

AARC Clinical Practice Guideline

Blood Gas Analysis and Hemoximetry 2013

Michael D Davis RRT, Brian K Walsh RRT-NPS RPFT FAARC,

Steven E Sittig RRT-NPS NPT FAARC, and Ruben D Restrepo MD RRT FAARC

MDD - Adult Health and Nursing System, Virginia Commonwealth University, Richmond, VA

BKW - Department of Respiratory Care, Boston's Children Hospital, Boston, MA

SES - Department of Anesthesia, Mayo Clinic, Rochester, MN

RDR - Department of Respiratory Care, The University of Texas Health Sciences Center at San Antonio, San Antonio, TX

Abstract

We searched Medline, CINAHL, and Cochrane Library database for articles published between January 1990 and December 2012. The update of this clinical practice guideline is based on 237 clinical trials, 54 reviews and 23 meta-analyses on Blood Gas Analysis (BGA) and

Hemoximetry. The following recommendations are made following the Grading of

Recommendations Assessment, Development, and Evaluation (GRADE) scoring system: 1.

BGA and hemoximetry are recommended for evaluating a patient's ventilatory, acid-base, and/or

oxygenation status. 2. BGA and hemoximetry are suggested for evaluating a patient's response

to therapeutic interventions. 3. BGA and hemoximetry are recommended for monitoring severity

and progression of documented cardiopulmonary disease processes. 4. Hemoximetry is

recommended to determine the impact of dyshemoglobins on oxygenation. 5. Capillary BGA is

not recommended to determine oxygenation status. 6. Central venous BGA and hemoximetry are suggested to determine oxygen consumption in the setting of early goal-directed therapies (EGDT). 7. For the assessment of oxygenation, a peripheral venous PO₂ is not recommended as a substitute for an arterial PO₂. 8. It is not recommended to use venous PCO₂ and pH as a substitute for arterial PCO₂ and pH. 9. It is suggested that hemoximetry is used in the detection and evaluation of shunts during diagnostics cardiac catheterization.

BGA 1.0 DESCRIPTION:

Analysis of arterial and mixed venous blood provide information concerning the oxygenation, ventilatory, and acid-base status of the subject from whom the specimen was obtained. Analysis of samples from other sources (i.e., capillary, peripheral venous, umbilical venous samples, and pH measured from other body fluids) may provide limited information. The variables most generally measured are the partial pressures for carbon dioxide (PCO₂) and oxygen (PO₂), and pH. Additional clinically useful variables are the concentration of total hemoglobin (tHb), oxyhemoglobin saturation (O₂Hb), saturations of the dyshemoglobins (carboxyhemoglobin (COHb) and methemoglobin (metHb)),¹⁻⁷ and other calculated or derived values such as plasma bicarbonate and base excess/deficit.

While there is some evidence that venous and arterial pH, PCO₂, and HCO₃ may have sufficient agreement as to be clinically comparable in a variety of clinical settings, the venous blood gas (VBG) obtained from a central line should be considered a surrogate for ABG *only* in very specific clinical circumstances⁸⁻¹².

Central venous oxygen saturation (ScvO₂) and mixed venous saturation (SvO₂) can reflect the relationship between oxygen delivery and consumption. Venous oximetry monitoring may

reduce the morbidity and mortality of patients undergoing major surgery or patients with septic shock as it allows implementation of early goal-directed therapies (EGDT).¹²⁻¹⁴

This is an update of a previously published AARC Clinical Practice Guideline (CPG) from 2001¹⁵. The recommendations provided in this CPG are based on a search of Medline, CINAHL, and Cochrane Library database for articles published between January 1990 and December 2012. The update of this clinical practice guideline is based on 237 clinical trials, 54 reviews and 23 meta-analyses on Blood Gas Analysis (BGA) and Hemoximetry

BGA 2.0 SETTING:

Blood gas analysis should be performed by trained individuals^{16, 17} in a variety of settings including, but not limited to:

- 2.1 hospital laboratories,
- 2.2 hospital emergency departments,
- 2.3 patient-care areas,
- 2.4 clinic laboratories,
- 2.5 laboratories in physicians' offices.¹⁶
- 2.6 interfacility critical care transports.^{18, 19}
- 2.7 pulmonary diagnostic laboratories
- 2.8 operating room suites
- 2.9 cardiac catheterization laboratory²⁰
- 2.10 postmortem examination²¹

