INTENSIVE CARE UNITS

Patient Monitoring System (Intensive care unit):

- Most diseases of the heart and of the circulatory system, referred to as cardiovascular diseases, strike without warning and prompt treatment is required if death is to be averted. Such treatment is best provided in a specialized area of hospital referred to as "intensive care unit."(ICU). These specialized hospital units provide constant observation of the subject, constant monitoring of the subject's physiological condition and provide immediate emergency treatment whenever it is required. There are three important intensive care units which are given below.
- 1. Coronary intensive care units
- 2. Stroke intensive care Units
- 3. Pulmonary intensive care units

- **1. Coronary Intensive Care Units**
- Coronary intensive care units are used for treatment of diseases of the heart such as the Myocardial infarction or "heart attacks".
- **2. Stroke Intensive Care Units**
- Stroke intensive care Units are used for treatment of diseases of the circulatory system such as stroke.

- **3. Pulmonary Intensive Care Units**
- Pulmonary intensive care unit s are used for treatment of respiratory diseases**.** An intensive care unit may consist of one or more subject-monitoring sites, referred to as "beds" as each site, is in fact, a bed. Electronic instrumentation at each subject—monitoring site monitors various physiological signals from one subject and activates alarms should these physiological signals go above or below predetermined limits. The complete intensive care unit consists of not only the necessary monitoring equipment but also the necessary trained personnel and emergency equipment to allow immediate treatment of cardiac malfunctions.
- Intensive care units (ICUs) are usually constructed to suit a particular hospital's requirements. Widely varying approaches are taken to the physiological functions to be monitored and the type of monitoring equipment required. In general, no two intensive care units are alike.

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- Intensive care instrumentation is continuously being developed to accomplish more advanced physiological monitoring techniques. The following discussion on intensive care concepts is intended to present some of the physiological functions that may be monitored and some of the typical instrumentation that may be used to monitor these functions. The discussion is conceptual in nature and in no way attempts to survey all current intensive care applications and instrumentation.

- **Physiological Functions to be monitored During Intensive Care:**
- Since, subjects in coronary intensive care units are suffering from cardiovascular diseases, all physiological functions associated with the heart and circulatory system should be monitored.
- The following are the important physiological signal to be monitored in intensive care unit is given below:
- 1. ECG Monitoring
- 2. Blood pressure Monitoring
- 3. Respiration and
- 4. Body temperature

- **1. ECG Monitoring**
- The principal physiological signal monitored in an intensive care unit is often the electrocardiogram. The electrocardiogram is usually monitored in the lead-II configuration with two active electrodes. These two electrodes are placed approximately 12 inches apart along the maximum potential axis of the subject's heart. A third electrode (ground) should be located elsewhere on the chest. This electrocardiogram monitoring configuration is referred to as three-lead chest cluster. Tektronix produces a patient cable for use with their type 410 physiological monitor that is specifically intended for monitoring during intensive care.

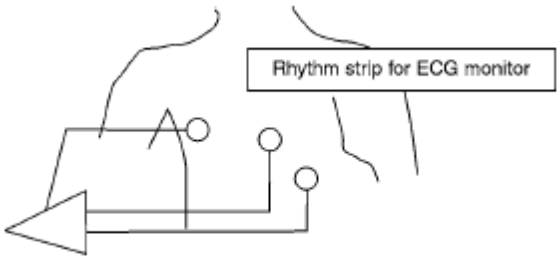

Fig. 17.1a. Showing the Rhythm strip for Intensive care ECG monitoring.

- The electrodes used for ECG monitoring during intensive care must be suited for long term monitoring applications. The Tektronix silver / silver-chloride electrode system provided with a physiological monitor is ideally suited for this application as the electrode paste supplied produces no subject discomfort or skin irritation. A relatively large amount of paste is required between the subject and the electrode which prevents the paste from drying out due to evaporation and skin absorption.
- The set of leads used for monitoring purpose is called 'rhythm' strip and its purpose is just to note the heart beat and not for analyzing it. Intensive care units have monitors built with either a long persistence monitor C.R.O. or with digital Raster scan display based non-fading displays.
- The bedside non fading display type ECG monitor for use in such ICUs can use either the TV type raster scan display with microprocessor board and memory or else use a graphics LCD display. Such a unit is shown below

- **2. Blood Pressure Monitoring**
- The second physiological parameter often of prime importance in intensive care monitoring is blood pressure. Blood pressure can be and often is monitored using intra - arterial catheter and transducer; however, the catheter results in considerable subject discomfort and many intensive care units prefer to monitor blood pressure by some alternative method only.
- **Korotkoff system-Riva-Rocci Method**
- Blood pressure can be monitored using the automatic cuff pump and Korotkoff microphone blood-pressure measurement system. Although, this system is occasionally used in intensive care units. it also possesses the disadvantage of being somewhat uncomfortable to the subject (bruises), and more importantly, being a sampling technique, it does not provide a continuous record of the subject's blood pressure. Thus, if for some reason the subjects blood pressure were to suddenly drop, this system may take some minutes or so to detect this pressure drop.

