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STRIVING FOR PULMONARY CARE

Clinical Practice Guidelines

Arterial Blood Gases

PAKISTAN CHEST SOCIETY-2026

Guidelines On

Arterial Blood Gases

March 2026

PAKISTAN CHEST SOCIETY

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Preface

Arterial blood gas analysis is one of the most frequently performed investigations in acute and critical care, yet practice across Pakistan remains inconsistent. Training gaps, variable sampling methods, and the absence of a unified national reference have been recognised problems for some time. This guideline is an attempt to address them.

The document covers the full pathway from sampling and specimen handling through to interpretation, quality assurance, and training standards. It is intended for anyone who performs or interprets arterial blood gases, across all clinical settings and levels of care. Where relevant, guidance is also provided on venous blood gas sampling and paediatric practice.

The aim is straightforward: to standardise practice, reduce avoidable error, and ensure that blood gas results are reliable enough to support sound clinical decisions.

I am grateful to Prof Gen (Rtd) Jawad Ansari for his mentorship and for encouraging me to contribute to the pulmonology community in Pakistan. I thank Prof Muhammad Ashraf Jamal for entrusting me with this work, and my working group colleagues for their input and commitment throughout.

I hope it is implemented, built upon, and that it makes a genuine difference to the care patients receive across Pakistan.

Dr. Syed Murtaza Hassan Kazmi
Chair, ABG Guideline Working Group

Message by the President

Pakistan Chest Society

Arterial blood gas analysis is a fundamental investigation in respiratory and critical care medicine. These guidelines provide a clear and systematic approach to sampling, interpretation, and clinical application of ABGs in both acute and chronic settings. The Pakistan Chest Society hopes this document will enhance diagnostic accuracy, guide timely interventions, and improve patient outcomes across all levels of care.

Prof. Shereen Khan
President
Pakistan Chest Society

Message by the Chairman

Guideline Committee, Pakistan Chest Society

It gives me great pleasure to present the Guidelines for Arterial Blood Gas (ABG) Analysis developed by the Pakistan Chest Society. Arterial blood gas analysis remains an essential diagnostic and monitoring tool in the management of patients with acute and chronic respiratory disorders, as well as in critically ill patients, providing crucial information about oxygenation, ventilation, and acid–base balance. In Pakistan, conditions such as chronic obstructive pulmonary disease, asthma, pneumonia, and other critical illnesses frequently require timely ABG evaluation.

These guidelines have been developed by the working group under the chairmanship of Dr Syed Murtaza Hassan Kazmi and after reviewing the best available evidence and adapting it to the realities of our healthcare system. The document provides practical guidance on proper sampling techniques, systematic interpretation of acid–base disorders, and the clinical application of ABG findings in common respiratory and critical care scenarios. By promoting a standardized and evidence-based approach, these guidelines aim to improve diagnostic accuracy, guide appropriate management, and enhance patient outcomes across healthcare settings in Pakistan. On behalf of the Pakistan Chest Society, I extend my sincere appreciation to all members of the Guidelines Committee and contributing experts whose dedication and expertise made the development of these guidelines possible.

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Chapter 01: Overview of ABGs:
Background, Purpose, Scope and Context

1.1 Background

Arterial blood gas analysis is recognized worldwide as a rapid bedside investigation that clarifies ventilation, oxygenation, and systemic acid-base equilibrium. It supports critical decisions in both acute and chronic care settings. In emergency departments and intensive care units, ABG results inform ventilator adjustments, oxygen titration, and resuscitation priorities, and have been shown to predict clinical outcomes in patients presenting with acute dyspnoea.[1,2] Recent literature also supports the value of systematic blood gas interpretation in chronic cardiometabolic disease where early identification of derangement can prompt timely intervention.[3]

Blood gas results are most useful when they are interpreted alongside the clinical picture, including work of breathing, pulse oximetry, chest imaging, and key biochemical markers such as lactate, electrolytes, and ketones. In many clinical pathways, ABG testing is used not only to make an initial diagnosis, but also to guide escalation or de-escalation of respiratory support, monitor response to therapy, and identify complications such as worsening hypercapnia or evolving metabolic acidosis.

