

Abstracts of Original Contributions: Computer Applications

The American College of Cardiology received 84 abstracts of original contributions involving computer technology. Six will be presented at an oral session on Tuesday and fifteen will be presented at poster sessions scheduled throughout the week. These may be found elsewhere in this issue of *JACC*. In addition, twelve abstracts have been scheduled for demonstration at info@ACC, a new area in the exhibit hall which will bring together activities related to computer technology. These are featured below.

In addition, the info@ACC area will feature a series of presentations related to Internet, a series of presentations on enhancing productivity using computer technology, hardware and software advising, as well as displays of computer-related ACC products.

Many excellent programs are planned, and we look forward to an exciting meeting.

Alfred A. Bove, MD, FACC
Chair
Information Technology Committee

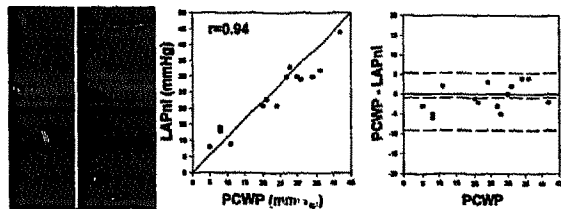
1050 Left Heart Analysis by Computer

Monday, March 25, 1996, 9:00 a.m.—12:30 p.m.
Orange County Convention Center, Hall C

1050-1 Computer-Assisted Noninvasive Measurement of Left Atrial Pressure

Jeffrey S. Soble, James H. Stein, Kuang-Lung Wu, Alex Neumann, Dae H. Kim, Joseph E. Parrillo, James Robergé, Richard H. Marcus. *Rush Medical College and Illinois Institute of Technology, Chicago, IL*

Left atrial pressure (LAP) can be measured from the diastolic blood pressure and mitral regurgitation (MR) Doppler spectrum, but this method is cumbersome and requires meticulous evaluation of hard-copy recordings. We developed and evaluated custom software which processes digital MR Doppler signals for use in measurement of LAP. *Methods:* Digital MR and aortic valve Doppler spectra were recorded in 14 patients during pulmonary artery catheterization. The interval from the ECG R-wave to aortic valve opening (AVO) was determined from the aortic valve Doppler. MR spectra were processed by averaging grey levels of individual ECG-gated pixel coordinates from 5–10 beats. The signal-averaged MR spectrum was used to determine the LV-LA gradient at AVO, which was subtracted from aortic diastolic pressure to give LAP. *Results:* Signal averaging (right picture) enhanced the spectral MR image, improved the signal:noise ratio, and facilitated identification of MR velocity at AVO. The correlation between invasive pulmonary wedge pressure (PCWP) and noninvasive LAP (LAPni) was good, with a bias of -0.9 ± 6.6 mmHg ($\pm 2SD$) and individual discrepancies of 6 mmHg or less.



Conclusions: Signal averaging enhances the sharpness of the MR Doppler envelope, and facilitates the computer-assisted measurement of LAP. This novel technique may improve other quantitative methods based on the MR Doppler spectrum and make possible accurate, fully-automated LAP determination.

1050-2 Accuracy of Computer-Generated Synthetic M-mode for Left Ventricular Regional Wall Thickening

Michael R. Bauer, Jeffrey S. Soble, Inhee Song, Alex Neumann, Philip R. Liebson, Joseph E. Parrillo, James Robergé, Richard H. Marcus. *Rush Medical College, Illinois Institute of Technology, Chicago, IL*

The clinical utility of wall thickening as a translation-independent quantitative parameter of regional left ventricular (LV) systolic function is limited by tedious data acquisition and loss of temporal continuity using 2-dimensional (2D) stop-frame images. We have shown that computerized redisplay of regional 2D data in M-mode format facilitates quantification of wall thickening in anterior and posterior (AP) segments, but this has not been evaluated in segments in the medial and lateral aspects of the 2D sector, where scan line density and specular definition are less. *Methods:* Digital 2D LV short axis images were acquired from 14 patients, along with conventional subcostal M-mode (M-conv) through the inferoseptal (IS) and posterolateral (PL) walls. An IS to PL synthetic M-mode (M-synth) was generated from the 2D cine loop using custom software. The IS and PL end-diastolic and end-systolic wall thicknesses [h(ed), h(es), mm] from M-synth and 2D images were compared with M-conv values. *Results:* Values are mean \pm SD ($^* = P < 0.01$). There were no significant differences between M-synth, 2D and M-conv values, for both the IS and PL walls, other than PL h(ed), which was overestimated by 2D. *Conclusions:* Computer generated synthetic M-mode facilitates accurate measurement of regional wall thickness in segments out of the AP dimension, and may be a clinically accessible method for translation-independent quantification of regional systolic function.

