Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

NATIONAL GUIDELINE CLEARINGHOUSE

# General

## Guideline Title

Clinical practice guideline: prevention of blood specimen hemolysis in peripherally-collected venous specimens.

## Bibliographic Source(s)

ENA Emergency Nursing Resources Development Committee. Clinical practice guideline: prevention of blood specimen hemolysis in peripherally-collected venous specimens. Des Plaines (IL): Emergency Nurses Association; 2012 Dec. 11 p. [26 references]

## Guideline Status

This is the current release of the guideline.

# Recommendations

## Major Recommendations

The grades of recommendations (A–C, Not Recommended, I/E), levels of evidence (I–VII), and quality of evidence (I–IV) are defined at the end of the "Major Recommendations" field.

Description of Decision Options/Interventions and the Level of Recommendation

*Please note that the references listed after each recommendation represent the evidence considered when making the recommendation. This does not mean that the evidence in each individual reference supports the recommendation.*

1. Education of the staff performing phlebotomy may decrease hemolysis. Level C – Weak (Halm & Gleaves, 2009; Ong, Chan, & Lim, 2009; Corkill, 2012)
2. The type of personnel performing phlebotomy does not influence hemolysis. Level C – Weak (Halm & Gleaves, 2009; Bush et al., 2010; Harrison et al., 2010; Saleem et al., 2009; Ong, Chan, & Lim, 2008)
3. Hemolysis is less likely when blood is drawn from the antecubital fossa. Level B – Moderate (Tanabe, Kyriacou, & Garland, 2003; Fang et al., 2008; Heyer et al., 2012)
4. Minimize tourniquet time by removing the tourniquet after identifying the venipuncture site while preparing equipment and as soon as good blood flow is established. Level C – Weak (Saleem et al., 2009)
5. There is insufficient evidence to determine if the number of venipuncture attempts affects hemolysis. Level – I/E (Saleem et al., 2009)
6. There is insufficient evidence as to whether intravenous catheter insertion perceived to be difficult is associated with an increased risk of hemolysis. Level – I/E (Stauss et al., 2012; Ong, Chan, & Lim, 2008)
7. Direct venipuncture with straight needles is less likely to cause hemolysis than blood collection through intravenous catheters. Level B – Moderate (Tanabe, Kyriacou, & Garland, 2003; Ong, Chan, & Lim, 2009; Bush et al., 2010; Berger-Achituv et al., 2010; Heyer et al., 2012; Saleem et al., 2009)

8. Stainless steel needles are less likely to cause hemolysis than intravenous catheters; teflon catheters are less likely to cause hemolysis than Vialon™ catheters. Level C – Weak (Raisky et al., 1994; Sharp & Mohammad, 1998)
9. There is conflicting evidence regarding the influence of needle or catheter gauge on hemolysis. Level – I/E (Sharp & Mohammad, 1998; Sharp & Mohammed, 2003; Tanabe, Kyriacou, & Garland, 2003; Sequin, McEachrin, & Murphy, 2004; Heyer et al., 2012)
10. There is conflicting evidence regarding hemolysis with syringes versus vacuum tubes. Level – I/E (Sharp & Mohammad, 2003; Halm & Gleaves, 2009; Ong, Chan, & Lim, 2009; Bush et al., 2010; Saleem et al., 2009; Sequin, McEachrin, & Murphy, 2004)
11. Drawing blood through an extension tubing attached to an intravenous catheter does not increase hemolysis in adults. Level C – Weak (Stauss et al., 2012)
12. Drawing blood through needleless connectors does not increase hemolysis. Level B – Moderate (Dwyer et al., 2006; Sharp & Mohammad, 2003)
13. There is insufficient evidence regarding the impact of the rate of blood flow into a vacuum tube on hemolysis. Level – I/E (Ong, Chan, & Lim, 2008)
14. Low (partial) vacuum tubes result in less hemolysis. Level B – Moderate (Heyer et al., 2012; Schwartzer et al., 2001)
15. Filling vacuum tubes to their recommended volume decreases hemolysis. Level C – Weak (Unger, Filippi, & Patsch, 2007; Tamechika et al., 2006)
16. Properly functioning pneumatic tube systems do not increase hemolysis. Level C – Weak (Stair et al., 1995; Fang et al., 2008; Ellis, 2009; Saleem et al., 2009; Streichert et al., 2011; Evliyaoglu et al., 2012)
17. There is insufficient evidence to determine if the volume of venipunctures performed influences hemolysis. Level – I/E (Hawkins, 2010)
18. There is insufficient evidence to determine if monitoring hemolysis rates and providing feedback to the staff performing phlebotomy decreases the incidence of hemolysis. Level – I/E (McGrath, Rankin, & Schendel, 2012)