BGA 3.0 INDICATIONS:

3.1 Indications for BGA and hemoximetry include:

3.1.1 the need to further evaluate the adequacy of a patient's ventilatory (PaCO_2), acid-base (pH), and oxygenation (PaO_2 and O_2Hb) status, the oxygen-carrying capacity (PaO_2 , O_2Hb , tHb, and dyshemoglobin saturations)^{1, 6, 7} and intrapulmonary shunt ($Q_{\text{sp}}/Q_{\text{t}}$);

3.1.2 the need to quantify the response to therapeutic intervention (e.g., supplemental oxygen administration, mechanical ventilation) or diagnostic evaluations (e.g., exercise desaturation);^{4, 6, 7, 22}

3.1.3 the need to assess early goal-directed therapy (EGDP) measuring ScvO_2 in patients with sepsis, septic shock and after major surgery.²³

3.1.4 the need to monitor severity and progression of documented disease processes.^{4, 7}

3.1.5 the need to assess inadequacy of circulatory response.

3.1.5.1 A high **central** venous – arterial PCO_2 gradient can indicate inadequate perfusion as observed in severe hemorrhagic shock, poor cardiac output, during cardiopulmonary resuscitation, and after cardiopulmonary bypass.²⁴⁻²⁸

3.1.6 the need to assess acid-base status when an arterial blood gas cannot be obtained.

A central venous sample or capillary sample is preferable to a peripheral venous sample. A peripheral venous sample reflects only local tissue consumption versus delivery.

- 3.1.6.1** When analyzed by an accurate instrument and in very specific clinical conditions, an adjusted **central** VBG¹² or CBG²⁹ may show sufficient agreement with some parameters of the ABG.¹⁰
- 3.1.6.2** VBG and CBG analysis has been found to reliably predict the ABG values of pH, PCO₂ and HCO₃ in patients with exacerbation of COPD.^{8, 9, 11, 29}
- 3.1.6.3** A peripheral venous blood sample can be used to evaluate the acid-base status in patients with uremia and diabetic ketoacidosis (DKA).^{30, 31}

BGA 4.0 CONTRAINDICATIONS:

Contraindications to performing pH-blood gas analysis and hemoximetry include:

- 4.1** an improperly functioning blood gas analyzer;
- 4.2** a blood gas analyzer that has not had functional status validated through:
 - 4.2.1** analysis of commercially prepared quality control products or tonometered whole blood or
 - 4.2.2** participation in a proficiency testing program(s);^{3, 32-38}
- 4.3** a specimen that has not been properly anticoagulated;^{1, 3, 36, 39, 40}
- 4.4** a specimen containing visible air bubbles;^{1, 7}
- 4.5** a specimen that has been stored at room temperature for longer than 30 minutes in a plastic vessel, stored at room temperature for longer than 5 minutes for a shunt study, or stored at room temperature in the presence of an elevated leukocyte or platelet count. In the case of samples that must be kept for longer than 30 minutes, they should be drawn and stored in a glass vessel and chilled to 0-4°C. Since PaO₂ in samples drawn from subjects with very high leukocyte counts can decrease rapidly immediate cooling and analysis are necessary in this patient population.^{1, 39, 41-52}

4.6 an incomplete requisition that precludes adequate interpretation and documentation of results and for which attempts to obtain additional information have been unsuccessful.

