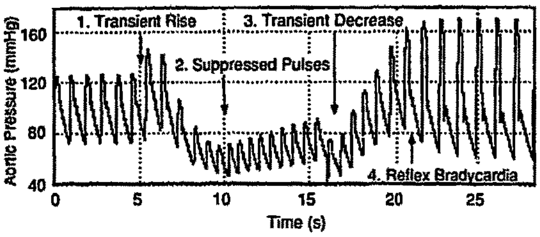
ver. Cardiac tamponade, characterized by the equalization of end-diastolic pressures in all chambers, involves coupling among chambers in the pericardium. Valsalva maneuver, forced expiration against a closed glottis, involves coupling between the intrathoracic pressure and the cardiovascular system. 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

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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 collaps 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 concommitant 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

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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 ($\leq$ 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 ($\leq$ 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

a) linear AR model b) nonlinear AR model c) chaotic Hénon System

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

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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 asses 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.