Definitions:

Levels of Recommendation for Practice

Level A Recommendations: High

- Reflects a high degree of clinical certainty
- Based on availability of high quality Level I, II and/or III evidence available using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- Based on consistent and good quality evidence; has relevance and applicability to emergency nursing practice
- Is beneficial

Level B Recommendations: Moderate

- Reflects moderate clinical certainty
- Based on availability of Level III and/or Level IV and V evidence using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- There are some minor flaws or inconsistencies in quality of evidence; has relevance and applicability to emergency nursing practice
- Is likely to be beneficial

Level C Recommendations: Weak

- Level V, VI and/or VII evidence available using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- Based on consensus, usual practice, evidence, case series for studies of treatment or screening, anecdotal evidence, and/or opinion
- There is limited or low quality patient-oriented evidence; has relevance and applicability to emergency nursing practice
- Has limited or unknown effectiveness

Not Recommended for Practice

- No objective evidence or only anecdotal evidence available; or the supportive evidence is from poorly controlled or uncontrolled studies
- Other indications for not recommending evidence for practice may include:
    - Conflicting evidence
    - Harmfulness has been demonstrated
    - Cost or burden necessary for intervention exceeds anticipated benefit
    - Does not have relevance or applicability to emergency nursing practice
- There are certain circumstances in which the recommendations stemming from a body of evidence should not be rated as highly as the individual studies on which they are based. For example:
    - Heterogeneity of results

| |
|---|
| • Uncertainty about effect magnitude and consequences<br>• Strength of prior beliefs<br>• Publication bias |
| Level I/E: Insufficient evidence upon which to make a recommendation. |

Grading the Levels of Evidence*

I. Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs) or evidence-based clinical practice guidelines based on systematic reviews of RCTs
II. Evidence obtained from at least one properly designed RCT
III. Evidence obtained from well-designed controlled trials without randomization
IV. Evidence obtained from well-designed case control and cohort studies
V. Evidence from systematic reviews of descriptive and qualitative studies
VI. Evidence from a single descriptive or qualitative study
VII. Evidence from opinion of authorities and/or reports of expert committees

Grading the Quality of the Evidence

I. Acceptable Quality: No concerns
II. Limitations in Quality: Minor flaws or inconsistencies in the evidence
III. Major Limitations in Quality: Many flaws and inconsistencies in the evidence
IV. Not Acceptable: Major flaws in the evidence

*Melnyk, B. M., & Fineout-Overholt, E. (2005). Evidence-based practice in nursing and healthcare: A guide to best practice. Philadelphia, PA: Lippincott, Williams, & Wilkins.

## Clinical Algorithm(s)

None provided

# Scope

## Disease/Condition(s)

Any disease or condition requiring a blood draw

## Guideline Category

Diagnosis

Prevention

Technology Assessment

## Clinical Specialty

Emergency Medicine

Hematology

Internal Medicine

Nursing

Pathology

## Intended Users

Advanced Practice Nurses

Allied Health Personnel

Clinical Laboratory Personnel

Emergency Medical Technicians/Paramedics

Hospitals

Nurses

Physician Assistants

Physicians

## Guideline Objective(s)

To evaluate which pre-analytic variables related to peripheral venous specimen collection and transportation decrease blood culture hemolysis

## Target Population

Patients requiring a blood draw

## Interventions and Practices Considered

1. Staff education about phlebotomy
2. Use of the antecubital space for blood draw versus other anatomic sites
3. Length of tourniquet time
4. Equipment used for blood collection
    - Needleless connectors
    - Extension tubing
    - Needles and intravenous (IV) catheters made of different materials and in different gauges
    - Vacuum tubes
    - Syringes
5. Blood collection technique (drawing from either an IV catheter when the IV is started, or from a separate venipuncture)
6. Specimen transport (hand carried or sent by pneumatic tube system to the laboratory)
7. Type of personnel drawing the blood specimen (emergency department personnel, trained phlebotomist, registered nurse)
8. Monitoring staff hemolysis rates and providing feedback

