence
Overall quality of evidence for the "previous exercise" component is VERY LOW.

Level of recommendation
Good practice.

The recommendations for these questions are based on the expert consensus of the group, due to the lack of quality information to support the recommendation. In consequence these recommendations have been graded as good practice.

Sampling phase

4. Effect of the phlebotomist education on the quality of sampling process

Background

In the European context, blood sampling in the ED is performed by different professionals with different training backgrounds. Nurses are the healthcare professionals most commonly responsible for the procedure [15, 16]. Other professionals such as junior doctors or dedicated phlebotomists are less universally found in the ED across the continent. Training programmes for different professions show great variability. There are also significant training differences between members of the same profession working across different settings [15].

Question 4: Effect of the profession who draws blood samples in the quality of the process.

Recommendation
In the ED we suggest that blood sampling in the adult patients should be performed by specifically trained healthcare professionals. Considering the patient workflow.

Quality of the evidence
Overall quality of evidence for all the outcomes is VERY LOW.

Strength of the recommendation
A weak recommendation, with very low-quality evidence; 2D GRADE.

5. Disinfectant choice (chlorhexidine-alcohol vs. povidone iodine) for venipuncture.

Background

The importance of skin preparation prior to phlebotomy has been considered in guidelines produced by various scientific organisations [17, 18]. The literature recommends the use of 70 % ethyl alcohol for lab-tested blood samples. The recommendation from expert groups is to use skin antiseptic for blood cultures [19], with insufficient evidence to indicate which option is more efficient.

Question 5: In adult ED patients, does the disinfectant choice (chlorhexidine-alcohol vs. povidone iodine) affect rate of blood culture contamination? Or laboratory results?

Note: Only blood culture contamination as outcome has been considered, as there was not enough evidence in the literature for an assessment on the impact of different skin antiseptics on test results.

Recommendation
When sampling for blood culture in the ED, chlorhexidine-alcohol should be used to disinfect needle insertion sites to prevent contamination.

Quality of the evidence
Overall quality of evidence for all the outcomes is VERY LOW.

Strength of the recommendation
A weak recommendation, with very low-quality evidence; 2D GRADE.

6. Effect of using non-sterile gloves in blood sampling

Background

In the ED, three different venipuncture procedures are frequently performed, each of them with different levels of aseptic requirements: phlebotomy for simple blood sampling; intravenous peripheral catheter insertion; and blood sampling for blood culture.

The published guidelines recommend gloves as part of both the aseptic and personal protective measures that should be used by the health professional [17, 18]. For simple phlebotomy, non-sterile gloves are recommended, while sterile gloves should be used for collecting blood cultures.

Question 6: What is the effect of using non-sterile gloves in blood sampling for analytical tests.

Recommendation
The working group does not recommend the use of sterile gloves for venous blood collection. For standard phlebotomy, the use of non-sterile single-use gloves as a protective measure can be considered to be good practice.
The use of non-sterile gloves is recommended as one of the protective measures that health care professionals may take.
Sampling for blood cultures has to be considered as a separate topic – details are described in question 14.
The recommendations for this question are based on the group experience due to the lack of quality information to support the recommendation. Hence, these recommendations have been graded as good practice.

7. In adult ED patients, does the tourniquet site (localisation from the venipuncture) affect the rate of complications; haemolysis, or haematomas?

Background

As an accessory during blood sampling, the main role of the tourniquet is to facilitate blood return from the punctured vein, rather than to help locate the vein. Its use is optional and is not without complications. A risk of cross-infection, with particular reference to multiresistant bacteria, has been demonstrated when reusable tourniquets are applied [20].

The length of time the tourniquet is left in place is of concern due to its effect on haemolysis. Two observational studies both found that a tourniquet time of more than 1 min led to significantly higher rates of haemolysis [21, 22].

Question 7: In adult ED patients, does the tourniquet site (cm localisation from the venipuncture) affect the rate of complications: test results, haemolysis, haematomas, patient satisfaction, or professional acceptance?

