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MONTE-CARLO SIMULATIONS OF COMPUTATIONAL GAS EXCHANGE ALGORITHM IN INDIRECT CALORIMETRY. P. Reischl, K. Molavi, and C.E. Bodwell. Dept. of Electrical Engineering, San Jose State Univ., San Jose, CA 95192, and Energy and Protein Nutrition Laboratory, Beltsville Human Nutrition Research Center, Agricultural Research Service, USDA, Beltsville, MD 20705.

Brown et al. [Med. & Biol. Engr. & Comput. 22: 333-338, 1984] describe mathematical algorithm to determine rapid change in metabolic gas exchange in subjects living in whole-body calorimeter. To investigate the robustness of their algorithm to experimental and instrumentation noise, we performed Monte Carlo simulations consisting of 1000 trials on this algorithm with data generated from a model of calorimeter. Model consists of 2 differential equations with non-constant coefficients, relating chamber gas concentrations, volume, chamber ventilation rate, and metabolism and solved using 4th order Runge-Kutta numerical method. We introduced perturbations into chamber by fluctuating helium gas and subsequently added additional 1% random Gaussian noise to variables. The mathematical algorithm recovers metabolic gas exchange accurately in the absence of 1% Gaussian noise but shows large deviations from expected mean values with noise presumably due to the non-Gaussian interactions in the computational algorithm. Cubic splines fit with smoothing applied to numerical data prior to insertion into algorithm shows much improvement to gas exchange estimates, although does not completely unbiased the estimate. [Supported in part by ARS Grant CA #58-32U4-4-669]

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A MODIFIED PNEUMOTACHOMETER FOR USE DURING HIGH FREQUENCY VENTILATION (HFV). J.R. Clarke, G. Atlas and E.T. Flynn. Naval Medical Research Institute, Bethesda, MD 20814-5055

The frequency response and phase characteristics of conventional screen pneumotachometers, largely determined by the pressure transducers associated with them, deteriorate above 20 Hz. To improve flow measurements during HFV we used two Millar catheter-tip transducers to measure pressure across the resistive element of a Rudolph screen pneumotachometer. A third identical transducer was used as a reference for phase information. Using sinusoidal and random flows from 3 to 100 Hz generated by a loudspeaker we computed cross-spectra between the reference and flow signal using a Fast Fourier Transform Analyzer. With a conventional flowmeter, phase varied as much as 45° per 10 Hz. With the Miller transducers, phase varied less than 2° from 3 to 100 Hz. The flow amplitude was flat up to 85 Hz. By replacing the conventional connectors and tubing with solid state components, the flowmeter was able to function at frequencies far in excess of normal HFV frequencies. This modification is especially useful for phase sensitive measurements, as in the calculation of power. In addition, the requirement for flowmeter nulling has been eliminated.

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OPTIMIZATION OF AN ACOUSTICAL PARTICLE GENERATOR. D.G. Frazer, V.A. Robinson, K. Jayaraman, D.A. Rose and K.C. Weber. DRDS, NIOSH, Morgantown, WV 26505.

A particle generator has been described for resuspending inspirable particles contained in cotton dust (Tox. Appl. Pharmacol. 76: 544, 1984). This generator, a modification of the ATM Sonic Sifter, consists of a loudspeaker enclosed in a wooden base which is acoustically coupled to a vertical plexiglass cylinder. The cylinder is sealed at both ends with thin latex rubber dam material. In operation, movement of the speaker cone vibrates the bottom latex rubber dam which in turn vibrates the air column in the plexiglass tube and the top latex dam. When bulk cotton dust is placed inside the plexiglass chamber, small particles are loosened by the dust's tumbling action and are suspended in air by acoustical energy. The small particles are removed from the generator by air flowing through the plexiglass tube. In the past the generator has been operated at 60 Hz with a speaker voltage of 6-9 volts RMS. Under these conditions the output dust concentration decreases exponentially with time having a time constant (T) of 45 min. By optimizing generator performance using acoustical spectral measurements, generator stability has been greatly increased. Values of T up to 1100 min have been achieved by operating the speaker at its optimum frequency (27-32 Hz). Increased stability makes this generator ideally suited for animal exposure studies.