Requisitions should contain

4.6.1 patient's name and at least one other unique identifier, such as medical record number; birth date or age, date and time of sampling⁵³;

4.6.2 location of patient;

4.6.3 name of requesting physician or authorized independent licensed practitioner;

4.6.4 clinical indication and tests to be performed;

4.6.5 sample source (arterial line, central venous catheter, peripheral artery);

4.6.6 respiratory rate and for the patient on supplemental oxygen fractional concentration of inspired oxygen (FIO₂) or oxygen flow;

4.6.7 site from which sample was acquired (radial artery, femoral artery, vein, etc)⁵⁴

4.6.8 ventilator settings for mechanically or non-invasively ventilated patients (tidal volume, respiratory rate, FIO₂, mode);

4.6.9 signature or initials of person who obtained sample.^{1, 16} It may also be useful to note body temperature⁵⁵, activity level and time, and working diagnosis. Test requisition should be electronically generated or handwritten and must be signed by the person ordering the test. Oral requests must be supported by written authorization within 30 days (unless local regulations specify a different timeframe).^{3, 16} [ENREF 11](#)

4.7 an inadequately labeled specimen lacking the patient's full name and other unique identifier (e.g., medical record number), date, and time of sampling.^{1, 3}

BGA 5.0 HAZARDS/COMPLICATIONS:

Possible hazards or complications include:

5.1 infection of specimen handler from blood carrying the human immunodeficiency virus (HIV), hepatitis C, other blood-borne pathogens,^{3, 17, 56-58}

5.2 inappropriate patient medical treatments based on improperly analyzed blood specimen or from analysis of an unacceptable specimen or from incorrect reporting of results.

5.3 in the case of samples received from a contaminated (isolation) room, cross-contamination of areas of the hospital or handlers of the sample.

5.4 improperly identified patient.

BGA 6.0 LIMITATIONS OF PROCEDURE/VALIDATION OF RESULTS:

6.1 Limitations of technique or methodology can limit value of the procedure. Erroneous results can arise from

6.1.1 sample clotting due to improper anticoagulation or improper mixing;^{1, 3, 39-41, 59}

6.1.2 sample contamination by

6.1.2.1 air,

6.1.2.2 improper anticoagulant and/or improper anticoagulant concentration,

6.1.2.3 saline or other fluids (specimen obtained via an indwelling catheter),

6.1.2.4 inadvertent sampling of venous blood if attempting to obtain an ABG;

6.1.3 deterioration or distortion of variables to be measured resulting from

6.1.3.1 delay in sample analysis (Section 4.5);

6.1.3.2 inappropriate collection and handling (accurate total hemoglobin concentration measurement depends on homogeneous mixture of specimen, appropriate anticoagulant concentration and specimen-size ratio, and absence of contamination of specimen by analyzer solutions or calibration gases. The concentration measured may also be dependent on the method incorporated by the specific analyzer.^{1,3});

6.1.3.3 incomplete clearance of analyzer calibration gases and previous waste or flushing solution(s);³

6.1.4 the presence of hyperlipidemia, methylene blue, and/or hydroxocobalamin, which causes problems with analyzer membranes and may affect CO-oximetry^{16, 60,}

⁶¹ [ENREF_12](#)

6.1.5 inappropriate sample size for the type of anticoagulant^{1, 4, 5, 7} and/or the sample requirements of the analyzer(s)³⁸. Attempts should be made to keep sample sizes as small as is technically feasible to limit blood loss, particularly in neonates.¹

6.1.6 the presence of dyshemoglobins. Some calculated values may be in error (e.g., calculated SaO₂ may overestimate O₂Hb in the presence of COHb or metHb and with changes in 2,3 DPG concentration).

6.1.7 the presence of excess fetal hemoglobin, as blood gas analyzers assume hemoglobin to be of the adult type (default), therefore calculated blood gas oxygen saturation values are underestimated in this instance⁶²

6.1.8 inappropriate sample site for the analyte being assessed. Arterialized capillary samples and central venous samples may be adequate to assess pH and PCO₂, in hemodynamically stable patients, but may underestimate patient oxygenation^{9, 11, 29}.

6.1.9 temperature related errors. The laboratory must have a defined procedure for temperature correction of the measured results. Errors in the measurement of the patient's temperature may cause erroneous temperature-corrected results. If temperature-adjusted results are reported, the report should be clearly labeled as such, and the measured results at 37 ° C must also be reported.³ It should be noted that there is no data currently available that can quantify the balance between oxygen delivery and oxygen demand at temperatures other than 37oC and that temperature correction of blood gas samples is not recommended⁶³.

6.1.10 hemodilution or altered osmolality when measuring hematocrit using conductometry sensor technology^{1, 52}.