	M-conv	2D	M-synth
h(ed)-IS	9.8 \pm 2.4	9.9 \pm 2.3	10.0 \pm 2.7
h(es)-IS	14.3 \pm 3.5	13.4 \pm 3.5	14.3 \pm 4.0
h(ed)-PL	9.1 \pm 1.7	10.5 \pm 1.8*	9.6 \pm 2.3
h(es)-PL	14.6 \pm 3.1	14.8 \pm 2.9	15.0 \pm 2.7

*P < 0.01

1051 Computer Models of Cardiac Function

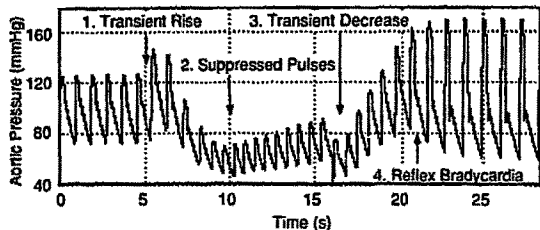
Monday, March 25, 1996, 1:30 p.m.—5:00 p.m.
Orange County Convention Center, Hall C

1051-1 Computer Model That Characterizes Hemodynamics During Cardiac Tamponade and the Valsalva Maneuver

Ying Sun, Mazen Beshara¹, Richard J. Lucariello¹, Salvatore A. Chiamarda¹. *University of Rhode Island, Kingston, RI; ¹ Our Lady of Mercy Medical Center, Bronx, NY*

A comprehensive model that incorporates heart rate-arterial pressure feedback into an electrical analog model was developed to simulate complex physiological conditions such as cardiac tamponade and the Valsalva maneuver.

ver. Cardiac tamponade, characterized by the equalization of end-diastolic pressures in all chambers, involves coupling among chambers in the pericardium. Valsalva maneuver, forced expiration against a closed glottis, involves coupling between the intrathoracic pressure and the cardiovascular system. The model was implemented on a Macintosh computer and was used to predict hemodynamic consequences of increasing intrapericardial pressure and intrathoracic pressure. The Valsalva maneuver was simulated by increasing the intrathoracic pressure by 40 mmHg during a 10-second period. As shown by the following figure, the model predicted the four phases of change in arterial pressure.



The model accurately characterizes hemodynamics during cardiac tamponade and the Valsalva maneuver and should be useful for studying the baroreflex regulations in the cardiovascular system.

1051-2 A Prognostic Computer Model to Predict Individual Outcome in Interventional Cardiology—The INTERVENT Project

Michael Haude, Thomas Budde¹, Hans W. Hoepf², Sebastian Kerber¹, Guido Caspari, Guido Faßbender², Maria Fingerhuth¹, Erland Erdmann², Günter Breithardt¹, Raimund Erbel, Manfred B. Wischniewski³, *Cardiology Department University Essen, Essen, Germany; ¹ Medical Clinic and Policlinic, Internal Medicine C, Westfälische Wilhelms-University Münster; ² Clinic III for Internal Medicine, University Cologne, Germany; ³ AI-Laboratory, University of Bremen, Germany*

Coronary balloon angioplasty (PTCA) has become a more frequently applied therapeutic tool to treat coronary artery disease. Despite extensive improvement in operator experience and balloon catheter technology certain limitations of PTCA still persisted. Primary success rate is about 90% and peri- and postprocedural complications include acute coronary artery closure with evolving myocardial infarction, hemodynamic collapse and death. Several retrospective and/or prospective univariate or multivariate analyses revealed risk factors for the development of PTCA associated complications. Nevertheless, individual outcome with respect to PTCA associated complications is not prospectively predictable.

The purpose of the INTERVENT project is 1.) to redefine complications associated to coronary interventions including alternative or adjunctive techniques to PTCA, and 2.) to set up a prognostic computer model to predict individual outcome after coronary interventions, and 3.) to compare results to those of conventional statistical techniques.

