

Pleural fluid pH – a Litmus Test for Quality Practices?

With the exception of pleural effusions secondary to typical cases of congestive heart failure, many patients with the new onset of a clinically evident pleural effusion will undergo a diagnostic thoracentesis with submission of a pleural fluid specimen to the laboratory for diagnostic assessment¹. Measurement of pleural fluid pH is commonly part of this assessment as the fluid pH can be helpful diagnostically and pH can provide useful prognostic information.

Evaluation of pleural fluid pH highlights the importance of matching clinical accuracy requirements to laboratory testing methodology. While relatively imprecise methods such as pH dipsticks or pH paper may be sufficient for the assessment of urine pH or the investigation of a possible esophageal rupture, these methods fail to meet the precision requirements for pleural fluid testing in most clinical situations.

While normal pleural fluid pH is thought to be approximately 7.63 (relative alkalosis compared to blood), pleural fluid pH below 7.2 can be an important indicator of a complicated pleural effusion requiring drainage. The pH also may be an important piece of information in therapeutic decisions regarding pleurodesis in patients with malignant effusions. But how well can laboratories distinguish a pH of 7.0 from 7.5? This may depend upon a few specific laboratory practices. Take this acid test:

1. Which specimen containers would you accept for measurement of pleural fluid pH?
 - a. Cup with lid.
 - b. Additive-free phlebotomy tube.
 - c. Arterial blood gas syringe.
 - d. Other?

Unless you answered “c” to the first question, you find yourself at odds with the Clinical and Laboratory Standards Institute’s recent guidelines². Anaerobic collection and storage is crucial, as the pH may be overestimated by 0.1-0.2 units if exposed to air³. Either direct collection into a heparinized syringe, or subsequent transfer to a heparinized syringe after collection is considered adequate, although a transfer step may slightly increase pH⁴. The transportation temperature and alacrity of pH testing are probably less important^{5,6}. The use of local anesthetics prior to thoracentesis can slightly depress pleural fluid pH, but the effect is small and the laboratory is usually ignorant of such practices.

2. How does your laboratory measure pleural fluid pH?
 - a. pH paper.
 - b. Point-of-care testing device.
 - c. Laboratory pH meter.
 - d. Blood gas analyzer.
 - e. Other?

Studies have shown that pH paper gives falsely elevated and imprecise measurements of pleural fluid pH, which correlate poorly with blood gas analyzer results^{7,8,9}. Likewise, laboratory pH meters also overestimate pleural fluid pH. The discrepancy between pH meters and blood gas

analyzer pH values is largely related to analytic temperature differences between the methods and variations in exposure to room air. In contrast, some POCT devices capable of measuring blood gases can provide accurate pleural fluid pH measurements¹⁰

A quick review of the pH results for this body fluid Survey (2009 FLD-A) lends credence to the literature data. Among the four major method/instrument groups (blood gas analyzer, pH meter, pH paper, pH dipstick), dipstick and paper analysis were the most imprecise with standard deviations in the range of 0.20-0.40 pH units, too imprecise to reliably discriminate between a pleural fluid pH of 7.10 and 7.30, a clinical decision point. pH meters yielded intermediate levels of imprecision with standard deviations in the 0.12-0.14 pH unit range, while blood gas analyzers were the most precise with peer group SD's that average 0.04-0.06 pH units. Also evident is the high bias of pH paper and dipsticks relative to blood gas analyzers, consistent with published reports, although matrix effects cannot be excluded on the basis of this Survey data alone.

For some clinical decisions in the 7.00-7.30 pleural fluid pH range analytic imprecision may make the difference between the placement of a chest tube and simple pleural fluid drainage, or it could make a difference in clinical decisions regarding pleurodesis. This clinical decision range mandates analytic precision within +/- 0.1 pH unit for pleural fluid pH testing – a range likely attainable by blood gas analyzers but not by pH paper or strips with 0.5 pH unit increments.

Many of you may be reluctant to analyze “gunk” on your critical care instruments. Fortunately, there is no need to determine pH on purulent samples as the need for drainage is clear when the sample is opaque. Additionally, commercial in-line filters are also available to prevent clogging of blood gas analyzers by fibrin or particulate debris.

For additional discussion regarding body fluid pH analysis, please refer to the recently approved CLSI document C49-A, Analysis of Body Fluids in Clinical Chemistry, and to a prior discussion of body fluid pH in the Participant Summary Report FLD-A 2007 by David S. Wilkinson, MD, PhD.

Darryl E. Palmer-Toy, MD, PhD
William W. West, MD

Chemistry Resource Committee

¹ Sahn, S.A., *The value of pleural fluid analysis*. Am J Med Sci, 2008. 335(1): p. 7-15.

² Clinical and Laboratory Standards Institute (CLSI). *Analysis of Body Fluids in Clinical Chemistry; Proposed Guideline*. CLSI document C49-A (ISBN 1-56238-609-3). Clinical and Laboratory Standards Institute, Wayne, Pennsylvania, 2007.

-
- ³ Venkatesh B, Boots RJ, Wallis SC. Accuracy of pleural fluid pH and PCO₂ measurement in a blood gas analyser. *Scand J Clin Lab Invest*. 1999;59(8):619-26.
- ⁴ Haro-Estarriol M, Calderón-López JC, Sabater-Talaverano G, Font Vall-Llobera N, Alvarez-Castillo LA, Sendra-Salillas S. [Influence of the method used to obtain pleural fluid on the determination of the acid-base balance]. *Arch Bronconeumol*. 2008 Aug;44(8):413-7.
- ⁵ Sarodia BD, Goldstein LS, Laskowski DM, Mehta AC, Arroliga AC. Does pleural fluid pH change significantly at room temperature during the first hour following thoracentesis? *Chest*. 2000 Apr;117(4):1043-8.
- ⁶ Haro-Estarriol M, Baldó-Padró X, Lora-Díez M, Rubio-Garay M, Rubio-Goday M, Sebastián-Quetglás F. [Changes in the acid-base equilibrium of pleural fluid during the first 2 hours after thoracentesis]. *Arch Bronconeumol*. 2005 Nov;41(11):612-7.
- ⁷ Lesho EP, Roth BJ. Is pH paper an acceptable, low-cost alternative to the blood gas analyzer for determining pleural fluid pH? *Chest*. 1997 Nov 5;112(5):1291-2.
- ⁸ Chandler TM, McCoskey EH, Byrd RP Jr, Roy TM. Comparison of the use and accuracy of methods for determining pleural fluid pH. *South Med J*. 1999 Feb;92(2):214-7.
- ⁹ Cheng DS, Rodriguez RM, Rogers J, Wagster M, Starnes DL, Light RW. Comparison of pleural fluid pH values obtained using blood gas machine, pH meter, and pH indicator strip. *Chest*. 1998 Nov;114(5):1368-72.
- ¹⁰ Kohn GL, Hardie WD. Measuring pleural fluid pH: high correlation of a handheld unit to a traditional tabletop blood gas analyzer. *Chest*. 2000 Dec;118(6):1626-9.