3.1: Overview

1.1.1: Approaches to understanding acid-base physiology

Traditional Approach

The discussion of acid-base physiology outlined in most of this book is the traditional empirical approach. The concepts and explanations of this approach are still the most common way that acid-base physiology is taught and understood by many clinicians.

But this is not the only approach.

Physico-chemical Approach

An alternative approach derived from physico-chemical principles was proposed by a Canadian physiologist, Peter Stewart in 1981. Alternative names for this approach are the "Stewart approach" and "Quantitative Acid-base Analysis".

The two approaches are very similar in the way that acid-base disorders are classified and measured. The major difference is in the explanation and interpretation of acid-base disorders and control mechanisms. Recent research has largely confirmed the correctness of the Stewart approach but it must be admitted that it will take quite some time for main-stream acid-base physiology teaching to catch up. Indeed, there has been some vitriolic resistance from the traditionalists.

The rest of this chapter discusses some introductory concepts.
1.1.2: What to expect in this book

Chapter 1 provides an introduction to basic concepts of acids & bases and the hydrogen ion. The reason why the extremely low hydrogen ion concentrations in the body have such major effects on body processes is discussed. The final part of this chapter is about the imidazole alpha-stat hypothesis and the pH-stat hypothesis.

Chapter 2 considers the control of acid-base balance, including:

- The acids produced by the body and the concept of balance, both internal and external
- Buffering and other aspects of the body's response to acid-base stress
- The major roles of the lungs and the kidneys in acid-base regulation
- The importance of the liver
- Regulation of intracellular pH.

Chapters 3 discusses the terminology of acid-base disorders. A distinction is made between primary processes which generate an acid-base disorder and the body's compensatory responses. The concepts of anion gap, delta ratio, urinary anion gap, and osmolar gap are useful in analysis of some acid-base disorders.

The 4 types of acid-base disorder - Chapter 4: Respiratory acidosis, Chapter 5: Metabolic acidosis, Chapter 6: Respiratory alkalosis, Chapter 7: Metabolic alkalosis - are each covered in a systematic way: definition, causes, maintenance, metabolic effects, compensation, correction, assessment, prevention.

Chapter 8 covers some of the major types of metabolic acidosis in more detail. In particular, attention is focussed on lactic acidosis, ketoacidosis, acidosis with renal failure, hyperchloreaemic acidosis, renal tubular acidosis, and acidosis occurring with drugs and toxins. The place of sodium bicarbonate therapy is discussed.

Chapter 9 explains a structured approach to the assessment of acid-base disorders & includes numerous worked clinical examples. You can work through these examples yourself, then compare your results with my analysis. The approach to analysis used in this book is based on the 'Boston approach' so an introduction to the 'Great transatlantic acid-base debate' discusses why this approach is best.

Chapter 10 introduces quantitative acid-base analysis (or "the Stewart approach"). This is only an introductory treatment but will be enhanced as this method of analysis becomes more common in clinical use. Peter Stewart introduced an approach that leads to an improved understanding of acid-base control in the body. His landmark 1981 book ("How to Understand Acid-Base") has recently been placed online at http://www.AcidBase.org.

Chapter 11 considers several special areas including children & pregnancy.

The best way to learn analysis of acid-base results is to frequently practice what you have learned.

As a neophyte to acid-base analysis, you will generally consider this a pretty daunting topic. You will notice that arterial blood gas results are frequently ordered on ill patients but little comment is made on these in the patient record. It is certain that a lot of relevant clinical information is lost because of a lack of understanding of acid-base analysis. A particular aim of this book is to develop the subject gradually and systematically, and to lead you to a practical structured approach to analysis of blood gas results which you can use in your clinical practice. Because of the interaction of acid-
base physiology with respiratory, cardiovascular, and renal systems and substrate metabolism, in particular, a set of blood-gas results can be a very useful teaching aid. The Blood Gas Archive contains a set of six (hopefully entertaining) simulated teaching exercises; this is constructed as a dialogue between a consultant and a registrar.

Some of the difficulties in learning acid-base physiology are outlined in the following quote.

**Pertinent Quote**

"Acid/base homeostasis is arguably one of the most difficult of the subdisciplines of physiology for veterinary and human medical students to master. There are several reasons for this. Typically, the approach to this material is highly quantitative and based on the physical characteristics and fundamental behaviors of acids and bases, which can be off-putting to veterinary and human medical students."

"Neophyte students are also often intimidated by acid/base physiology, because it is patently integrative. Students quickly realize that understanding the data in a blood gas panel requires an appreciation for not only acids and bases, but also ventilation, gas exchange, dynamics of electrolyte and water movement, plasma composition, respiratory control, and renal mechanisms of hydrogen ion, electrolyte, and water excretion."

"In addition, it is essential that the student develop an understanding of a host of other organ, metabolic, and structural dysfunctions that can potentially contribute acid or base loads to the extracellular fluid."


Some additional materials on this web site provide examples of gas results worked through in a more integrative context.