- **Plethysmograph**
- Blood pressure monitoring with plethysmograph offers the least discomfort to the subject; however, it provides only a relative indication of the well being of the circulatory system rather than providing absolute values for diastolic and systolic pressure.
- Digital blood pressure monitors are now-a-days often used in many intensive care units. Any intensive care unit may employ one or more of these techniques and indeed all three may be available if required. Although diastolic and systolic arterial pressure are commonly monitored, mean arterial pressure and venous pressure are also be monitored in some instances.

- **3. Respiration Monitoring**
- It is often desirable to monitor the subject's respiratory activity during intensive care; this may be accomplished with a thermistor pneumograph placed in the subject's nostril.
- **4. Body Temperature**
- It is often also desirable to monitor body temperature in intensive care subjects via a rectal or armpit thermistor probe.
- **5. Blood Chemistry PO2**
- In order to measure and monitor the patient blood periodically, a finger type oximeter is also required.
- **Pacemaker:**

- Monitoring of the physiological signals referred to previously necessitates numerous electrodes etc., being placed on the subject. In addition, it is often desirable to have cardiac pacemaker electrodes applied to the subject's chest. Although these electrodes are not used during routine intensive care, they should be connected to a cardiac pacemaker for immediate emergency use if required.
- **Instrumentation Requirements for Intensive Care Units:**
- A conceivable intensive care instrumentation system is shown in Figs. 17.1, 17.2 and 17.3. Fig. 17.1 shows the instrumentation in an intensive care unit for four beds. Each of the four beds includes separate subject-monitoring instrumentation. This provides an indication of the subject's physiological condition as shown in Fig. 17.2. Signals from each of these four instrumentation modules are also connected to a central nurse on duty, to allow selective recording of the ECG, and to allow the ECG signal and or audio/visual information to be transmitted throughout the hospital via a closed circuit television link. The television camera and closed circuit link may be regarded as "luxury items", most other features shown are essential.
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- **Plethysmograph:**
- Referring to the patient monitoring instrumentation located beside each intensive care bed as shown in Fig. 17.2, the following four parameters are monitored .
- 1. Relative arterial blood pressure
- 2. Respiration activity
- 3. The electrocardiogram
- 4. Body temperature
- **Relative arterial blood pressure** is monitored by using a plethysmograph on either the subject's forehead, his nasal septum or the lobe of his ear. Finger plethysmographs are rarely used in intensive care units due to their susceptibility to subject movement. The instrumentation
- associated with the plethysmograph may provide an alarm signal should the cardiac rate go over or below preset limits or should the amplitude of signal produced by the plethysmograph fall below the predetermined level which indicates the loss in blood pressure or blood flow.
- **Respiratory activity** is monitored via a thermistor pneumograph in the nostril with the associated instrumentation providing an indication of respiratory rate as well as providing an alarm if this rate falls outside the predetermined limits or if the signal level produced by the thermistor pneumograph is reduced below some predetermined amplitude. This indicates the loss of respiratory activity.
- **Fig. 17.2a.** Shows the subject monitoring instrumentation for one intenstive care "bed".

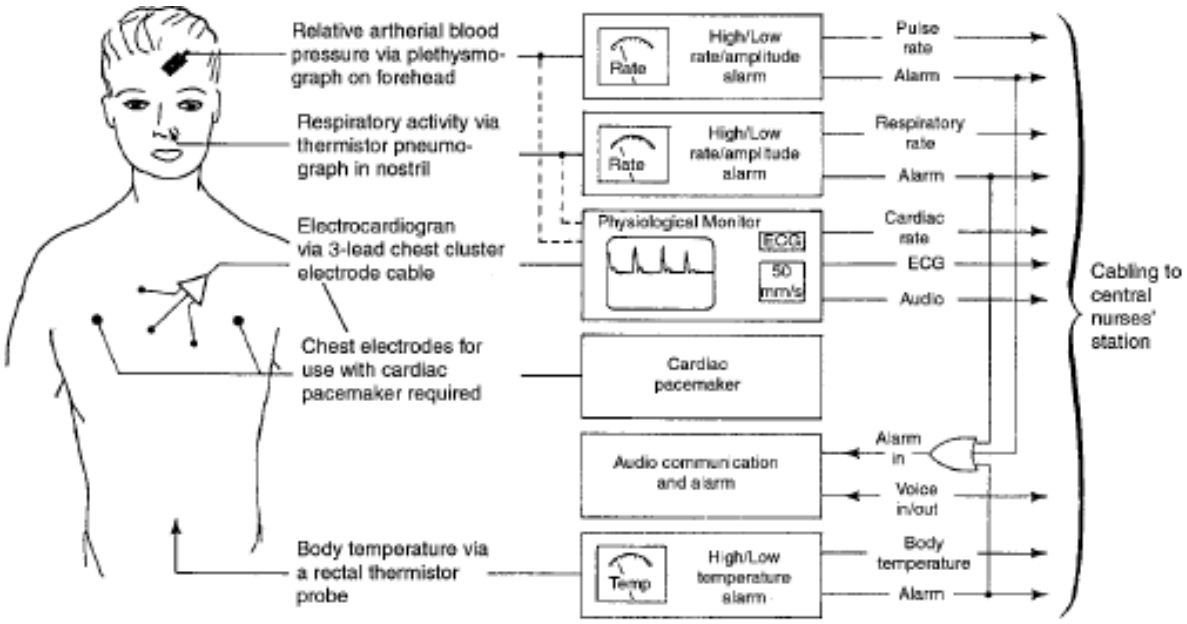

Fig. 17.2a. Shows the subject monitoring instrumentation for one intenstive care "bed".

