Biosignal monitoring and recording is the extension of medical investigations taking into consideration the development over time. The usual practice for medical tests is the investigation at one particular time point when the physician sees the patient. Besides the clinical interview the physician checks the pulse, measures blood pressure, takes a blood sample and sometimes urinary sample, and perhaps also measures body temperature and sweating. This collected information is used to develop a diagnosis or if it is not sufficient, to request more investigations. The additional investigations are in many cases functional tests or image-producing examinations. Such examinations can be radiology or ultrasound investigations or endoscopic or angiographic investigations. Functional investigations being requested can be electrocardiography, lung function test or a physical stress test. All these investigations are really point measures even if they involve image generation or a functional test over a short period of time. These point measures are used to generate a medical diagnosis. Based on the diagnosis the physician tries to predict changes over time (e.g. development of a disease or a treatment outcome). In order to verify these predicted changes often a second or a third investigation follows after a couple of days or weeks, again being point measures in essence. This type of measurement is always restricted to a few time points (Figure 13-1).
By its nature it cannot give any conclusion about the dynamic behavior of physiological systems. Functional tests are the only and still limited approach to dynamic behavior. To extend the investigations of physiological variables in the time domain is the primary aim of biosignal acquisition or in other terms time series analysis in medicine. By this approach a better understanding of physiological control systems can be achieved. Predictions can be improved by considering the dynamic behavior of physiological regulation.

### 1 Basics of Monitoring and Recording

During the last few decades biosignal monitoring and recording became essential in many areas of modern medical services. This reflects the recognition of the importance of physiological control systems. The best known case for biosignal monitoring is electrocardiography (ECG). ECG has certainly the longest tradition in biosignal monitoring and recording because it is a strong (amplitude near 1 mV) and relatively robust signal [14]. Electrocardiography can be monitored for diagnostic purposes in a general physician’s office with relatively simple and inexpensive devices. It may be recorded with 6 or 12 leads by a cardiologist for a comprehensive diagnosis of specific heart problems (e.g. signs of ischemia or heart attack). This type of ECG is still time limited and it may last a couple of minutes only. This examination can be regarded as a functional investigation which still represents a point measure based on a limited time segment of the continuous signals. In addition to this category of point measures based on functional investigations the ECG may be recorded over much longer periods of time (e.g. 24 hours) in order to detect and possibly explain arrhythmias. This long-term recording allows one to investigate dynamic properties and regulation mechanisms of heart rate for at least one 24-hour period. A 24-hour period is often chosen to obtain information on the circadian changes and the changes observed during sleep compared to daytime activities. Some ECG problems may become manifest only during the sleep period.