Chapter I
Cardiovascular System Monitoring

1- Stethoscopy

Today, intraoperative stethoscope has become a fundamental extension of the physical examination for all anesthetized patients. Stethoscopy provides a simple and reliable means of listening to heart and breath sounds continuously throughout an operation (Park R et al., 2003).

Electronically amplified stethoscopes have been designed in an attempt to improve the quality and clarity of heart and breath sounds, and wireless systems using radio-transmitted signals allow continuous monitoring without the anesthetist being adherent to the patient by the stethoscope extension tubing (Barthram CN and Taylor L, 1999).

Despite the apparent value of the precordial or esophageal stethoscope for basic monitoring of patient safety, its widespread application in clinical practice has diminished in recent years. This decline may be driven by the routine use of pulse oximetry, capnography, and other electronic safety monitors that have become mandatory and even required by law in some locations (Priellip RC et al., 1998).

2- Peripheral Pulse Monitoring:

The simplest and least invasive form of cardiac monitoring remains measurement of the pulse rate. As a circulatory vital sign, the heart rate provides an important guide to the patient's base line condition and the
influence of anesthetics and surgical stimuli. The ability to estimate the heart rate quickly with a "finger on the pulse" is a skill as important as this expression is common. However, under most circumstances in modern anesthesia practice, electronic monitoring devices are used to provide a continuous, numeric display of the pulse rate. *(Block FE, 1994).*

Most monitors report heart rate and pulse rate separately. The former is measured from the Electrocardiography (ECG) trace, and the latter is determined by a pulse source, which is generally selectable by the user. For example, the pulse oximeter will provide a suitable pulse measurement source for most patients except those with severe arterial occlusive disease or those with marked peripheral vasoconstriction *(Mark JB et al, 1998).*

Automatic noninvasive blood pressure devices determine the pulse rate by counting oscillations in pressure sensed by the surrounding cuff. When direct arterial pressure measurement is in place, the pressure waveform provides a reliable pulse source. separately. *(Block FE, 1994).*

Pulse rate monitoring and heart rate monitoring complement one another. Even though monitoring both pulse rate and heart rate may seem redundant in many cases, such intentional redundancy is being applied to modern computerized monitoring algorithms to reduce measurement errors and false alarms. *(Mark JB et al, 1998).*
3-Electrocardiography (ECG) Monitoring:

Although any monitor that senses the period of the cardiac cycle can be used to determine heart rate, the most common technique applied in the operating room is electrocardiography. Current monitors use multiple ECG leads to sense cardiac electrical activity. (Klepper ID et al., 1993).

The intraoperative use of the (ECG) has markedly developed over the past several decades. Originally, this monitor was used during anesthesia for the detection of arrhythmias in high-risk patients. At that time, standard limb lead II was displayed, because its electrical axis parallels the electrical axis of the heart and the P wave is usually easily observed. (Thys DM and Kaplan JA, 1997).

One of the major indications for electrocardiographic monitoring is the intraoperative diagnosis of myocardial ischemia. Despite widespread attempts at prevention, coronary artery disease continues to be a major health problem in the United States. Some patients undergoing different types of surgical procedures have significant coronary artery disease, and the ECG should be used to identify myocardial ischemia and to recognize arrhythmias. (Skeehan TM and Thys DM, 2000).

The electrocardiographic changes occurring during myocardial ischemia are often characteristic and are detected with careful electrocardiographic monitoring. Although the electrocardiographic criteria for ischemia were established in patients undergoing exercise stress testing, they may also be applied to anesthetized patients. These criteria are (1) horizontal or downsloping ST-segment depression of 0.1
mV, (2) ST-segment elevation of 0.1 mV in a non-Q wave lead, and (3) slowly upsloping ST-segment depression of 0.2 mV (all measured from 60 to 80 msec after the J point). (Chaitman BR and Hanson JS, 1999).

Conduction defects can be observed during surgery. They can result from the passage of the pulmonary artery catheter through the right ventricle, or they can be a manifestation of myocardial ischemia. Because high-grade (second- and third-degree atrioventricular blocks) conduction defects often have deleterious effects on hemodynamic performance, their intraoperative recognition is important. (Kastor JA, 1998).

Computer programs for the interpretation of ECG are widely used. In a large study, the ECGs of 1200 adult patients with known clinical conditions were interpreted by cardiologists and by nine computer programs. The results demonstrated that, in some cases, computer interpretations of ECG were correct and cardiologists were incorrect when their diagnoses were tested against the clinical evidence. (Romhilt DW et al, 2004).

4-Arterial Blood Pressure Monitoring:

Blood pressure is a fundamental vital sign, which reflects the force that derives perfusion of the body. Frequent measurement of arterial blood pressure is a critical part of monitoring anesthetized patients. The importance of its monitoring is underscored by the fact that standards for basic anesthetic monitoring mandate measurement of arterial blood pressure at least every 5 minutes in all anesthetized patients (Park R et al., 2003).

Techniques for measuring blood pressure fall into two major
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categories: indirect Riva-Rocci cuff devices and direct arterial cannulation and pressure transduction. These methods differ in nearly every respect, notably in terms of the physical process being monitored and in the level of invasiveness of their application. In clinical practice, blood pressures measured by different techniques often yield significantly different values. (Davis RF, 1985).

Studies comparing different blood pressure monitoring techniques usually use direct arterial pressure measurement as the reference standard against which another method is judged. (Gorback MS, 1988).

A-Indirect Measurement of Arterial Blood Pressure (Non-Invasive Blood Pressure) (NIBP)

Indications

The use of any anesthetic, no matter how "trivial," is an absolute indication for arterial blood pressure measurement. The techniques and frequency of pressure determination depend on the patient's condition and the type of surgical procedure. An oscillometric blood pressure measurement every 3–5 min is adequate in most cases. (Morgan GE et al, 2006).

Techniques:

1-Manual Intermittent Techniques

The most widely used intermittent manual method for blood pressure determination is the auscultation of sounds originally described by Korotkoff. Using a Riva-Rocci sphygmomanometer and cuff, Korotkoff applied a stethoscope to the artery directly below the cuff to auscultate the sounds generated as the cuff was deflated. (Shevchenko Y et al, 1996).