6.1.11 high speed transport tube systems, which may produce erroneous PO₂ results⁶⁴. Specifically, samples with a PO₂ above that of ambient air may be underestimated and those with a PO₂ below that of ambient air may overestimated.⁶⁵⁻⁶⁷

6.2 Results of analysis can be considered valid if

6.2.1 analytic procedure conforms to recommended, established guidelines^{3, 38} and follows manufacturer's recommendations;

6.2.2 results of pH-blood gas analysis fall within the calibration range of the analyzer(s) and quality control product ranges¹⁶. If a result outside of the usual calibration range is obtained (e.g., PaO₂ measured as 250 mm Hg, but analyzer calibrated to 140 mm Hg), refer to the manufacturer instructions for the particular machine in use.

6.2.3 laboratory procedures and personnel are in compliance with quality control and recognized proficiency testing programs.^{3, 16, 37, 38}

6.3 If questionable results are obtained and are consistent with specimen contamination:

6.3.1 the labeling of the blood sample container should be rechecked for patient's full name, medical record number or date of birth (patient identifier), date and time of acquisition, and measured FIO₂ (or supplemental oxygen liter flow);^{1, 3}

6.3.2 the residual specimen should be reanalyzed (preferably on a separate analyzer), assuming sufficient sample remains;

6.3.3 an additional sample should be obtained if the discrepancy cannot be resolved;

6.3.4 results of analysis of discarded samples should be logged with reason for discarding.¹⁶

6.4 ScvO₂ may not reliably predict (overestimate) SvO₂ in patients with severe sepsis in EGDT.^{68, 69}

6.5 VBG values should only be interpreted as interchangeable with ABG *only* in very specific clinical conditions.

6.5.1 Available evidence suggests that there is good agreement for pH and HCO₃ values between arterial and venous blood gas results obtained from a peripheral vein in patients with COPD, but not for PO₂ or PCO₂.^{70, 71} [ENREF 58](#)

6.5.2 VBG pH and PCO₂ levels have relatively good correlation with ABG values but cannot be substituted for ABG in exacerbation of COPD or in the setting of acute trauma^{72, 73} [ENREF 59](#)

6.5.3 While a VBG may be used instead of ABG to determine pH, PCO₂, and HCO₃ in some diseases such as respiratory distress syndrome, neonatal sepsis, renal failure, pneumonia, diabetic ketoacidosis and status epilepticus, it should not be used as a substitute in other diseases such as neonatal seizure, shock, congestive heart failure and congenital heart diseases.⁷⁴

6.5.4 The presence of a high **central** venous – arterial PCO₂ gradient helps identifying inadequacy of circulatory response as the one present in severe hemorrhagic shock, poor cardiac output, during cardiopulmonary resuscitation, and after cardiopulmonary bypass.²⁴⁻²⁸

BGA 7.0 ASSESSMENT OF NEED:

The presence of a valid indication (BGA 3.0) in the subject to be tested supports the need for sampling and analysis. Results of BGA should either a) help diagnose or confirm the presence of a disease or b) potentially alter patient treatment.

BGA 8.0 ASSESSMENT OF QUALITY OF TEST AND VALIDITY OF RESULTS:

The consensus of the committee is that all diagnostic procedures should follow the quality model described in the NCCLS GP26 A Quality System Model for Health Care.⁷⁵ The document describes a laboratory path of workflow model that incorporates all the steps of the procedure. This process begins with patient assessment and the generation of a clinical indication for testing through the application of the test results to patient care. The quality system essentials defined for all healthcare services provide the framework for managing the path of workflow. A continuation of this model for respiratory care services is further described in NCCLS HS4-A A Quality System Model for Respiratory Care.⁷⁶ In both quality models the patient is the central focus.

8.1 General considerations include:

8.1.1 As part of any quality assurance program, indicators must be developed to monitor areas addressed in the path of workflow.

8.1.2 Each laboratory should standardize procedures and demonstrate intertechnologist reliability. Test results can be considered valid only if they are derived according to and conform to established laboratory quality control, quality assurance, and monitoring protocols.

8.1.3 Documentation of results, therapeutic intervention (or lack of) and/or clinical decisions based on testing should be placed in the patient's medical record.

