Effects of High atmospheric CO2 on Serum Total Carbon-dioxide Determination

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Background:

Clinical utility of serum total CO_2 (TCO_2) is identifying of respiratory alkalosis and metabolic acidosis, especially acid-base derangement in chronic kidney disease [1-2]. Typically, falsely low amounts of TCO_2 trends can be found in routine analysis when exposure of the sample to air causes the loss of TCO_2. It will allow loss of TCO_2, up to 4-6 mmol/L in an hour [3-4]. Less is known about an irregular high CO_2 in the atmosphere impact the outcome of TCO_2 measurement.

Materials and Methods:

Core Laboratories in University Hospital

Building 1 and SDMC laboratories (Faculty of Medicine Ramathibodi Hospital, Mahidol University, Bangkok, Thailand) is approximately 0.4 mile apart. The SDMC building is located at the road intersection, which is one of the worst areas for traffic. Atmospheric CO_2 levels of Building 1 and SDMC laboratories were ranged from 528 to 831 ppm and 776 to 1917 ppm, respectively. Both laboratories implemented the Six Sigma for evaluating the quality of laboratory results.

Determinations of CO_2

TCO_2 measurement in both laboratories was performed using the enzymatic assay (Abbott Laboratories, IL, USA). Atmospheric CO_2 was determined by using TSI Quest™ Environmental Monitors (TSI Incorporated, MN, USA).

To investigate the effect of atmospheric CO_2 on the determination of TCO_2, we made repeated measurements of TCO_2 in three different levels of control material over a one-day period, run 5 times per run. Simultaneously in both Building 1 and SDMC laboratories, the levels of atmospheric CO_2 were determined.

Results

With regards to Building 1 (Fig 1A), not only the measuring TCO_2 concentrations of each control material but also the atmospheric CO_2 in any time were quite stable. By contrast, the measuring TCO_2 concentrations of all control levels for SDMC (Fig 1B) were clearly increasing during 10am to 4pm with the peak at 12pm which related to increase the atmospheric CO_2. The %CV of TCO_2 obtained from SDMC (range from 6.6% to 10.7%) were higher than those from Building 1 (range from 3.2% to 4.3%).

TCO_2 at critical medical decision level showed the acceptable performance for Building 1 (5-Sigma) but did not for SDMC (2-Sigma).

Conclusions

The atmospheric CO_2 is an important environmental factor resulting to variability in determination of serum TCO_2. Irregular high atmospheric CO_2 may dissolve in the sample, leading to falsely high values. Due to the atmospheric CO_2's great effect on bias and imprecision of measurement procedure, more stringent QC strategy and more frequently check standardization curve may be necessary.

References

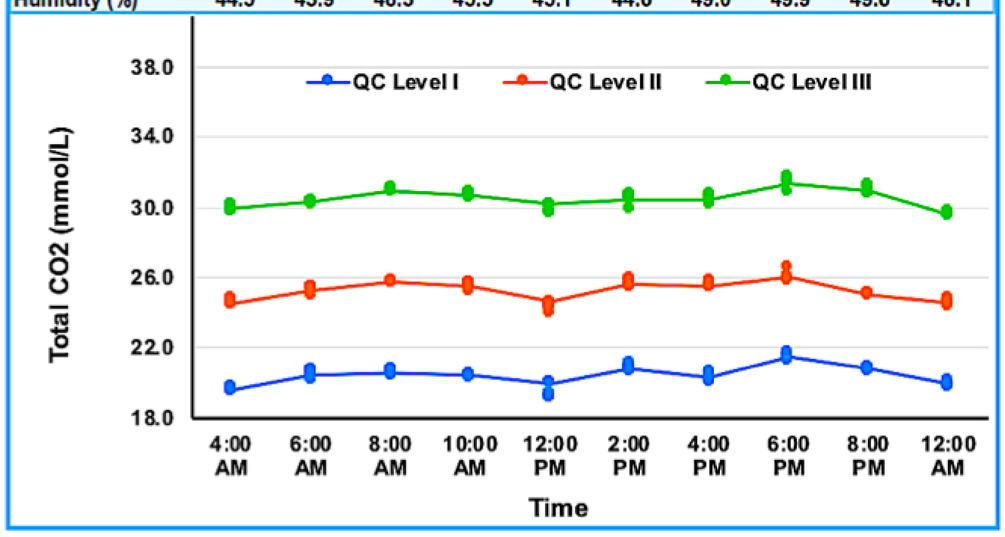
1. Fencl V, Jabor A, Kazda A, Figge J. Diagnosis of metabolic acid-base disturbances in critically ill patients. Am J Respir Crit Care Med 2000;162:2246-51.
2. Kraut JA, Madias NE. Metabolic acidosis of CKD: An update. Am J Kidney Dis 2016;67:307-17.
3. Scott MG, LeGrys VA, Hood JL. Electrolytes and blood gasses. In: Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 5th ed. (Burtis CA, Ashwood ER, Burns DE, Eds), St Louis, Missouri: Elsevier Saunders; 2012; pp. 807-35.
4. Bray SH, Tung RL, Jones ER. The magnitude of metabolic acidosis in dependent on differences in bicarbonate assays. Am J Kidney Dis 1996;28:700-3.

Figure 1 Measuring amount of TCO_2 concentrations in samples and atmospheric CO_2 from Building 1 (A) and SDMC (B) laboratories.

A

Building 1 Laboratory

Atmospheric CO_2 (ppm)	592	692	677	831	674	772	707	625	590	528
Temperature (°C)	20.0	22.4	23.3	23.7	22.4	20.7	20.6	20.3	20.1	20.2
Humidity (%)	44.5	43.9	48.3	45.5	45.1	44.6	49.0	49.9	49.6	48.1



B

SDMC Laboratory

Atmospheric CO_2 (ppm)	776	861	1148	1539	1917	1778	1628	1444	1170	896
Temperature (°C)	22.6	23.6	24.9	25.4	24.4	24.4	24.0	24.2	24.0	23.2
Humidity	42.0	42.0	42.0	42.0	42.0	41.0	41.0	42.0	42.0	42.0