Computer technology has become an integral part of cardiovascular monitoring in the ICU. No modern monitor is without an underlying computer to allow visualization of vital signs, analyze biological signals or perform calculations on the basis of measurements (MS), such as cardiac output, heart rate, blood pressure (BP), wedge pressure (WP) to derive parameters such as left ventricular systolic work \((Sv \times BP_{systolic} - WP)\).

Beyond these simple calculations, the computer is a precious aid for two different important purposes: (1) the graphic display of data and (2) signal analysis.

**Graphic Display of Data**

The simplest way of presenting data is through a numeric display. The numbers are presented to the operator in different colors next to the graphs from which they were derived or within windows if the data were calculated from a continuous signal (e.g. thermodilution curve). This is the most commonly used format found in ICU displays, but it has its disadvantages. When the data are numerous (such as in classic hemodynamic and metabolic monitoring), the numbers may be presented in a disorderly fashion which is difficult for the inexpert eye to interpret.

The second mode is the presentation of graphic trends. This is probably the mode intensive care physicians around the world are most used to. In this way, even minimal variations in vital parameters are easily read, but the problem of simultaneous reading and interpretation of numerous trends remains. This may create difficulties in reaching a rapid diagnosis and subsequent therapeutic decision.

The profilogram display is the third mode of presentation. In this mode, the parameters are displayed as horizontal bars with intelligent alarms which sound if a parameter falls outside the normal range. Diagnostic interpretations may be automatically presented (e.g., alterations in contractility, preload or afterload), and anticipate the third modality - the so-called ecological interface.

The latter method consists of an even more sophisticated data analysis system which often presents plots in such a way so as to enable comparisons and facilitate interpretations. An example of this type of sophisticated control is the recording of left ventricular pressure/volume curves.

It would seem obvious that the use of sophisticated systems such as those described above permits the physician to obtain the best performance in terms of diagnosis and therapy. However, this has not yet been proven.
A study conducted at the University of Bonn and published less than a year ago [1] examined the behavior of 20 anesthesiologists of varying levels of experience in the face of a hemodynamic situation which was presented in three ways: (1) trends, (2) profilograms and (3) ecological interface. The experiment was conducted using a dual compartment circulation model which was a simplified version of Tham's model [2]. Heart rate (HR), left atrial pressure (LAP), systolic blood pressure (BP), and blood volume (BV) were presented as trends. HR, cardiac output (CO), LAP, systolic BP and BV were presented in profilograms. HR, LAP, CO, systolic BP and left ventricular pressure/volume curves were presented in the ecological interface modality.

The anesthesiologists were each given two attempts to diagnose and correct hemodynamic alterations using each of the three modes of presentation. Corrections were effected by acting on one or more of the following: (1) vasomotor tone, (2) HR, (3) left ventricular contractility, (4) BV (adding or removing fluid).

The first and most interesting observation was that there were no statistically significant differences between the performances of physicians when they were grouped according to years of experience. The second observation was that the ecological interface display gave the best results (87% proper problem solving) followed by the profilogram display (81%) and then by the trends display (61%). Repeating the test did not improve the results for the trends display but did for the other two, especially for the profilograms.

This seems to support the hypothesis that the use of sophisticated monitoring systems improves physician performance, but this is not necessarily true.

The above mentioned study also evaluated the amount of time and effort that the anesthesiologists used to obtain their results with each of the three modalities. Advanced measurements were undertaken, such as the recording of the number of eye movements during the test, the number of times that adjustments were made to the various parameters (vasomotor tone, contractility, BV, HR), the difference between adjusted values and normal values at the end of the test.

This ulterior analysis showed that, even though the advanced methods gave better results, these were reached through a greater expense of time and effort. Therefore, the authors concluded that the best global performance was offered by the trends display. The reason for this is that anesthesiologists are much more familiar with this type of display. At the present time, the trends display provides the most rapid way for the anesthesiologist to formulate the correct diagnosis.

This study is of fundamental importance for deciding on the future types of monitoring equipment to be employed. The fact that repeated tests led to improvements in the results obtained with the profilogram and ecological interface displays means that improvement is possible and that this is the right direction in which to proceed. The ergonomics of these systems needs improvement, however. It is hoped that equipment manufacturers will use the results of this and similar studies to improve the way in which data are presented on monitors.