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Title: COMPUTER CORRECTION FOR POOR HIGH FREQUENCY PEFORMANCE OF A CENTRAL MASS SPECTROMETER SYSTEM

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Introduction. We have previously reported that the long sampling catheters necessary to access a central mass spectrometer (MS) restrict the upper breathnig frequency at which CO_2 values may be determined accurately (1,2). Errors as large as 10% may occur at 40 breaths per min. We have developed a computer program to correct these values as a function of frequency.

Methods. The MS investigated was a clinically operating Perkin-Elmer Advantage system servicing 12 operating rooms. Square wave changes in CO_2 were created by an electronically driven solenoid valve which switched between 1.2% CO_2 in O_2 simulating inspiration and 7.4% CO_2 in 50% O_2 balance N_2 simulating expiration. The frequencies of the changes were varied from 12 to 80 breaths/min. The catheter length between the outlet of the valve and the MS was 50 meters. The inspired and expired data stream was captured from the serial communications port of the MS directly onto disk by an IBM-PC. A program written in BASIC extracted data for analysis and correction.

Results. Least squares analysis of inspiratory and expiratory data revealed that the system frequency response for CO_2 values could be described by a fourth-order equation of the form:

$$\% \text{ error} = 100\ (1 - Fn/(Fn^4 + F^4)^{-4})$$

where F is the independent frequency and Fn is the frequency where a 16% error occurs. It was possible from this equation to calculate a factor as a function of frequency which when multiplied times the value of CO_2 at that frequency corrected the observed value to within 0.15% absolute of the true value for frequencies up to 80 breaths/min (Table). The correction was effective for both inspired and expired CO_2 values.

Discussion. It is possible for the respiratory rate of a child under halothane anesthesia to exceed 60 breaths/min. Notwithstanding the physical problems of obtaining a valid end-tidal CO_2 sample at this frequency, the analysis system must have an accurate response above this frequency if valid data are to be presented. This operating room MS system was incapable of meeting this requirement. We have shown that it is now possible to correct the system errors for frequency and present accurate CO_2 data to the anesthetist.

References.

1. Scamman FL, Fishbaugh JK: Frequency response of long mass-spectrometer sampling catheters. Anesthesiology 65:422-25, 1986
2. Scamman FL: Accuracy of a central mass spectrometer system at high respiratory frequencies. J Clin Monit (in press)

TABLE

Breaths/ minute	Inspired $\%CO_2$ Meas	Corr	Expired $\%CO_2$ Meas	Corr
8	1.23	1.22	7.42	7.42
13	1.30	1.26	7.39	7.39
20	1.41	1.24	7.39	7.39
25	1.58	1.24	7.38	7.39
41	2.54	1.34	7.30	7.36
80	4.53	1.24	6.73	7.43

Meas = measured from serial port
Corr = corrected by BASIC program