

Effective practices to reduce blood sample hemolysis in emergency departments

When blood samples are hemolyzed they can produce unreliable results due to interference and bias in 39 different laboratory tests. A new clinical sample is often required to replace the hemolyzed blood specimen. Collection of additional samples may delay patient care in overcrowded emergency departments. The studies included in this systematic review assessed the effectiveness of personnel and practices to reduce the hemolysis of blood samples obtained from adult patients in the emergency department.

Summary of LMBP™ Findings and Recommendations

Use of new, straight needle venipuncture instead of existing intravenous (IV) access is effective for reducing rates of hemolysis in emergency departments, and is recommended by the [Laboratory Medicine Best Practices Workgroup](#) as an evidence-based best practice. The overall strength of evidence rating is high and the effect size is substantial. When IV starts must be used for blood collection, placing the IV at the antecubital site is recommended by the Laboratory Medicine Best Practices Workgroup as a best practice for reducing hemolysis. Although the evidence is suggestive, the use of partial vacuum tubes likely reduces the risk of hemolysis in emergency departments, however no recommendation for or against the use of partial vacuum tubes is advanced by the Laboratory Medicine Best Practices Workgroup at this time.

About the Interventions and their Comparators

- **Phlebotomists** are specifically trained and practiced in drawing blood using straight needle venipuncture.
 - Hemolysis rates associated with phlebotomists may be contrasted with the hemolysis rates associated with emergency department medical staff blood draws. Some emergency department staffs are trained in and use both straight needle venipuncture and starting IVs to collect blood samples.
- **New Straight Needle Venipuncture** involves using a dedicated needle to withdraw blood by puncturing a vein through the skin

Through the Laboratory Medicine Best Practices (LMBP™) Initiative, evidence-based evaluations are conducted to identify effective laboratory medicine practices associated with improved healthcare quality outcomes.

The LMBP Workgroup and Expert Panels provide guidance and subject matter expertise to the Centers for Disease Control and Prevention to complete these reviews.

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- Studies have contrasted hemolysis rates associated with new straight needle venipuncture with blood collection using IV starts. By using these existing IV starts for collecting blood, many nurses and emergency department medical staff believe that they save time and reduce patient discomfort by avoiding a second needle stick.
- **Syringes** allow emergency department staff who are collecting blood samples to control the amount of vacuum applied when drawing blood from an IV start
 - Studies have contrasted hemolysis rates associated with use of a syringe with rates associated with fixed pressure vacuum tubes.
- **Antecubital fossa Site** provides access to a large vein for drawing blood samples, allowing easier access, the use of larger needles, and a lower likelihood of vessel collapse.
 - Studies have contrasted hemolysis rates associated with antecubital sites with blood collection using more distal sites.
- **Larger (≤ 21 Gauge) Needles** may reduce hemolysis by reducing the stress and/or turbulence for the red blood cells as the specimen is collected.
 - Studies have contrasted hemolysis rates associated with larger gauge needles with blood collection using smaller gauge needles.
- **Partial Vacuum Tube** may reduce hemolysis by slowing the blood transfer rate thus reducing the stress and/or turbulence for the red blood cells as they are collected
 - Studies have contrasted hemolysis rates associated with partial vacuum tubes with blood collection using full vacuum tubes.
- **Tourniquet time <1 minute** Tourniquets constrict blood vessels and can, themselves, result in hemolysis. It has been recommended that tourniquets not be applied for more than 1 min when collecting blood
 - Hemolysis rates associated with tourniquet times of less than one minute can be contrasted with hemolysis rates associated with tourniquet times of one minute or more.

Results from the Systematic Review

A total of 16 studies met the review inclusion criteria (12 published and 4 unpublished).

- No studies of phlebotomists and hemolysis were found for the ED setting.
- Eleven studies assessed the reduction in hemolysis rates associated with straight needle venipuncture (8 published and 3 unpublished).

