Acid–Base Reports Need a Text Explanation

To the Editor:

The Problem

The 1952 epidemic of poliomyelitis in Copenhagen resulted in critical interest in acid–base disturbances[1] and the creation of intensive care.[2] Technical advances[3] in measurement were accompanied by improvements in the diagrammatic representation.[4] The vigorous "Great Transatlantic Debate" faded with the introduction of "standard base excess" (SBE) to represent metabolic acidosis. Nevertheless, the potential for confusion remains. Partial pressure of carbon dioxide (PCO_2) is measured in different units by geographical location (mm Hg or kPa), and metabolic acidosis may be represented by SBE, BE_B (base excess of blood), BD (base deficit), BE_{ECF} (base excess of extracellular fluid), or BD_{ECF} (base excess of extracellular fluid), and less reliably by HCO_3^- (bicarbonate).

The Acid–Base Chart presented in 1971 by Siggaard-Andersen[5] plotted pH against log(PCO_2). It generated a value for standard base excess and offered curved outlined areas where clinical conditions (and normal) might be found. In 1976, a new diagram was created[6] plotting partial pressure of carbon dioxide against standard base excess. This produced linear pH lines as well as linear zones for six typical clinical conditions (and normal); the partially compensated zones were placed midway between complete compensation and none.

In 1998, Schlichtig *et al.*[7] refined the location of the partially compensated zones using Schlichtig's comprehensive collection of data from 21 published reports (see fig. 1).

There is one published attempt to validate this diagram.[8] The authors found that it presented the "higher diagnostic agreement" but also reported that their own "two expert physicians disagreed with each other in the diagnosis of 1/3 of the cases." This last statement, in conjunction with abundant anecdotes of error and confusion in critical care, emergency care, and anesthesia, prompted the present article.

The Proposal

Artificial intelligence already generates various clinical text reports. For example, text may be added to an electrocardiogram report and a tentative diagnosis may be created from a mammogram. Accuracy has improved, but such reports cause concern[9–11] and caution persists.[12] In striking contrast, there appear to be no text reports associated with acid–base values despite the level of certainty that can be achieved. The proposal is that values for pH and partial pressure of carbon dioxide should generate accurate text descriptions. These are examples of reports generated by this system:

Blood: moderate acidemia (pH = 7.27, [H+] = 54 nmol/l)
Primary: Respiratory: mild acidosis (PCO_2 = 50 mm Hg)
Secondary: Metabolic: minimal acidosis (SBE = –3.7 mEq/l)

Blood: some acidemia (pH = 7.35, [H+] = 45 nmol/l)
Primary: Respiratory: moderate acidosis (PCO_2 = 58 mm Hg)
Secondary: Metabolic: mild alkalosis (SBE = 5.6 mEq/l)
Consider: Chronic respiratory disease with metabolic compensation

Blood: some alkalemia (pH = 7.49, [H+] = 32 nmol/l)
Primary: Metabolic: marked alkalosis (SBE = 12.0 mEq/l)
Secondary: Respiratory: mild acidosis (PCO_2 = 48 mm Hg)
Consider: Metabolic alkalosis with respiratory compensation

Ideally, a diagram showing the location of the values should accompany the text. For further examples of such text reports, use a laptop or desktop computer to visit the site http://www.acid-base.com/diagramlarge.php (accessed December 11, 2018).

The proposed text presents four separate items:

1. The direction and magnitude of the overall change in blood acidity
2. The primary, or major, component (respiratory or metabolic), magnitude, and value
3. The secondary, or minor, component (metabolic or respiratory), magnitude, and value
4. Description of a characteristic zone where one exists

The first three items are not controversial. They are accurate text descriptions that reduce the possibility of confusion. Although the fourth line is soundly derived from published data, the nature of acid–base disturbances means that outliers will exist. For this reason line four is preceded with the word "Consider…."

Conclusion

Environments in which acid–base values are interpreted are often far from ideal: in many hospitals in different parts of the world, fatigue, staff shortage, and inexperience are common. Blood gas reports should include a version of this text report: it may not have the vivid colors shown on the website, text may continue on a single line, and the units used will depend on location (*e.g.*, rarely, if ever, will the acidity be shown both as pH and [H^+]).

There is no longer any reason for providing acid–base results as just numbers with, in some cases, a string of confusing options for metabolic acidosis. Minimizing confusion in high-stress environments must be a priority. This proposal provides a solution.

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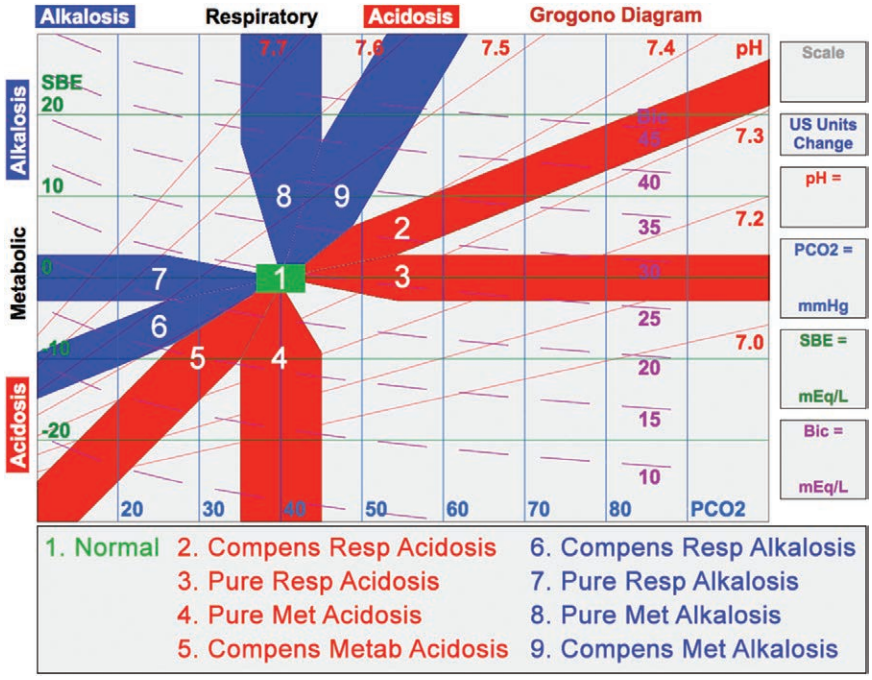

Fig. Acid–base diagram showing characteristic zones on PCO_2/standard base excess (SBE) axes.

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Competing Interests

The author is not supported by, nor maintains any financial interest in, any commercial activity that may be associated with the topic of this article.

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