Although modern analysers have improved analytical precision, errors arising before analysis remain common. Inadequate site preparation, delays in analysis, air contamination, clotting, and incorrect documentation of fraction of inspired oxygen can distort gas tensions and derived indices, leading to inappropriate management. Evidence consistently shows that most mistakes in blood gas testing occur in the pre-analytical phase, highlighting the need for standardized sampling and handling protocols.[4]

Within Pakistan, ABG testing is performed across diverse settings, from tertiary intensive care to district emergency care and theatre recovery. Practice variation is common, including inconsistent use of collateral circulation testing, variable sample transport times, and uneven access to training. A single national standard, adapted from international evidence and aligned with local resource realities, can reduce avoidable error, strengthen teaching, and support quality improvement across this spectrum.

The Pakistan Chest Society convened a working group to develop this guideline as a practical reference for frontline clinicians, nurses, and laboratory teams. The intent is to establish a shared national language for sampling, reporting, and interpretation, while remaining flexible enough for local implementation.

1.2 Purpose

These guidelines provide a national framework for the standardized sampling, handling, analysis, and interpretation of arterial blood gas parameters to enhance clinical decision making and patient care in Pakistan. They aim to support safe, reproducible practice in both

laboratory and point of care environments, and to minimize common pre analytical and post analytical pitfalls.

The guideline also aims to support structured education and competency assessment, so that ABG interpretation can be taught consistently across training programs. It is written as narrative recommendations without grading, recognizing that local resources and case mix may vary.

1.3 Scope

This guideline is intended for:

- Healthcare providers including physicians, nurses, respiratory therapists, and allied health professionals involved in acute and chronic care.
- Clinical laboratories and point of care services performing blood gas testing, with emphasis on maintaining high quality standards.
- Educational institutions and training programmes to ensure structured teaching of ABG and capillary sampling, interpretation, and reporting.

It applies to adult, paediatric, and neonatal patients. Where age specific physiological differences influence interpretation, these are highlighted within the relevant sections.

The guideline addresses arterial and capillary sampling and provides guidance on when venous blood gas sampling can be used to assess acid base status and ventilation. It does not replace disease specific protocols, such as management of diabetic ketoacidosis or ventilator weaning bundles, but it complements them by standardising blood gas practice.

1.4 Context

These guidelines are relevant for public and private healthcare settings across Pakistan, recognising diversity in resources, staffing, and patient demographics. They aim to bridge gaps in knowledge and practice while fostering a consistent, evidence informed approach that can be taught, audited, and improved over time.

Local implementation should include alignment with institutional policies on consent, infection prevention, sharps safety, and critical value reporting. Units with high throughput, such as intensive care and emergency departments, should also define local targets for time from collection to analysis, and establish clear accountability for corrective actions when targets are not met.

Chapter 02:

Clinical Indications, Contraindications, Specimen Collection and Handling

2.1 Indications for arterial blood sampling

Arterial blood sampling is indicated for the following clinical situations: [5]

- Evaluation of adequacy of ventilation, acid base status, oxygenation status, and oxygen carrying capacity of blood
- Quantification of the patient's response to therapeutic intervention and diagnostic evaluation
- Monitoring severity and progression of a documented disease process

Common clinical examples include acute hypoxaemic respiratory failure, suspected ventilatory failure with hypercapnia, monitoring of invasive ventilation, evaluation of shock with suspected lactic acidosis, and assessment of severe metabolic derangements such as diabetic ketoacidosis. ABG testing is also appropriate when non-invasive monitoring is unreliable, for example poor perfusion states where pulse oximetry readings are unstable.

2.2 Contraindications for arterial blood sampling

Contraindications are generally relative and should be weighed against clinical urgency. Relative contraindications include: [6,7]

- Negative modified Allen test suggesting inadequate collateral circulation
- Puncturing through a lesion or infected skin
- Puncturing through or distal to a surgical shunt
- Coagulopathy or medium to high dose anticoagulation therapy

When contraindications are present and arterial sampling is still clinically required, consider alternatives such as arterial line sampling under appropriate supervision, or venous blood gas sampling for acid base and ventilation assessment, with pulse oximetry to assess oxygenation.

2.3 Sampling technique

Before sampling, confirm patient identity using at least two identifiers, explain the procedure, and review relevant risk factors such as anticoagulation status, vascular disease, and prior arterial puncture complications. If the patient is receiving oxygen therapy or ventilatory support, document fraction of inspired oxygen and relevant settings at the time of sampling.