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FLUID MECHANICAL MODELS FOR HIGH FREQUENCY PISTON PUMP OSCILLATORS. F. Moslehi, J.R. Ligas, and M.A.F. Epstein. Departments of Anesthesiology, Pharmacology and Surgery, Univ. of Connecticut Medical School, Farmington, CT 06032.

A theoretical study of the mechanics of piston pump oscillators, based solely on fluid dynamics principles, has provided new insights into the physical processes affecting operation of such HFV ventilators. Three different flow models (incompressible, isothermal, and adiabatic) were used to solve the equations of motion of a gas (air) through the oscillator. All three models predict transfer of energy from the fundamental mode, as determined by the frequency of the piston motion, to higher harmonics. The classical fluid dynamics approach allows calculation of the thermodynamic state, velocity and volume of the delivered gas. It also predicts the phase relations between the piston motion, and velocity and pressure of the flow produced. These models show remarkable agreement with experimental data especially with regard to higher harmonics and phase relationships, and have identified dimensionless groups important for improved design of several classes of high frequency ventilators.

The isothermal model was also used to rederive several widely used inertia, resistance, compliance (IRC) models. Previous IRC models are incapable of representing certain significant features of oscillator flows. In contrast, our fluid dynamics derivation allows more accurate estimate of volume flow, and provides expressions for direct calculation of the parameters of the IRC model. (Supported in part by NIH grant R01-HL29723 and Am Lung Assoc of Conn).

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A NOVEL COMPUTER CONTROLLED SYSTEM FOR MONITORING AND ANALYSIS OF TELEMETRIC ELECTROCARDIOGRAMS IN UNRESTRAINED PRIMATES. D. Price, M. Wilson, R. Lewis and A. Verlangieri. Atherosclerosis Research Laboratories, Dept. Pharmacology, Sch. of Pharmacy, Univ. of Mississippi, University, MS 38677.

This system consists of three components: 1) telemetry hardware, 2) an IBM PC and interfacing hardware, and 3) data collection and analysis software. The telemetry hardware, which is available from Konigsberg Instruments (Pasadena, Calif.) includes self-contained, implantable transmitters (T4C) that convert cardiac electrical activity into an FM signal which is received by antennae attached to the walls of a primate social room that measures approximately 3x3x3 m. A demodulator unit then reconverts the signal and amplifies it to a + or - 1V (max) level. The interface hardware provides necessary additional amplification and rectification before the signal is digitized by an A/D converter. The data collection program samples the A/D output 1024 times/sec and places the result of each conversion in memory for later storage in disk files. The analysis programs reconstruct the electrocardiographic activity which may then be analyzed for a variety of quantitative characteristics (e.g., rate, inter-beat interval, P,Q,R,S,T amplitudes and durations). This information is then displayed on a CRT, printer or graphics plotter. Described are system advantages, transmitter implant techniques, antennae and signal conditioning requirements, program algorithms, and sample data. This system has been used in both rabbits and non-human primates. (Supported by the AHAF, Wash., D.C.)

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DEVELOPMENT OF A QUANTITATIVE AUTORADIOGRAPHY IMAGE ANALYSIS SYSTEM. T.J. Hoffman, W.A. Volkert, and R.A. Holmes (SPON: M. Zatzman). Research Service, Harry S Truman Memorial Veterans Hospital and Department of Radiology, University of Missouri, Columbia, MO 65201.

A low cost image analysis system suitable for quantitative autoradiography (QAR) analysis has been developed. Autoradiographs can be digitized using a conventional Newicon television camera interfaced to an IBM-XT microcomputer. Software routines for image digitization and capture permit the acquisition of thresholded or windowed images with graphic overlays that can be stored on storage devices. Image analysis software performs all background and non-linearity corrections prior to display as black/white or pseudocolor images. The relationship of pixel intensity to a standard radionuclide concentration allows the production of quantitative maps of tissue radiotracer concentrations. An easily modified subroutine is provided for adaptation to use appropriate operational equations when parameters such as regional cerebral blood flow or regional cerebral glucose metabolism are under investigation. This system could provide smaller research laboratories with the capability of QAR analysis at relatively low cost.