## Major Outcomes Considered

- Hemolysis rate of blood specimens
- Reliability of laboratory results

# Methodology

## Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

## Description of Methods Used to Collect/Select the Evidence

All articles relevant to the topic were identified via a comprehensive literature search. The following databases were searched: PubMed, Google Scholar, Cumulative Index to Nursing and Allied Health (CINAHL), eTBlast, Ovid, Cochrane Library, Agency for Healthcare Research and Quality (AHRQ; www.ahrq.gov ), Specimen Care (www.specimencare.com ), and the National Guideline Clearinghouse (www.guideline.gov ). Searches were conducted using various combinations of key words including hemolysis, phlebotomy technique, and blood samples. Initial searches were limited to English language articles from January 2002 to October 2012. This search limit was found to be inadequate and, therefore, the time frame was extended to begin with January 1990. In addition, the reference lists in the selected articles were scanned for pertinent research articles. Research articles from emergency department settings, non-emergency department settings, position statements and guidelines from other sources were also reviewed.

Articles that met the following criteria were chosen to formulate the clinical practice guideline (CPG): research studies, meta-analyses, systematic reviews, and existing guidelines relevant to the topic of blood specimen hemolysis. Articles included in meta-analyses or systematic reviews were not considered independently unless there were factors not addressed in the meta-analysis/systematic review. Other types of reference articles and textbooks were also reviewed and used to provide additional information.

## Number of Source Documents

28 documents were included in the evidence tables.

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Grading the Levels of Evidence*

I. Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs) or evidence-based clinical practice guidelines based on systematic reviews of RCTs
II. Evidence obtained from at least one properly designed RCT
III. Evidence obtained from well-designed controlled trials without randomization
IV. Evidence obtained from well-designed case control and cohort studies
V. Evidence from systematic reviews of descriptive and qualitative studies
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I. Acceptable Quality: No concerns
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IV. Not Acceptable: Major flaws in the evidence

*Melnyk, B. M., & Fineout-Overholt, E. (2005). Evidence-based practice in nursing and healthcare: A guide to best practice. Philadelphia, PA: Lippincott, Williams, & Wilkins.

## Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

The clinical practice guideline (CPG) authors used a standardized reference table to collect information and assist with preparation of tables of evidence ranking each article in terms of the level of evidence, quality of evidence, and relevance and applicability to practice. Clinical findings and levels of recommendations regarding patient management were then made by the Emergency Nurses Association (ENA) 2012 Emergency Nursing Resources Development Committee according to ENA's classification of levels of recommendation for practice, which include: Level A High, Level B Moderate, Level C Weak or Not recommended for practice (see the "Rating Scheme for the Strength of the Recommendations" field).

## Methods Used to Formulate the Recommendations

Expert Consensus

## Description of Methods Used to Formulate the Recommendations

This clinical practice guideline (CPG) was created based on a thorough review and critical analysis of the literature following Emergency Nurses Association (ENA)'s Guidelines for the Development of Clinical Practice Guidelines (see the "Availability of Companion Documents" field).

Conference calls with Subcommittee members and staff are held as necessary to discuss progress and facilitate the Subcommittee's work. All members of the Subcommittee independently complete an exhaustive review of all identified literature, complete a separate evidence table for each topic (if possible), and then reconvene to reach consensus. Each Subcommittee prepares a description of the topic, definition, background, significance, and evidence table. The Subcommittee identifies and assigns preliminary scores for quality and strength of evidence, and describes conclusions based on the review of the body of evidence. Each Subcommittee also serves as "second readers" for another topic; this assures an in-depth look at the literature by two Subcommittees. The entire Committee reads the articles and reviews the evidence-appraisal tables for each topic and then finalizes implications for practice and the level of recommendation.