8.1.4 The mode of ventilation, the oxygen concentration, and the oxygen delivery device and the results of the pretest assessment should be documented. These should also be placed in the patient's medical record.

8.1.5 Report of test results should contain a statement by the licensed medical professional performing the test regarding test quality (including patient understanding of directions and effort expended) and, if appropriate, which recommendations were not met⁵⁴.

8.1.6 Test results should be interpreted by a physician or qualified medical professional, taking into consideration the clinical question to be answered.

8.1.7 There must be evidence of active review of quality control, proficiency testing, and physician alert, or critical values, on a level commensurate with the number of tests performed⁷⁷

8.2 Blood gas-pH analysis and hemoximetry are beneficial only if preanalytical error has not occurred.³

8.3 Considerations related to equipment quality control and control materials:

8.3.1 For internal-equipment quality control using commercial controls:

8.3.1.2 Establish the mean and standard deviation (SD) for each constituent (ie, pH, PCO₂, PO₂) in each level for a new lot number of commercial quality control material prior to expiration of the old lot number. The laboratory director or designee should determine the acceptable range for quality control results based on statistically relevant or medical-needs criteria.

8.3.1.3 The frequency of each control run and number of levels is dependent on regulatory requirements and manufacturer's recommendations.¹⁶

8.3.1.4 Quality control results outside predefined acceptability limits should trigger equipment troubleshooting. Quality control must be verified to be "in control" prior to analysis of specimens. Appropriate documentation of actions taken and results of verification are required.

8.3.1.5 Duplicate specimen analysis (i.e., twice on one instrument or once on two instruments) may also be performed on a regular basis as an additional method of quality control. Duplicate analysis of the same analytes on different models of equipment is generally required by accrediting agencies and should be crosschecked twice a year for correlation of results⁵⁴. However, oxygen saturation measurements have been shown to vary significantly, even between identical devices, in the setting of moderate to severe hypoxemia⁷⁸.

8.3.1.6 Tonometry is the reference procedure to establish accuracy for blood PO₂ and PCO₂. If issues of true accuracy arise, tonometry should be available.^{3,79}

8.3.1.7 Electronic quality control monitors only the equipment performance. The use of nonelectronic controls at periodic intervals should also be employed to evaluate the testing process.³

8.3.1.8 Record keeping. Summarize all quality control data for a specified lot number. Maintain and generate reports according to regulatory and institutional policy.

8.3.2 External quality control or proficiency testing³ considerations:

8.3.2.1 Proficiency testing is required by the Clinical Laboratory Amendments of 2004 (CLIA'04)¹⁶ for each regulated analyte. Specimens of unknown values from an external source are to be analyzed a minimum of 3 times a year.

8.3.2.2 Proficiency-testing materials should be obtained from an approved source to meet regulatory requirements.

8.3.2.3 The proficiency testing survey report should be carefully reviewed by the medical director and laboratory supervisor. If the results are suboptimal, the medical director and supervisor should promptly review their equipment, procedures, and materials to ascertain the cause of the poor performance.⁸⁰

8.3.3 With new equipment installation:⁸⁰

8.3.3.1 CLIA '04 requires the evaluation of equipment accuracy and imprecision prior to analysis of patient samples.¹⁶

8.3.3.2 Tonometry is the reference method for establishing accuracy for PaO₂ and PaCO₂,⁷⁹ but unless the entire tonometry process is of the highest quality, it, too, can have errors.

8.3.3.3 When an existing instrument is replaced, duplicate analysis must be performed to compare the new instrument to the existing instrument.

8.3.4 Calibration verification⁸⁰

8.3.4.1 Calibration verification is performed prior to initial use and at 6-month intervals.

Calibration verification is completed by analyzing a minimum of 3 levels of control material to verify the measuring range of the analyzer. A fourth level should be considered if samples with high O₂ levels are analyzed on the instrument.

8.3.4.2 Frequency of calibration verification may vary according to regulatory agencies under which the laboratory is accredited or licensed [i.e., College of American Pathologists (CAP) or The Joint Commission(TJC)].

