



**BLOOD PH HOMEOSTASIS AND ITS DISTURBANCES:
ACIDOSIS AND ALKALOSIS – A MEDICAL CHEMISTRY PERSPECTIVE**

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Abstract: *This article is written based on the analysis of modern scientific publications devoted to the chemical basis of blood pH regulation and the pathophysiology of acid-base disorders, including materials from international research centers and clinical chemistry laboratories. Particular attention is paid to the biochemical mechanisms of acidosis and alkalosis, their diagnosis, and the potential application of modern therapeutic approaches in the healthcare system of the Republic of Uzbekistan.*

Keywords: *Blood pH, acid-base balance, acidosis, alkalosis, bicarbonate buffer system, Henderson-Hasselbalch equation, anion gap, carbonic anhydrase, metabolic acidosis, respiratory alkalosis, blood gas analysis, modern medical chemistry.*

Introduction

Part 1. Introduction and Main Directions

Blood pH homeostasis is a fundamental concept in medical chemistry and clinical physiology. Normal arterial blood pH ranges from 7.35 to 7.45, maintained by complex buffer systems, respiratory regulation, and renal compensation. According to modern scientific articles, disturbances in acid-base balance are divided into two main categories. The first category is acidosis ($\text{pH} < 7.35$), which can be metabolic (decreased bicarbonate) or respiratory (increased pCO_2). The second category is alkalosis ($\text{pH} > 7.45$), which can be metabolic (increased bicarbonate) or respiratory (decreased pCO_2).

The second direction is the study of compensatory mechanisms. In this case, the main role is played not only by the bicarbonate buffer system but also by hemoglobin, phosphate, and protein buffers, as well as renal excretion of H^+ and NH_4^+ . The development of these technologies — including point-of-care blood gas analyzers and nanobiosensors — is considered promising for the modernization of healthcare systems, including the medical institutions of Uzbekistan.

Part 2. Areas of Application in Medicine





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Analysis of scientific publications shows that understanding blood pH chemistry allows clinicians to diagnose and treat life-threatening conditions. Acid-base disorders can be identified using:

- arterial blood gas (ABG) analysis
- serum electrolyte measurement
- anion gap calculation ($\text{Na}^+ - (\text{Cl}^- + \text{HCO}_3^-)$)
- strong ion difference (Stewart approach)

In modern medicine, acid-base chemistry is applied in the following areas:

- emergency medicine and intensive care
- nephrology and dialysis
- endocrinology (diabetic ketoacidosis)
- pulmonology (chronic obstructive pulmonary disease, COPD)
- neonatology
- toxicology (salicylate or methanol poisoning)

For Uzbekistan, these directions are important for reducing mortality from diabetic complications, acute renal failure, and severe infections.

Results/Main Findings

Part 3. Modern Research Projects

1. Diagnostics and Monitoring: Blood Gas Analysis and Anion Gap

Scientific articles show that blood gas analyzers are widely used in modern clinical chemistry. These devices measure pH, pCO_2 , pO_2 , HCO_3^- , base excess (BE), and lactate. The Henderson-Hasselbalch equation ($\text{pH} = \text{pKa} + \log [\text{HCO}_3^-] / [0.03 \times \text{pCO}_2]$) remains the theoretical foundation for interpreting these results.

Such technologies can be used in Uzbekistan for:

- early diagnosis of metabolic acidosis in diabetic ketoacidosis
- detection of respiratory acidosis in COPD exacerbations
- monitoring of alkalosis in patients receiving mechanical ventilation
- assessment of renal tubular acidosis

The development of laboratory diagnostics based on portable blood gas analyzers can significantly improve the quality of emergency medical care.

2. Metabolic Acidosis: Biochemical Mechanisms and Therapy

One of the most important directions in medical chemistry is metabolic acidosis, characterized by a primary decrease in plasma HCO_3^- . Causes include increased endogenous acid production (lactic acidosis, ketoacidosis), decreased renal acid excretion (chronic kidney disease), or bicarbonate loss (diarrhea, renal tubular acidosis).

Research articles describe the use of intravenous sodium bicarbonate in severe acidosis ($\text{pH} < 7.1$), although its role remains debated. Newer approaches include the use of carbicarb (equimolar sodium carbonate and bicarbonate) and THAM (tromethamine), a buffer that does not produce CO_2 .





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Such technologies are promising for intensive care units and emergency departments, including those operating in Uzbekistan.

Possible applications:

- treatment of diabetic ketoacidosis
- therapy of lactic acidosis in septic shock
- management of acute salicylate poisoning

3. Metabolic Alkalosis: Pathophysiology and Compensation

Scientific studies show that metabolic alkalosis ($\text{pH} > 7.45$ with elevated HCO_3^-) is often caused by gastric acid loss (vomiting, nasogastric suction), diuretic use, or mineralocorticoid excess. Chloride-responsive alkalosis (urine $\text{Cl}^- < 10$ mEq/L) is treated with saline infusion, while chloride-resistant alkalosis requires potassium replacement and treatment of the underlying cause.

