EDITORIAL

Arterial Blood Gas: Bowling Wide and Poor Wicketkeeping

Rajesh K Pande

Abstract

Arterial blood gas (ABG) is an essential point-of-care test to identify the pH, metabolic, and respiratory status of critically ill patients. In addition, it provides useful information about co-oximetry, lactate, electrolytes, and other parameters. Studies show that it is widely prescribed but the impact of ABG result on clinical care is limited. Protocols addressing effective utilization of ABG can address and help in minimizing cost and complications.

Keywords: Arterial blood gas, ICU, Point-of-care testing, Protocol, Utilization.

Indian Journal of Critical Care Medicine (2021): 10.5005/jp-journals-10071-23735

Even though the indications are not well defined, arterial blood gas (ABG) analysis continues to remain one of the most commonly done tests in critically ill patients.[1] Some of the potential advantages of ABG include help in diagnosis, ventilator management, and guiding treatment plans including acid–base and electrolyte management.[2] In fact, ABG has become an essential point-of-care test (POCT) to look at the pH, metabolic, and respiratory status of these patients. In addition, co-oximetry, lactate, electrolytes, and other parameters add more punch to this critical information.

Initial attempts to use blood pH to improve diagnosis and management were made by Poul Astrup and Bjørn Ibsen during the European polio epidemic.[3] The popular bicarbonate-based analysis (Boston school), which characterizes acids as hydrogen-ion donors and bases as hydrogen-ion acceptors, uses the carbonic acid–bicarbonate buffer system.[4,5] In this approach, primary respiratory (PCO_2) or metabolic (HCO_3) changes result in a secondary adjustment in metabolic or respiratory parameters. It identifies six disorders—two metabolic (acidosis, alkalosis) and four respiratory (acute and chronic respiratory acidosis and alkalosis) based on six bicarbonate-based formulas, based on the assumption that base excess is not independent of PCO_2 *in vivo*. These formulas are also part of standard blood gas teaching in India. The other Copenhagen school relies on standard base excess (SBE), which is independent of PCO2 to interpret the data.[5] Another reintroduced old concept gaining traction is the concept of using strong ion deficit (SID), rather than pH (Stewart approach) to define acid-base disorders.[6]

Most common reasons for doing ABG include weaning from the ventilator, with FIO_2 and pressure support adjustments cited as most common reasons, but studies looking at the correlation between ABG orders and weaning decisions have shown that ABG values did not really affect clinical decision-making in as high as 93% of cases.[7] A limited number of published studies look at the utilization of ABG in clinical decision-making, and most of them are inconclusive being single center involving a small number of subjects. One such study looking at the usefulness of ABG in patients presenting with acute dyspnea to the emergency department found it to be of limited value, but interestingly, pH was found to be an independent predictor of 12-month mortality, prompting consideration for the substitution of arterial by venous blood in these patients.[8]

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How to cite this article: Pande RK. Arterial Blood Gas: Bowling Wide and Poor Wicketkeeping. Indian J Crit Care Med 2021;25(2):119–120.

Source of support: Nil

Conflict of interest: None

Most ABG utilization surveys have reported a non-utilization of ABG values in clinical decision-making. This single-center prospective observational study looks at two important aspects, reason for ordering the test and application of test result in clinical decision-making.[9] About 70% of the tests were done during regular hours with a large percentage (80%) done without any clear indications. Clinical interventions based on ABG report were made in 26.29% of patients only, and surprisingly among those where metabolic assessment was listed as a reason for doing ABG, the study did not find any reason to assess metabolic status in as high as 93.5% of patients. It just means that critical care physicians and nurses are still ordering ABG routinely more like a habit and not always utilizing the results in clinical practice. Ventilator and FIO_2 adjustments were done only in 13.6 and 0.81% of patients, respectively, which again prompt us to rethink our approach toward casually ordering ABG in ICU. Although a number of attempts at arterial puncture, pain, local hematoma, arterial vasospasm, air or thrombus embolism, hemorrhage, and other complications were not measured, these could have been significant concerns as only about 50% of patients had an indwelling arterial cannula. Even though reported complications are less with arterial cannulation, repeated arterial punctures can increase these complications.

Unnecessarily drawn samples possibly reflect fear of litigation, easy access to arterial lines, routine work patterns in ICUs, and habit.[10,11] As high as 30% of the ABG tests may be unnecessary.[12] Most protocol-based studies have shown a significant 24 to 44% reduction in frequency of ABG sampling after protocol implementation with not much change in safety indicators.[13] However, a computer-based intervention study prompting mandatory display of previous ABG values and oxygen saturations while ordering new tests did not show significant changes in ABG utilization, possibly because a large number of tests were ordered by non-physician users.[13]

Adhering to protocols has been reported to reduce annual costs, which ranged from 10,000 USD in Nepal to 100,000 US dollars in the United States.[12,14] There have also been concerns about blood loss, patient discomfort, and complications related to uncontrolled ABG sampling, which can be reduced if some kinds of protocols or algorithms are followed.[15] In the present study, pain, hematoma, and other complications (not reported) could have been major concerns as only about 50% of patients had an indwelling arterial cannula. Many protocols do not identify indications for ABG sampling, which should be essential component of such protocols to control unnecessary sampling.

Finally, this study brings focus back on effective utilization and better clinical application of ABG, which will help us reduce unnecessary costs and complications associated with arterial puncture. However, these results cannot be generalized as the study suffers from the same drawback as previous studies—single center, smaller number, and limited duration of the study. A larger multicenter longitudinal prospective study looking at the effectiveness of ABG is needed.

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