Recommendation
No literature specifically covering this PICO question was found in the search period; the working group has no new recommendations to add about the tourniquet position.

8. Differences in laboratory test results between sampling done using needles and short catheters (in patients with no IV access)

Background

When comparing the impact of sampling devices on the haemolysis rates between specimens drawn using peripheral intravenous catheter (PIVC) and straight needle venipuncture, a research clinical trial (RCT) [23] and three observational studies all [24-26] reported significantly higher rates of haemolysis for specimens drawn through a PIVC or with a butterfly needle, compared to straight needle venipuncture. The size of the PIVC is widely recognised as a relevant factor. An observational study by Tanabe et al. [24] found that while increased IV catheter gauge (i.e. narrower diameter) led to a significant increase in haemolysis rates.

Question 8: In adult patients undergoing a new phlebotomy for laboratory testing at the ED, does venipuncture using butterfly or straight needles, as opposed to short peripheral IV catheters, decrease the rate of haemolysis or the frequency of phlebotomy-related complications, such as haematomas and what is the effect on patient satisfaction?

Recommendation
The use of straight needle venipuncture or butterfly needles rather than sampling from IV catheters is recommended.

Quality of the evidence
Overall quality of evidence for the endpoint haemolysis is LOW.

Strength of the recommendation
A weak recommendation; 2C GRADE.

9. In adult ED patients with established peripheral venous access, are blood samples drawn from the peripheral intravenous catheter acceptable, comparable to those collected by venipuncture

Background

The use of peripheral intravenous catheter (PIVCs) for blood sampling in daily practice is associated with potential complications, as reported in an Australian survey which also found that PIVCs are more frequently used for blood sampling in the ED than in other hospital departments. More than 50 % of the professionals that took part in the survey took blood samples via a PIVC[27]. Potential side effects include infection; breach of patient safety due to possible management errors; and the need for resampling due to haemolysis. Haemolysis was systematically reported as the most relevant issue associated with this blood collection procedure.

Question 9: In adult ED patients with a new placed the PIVC, including catheters with infusions in place, are blood samples drawn from PIVC admissible, compared to a new venipuncture.

Note: Haemolysis rate was the only measured outcome due to limited studies suitable for appraisal regarding the other selected outcomes, based on the validity of the results.

Recommendation
Blood samples should be drawn through new venipuncture in adult ED patients.
In the process of placing a new peripheral venous catheter with a needle gauge ≤18, we suggest that blood samples could be drawn through the PIVC, after carrying out a risk/benefit analysis, and given the proper standard operating procedure (SOP) is followed to reduce risks. In any case, precautions to reduce haemolysis rates, such as the use of low-vacuum tubes or manual aspiration, is recommended in these cases.
The risk analysis should include the contraindications of a new venipuncture and an estimate of the risk of haemolysis using the newly placed PIVC.

Quality of the evidence
Overall quality of evidence for the endpoint haemolysis is VERY LOW.

Strength of the recommendation
A weak recommendation, with very low quality of evidence; 2D GRADE.

10. Effect of the sampling devices, aspiration models, through peripheral intravenous catheters

Background

Mrazek et al.[28] found that the force (negative pressure) with which blood was drawn through the collection device was the major factor contributing to haemolysis rates, regardless of the type of collection container. Additionally, the authors found that the use of low-vacuum tubes reduces haemolysis rates by lowering negative pressure (suction) during phlebotomy.

Question 10: What is the effect of the sampling devices used through PIVC, vacuum vs. manual aspiration.

Haemolysis rate has been used as an undesirable outcome. Other endpoints such as turnaround time (TAT), local haematomas or phlebotomist acceptance were not analysed due to the lack of information.

Recommendation
To reduce the haemolysis rate, we recommend, for patients with already established peripheral intravenous catheters, in whom blood sampling is necessary for laboratory tests, not to sample through the PIVC.
If after a risk analysis blood is drawn from a PIVC, the professional should use a closed manual aspiration or low vacuum system, to reduce the risk of haemolysis.

Quality of the evidence
Overall quality of evidence for the endpoint haemolysis is VERY LOW.