8.4 Testing (analytical phase) is carried out according to an established proven protocol, conforming to manufacturer recommendations;^{3,38} The following aspects of analysis should be monitored and corrective action taken as indicated:

8.4.1 detection of presence of air bubbles or clots in specimen, with evacuation prior to mixing and sealing of syringe;^{1,3,7}

8.4.2 assurance that an uninterrupted (i.e., continuous) sample is aspirated (or injected) into analyzer and that all of the electrodes are covered by the sample (confirmed by direct viewing of sample chamber if possible;^{38,53} [ENREF 35](#))

8.4.3 assurance that 8-hour quality control and calibration procedures have been completed and that instrumentation is functioning properly prior to patient sample analysis;^{3,16,37}

8.4.4 assurance that specimen was properly labeled, stored, and analyzed within an acceptable period of time^{1,3}(see Section 4.5).

8.5 Post-testing (post-analytical phase); The results should validate or contradict the patient's clinical condition (i.e., the basis for ordering the test).⁸¹⁻⁸³

8.5.1 Documentation of results, therapeutic intervention (or lack of), and/or clinical decisions based upon the pH-blood gas measurements should be available in the patient's medical record and/or be otherwise readily accessible (e.g., at the testing area) for at least 2 years.¹⁶

8.5.2 Reference intervals and 'critical values' must be determined for each analyte prior to sample analysis. If the reference interval is determined by transference, the interval should be validated. Defining and determining reference intervals is described in NCCLS document C24-A2.⁸⁴

BGA 9.0 RESOURCES:

Federal regulations¹⁶ stipulate that requirements relative to personnel (levels of education and training), documentation procedures and equipment be fulfilled. Blood gas instrumentation is classified as being either moderately or highly complex. Persons performing blood gas analysis should be conversant with applicable federal regulations (CLIA'04)¹⁶ and appropriately qualified. In addition to federal regulations, state regulatory requirements for blood gas analysis must also be met.

9.1 Recommended Equipment:

9.1.1 Automated or semi-automated pH-blood gas analyzer with related calibration gases, electrodes, membranes, electrolytes, reagents, and accessories.^{3, 16, 38}

9.1.2 Fixed, multiple wavelength spectrophotometer (hemoximeter or CO-oximeter)³² or other device for determining total hemoglobin and its components.

9.1.3 Protective eye wear as necessary and outer wear, protective gloves, impenetrable needle container, face mask and/or face-shield.⁵⁷

9.1.4 Quality control and proficiency testing materials.

9.2 Personnel:

The following recommendations are for tests of moderate complexity, as designated by CLIA.¹⁶ Persons at either of the levels described should perform pH-blood gas analysis under the direction and responsibility of a laboratory director and technical consultant (may be the same individual) who possess at least a baccalaureate degree and who have specific training in blood gas analysis and interpretation.¹⁶

9.2.1 Level I: Personnel should be specifically trained in pH-blood gas analysis, oxygen delivery devices, and related equipment, record keeping, and hazards and sources of specimen and handler contamination(s) associated with sampling and analysis. Such persons should be, at minimum, high school graduates (or equivalent) with strong backgrounds in mathematics, and preferably with one or more years of college courses in the physical and biological sciences.⁸⁵ Such persons must have documented training and demonstrated proficiency in pH-blood gas analysis, preventive maintenance, troubleshooting, instrument calibration, and awareness of the factors that influence test results, and the skills required to verify the validity of test results through the evaluation of quality-control sample values, prior to analyzing patient specimens and reporting results.^{16, 84} Performance of pH-blood gas analysis must be supervised by a Level-II technologist.

9.2.2 Level II: Level-II personnel supervise Level-I personnel and are health care professionals specifically trained (with proven, documented proficiency) in all aspects of blood gas analysis and hemoximetry:

9.2.2.1 quality control, quality assurance, and proficiency testing;

9.2.2.2 operation and limitations, including instrument troubleshooting and appropriate corrective measures.

9.2.2.3 Level-II personnel should be cognizant of various means for specimen collection and the causes and impact of preanalytical and instrument error(s).