- Three studies assessed the reduction hemolysis associated with the use of syringes (2 published and 1 unpublished).
 - Four studies of blood draws using IV catheters assessed the reduction in hemolysis rates associated with the use of antecubital sites (3 published and 1 unpublished).
 - Three studies assessed the reduction in hemolysis rates associated with the use of ≤ 21 gauge (larger) needles (2 published and 1 unpublished).
 - Two published studies assessed the reduction hemolysis rates associated with the use of partial vacuum tubes.
 - No studies of tourniquet time and hemolysis were found for the emergency department setting.
- The estimated effects for straight needle venipuncture consistently and significantly favor the tested practice over using IV starts to collect blood samples. Results from studies comparing hemolysis from syringes with hemolysis from vacuum tubes are inconsistent and do not favor the tested practice. When using IV starts to draw blood, blood drawn from the antecubital site is consistently less likely to be hemolyzed than blood drawn from more distal sites. Although using a larger (≤ 21 gauge) needle may reduce hemolysis rates relative to smaller needles, but results are inconsistent. Partial vacuum tubes appear to reduce hemolysis relative to full vacuum tubes, but current evidence is only suggestive. Meta-analysis indicates that:
 - new straight needle venipuncture reduces hemolysis rates approximately 84% relative to IV starts ($\overline{RR} = 0.16$; 95% CI = 0.11–0.24).
 - using syringes does not reduce hemolysis rates relative to vacuum tubes ($RR = 0.97$; 95% CI = 0.81–1.17).
 - when using IV catheters, drawing blood from antecubital sites reduces hemolysis rates approximately 55% relative to more distal sites ($\overline{RR} = 0.45$, 95% CI = 0.35–0.57).
 - use of ≤ 21 gauge (larger) needles reduces hemolysis rates approximately 63% relative to using smaller needles ($\overline{RR} = 0.37$; 95% CI = 0.27–0.52).
 - use of partial vacuum tubes reduces hemolysis rates approximately 89% relative to using full vacuum tubes ($\overline{RR} = 0.11$; 95% CI = 0.02–0.52).

Additional Considerations

Eleven of the 16 studies were conducted in the United States. Seven studies from the United States and four studies outside of the U.S. (France, Italy, Spain, and the Republic of Singapore) contributed evidence to the straight needle venipuncture comparison. One of the four studies contrasting antecubital site to more distal sites was conducted in the Netherlands; all other studies included in this review were conducted in the United States.

- The practices summarized co-occur. Many studies summarized in this review controlled for only one or two of the variations and allowed others to vary without evaluation. This was considered in our evaluation of these practices.
 - If co-occurring practices are unrelated, failure to control for those practices reduces consistency across studies, but does not fundamentally bias the overall estimate of effectiveness for the practice.
 - If the co-occurring practices are related and co-vary systematically, conclusions may be biased (i.e., systematically inflated or deflated depending on the hemolysis rate associated with the co-occurring practice).

- Hemolysis may also result from improper centrifugation, delayed separation of blood components, and recentrifugation within gel barrier tubes; rates from these sources are expected to be much lower than those associated with pre-analytic blood collection and transport.
- Straight needle venipuncture for blood collection requires no additional training of personnel. The modest additional cost and time to place an IV and collect blood from straight needle venipuncture is likely to be mitigated when the additional laboratory staff time to evaluate a hemolyzed sample plus the burden of soliciting, executing, and evaluating a second draw are considered.
- The antecubital fossa provides access to a large vein for drawing blood samples, allows the use of larger needles, and is less likely to collapse than smaller veins.
- Using partial vacuum tubes requires no behavioral changes on the part of ED medical staff and likely places no additional economic burden on the hospital.

These results are based on a systematic review of all available studies. This systematic review is supported by contract CB-11-214 from the Centers for Disease Control and Prevention. Battelle Memorial Institute provided administrative, research and technical support for this review with input from a panel of subject matter experts in laboratory medicine and systematic review methods.

Supporting Materials

- [Supplementary Data: Evidence summary tables & included studies](#)
- [Search strategy](#)

Publications

Heyer NJ, Derzon JH, Wings L, Shaw C, Mass D, Christenson RH, Snyder SR, Epner P, and Liebow EB. Effectiveness of practices to reduce blood sample hemolysis in EDs: A laboratory medicine best practices systematic review and meta-analysis. *Clin Biochem*. 2012;45(13-14):1012-1032
[Hemolysis Clin Biochem 2012](#)

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