2.3.1 Radial artery puncture

Radial artery puncture is the preferred approach in most settings.[6,8]

1. Perform the modified Allen test to confirm adequate collateral circulation.

2. Position the patient seated or supine with the wrist extended to about 30 degrees, using a rolled towel for support.

3. Clean the site using aseptic technique and allow antiseptic to dry.
4. Use a 20-to-25-gauge short bevel needle with a pre-heparinised syringe as per analyser recommendation.
5. Insert the needle bevel up at a 30-to-45-degree angle distal to the palpated artery.
6. On arterial entry, allow blood to fill the syringe spontaneously without aspirating.
7. After collection, place gauze over the site and withdraw the needle promptly.
8. Apply firm pressure for at least 3 to 5 minutes, and longer in anticoagulated patients, until haemostasis is confirmed.
9. Activate the needle safety feature and dispose of the device properly.
10. Expel air bubbles immediately, cap the syringe, and mix the sample gently to prevent micro clots.

After the procedure, reassess distal perfusion and provide patient advice on pressure dressing care and signs of complications that should be reported, including increasing pain, swelling, numbness, or pallor.

2.3.2 Brachial artery puncture

Brachial puncture may be used if the radial site is not feasible. Apply longer post puncture pressure due to lack of collateral circulation.[6]

1. Extend the arm and identify the point of maximal pulse.
2. Cleanse the site aseptically.
3. Insert the needle at about 45 degrees along the artery path.
4. Follow the same post collection procedure, applying firm pressure for at least 5 minutes, and reassess distal perfusion.

2.3.3 Capillary sampling for neonates and paediatric patients

Where an arterial line is not present, arterialised capillary blood gas sampling may be used in neonates and children to assess acid base status and ventilation. It is not a substitute for arterial oxygenation assessment in critically unwell patients. [10,11]

1. Warm the site to about 42 °C for 3 to 5 minutes to arterialise the sample.
2. Common sites include heel in infants, and finger or toe in older children. Avoid the central heel area and previous puncture sites.
3. Use a sterile lancet and collect blood in a heparinised capillary tube.
4. Seal both ends immediately to maintain an anaerobic environment and mix as per local practice.
5. Apply gauze until haemostasis is achieved and document the sampling method in the report.

2.4 Sample handling, transport, and storage

Correct sample handling is essential. When results are inconsistent with the clinical picture, consider pre analytical error and repeat sampling if needed, rather than acting on an implausible value.

2.4.1 Collection device and sample volume

Use pre heparinised plastic syringes recommended by the analyser manufacturer. Avoid air bubbles and expel immediately. [8,9]

Recommended sample volumes

- Minimum 0.5 mL for standard blood gas analysis
- No more than 0.5 mL for infants under 10 kg

Where locally used syringes require manual heparinisation, avoid excessive liquid heparin volume as this can dilute the specimen and lower measured carbon dioxide and electrolytes.

2.4.2 Labelling requirements

Each specimen should include: [6]

- Patient full name and identification number
- Date and time of collection
- Sampling site and method, and modified Allen test result when relevant
- Patient location and temperature where available
- Relevant therapy, for example ventilator settings and fraction of inspired oxygen
- Operator name or initials and requesting clinician details

2.4.3 Transport and storage

Delays can materially alter results, particularly oxygen tensions[9,12]

Plastic syringes: if analysed within 30 minutes, store at room temperature. [9]

If delay exceeds 30 minutes: use a glass syringe and immerse in an ice water bath at 1 to 5 °C. [9,12]

Avoid freezing. If a sample is transported on ice, ensure that the syringe and stopper remain intact and that the sample is mixed gently before analysis.

2.4.4 Sample rejection criteria

Samples should be repeated when any of the following is present

- Incorrect or incomplete patient identifiers
- Visible clots or inadequate mixing
- Excessive air bubbles not removed promptly
- Unacceptable delay between collection and analysis as per local policy
- Missing documentation of fraction of inspired oxygen or ventilator settings when clinically required

2.5 Safety and infection control

Adhere to standard precautions:[6]

- Use gloves and eye protection if splatter is likely
- Perform hand hygiene after the procedure
- Avoid recapping needles
- Use puncture resistant containers for disposal
- Report needlestick injuries immediately
- Staff should be vaccinated against hepatitis B, or follow institutional waiver policy

Complications such as haematoma, arterial spasm, vasovagal episodes, and rare distal ischaemia should be recognized early. Persistent pain, neurological symptoms, or evidence of impaired perfusion requires urgent senior review.