During the pilot phase of the project data of 400 consecutive patients undergoing coronary interventions were collected in computer based case record forms including 2450 items. By applying an inductive acquisition method based on the probabilistic inference technique our proposed system can generate decision rules for characterizing patients at high risk to undergo coronary interventions. Based on the patient data base of the pilot phase this method can detect the inherent probabilistic patterns in the data in form of explicit production rules with the associated probabilistic weight of evidence. Thereby, high and low risk patients can be classified by only 40 parameters with a precision of 95%. These include the presence of antithrombotic therapy, the extent of coronary artery disease, angina class, stenosis morphology, hyperlipoproteinemia and concomitant medication. New cases can be classified quickly and accurately by entering individual data for the previously evaluated 40 key items to the computer software.

1052 Time and Frequency Analysis of Cardiac Rhythms

Tuesday, March 26, 1996, 7:30 a.m.—11:00 a.m.
Orange County Convention Center, Hall C

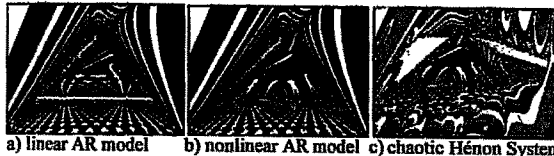
1052-1 Interactive Computer Program for Linear and Nonlinear Analysis of PP- and PR-Time Series From Holter ECG

Lutz Klinghammer, Eckhard Meisel, Henry Kocpsek, Werner G. Daniel. *Div. of Cardiology, University Clinic Dresden, Germany*

The dynamics of alternans in times series (TS) of RR, PP, PR, PQ and other ECG intervals are the result of a complex system involving divergent influences of the sympathetic and parasympathetic autonomic nervous system.

Our newly developed system can record and analyze real time ECG signals, as well as any digitized ECG (formats: AHA, MIT, CSE, Holter systems). The algorithm calculates the PP, PR and RR TS using virtual trigger points. Nonlinear analysis needs a careful ECG segment-selection and a high accuracy (≤ 2 ms) in measurements. For this reason the program includes various tools for interactive single P-wave and QRS-complex editing, and trigger point interpolation (square regression) for lower sample rates (≥ 125 Hz). For short TS segments we have adapted an autoregressive (AR) linear model in a tracking mode. The methods of non-linear analysis are based on two-dimensional discrete systems. The results in the phase plane of each TS segment can be displayed and compared in color coded plots (figure).

Detection of nonlinearity in PR time series



Particularly for identification of small changes in the balance of the autonomic system (e.g. the regulation of conduction) and for evaluation of prognostic parameters the combination of linear and nonlinear models is important.

1052-2 Time-Frequency Analysis of Heart Rate Variability Signal Using Wigner Distribution

Ahmet Birand, Sokol Saliu¹, Gulmira Z. Kudaiberdieva. *The University of Cukurova, Department of Cardiology, Turkey; ¹ The University of Cukurova, Department of Electronics, Turkey*

Considering the nonstationarities observed in heart rate perturbation, extracted from short term ECG recording, we used time-frequency representation, namely smoothed Wigner Distribution (SPWD), complemented by spectrogram, to assess and evaluate those nonstationarities.

Fifteen apparently healthy persons (mean age 20 to 30 years) without signs of cardiovascular and neurological disorders entered this study. ECG recordings of 7.5 minutes were obtained from each subject during steady supine and head-up tilting positions with simultaneous assessment of blood pressure and respiration rate. Nonparametric (Fourier) spectral estimates usually show two low frequency components below 0.15 Hz (VLF, LF), and one high frequency (HF) component around 0.3 Hz.

The SPWD shows that in steady supine position the HF frequency component is stable, i.e., it manifests small smooth changes over time, which can be attributed to its close relation with respiration. On the other hand, LF components show burst-like activity in time. The VLF and LF components seem to be interrelated and possess high local energies. Head-up tilting produces a uniform reduction of HF energy and increases the burst-like activity of the LF components. The nature of LF components' nonstationary needs to be established.

The clinical study shows that SPWD is a useful tool in the assessment of temporal changes of the HRV and provides additional information about the nature of cardiac autonomic regulation.