## Rating Scheme for the Strength of the Recommendations

Levels of Recommendation for Practice

Level A Recommendations: High

- Reflects a high degree of clinical certainty
- Based on availability of high quality Level I, II and/or III evidence available using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- Based on consistent and good quality evidence; has relevance and applicability to emergency nursing practice
- Is beneficial

Level B Recommendations: Moderate

- Reflects moderate clinical certainty
- Based on availability of Level III and/or Level IV and V evidence using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- There are some minor flaws or inconsistencies in quality of evidence; has relevance and applicability to emergency nursing practice
- Is likely to be beneficial

Level C Recommendations: Weak

- Level V, VI and/or VII evidence available using Melnyk & Fineout-Overholt grading system* (see the "Rating Scheme for the Strength of the Evidence" field)
- Based on consensus, usual practice, evidence, case series for studies of treatment or screening, anecdotal evidence, and/or opinion
- There is limited or low quality patient-oriented evidence; has relevance and applicability to emergency nursing practice
- Has limited or unknown effectiveness

Not Recommended for Practice

- No objective evidence or only anecdotal evidence available; or the supportive evidence is from poorly controlled or uncontrolled studies
- Other indications for not recommending evidence for practice may include:
  - Conflicting evidence
  - Harmfulness has been demonstrated
  - Cost or burden necessary for intervention exceeds anticipated benefit
  - Does not have relevance or applicability to emergency nursing practice
- There are certain circumstances in which the recommendations stemming from a body of evidence should not be rated as highly as the individual studies on which they are based. For example:
  - Heterogeneity of results
  - Uncertainty about effect magnitude and consequences
  - Strength of prior beliefs
  - Publication bias

Level I/E: Insufficient evidence upon which to make a recommendation.

*Melnyk, B. M., & Fineout-Overholt, E. (2005). Evidence-based practice in nursing and healthcare: A guide to best practice. Philadelphia, PA: Lippincott, Williams, & Wilkins.

## Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

## Method of Guideline Validation

Internal Peer Review

## Description of Method of Guideline Validation

The Institute for Emergency Nursing Research (IENR) Advisory Council reviews the final document for overall validity and provides feedback as appropriate using the Clinical Practice Guidelines (CPGs) Evaluation Worksheet. Reviews and feedback are sent to the Subcommittee to evaluate and incorporate, as appropriate. Emergency Nurses Association (ENA) staff creates the final products for publication with input from the Committee.

# Evidence Supporting the Recommendations

## References Supporting the Recommendations


Berger-Achituv S, BuddeSchwartzman B, Ellis MH, Shenkman Z, Erez I. Blood sampling through peripheral venous catheters is reliable for selected basic analytes in children. Pediatrics. 2010 Jul;126(1):e179-86. PubMed

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Dwyer DG, Fry M, Somerville A, Holdgate A. Randomized, single blinded control trial comparing haemolysis rate between two cannula aspiration techniques. Emerg Med Australas. 2006 Oct-Dec;18(5-6):484-8. PubMed

Ellis G. An episode of increased hemolysis due to a defective pneumatic air tube delivery system. Clin Biochem. 2009 Aug;42(12):1265-9. PubMed

Evliyaoglu O, Toprak G, Tekin A, Basarali MK, Kilinc C, Colpan L. Effect of pneumatic tube delivery system rate and distance on hemolysis of blood specimens. J Clin Lab Anal. 2012 Feb;26(2):66-9. PubMed

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Heyer NJ, Derzon JH, Winges L, Shaw C, Mass D, Snyder SR, Epner P, Nichols JH, Gayken JA, Ernst D, 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 Sep;45(13-14):1012-32. [25 references] PubMed

McGrath JK, Rankin P, Schendel M. Let the data speak: decreasing hemolysis rates through education, practice, and disclosure. J Emerg Nurs. 2012 May;38(3):239-44. PubMed

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### Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Appropriate prevention of blood specimen hemolysis in peripherally-collected venous specimens

