ADVANCED BIO MEDICAL INSTRUMENTATION

LECTURE 2: ELECTRODES

MICROPHONES AND AMPLIFIERS FOR PCG

Microphones

Two types of microphones are used- contact microphone and air coupled microphone. They are also classified into crystal type or dynamic type.

The piezoelectric (crystal) microphone is more sensitive than the dynamic (based on Faraday's principle) microphone at low frequencies. The crystal microphone can be used for essentially all PCG easurements. The dynamic microphone, on the other hand, has a higher output voltage than the crystal. But it cannot be used for pulse-wave recordings because of its inadequate low-frequency response.

The crystal microphone generally costs less. The dynamic microphone uses a moving coil coupled to the acoustical diaphragm. The dynamic microphone is used when it is desirable to have a signal frequency response similar to that of the mechanical stethoscope. An air-coupled crystal microphone with a time constant of 2-s is often used for apex PCG recordings.

Amplifiers

The electrical signals from the microphone are amplified by a phonocardiographic preamplifier. The amplifier must have similar response characteristics. The electrical signals from the microphone are amplified by a phonocardiographic preamplifier. The amplifier must have similar response characteristics. The high pass filters are used to separate the louder low frequency components from the medically interesting soft high frequency murmurs. For heart sounds, high pass filters with gradual slope are required and for murmurs, high pass filters with sharper slopes are required.

The readout is high frequency chart recorder, oscilloscope, photographic or light galvanometer recorders, optical or high velocity ink jet recorder. Some models use envelope recording technique in which the frequency components below 80Hz are recorded directly,but the frequency components above 80Hz are integrated (averaged) before recording. This allows use of low frequency thermal or ink pen type strip chart recorder.Some times a digital computer with high speed analog to digital conversion capability and Fourier-transform software, is used for spectral analysis of heart sounds because presence of higher frequencies (murmurs) in the PCG indicates heart disorder.

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OPERATING ROOMS

An operating theater, also known as an operating room (OR) or operating suite,is a facility within a hospital where surgical operations are carried out in a sterile environment.

OR environment

Operating rooms are sterile environments; all personnel wear protective clothing called scrubs. They also wear shoe covers, masks, caps, eye shields, and other coverings to prevent the spread of germs. The operating room is brightly lit and the temperature is very cool; operating rooms are air-conditioned to help prevent infection. The patient is brought to the operating room on a wheelchair or bed with wheels (called a gurney). The patient is transferred from the gurney to the operating table, which is narrow and has safety straps to keep him or her positioned correctly. The monitoring equipment and anesthesia used during surgery are usually kept at the head of the bed. The anesthesiologist sits here to monitor the patient's condition during surgery. Depending on the nature of the surgery, various forms of anesthesia or sedation are administered. The surgical site is cleansed and surrounded by a sterile drape. The instruments used during a surgical procedure are different for external and internal treatment; the same tools are not used on the outside and inside of the body. Once internal surgery is started, the surgeon uses smaller, more delicate devices.

Operating room equipment

An operating room has special equipment such as respiratory and cardiac support, emergency resuscitative devices, patient monitors, and diagnostic tools.

Life support and emergency resuscitative equipment

Equipment for life support and emergency resuscitation includes the following:

Heart-lung bypass machine, also called a cardiopulmonary bypass pump—takes over for the heart and lungs during some surgeries, especially heart or lung procedures. The heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the aorta to carry the oxygenated blood from the bypass machine to the aorta for circulation to the body. The heart-lung machine allows the heart's beating to be stopped during surgery.

Ventilator (also called a respirator)—assists with or controls pulmonary ventilation. Ventilators consist of a flexible breathing circuit, gas supply, heating/humidification mechanism, monitors, and alarms. They are microprocessor-controlled and programmable, and regulate the volume, pressure, and flow of respiration.

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Infusion pump—device that delivers fluids intravenously or epidurally through a catheter. Infusion pumps employ automatic, programmable pumping mechanisms to deliver continuous anesthesia, drugs, and blood infusions to the patient. The pump hangs from an intravenous pole that is located next to the patient's bed.

Crash cart—also called resuscitation cart or code cart. A crash cart is a portable cart containing emergency resuscitation equipment for patients who are "coding" (i.e., vital signs are in a dangerous range). The emergency equipment includes a defibrillator, airway intubation devices, resuscitation bag/mask, and medication box. Crash carts are strategically located in the operating room for immediate accessibility if a patient experiences cardiorespiratory failure.

Intra-aortic balloon pump—a device that helps reduce the heart's workload and helps blood flow to the coronary arteries for patients with unstable angina, myocardial infarction, or those awaiting organ transplants. Intra-aortic balloon pumps use a balloon placed in the patient's aorta. The balloon is on the end of a catheter that is connected to the pump's console, which displays heart rate, pressure, and electrocardiogram (ECG) readings. The patient's ECG is used to time the inflation and deflation of the balloon.

Patient monitoring equipment

Patient monitoring equipment includes the following:

Acute care physiologic monitoring system—comprehensive patient monitoring systems that can be configured to continuously measure and display various parameters via electrodes and sensors connected to the patient. Parameters monitored may include the electrical activity of the heart via an ECG, respiratory (breathing) rate, blood pressure (noninvasive and invasive), body temperature, cardiac output, arterial hemoglobin oxygen saturation (blood oxygen level), mixed venous oxygenation, and end-tidal carbon dioxide.

Pulse oximeter—monitors the arterial hemoglobin oxygen saturation (oxygen level) of the patient's blood with a sensor clipped over the finger or toe.

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Intracranial pressure monitor—measures the pressure of fluid in the brain in patients with head trauma or other conditions affecting the brain (such as tumors, edema, or hemorrhage). Intracranial pressure monitors are connected to sensors inserted into the brain through a cannula or bur hole. These devices signal elevated pressure and record or display pressure trends. Intracranial pressure monitoring may be a capability included in a physiologic monitor.

Diagnostic equipment

The use of diagnostic equipment may be required in the operating room. Mobile x ray units are used for bedside radiography, particularly of the chest. These portable units use a battery-operated generator that powers an x ray tube. Handheld portable clinical laboratory devices, called point-of-care analyzers, are used for blood analysis at the bedside. A small amount of whole blood is required, and blood chemistry parameters can be provided much faster than if samples were sent to the central laboratory.

Other operating room equipment

Disposable OR equipment includes urinary (Foley) catheters to drain urine during surgery, catheters used for arterial and central venous lines to monitor blood pressure during surgery or withdraw blood samples), Swan-Ganz catheters to measure the amount of fluid in the heart and to determine how well the heart is functioning, chest and endotracheal tubes, and monitoring electrodes.