2.6 Optional use of local anaesthetic

Local anaesthetic may improve patient comfort and cooperation. One percent lidocaine without epinephrine may be used if needed.[6]

Chapter 03:

Interpretation Framework, Reference Ranges, Common Acid Base Disorders and Clinical Correlation

3.1 Reference ranges

Reference ranges vary by analyser methodology, laboratory calibration, altitude, age, and clinical context. Use local laboratory ranges where available and interpret trends over time rather than isolated values

Parameter	Typical adult reference range
pH	7.35 to 7.45
PaCO2	35 to 45 mmHg (4.7 to 6.0 kPa)
PaO2	80 to 100 mmHg on room air (10.6–13.3 kPa) at sea level
Bicarbonate (HCO3)	22 to 26 mmol/L
Base excess	minus 2 to plus 2 mmol/L
Arterial oxygen saturation (SaO2)	95 to 100 percent

In pregnancy, sepsis, and chronic lung disease, baseline values may differ. In paediatric and neonatal practice, reference ranges differ substantially, particularly for oxygenation and carbon dioxide tension. For neonates and children, results should be interpreted using age-appropriate local reference ranges, and in the context of clinical status and respiratory support. [11]

3.2 Structured approach to ABG interpretation

Use a consistent sequence to reduce missed mixed disorders and misinterpretation. Where available, interpret against previous blood gases and against the trend in oxygen requirement and ventilator settings.

Step 1: Assess oxygenation

Review PaO2 and measured SaO2, then relate these to fraction of inspired oxygen and the clinical setting. On room air at sea level, PaO2 below 80 mmHg suggests hypoxaemia, and below 60 mmHg suggests severe hypoxaemia.

Where the cause of hypoxaemia is unclear, consider the alveolar arterial oxygen gradient as part of the assessment. A commonly used equation is:

A gradient equal (FiO2 × (Patm minus PH2O) minus (PaCO2 divided by 0.8)) minus PaO2

An elevated gradient supports ventilation perfusion mismatch, diffusion limitation, or shunt. A normal gradient in the presence of hypoxaemia supports hypoventilation or low inspired oxygen.

Step 2: Determine acid base status

Acidaemia: pH below 7.35. Alkalaemia: pH above 7.45.

A pH within the reference range does not exclude a clinically important mixed disorder or full compensation, particularly when both PaCO2 and bicarbonate are markedly abnormal.

Step 3: Identify the primary process

Respiratory disorders: pH and $PaCO_2$ move in opposite directions.

Metabolic disorders: pH and bicarbonate move in the same direction.

Decide which variable best explains the pH change, then assess whether the other change is appropriate compensation or indicates a mixed disorder. In complex critical illness, more than two processes may coexist.

Step 4: Check whether compensation is appropriate

Compare observed compensation to expected compensation using the formulas below. If values fall outside expected ranges, suspect a mixed disorder.[13]

Step 5: If metabolic acidosis is present, calculate the anion gap

Anion gap is commonly calculated as sodium minus (chloride plus bicarbonate). Interpretation should use local laboratory reference ranges.

When a high anion gap metabolic acidosis is present and a second metabolic disorder is suspected, delta assessment may help.

Delta ratio equals change in anion gap divided by change in bicarbonate. Values near 1 suggest a single high anion gap acidosis. Values above 2 suggest a concurrent metabolic alkalosis. Values below 1 suggest a concurrent normal anion gap acidosis. [16]

Step 6: Integrate with clinical context

Confirm plausibility against history, examination, electrolytes, lactate, ketones, renal function, medications, and toxins. If the result is inconsistent with the patient's physiology, consider sampling or documentation error and repeat testing when clinically appropriate.