One important direction is the role of the kidneys in maintaining alkalosis through enhanced HCO_3^- reabsorption. Acetazolamide, a carbonic anhydrase inhibitor, can be used to correct severe metabolic alkalosis by promoting renal bicarbonate excretion.

The introduction of such therapeutic protocols in Uzbekistan could improve outcomes in postsurgical and critically ill patients.

4. Respiratory Acid-Base Disturbances

Respiratory acidosis occurs due to alveolar hypoventilation (CO_2 retention), seen in COPD, opioid overdose, or neuromuscular disease. Respiratory alkalosis results from hyperventilation, common in anxiety, pulmonary embolism, or mechanical overventilation.

Modern nanotechnologies are being developed for continuous monitoring of transcutaneous pCO_2 and pH using wearable biosensors. Nanoparticle-based optical sensors embedded in microneedle patches can detect pH changes in interstitial fluid, allowing real-time detection of developing acidosis or alkalosis.

For Uzbekistan, the development of such monitoring systems could increase the effectiveness of intensive care and postoperative management.

5. Nanotechnologies in Acid-Base Balance Correction

Emerging scientific publications describe the creation of nanostructured buffer systems. Liposomal bicarbonate formulations provide controlled release and prolonged buffering capacity compared to free bicarbonate. Additionally, polymer-based nanoparticles containing carbonic anhydrase mimics can accelerate CO_2 hydration and improve pH regulation in respiratory failure.

These systems may be important for:

- emergency medicine (rapid correction of severe acidosis)
- military medicine (field stabilization of trauma patients)
- neonatology (precise pH control in premature infants)





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Conclusion

Analysis of modern scientific articles shows that understanding blood pH balance and its disturbances is essential for medical chemistry and clinical practice. Acidosis and alkalosis are common, life-threatening conditions that require rapid biochemical diagnosis and targeted therapy.

The introduction of modern acid-base diagnostic tools and therapeutic strategies into the healthcare system of Uzbekistan can contribute to:

- improvement of emergency and intensive care quality
- reduction of mortality from diabetic ketoacidosis and renal failure
- development of modern clinical chemistry laboratories
- modernization of medical education in acid-base physiology

REFERENCES

1. Henderson L. J. The theory of neutrality regulation in the animal body // *Science*. Vol. 28, № 718. 1908. P. 185–193.
2. Hasselbalch K. A. Die Berechnung der Wasserstoffzahl des Blutes aus der freien und gebundenen Kohlensäure desselben, und die Sauerstoffbindung des Blutes als Funktion der Wasserstoffzahl // *Biochemische Zeitschrift*. Bd. 78. 1916. S. 112–144.
3. Stewart P. A. Modern quantitative acid–base chemistry // *Canadian Journal of Physiology and Pharmacology*. Vol. 61, № 12. 1983. P. 1444–1461.
4. Kraut J. A., Madias N. E. Serum anion gap: its uses and limitations in clinical medicine // *Clinical Journal of the American Society of Nephrology*. Vol. 2, № 1. 2007. P. 162–174.
5. Adrogue H. J., Madias N. E. Management of life-threatening acid–base disorders // *New England Journal of Medicine*. Vol. 338, № 1. 1998. P. 26–34.
6. Adrogue H. J., Madias N. E. Secondary responses to altered acid–base status: the rules of compensation // *New England Journal of Medicine*. Vol. 384, № 3. 2021. P. 253–262.
7. Galla J. H. Metabolic alkalosis // *Journal of the American Society of Nephrology*. Vol. 11, № 2. 2000. P. 369–375.
8. Palmer B. F., Clegg D. J. Diagnosis and treatment of metabolic alkalosis // *Clinical Journal of the American Society of Nephrology*. Vol. 15, № 9. 2020. P. 1349–1359.
9. Rastegar A. Use of the anion gap in clinical medicine // *The American Journal of Medicine*. Vol. 135, № 6. 2022. P. 672–678.
10. Kellum J. A. Disorders of acid–base balance // *Critical Care Medicine*. Vol. 35, № 12. 2007. P. 2778–2784.
11. Forni L. G., Hilton P. J. Continuous monitoring of blood pH and blood gases in the critically ill // *Critical Care*. Vol. 13, № 6. 2009. P. 219.





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12. Jung B., Rimmele T., Le Goff C. et al. Severe metabolic or mixed acidemia on intensive care unit admission: incidence, prognosis and administration of buffer therapy // *Annals of Intensive Care*. Vol. 1, № 1. 2011. P. 5. ion gap in clinical medicine. *Am J Med*. 2022.