### Potential Harms

Not stated

## Qualifying Statements

### Qualifying Statements

- The Emergency Nurses Association (ENA)'s Clinical Practice Guidelines (CPGs) are developed by ENA members to provide emergency nurses with evidence-based information to utilize and implement in their care of emergency patients and families. Each CPG focuses on a clinical or practice-based issue, and is the result of a review and analysis of current information believed to be reliable. As such, information and recommendations within a particular CPG reflect the current scientific and clinical knowledge at the time of publication, are only current as of their publication date, and are subject to change without notice as advances emerge.
- In addition, variations in practice, which take into account the needs of the individual patient and the resources and limitations unique to the institution, may warrant approaches, treatments and/or procedures that differ from the recommendations outlined in the CPGs. Therefore, these recommendations should not be construed as dictating an exclusive course of management, treatment or care, nor does the use of such recommendations guarantee a particular outcome. CPGs are never intended to replace a practitioner's best nursing judgment based on the clinical circumstances of a particular patient or patient population. CPGs are published by ENA for educational and informational purposes only, and ENA does not approve or endorse any specific methods, practices, or sources of information. ENA assumes no liability for any injury and/or damage to persons or property arising out of or related to the use of or reliance on any CPG.

# Implementation of the Guideline

## Description of Implementation Strategy

An implementation strategy was not provided.

## Implementation Tools

Quick Reference Guides/Physician Guides

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

# Institute of Medicine (IOM) National Healthcare Quality Report Categories

## IOM Care Need

Getting Better

Living with Illness

Staying Healthy

## IOM Domain

Effectiveness

Safety

# Identifying Information and Availability

## Bibliographic Source(s)

ENA Emergency Nursing Resources Development Committee. Clinical practice guideline: prevention of blood specimen hemolysis in peripherally-collected venous specimens. Des Plaines (IL): Emergency Nurses Association; 2012 Dec. 11 p. [26 references]

## Adaptation

Not applicable: The guideline was not adapted from another source.

## Date Released

2012 Dec

## Guideline Developer(s)

Emergency Nurses Association - Professional Association

## Source(s) of Funding

Emergency Nurses Association

## Guideline Committee

2012 ENA Emergency Nursing Resources Development Committee

## Composition of Group That Authored the Guideline

*Committee Members*: Jean A. Proehl, MN, RN, CEN, CPEN, FAEN; Judith Young Bradford, DNS, RN, FAEN; Sherry Leviner, MSN, RN, CEN; Andrew Storer, DNP, RN, ACNP, CRNP, FNP; Susan Barnason, PhD, RN, APRN-CNS, CEN, CCRN, FAAN; Carla Brim, MN, RN, CEN, CNS; Judith Halpern, MS, RN, APRN; Cathleen Lindauer, MSN, RN, CEN; Vicki C. Patrick, MS, RN, SRPN, ACNP, CEN, FAEN; Jennifer Williams, MSN, RN, CEN, CCRN, CNS

## Financial Disclosures/Conflicts of Interest

Not stated

## Guideline Status

This is the current release of the guideline.

## Guideline Availability

Electronic copies: Available in Portable Document Format (PDF) from the Emergency Nurses Association Web site .

## Availability of Companion Documents

The following are available:

- Requirements for the development of: clinical practice guidelines, clinical practice guidelines synopsis, and translation into practice (TIP) recommendations. Des Plaines (IL): Emergency Nurses Association; 2013 Dec. 40 p. Electronic copies: Available in Portable Document Format (PDF) from the Emergency Nurses Association Web site .
- Clinical practice guideline: prevention of blood specimen hemolysis in peripherally-collected venous specimens. Synopsis. Des Plaines (IL): Emergency Nurses Association; 2012 Dec. 1 p. Electronic copies: Available in PDF from the Emergency Nurses Association Web site .
- CPG evidence table: prevention of blood specimen hemolysis in peripherally-collected venous specimens. Des Plaines (IL): Emergency Nurses Association; 2012 Dec. 16 p. Electronic copies: Available in PDF from the Emergency Nurses Association Web site .
- CPG other resources table: prevention of blood specimen hemolysis in peripherally-collected venous specimens. Des Plaines (IL): Emergency Nurses Association; 2012 Dec. 1 p. Electronic copies: Available in PDF from the Emergency Nurses Association Web site .

## Patient Resources

None available

## NGC Status

This NGC summary was completed by ECRI Institute on February 13, 2014. The information was verified by the guideline developer on March 27, 2014.

## Copyright Statement

This summary is based on the original guideline, which is subject to the guideline developer's restrictions.

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