9.2.2.4 Level-II personnel should be trained in patient assessment, acid-base and oxygenation disorders, and diagnostic and therapeutic alternatives. A baccalaureate, or higher, degree in the sciences or substantial experience in pulmonary function technology is preferred, although 2 years of college in biological sciences and mathematics, plus 2 years of training and experience, or equivalent may be substituted for personnel supervising arterial pH-blood gas analysis^{76, 84} A nationally recognized credential (MT, MLT, CRT, RRT, CPFT, RPFT, RN) is strongly recommended.¹⁶

9.3 Personnel who do not meet annual competency requirements or whose competency is deemed unacceptable as documented in an occurrence report should not be allowed to participate, until they have received remedial instruction and have been re-evaluated.

BGA 10.0 MONITORING:

Monitoring of personnel, sample handling, and analyzer performance to assure proper handling, analysis, and reporting should be ongoing, during the process.

BGA 11.0 FREQUENCY:

Frequency of execution of quality control maneuvers depends upon the sample load of the laboratory and the requirements of agencies that specify those maneuvers.

BGA 12.0 INFECTION CONTROL:

12.1 The staff, supervisors, and physician-directors associated with the blood gas laboratory should be conversant with "Guideline for Isolation Precautions in Hospitals" made by the Centers for Disease Control and Prevention and the Hospital Infection Control Practices Advisory Committee (HICPAC)^{86, 87}. The blood gas laboratory staff should develop and implement policies and procedures for the laboratory that comply with its recommendations for Standard Precautions and Transmission-Based Precautions.

12.2 The laboratory's manager and its medical director should maintain communication and cooperation with the institution's infection control service and the personnel health service to help assure consistency and thoroughness in complying with the institution's policies related to immunizations, post-exposure prophylaxis, and job- and community-related illnesses and exposures.⁵⁶

12.3 Primary considerations include

12.3.1 adequate hand washing,^{88, 89}

12.3.2 provision of prescribed ventilation with adequate air exchanges,^{90, 91}

12.3.3 careful handling and thorough cleaning and processing of equipment,⁵⁸

12.3.4 the exercise of particular care in scheduling and interfacing with the patient in whom a diagnosis has not been established.^{56, 57}

BGA 13.0 AGE-SPECIFIC ISSUES:

This document applies to samples from neonatal, pediatric, adult, and geriatric populations.

BGA 14.0 RECOMMENDATIONS

The following recommendations are made following the Grading of Recommendations

Assessment, Development, and Evaluation (GRADE) criteria.⁶⁹

14.1 BGA and hemoximetry are recommended for evaluating a patient's ventilatory, acid-base and/or oxygenation status. (1A)

14.2 BGA and hemoximetry are suggested for evaluating a patient's response to therapeutic interventions. (2B)

14.3 BGA and hemoximetry are recommended for monitoring severity and progression of documented cardiopulmonary disease processes. (1A)

14.4 Hemoximetry is recommended to determine the impact of dyshemoglobins on oxygenation. (1A)

14.5 Capillary BGA is not recommended to determine oxygenation status. (1A)

14.6 Central venous BGA and hemoximetry are suggested to determine oxygen consumption in the setting of EGDT. (2B)

14.7 For the assessment of oxygenation, a peripheral venous PO₂ is not recommended as a substitute for an arterial PO₂. (1A)

14.8 It is not recommended to use venous PCO₂ and pH as a substitute for arterial PCO₂ and pH. (2B)

14.9 It is suggested that hemoximetry is used in the detection and evaluation of shunts during diagnostics cardiac catheterization. (2B)

BGA 15.0 Identifying Information and Availability

15.1 Adaptation

Original Publication: Respir Care 2001;46(5):498–505.

15.2 Guideline Developers

American Association for Respiratory Care Clinical Practice Guidelines Steering Committee.

Michael D. Davis, RRT. Virginia Commonwealth University, Richmond, Virginia

Brian K. Walsh, RRT-NPS, RPFT, FAARC. Boston Children's Hospital, Boston, Massachusetts

Steven E. Sittig, RRT-NPS, NPT, FAARC Mayo Clinic, Rochester, Minnesota

Ruben D. Restrepo, MD, RRT, FAARC (Chair). The University of Texas Health Science Center at San Antonio. San Antonio, Texas

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15.4 Financial disclosures/conflicts of interest

No conflicts of interest.

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