3.3 Expected compensation formulas

Respiratory compensation occurs over minutes to hours. Renal compensation generally takes days. These relationships help identify single versus mixed disorders. [12,13,14,15]

- Metabolic acidosis (Winter's formula): expected $PaCO_2$ equals (1.5 × bicarbonate) plus 8, with an allowance of plus or minus 2. [12]
- Metabolic alkalosis: expected $PaCO_2$ equals (0.7 × bicarbonate) plus 20, with an allowance of plus or minus 5. [13]
- Respiratory acidosis: acute rise in bicarbonate is about 1 mmol/L per 10 mmHg $PaCO_2$ increase above 40; chronic rise is about 3 to 4 mmol/L per 10 mmHg. [14]
- Respiratory alkalosis: acute fall in bicarbonate is about 2 mmol/L per 10 mmHg $PaCO_2$ decrease below 40; chronic fall is about 4 to 5 mmol/L per 10 mmHg. [14]

Expected compensation provides guidance rather than certainty. In patients with chronic respiratory failure, baseline bicarbonate may be elevated. In severe critical illness, compensation may be incomplete due to fatigue, altered drive, or concurrent organ dysfunction.

3.4 Common acid base disorders and typical causes

Use pattern recognition as a starting point, then confirm using expected compensation and the anion gap where relevant.

Respiratory acidosis

Pattern: low pH with raised $PaCO_2$; bicarbonate increases with compensation.

Common causes include COPD exacerbation, sedative or opioid effect, neuromuscular weakness, airway obstruction, severe pneumonia, and ventilatory failure.

Respiratory alkalosis

Pattern: raised pH with low $PaCO_2$; bicarbonate reduces with compensation.

Common causes include hypoxaemia driven hyperventilation, pulmonary embolism, early sepsis, pain or anxiety, pregnancy, liver failure, and ventilator over assistance.

Metabolic acidosis

Pattern: low pH with low bicarbonate; $PaCO_2$ falls with appropriate respiratory compensation.

High anion gap causes include ketoacidosis, lactic acidosis, uraemia, and toxins such as methanol, ethylene glycol, and salicylates.

Normal anion gap causes include diarrhoea, renal tubular acidosis, saline load, and carbonic anhydrase inhibitors.

Metabolic alkalosis

Pattern: raised pH with raised bicarbonate; $PaCO_2$ rises with appropriate respiratory compensation.

Common causes include vomiting or gastric suction, diuretics, mineralocorticoid excess, and citrate load.

In paediatric and neonatal practice, causes and thresholds may differ, and blood gas interpretation should be integrated with gestation, age, respiratory support mode, and clinical trajectory.

3.5 Mixed disorders

Suspect mixed disorders when clinical severity is high, when pH is near normal despite markedly abnormal $PaCO_2$ or bicarbonate, or when compensation is inappropriate.

- High anion gap metabolic acidosis with respiratory acidosis, for example septic shock with ventilatory failure
- Metabolic acidosis with metabolic alkalosis, for example vomiting plus diarrhoea
- Multiple concurrent processes in complex critical illness

3.6 Worked examples

The following examples illustrate application of the structured approach. Values are illustrative and should be interpreted in context.

- **Example 1: Acute respiratory acidosis**

ABG: pH 7.26, $PaCO_2$ 68 mmHg, bicarbonate 30 mmol/L, PaO_2 58 mmHg

Interpretation: Primary respiratory acidosis with hypoxaemia. Consider acute hypoventilation causes and urgent support.

- **Example 2: Chronic respiratory acidosis**

ABG: pH 7.36, PaCO2 58 mmHg, bicarbonate 32 mmol/L, PaO2 65 mmHg
Interpretation: Chronic respiratory acidosis with renal compensation, consistent with stable CO2 retention.

- **Example 3: High anion gap metabolic acidosis**

ABG: pH 7.12, PaCO2 20 mmHg, bicarbonate 7 mmol/L, anion gap 27
Interpretation: High anion gap metabolic acidosis with PaCO2 close to expected by Winter's formula.

- **Example 4: Mixed metabolic and respiratory acidosis**

ABG: pH 7.05, PaCO2 55 mmHg, bicarbonate 12 mmol/L, anion gap 28
Interpretation: High anion gap metabolic acidosis with PaCO2 far higher than expected, indicating concurrent respiratory failure.

- **Example 5: Salicylate pattern**

ABG: pH 7.38, PaCO2 18 mmHg, bicarbonate 11 mmol/L
Interpretation: Mixed respiratory alkalosis and metabolic acidosis, classically seen in salicylate toxicity.