Strength of the recommendation
A weak recommendation, with very low quality of evidence; 2D GRADE.

11. "Difficult venous access" The use of facilitators; ultrasonography-guided peripheral venous access

Background

In patients with difficult venous access (DIVA), ultrasound (US) can expedite diagnosis by enabling blood samples to be drawn more quickly and easily, and is also associated with fewer side effects [29, 30]. Patients with DIVA include obese patients with a range of comorbidities; hypotensive patients [31, 32]; and patients with anticoagulation where blind cannulation could generate further complications.

Question 11: In the "Difficult venous access" what is the role of facilitators; ultrasonography guided peripheral venous access?

Recommendation
We recommend, in patients with difficult vascular peripheral venous access, the use of ultrasound guided access.

Quality of the evidence
The overall quality of evidence for the selected outcomes is HIGH.

Strength of the recommendation
A strong recommendation with a high level of evidence; 2A GRADE.

Post-sampling phase

12. In adult ED patients, does transporting the blood samples via pneumatic tube system affect haemolysis rate, compared to manual transportation?

Background

Sample transport is one of the preanalytical processes and is often a significant contributing factor to total turnaround time (TAT). If the laboratory is close by, samples may be delivered by hand, while for longer distances vehicle transport (car, train, plane or drone) may be necessary. As demands for faster TATs increased over time, sample transportation via pneumatic tube systems (PTSs) became widespread in healthcare facilities. This method is claimed to be not only faster but also less of a drain on personnel resources.

In theory, the mechanical impact on the transported blood sample may cause red blood cells to rupture, leading to haemolysed serum/plasma. Analytical measurements from such samples may result in biased test results and lead to potentially inappropriate medical interventions [33]. However, some authors report that PTS transportation has no impact of on sample haemolysis [34, 35].

Question 12: In adult ED patients, does transporting the blood samples via pneumatic tube systems affect haemolysis rate, compared to manual transportation?

Recommendation
If available, the group is in favour of using a PTS for sample transportation from the ED to the laboratory to reduce TAT and LOS, especially when EDs are dependent on a central laboratory that is not located near the ED.

Quality of the evidence
Overall quality of evidence for the endpoint haemolysis is VERY LOW.

Strength of the recommendation
A weak recommendation in favour of the use of a PTS for sample transportation; 2D GRADE.

13. Collection of a standard set of samples in all adult ED patients for future analysis

Background

In some EDs a standard set of samples is collected, despite not all these samples being needed for the required tests. This practice sometimes involves drawing predefined tubes, to allow for add-on testing later if requested. The cost-effectiveness of drawing the extra tubes has not been widely analysed. One study from a single centre [36] concluded that the extra tubes were only used in 2.8 % of cases, a low figure that does not support the cost-effectiveness of the process and the authors observed reduction in the use of the extra samples, along the seven years of study.

Question 13: Is it reasonable to collect a standard set of samples in all adult ER patients for future analysis (rainbow sampling)?

Is the collection of a standard set of samples for eventual future analysis (rainbow draw) in all adult ER patients more effective compared to collecting distinct samples for the selected tests?

Recommendation
The group does not recommend the collection of a standard set of samples in all adult ER patients for future analysis.
Not enough literature specifically covering this PICO question was found in the search period for proper appraisal of the quality of the evidence.

14. Blood sampling for blood cultures

Background

Skin bacteria from non-clean, non-sterile puncture sites are a common source of such contaminations, with reported contamination rates ranging from 0.8 to 23 % of all blood cultures (BCs) [37]. The Clinical and Laboratory Standards Institute (CLSI) Guideline on BC collection and handling recommends keeping contamination rates below 3 % [38]. False positive BCs (FPBCs) are not only a severe patient risk due to inadequate treatment, but are also associated with significantly increased hospital and laboratory charges [39].

Question 14: Blood sampling for BC, using existing peripheral intravenous catheters vs. new venipuncture.

