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The stability of pleural fluid pH under slushed ice and room temperature conditions

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Letter to the Editor

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The stability of pleural fluid pH under slushed ice and room temperature conditions

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To the Editor,

Accurate pH analysis in pleural fluid is essential for patient management. During respiration, pleural fluid functions as a lubricant that surrounds the lungs allowing the two layers of pleura to glide smoothly past each other [1]. Pleural fluid can also diagnose disease and assess trauma [1]. A low pleural fluid pH implies high metabolic activity in the pleural space [2]. Specifically, a pH of less than 7.20 determines the need for chest tube drainage pleural effusions caused by pneumonia [2]. The pH in pleural fluid is also a predictor of survival in those with malignant pleural effusions [3].

One issue laboratories encounter pertains to the stability of pH in pleural fluid. Few published studies demonstrated that pleural fluid was stable for 1 h at room temperature when stored in plastic syringes [2, 4]. Still, by 4 h at room temperature, significant increases in pH occurred [2]. Due to the lack of data, my study aimed to examine the stability of pleural fluid pH specimens stored at room temperature and in slushed ice using plastic syringes without air. As these specimens were not kept on ice [2, 4], the stability of specimens kept on ice is unknown.

This observational, prospective cohort study was completed between September 2020 and December 2021. The UC Davis Institutional Review Board determined that this project (ID no. 1469859-1) was exempt from review since no human subjects were used, and no patient-identifying information was obtained.

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Pleural fluid pH specimens were analyzed at the UC Davis Medical Center's blood gas lab, a CLIA accredited laboratory. All specimens were assessed to ensure no air was left inside the syringe at any time. As blood gas analyzers are the correct instruments for pleural fluid pH analysis rather than a pH meter or pH indicator paper [5], all specimens were analyzed by one Siemens RapidPoint 500 blood gas analyzer. The specimens were analyzed first for patient care and then de-identified for this study. All specimens were obtained using 3 mL Portex Line Draw Arterial Blood Sample Syringes that contained 23.5 IU of dry lithium heparin neutralized for ionized calcium per mL (Ref: 4042-2, Smiths Medical, ASD, Inc., USA).

To determine the measurement error in pleural fluid pH analysis from the analyzer, 20 specimens were analyzed twice each, within 5 min of each other. The within-analyzer standard deviation (SD) was the measurement error, but only if the within-analyzer variability was not related to the magnitude of measurement [6]. Kendall's Tau correlation coefficient assessed the association of the absolute difference between the two measurements against its mean [6]. If the correlation was insignificant, then a one-way analysis of variance was used to calculate the within-analyzer SD. If the correlation was significant, then the mean pH value of both tests was log-transformed, and a one-way analysis of variance calculated the within-analyzer log-transformed SD. The square root of the residual mean square error was the within-analyzer SD [7]. Then, repeatability was calculated as 2.77·within-analyzer SD [7]. The repeatability indicates the analyzer's minimum detectable change. A change within the repeatability value would not be considered an actual change 95% of the time, as the analyzer's variability would mask it.

Once the within-session repeatability was known, the stability portion of the study began. New specimens were placed on ice or stored at room temperature for about 150 min. Each syringe was analyzed at baseline and then at three additional time points. Kaplan-Meier survival analysis was employed [8] to determine the time at which 5% of the specimens exceeded a change of more than 0.040 pH units. According to the Royal College of Pathologists of Australasia [9], the 0.040 pH unit criteria were chosen

because that value is the maximum acceptability for between-analyzer comparisons.

Twenty pleural fluid pH specimens were measured for intra-session repeatability. The pH values ranged from 7.111 to 7.568 and followed a normal distribution (Shapiro–Wilk test, W=0.92, p=0.12). The within-analyzer SD was 0.00656 pH units, and the repeatability was 2.77· 0.00656=0.018 pH units=the minimal detectable change of the analyzer. The within-syringe SD was the measurement error since the absolute difference between the two measurements plotted against the mean was not correlated (Kendall's Tau=0.08, p=0.67).

At baseline, the pH for the 121 pleural fluid specimens ranged from 7.002 to 7.614 pH units (mean=7.415, SD=0.0962). Sixty-one pleural fluid pH specimens were stored at room temperature (22–24 °C) for up to 394 min (mean=147 min) and 60 pleural fluid pH specimens were stored in slushed ice (0.2–0.4 °C) for up to 320 min (mean=156 min). Thus all specimens were measured at four different time points. Furthermore, visual observation was used to examine all specimens to ensure the absence of air.

At room temperature, 26 of 61 specimens (43%) demonstrated a change of >0.040 pH units over the measurement period. Specifically, compared to baseline, six samples showed a difference between 0.041 and 0.050 units, three samples showed a change of 0.051–0.060 units, seven samples showed a change of 0.061–0.07 units, and 10 samples showed a change of ≥0.071 units. Five percent of the specimens stored at room temperature exceeded 0.040 pH units by 58-min postsampling (Figure 1).