3.7 When venous blood gas can be used

Venous blood gas sampling can be used in many settings to assess acid base status and ventilation, particularly when arterial sampling is difficult or delayed. In adults, venous pH and PaCO2 show clinically useful agreement with arterial values, and venous bicarbonate and lactate are generally acceptable for decision making. [21,22]
Venous samples should not be used to assess arterial oxygenation. If oxygenation assessment is required, use pulse oximetry and clinical assessment, and obtain an arterial sample when accurate PaO2 is needed.
Consider VBG in the following situations:

- Initial assessment of acid base status and ventilation where the patient is not in extremis
- Serial trending of pH and PaCO2 when arterial access is not available
- Situations where pain reduction and speed of sampling are priorities
- Situations where an arterial result is not expected to change immediate management, but acid base status needs confirmation

Prefer ABG when:

- Precise assessment of oxygenation is required, including shunt assessment and severe hypoxaemia
- Non-invasive saturation is unreliable, for example poor perfusion states
- Clinical condition is rapidly changing and accurate PaO2 and PaCO2 are required for ventilator titration
- A venous result is discordant with the clinical picture and confirmation is required

Chapter 04:
Training, Quality Assurance, Laboratory Standards and Reporting

4.1 Policy statement

Arterial blood gas sampling and analysis shall be performed only by healthcare professionals who have received formal training, have demonstrated documented competency, and maintain ongoing proficiency in accordance with institutional policies and Pakistan Chest Society recommended standards. This applies to testing performed in a central laboratory and to point of care testing in areas such as intensive care units, emergency care, and theatres. [18,19,20]

Institutions should define a governance structure for blood gas testing, including clinical leadership for sampling practice and laboratory oversight for analyser performance, quality control, and staff competency.

4.2 Eligible personnel

Personnel authorised to perform ABG sampling and or analysis include:

- Physicians including consultants, fellows, residents, and medical officers
- Registered nurses
- Respiratory therapists
- Medical laboratory technologists

All personnel must operate within their defined scope of practice and institutional policies, with clear local accountability for supervision and escalation.

4.3 Training requirements

Institutions must provide a structured training programme that covers both knowledge and hands on skills. The aim is consistent practice, patient safety, and reduction in avoidable pre analytical error.

Training should include:

Theoretical training:

- Indications and contraindications for ABG testing
- Physiology of acid base balance and gas exchange
- Basic interpretation of ABG parameters including recognition of mixed disorders
- Variables affecting accuracy of results, including pre analytical, analytical, and post analytical factors
- Clinical integration, including documentation of fraction of inspired oxygen and ventilator settings

Practical training:

- Correct patient identification and consent
- Correct arterial puncture technique with radial preferred and alternatives used when indicated
- Assessment of collateral circulation when radial puncture is planned
- Infection prevention and control and sharps safety
- Sample handling, labelling, transport, and storage

- Operation of ABG analysers were used in the unit, including routine quality checks
- Recognition and initial management of complications, including haemostasis and escalation pathways

4.4 Competency assessment

Competency assessment should be planned and documented. It should confirm that staff can perform the procedure safely and produce a valid sample that leads to reliable results. Competency should be:

- Assessed at completion of training
- Reassessed at least annually
- Reassessed following introduction of new equipment, consumables, or procedures

Acceptable assessment methods include:

- Direct observation with a structured checklist
- Written or oral evaluation
- Review of procedural outcomes and error rates
- Proficiency testing linked to local quality processes

4.5 Continuing professional development

All personnel involved in blood gas testing should participate in continuing professional education, including updates in acid base disorders, mechanical ventilation, advances in blood gas technology, and patient safety and quality improvement.

Units should use case-based teaching to reinforce interpretation skills, particularly around mixed disorders, compensation, and common sources of error.

4.6 Quality assurance

Facilities performing ABG testing must implement a quality assurance programme to ensure accuracy, reliability, and patient safety across all phases of testing. This should cover pre analytical controls, analyser performance, documentation, and incident learning. [4,18,19,20]

4.6.1 Pre analytical quality assurance

Mandatory measures include:

- Verification of patient identity using at least two identifiers
- Documentation of oxygen therapy or ventilator settings at the time of sampling
- Use of appropriate heparinised syringes and correct fill volume
- Removal of air bubbles and prevention of clot formation
- Prompt transport and analysis with locally defined time targets
- Defined sample rejection criteria and a repeat testing pathway

4.6.2 Analytical quality assurance

Minimum requirements include:

- Internal quality control according to manufacturer recommendations
- Calibration and maintenance according to manufacturer instructions with documented schedules
- Immediate investigation and corrective action for unacceptable quality control results
- Defined governance for point of care analysers, with laboratory oversight

- Documented verification when consumables, cartridges, or lot numbers change

4.6.3 Post analytical quality assurance

Post analytical controls should include:

- Defined critical values and a documented critical result communication protocol
- Verification of implausible or inconsistent results prior to reporting where feasible
- Clear unit reporting for gases and electrolytes, with local agreement on mmHg and kPa use
- Regular review of turnaround times and incident trends

4.6.4 Incident and error management

Errors, near misses, and adverse events must be reported through the institutional system. Significant incidents should trigger structured review and corrective actions, including targeted retraining and follow up audit.

4.7 Laboratory and point of care standards

ABG testing should be conducted in environments that meet minimum laboratory and safety standards, whether testing is performed in a central laboratory or at the point of care. [18,19]

Facilities should ensure:

- Environmental conditions within analyser specifications
- Reliable power supply with backup systems
- Infection prevention and waste disposal pathways
- Defined responsibility for analyser maintenance and consumable stock management

4.8 Documentation and reporting standards

Accurate, complete, and timely documentation and reporting of blood gas results are essential for safe clinical decision making and continuity of care.
For each sample, record at minimum:

- Patient identifiers, including name and hospital number
- Date, time, sampling site, and sampling method
- Fraction of inspired oxygen and relevant ventilator settings at the time of sampling
- Name and designation of the person collecting the sample
- Patient temperature where available

Reports should include pH, PaO_2, $PaCO_2$, bicarbonate, base excess, and measured oxygen saturation, alongside fraction of inspired oxygen and reference ranges. Institutions should define critical values and ensure immediate communication to the responsible clinician, with documentation of the time, recipient, and method.

Where derived indices such as anion gap or A gradient are reported, the method of calculation should be standardised locally to avoid confusion between different calculators or analyser settings.

Chapter 05:

Guideline Governance, Implementation, Acknowledgements and Appendices

The following items are included to align the guideline with international publication standards and to support implementation in diverse clinical settings.

Guideline development methods and governance

This guideline was developed by a Pakistan Chest Society working group. The scope, key questions, and draft recommendations were agreed by consensus. The group undertook a targeted review of major international standards and peer reviewed literature relevant to sampling, handling, interpretation, and quality systems. All conflicts of interest were declared and managed through discussion and consensus. The final guideline was reviewed, endorsed, and formally approved by the Pakistan Chest Society Guidelines Committee.

Implementation and Audit

Institutions should implement this guideline through local standard operating procedures, training, competency sign off, and audit cycles. Recommended audit indicators include:

- Completeness of documentation of fraction of inspired oxygen and ventilator settings at the time of sampling
- Sample rejection rate and reasons for rejection, including clotting and labelling errors
- Time from sample collection to analysis compared with local targets
- Compliance with critical result communication protocol
- Training completion and annual competency reassessment rates in relevant units