Recommendation
We suggest that in case of BC collections in EDs in adult patients, a new phlebotomy should be preferred over collection from available catheter lines to minimise the risk of sample contamination. In any case, we suggest discarding the first few ml of blood either by using a discard tube or initial specimen diversion devices when sampling is done through a PIVC.

Quality of the evidence
Overall quality of evidence for the endpoint false positive blood cultures is VERY LOW.

Strength of the recommendation
A weak recommendation in favour of the use of a new venipuncture; 2D GRADE.

Quality assurance

15. Effect of point of care testing on the quality of the laboratory process

Background

The use of point of care testing (POCT) reduces or avoids transportation time and paves the way for faster clinical action. This is particularly important for determining levels of metabolites such as glucose and lactate, as well as blood gas and electrolytes [40]. However, there are many aspects to consider prior to introducing POCT to the ED. Despite blood gas analysers, for which there is no real equivalent in the central laboratory, POCT devices are often more costly than the high-throughput devices that are used in dedicated laboratories. Such POCT instruments are often operated by staff who have not been trained appropriately, and are hence prone to errors in the analytical phase. Additionally, preanalytical errors such as haemolysis rates are not routinely checked in POCT settings [41].

Question 15: What is the effect of POCT for the working process in the ED, using TAT as the main outcome?

Recommendation
We recommend POCT as one possibility to reduce the total TAT after interdisciplinary risk/benefit analysis and definition of an appropriate quality control program, regular staff training and documentation (e.g. by connecting devices to the Hospital- or Laboratory information system).

Quality of the evidence
Overall quality of evidence for the endpoint TAT is VERY LOW.

Strength of the recommendation
A weak recommendation in favour of implementing POCT, when using TAT as the outcome; 2D GRADE.

16. Impact of monitoring preanalytical blood sampling quality indicators in management for ED blood samples.

Background

Given the importance of a robust and comprehensive total testing process (TTP) for laboratory values, ED and laboratory staff need to be aware of the critical importance of quality assurance in the preanalytical and analytical phases of blood sample processing for patients in the ED. The preanalytical phase is particularly prone to quality deficits [3], as highlighted in the recent publication of Sciacovelli et al. [42].

Quality assurance systems must be established in order to detect and correct such deficits. A recent survey demonstrated that only 32 % of clinical departments and 80 % of laboratory departments staff in hospitals in Austria, Germany and Switzerland were aware of TAT as one of the most relevant quality parameters for emergency situations [43].

Question 16: Impact of monitoring preanalytical blood sampling quality indicators in management for ED blood samples.

Recommendation
We recommend the selection and implementation of quality indicators (QI)/key performance indicators (KPI), to support ED and laboratory teams to maintain/improve the preanalytical, analytical and postanalytical process quality of ED blood sampling.
Suitable quality indicators include: contamination rate of blood cultures, the incidence of duplicate chemistry tests and other reasons for samples being rejected such as haemolysis, underfilling, and clotting.
We recommend including TAT KPI, for ED laboratory processes. We recommend using the "Model of Quality Indicators" project for documentation and monitoring of preanalytical Qis [44].

Quality of the evidence
Level of evidence is VERY LOW.

Strength of the recommendation
The recommendations for this question are based on the group's experience, due to the lack of evidence to support them. In consequence these recommendations have been graded as good practice.

Working group conclusions

The collaboration of the three participating scientific societies as approach is congruous with the integration of the different sensibilities in the elaboration and application of the recommendations and constitutes a relevant added value.

The emphasis on safety of patients and professionals have been pertinent and online with the quality assurance programs inherent to the management programs of the services.

The quality of the evidence to support the recommendations is in general very low high lighting the need of quality publications, focus on the areas not supported by the actual literature.

The guideline setting is based on the peculiarities of the emergency medical areas, and need of specific considerations to minimise the possibility of errors in the preanalytical phase.

The complete Guidelines on Blood Sampling in the Emergency Department, including comprehensive description of the methodology and the justification of the recommendations, with an extensive annex that includes the conflict of interest report of the authors, can be found at the following links (Supplementary Material, Extended version).

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