Under slushed ice conditions, six of 60 specimens (10%) exceeded a change of >0.040 units over the measurement period. Specifically, compared to baseline, one sample showed a change between 0.041 and 0.050 units, two samples showed a difference of 0.051–0.060 units, two samples showed a change of 0.061–0.070 units, and one sample showed a change of ≥0.071 units. Five percent of the specimens exceeded a change of >0.040 pH units by 135-min postsampling (Figure 1). The proportion of specimens that demonstrated a change of >0.040 pH units at room temperature was more than under slushed ice conditions (37% difference between two conditions, 95% CI=22–50% difference between two conditions, Chi-square=22.1, p<0.001).

This study determined that pH pleural fluid specimens stored at room temperature can be analyzed within an hour of the draw time. When stored in slushed ice, samples can be analyzed within 2 h and 15 min of draw time if plastic blood gas syringes are used. In agreement with

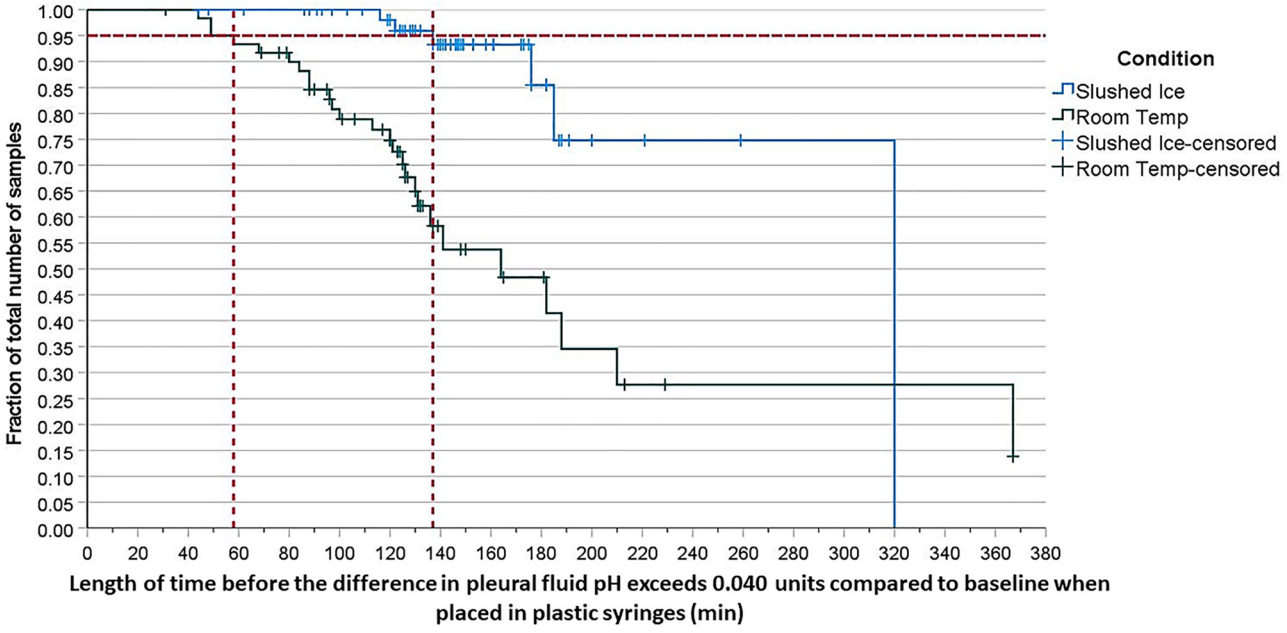

Figure 1: Kaplan–Meier survival analysis depicting the length of time before pleural fluid exceeds 0.040 units when placed in a plastic syringe. Five percent of the samples exceeded 0.040 pH units at 58 min at room temperature. Five percent of the samples exceeded 0.040 pH units at 135 min when stored in slushed ice. The overall difference between conditions was statistically significant (log-rank [Mantel–Cox] chi-square=16.8, p<0.001). The word "censored" in the figure means that the change in pH>0.040 units compared to baseline was not observed in some samples before study termination. Thus, the survival time in some samples was unavailable.

others [2, 4] pleural fluid pH was stable for up to an hour at room temperature. However, those specimens were not measured under slushed ice conditions [2, 4]. This study adds novelty to the literature as the stability on ice is now determined to be 2 h 15 min (when there is no residual air remaining in syringes).

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Competing interests: The author states no conflict of interest.

Informed consent: Not applicable.

Ethical approval: The local Institutional Review Board deemed the study exempt from review.

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