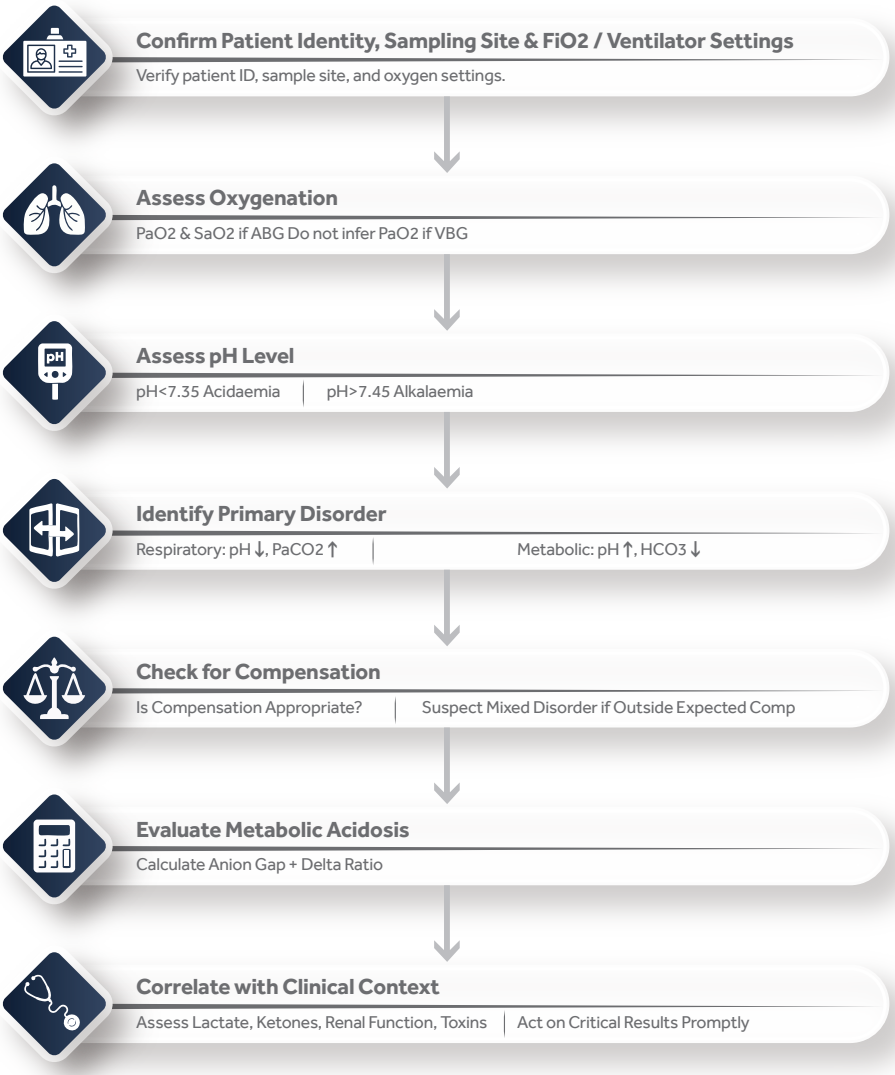
Acknowledgements

Pakistan Chest Society acknowledges the contributions of committee members and external reviewers. The final list of contributors and reviewers should be included in the endorsed publication.

Appendices

Appendix A: One-page ABG and VBG interpretation algorithm
Appendix B: Minimum dataset for ABG documentation and reporting
Appendix C: Quick reference compensation formulas
Appendix D: Paediatric and neonatal sampling notes

Appendix A. ABG & VBG Interpretation Algorithm



Appendix B. Minimum dataset for documentation

- Patient name and hospital number
- Age, sex, ward, or unit
- Date and time of sampling
- Sampling site and method (arterial line, puncture, capillary)
- Fraction of inspired oxygen and device, plus ventilator settings where relevant
- Clinical indication for sampling
- Measured values: pH, PaCO2, PaO2 if arterial, bicarbonate, base excess, oxygen saturation

- Operator name and designation
- Time and recipient of communication if critical results

Appendix C. Quick reference compensation formulas

- Metabolic acidosis: expected $PaCO_2$ equals (1.5 × bicarbonate) plus 8, plus or minus 2.
- Metabolic alkalosis: expected $PaCO_2$ equals (0.7 × bicarbonate) plus 20, plus or minus 5.
- Respiratory acidosis: acute bicarbonate rise about 1 mmol/L per 10 mmHg $PaCO_2$ above 40; chronic rise about 3 to 4 mmol/L per 10 mmHg.
- Respiratory alkalosis: acute bicarbonate falls about 2 mmol/L per 10 mmHg $PaCO_2$ below 40; chronic fall about 4 to 5 mmol/L per 10 mmHg.

Appendix D. Paediatric and neonatal sampling notes

- Capillary sampling may be used in neonates and children for assessment of acid base status and ventilation when arterial sampling is not feasible.
- Capillary samples should be arterialised by warming and collected anaerobically with prompt sealing and mixing.
- Oxygenation assessment requires arterial sampling or reliable non-invasive oxygen saturation monitoring, as capillary and venous samples do not provide arterial PaO_2.
- Interpret results using age-appropriate reference ranges and in the context of respiratory support.

Conflicts of interest

All committee members should declare relevant financial, academic, and professional conflicts of interest. Declarations should be recorded by Pakistan Chest Society and updated if circumstances change.

Update and review schedule

This guideline should be reviewed every 3 years, or earlier if major new evidence, equipment standards, or national regulatory requirements emerge.

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