- **Blood PO2**
- Blood oxygen saturation needs to be often measured in a patient under respiratory care unit. This is based on the finger pulse photo signal using red and IR light through the finger pulp.
- Though accurate measurements are not guaranteed by this, it provides the needed trend information for monitoring a critically ill patient with no need to take blood samples from him.

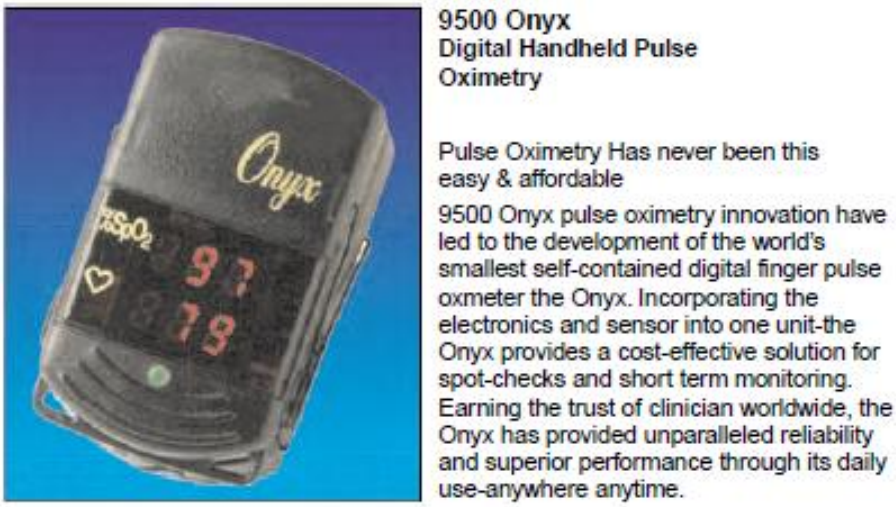

Fig. 17.2b

Figure shows a unit of such a type which is handy and portable. It uses bright LED display for clear visibility.

- **The electrocardiogram** is monitored by the rhythm string having three chest leads. The physiological monitor provides an ECG output with a low audibility to indicate the cardiac rate or to indicate a loss of cardiac activity.
- **Thermistor probe**
- Body temperature is monitored by using a rectal thermistor probe. The associated instrumentation indicating body temperature may also contain an alarm system. It will be activated if the body temperature falls outside predetermined limits
- **Television Monitoring**
- Instrumentation located bedside each intensive care bed, should preferably be away from the subject's range of vision as its presence can be somewhat disturbing the subjects. The intensive care ward may also contain a closed - circuit television system to allow one or more subjects to be viewed via a television camera. This television camera may continuously scan the subjects in the intensive care ward or its position may be controlled from the central nurse's station.
- **Other Equipments:**
- In addition to physiological and visual monitoring of the subject, the following modules are required along with the instrumentation in intensive care unit. They are:
- 1. A cardiac pacemaker module and a defibrillator unit for emergency

- 2. Audio communication module and
- 3. Alarm module.
- The above units are also included with the instrumentation at each intensive care bed. The cardiac pacemaker provides variable-amplitude, variable-rate pulses for cardiac pace-making should it be required. The audio communication and alarm panel provides audio- visual alarm indication of abnormalities in blood pressure, cardiac rate, respiratory activity and body temperature and provides audio communication between the intensive care bed and the nurse's station.
- **General Nurse's Station:**
- An intensive care unit central nurse's station is shown in Fig. 17.3. Multiconnector cable connects the output form the four subject- monitoring sites located beside each intensive care bed to the central nurse's station. Each subject's ECG is continuously displayed via a four channel CRT display. And also these signals are being recorded continuously on a memory loop tape recorder.
- This tape recorder contains the previous one-minute ECG history for each subject by recording the ECG on a tape loop "one minute" in length. Some central stations duplicate physiological indicators for relative blood pressure, respiratory activity and body temperature. These indicators
- can be manually switched between the four beds or the switching may be activated by the alarm system with the monitors being automatically switched to the bed providing the alarm signal.
- When an alarm is received at the central nurse's station, it may also be used to connect the appropriate ECG signal to a scan converter and ECG chart recorder and to start the chart recorder.
- In this way, a permanent record is achieved on the chart recorder beginning one minute prior to the alarm being sounded and information is displayed on the scan converter for transmission via the hospital closed circuit TV system to other medical personnel involved. The scan converter and closed-circuit TV system may also incorporate alphanumeric input to allow alphanumeric data relating to the intensive care subject to be displayed on television receivers located throughout the hospital.

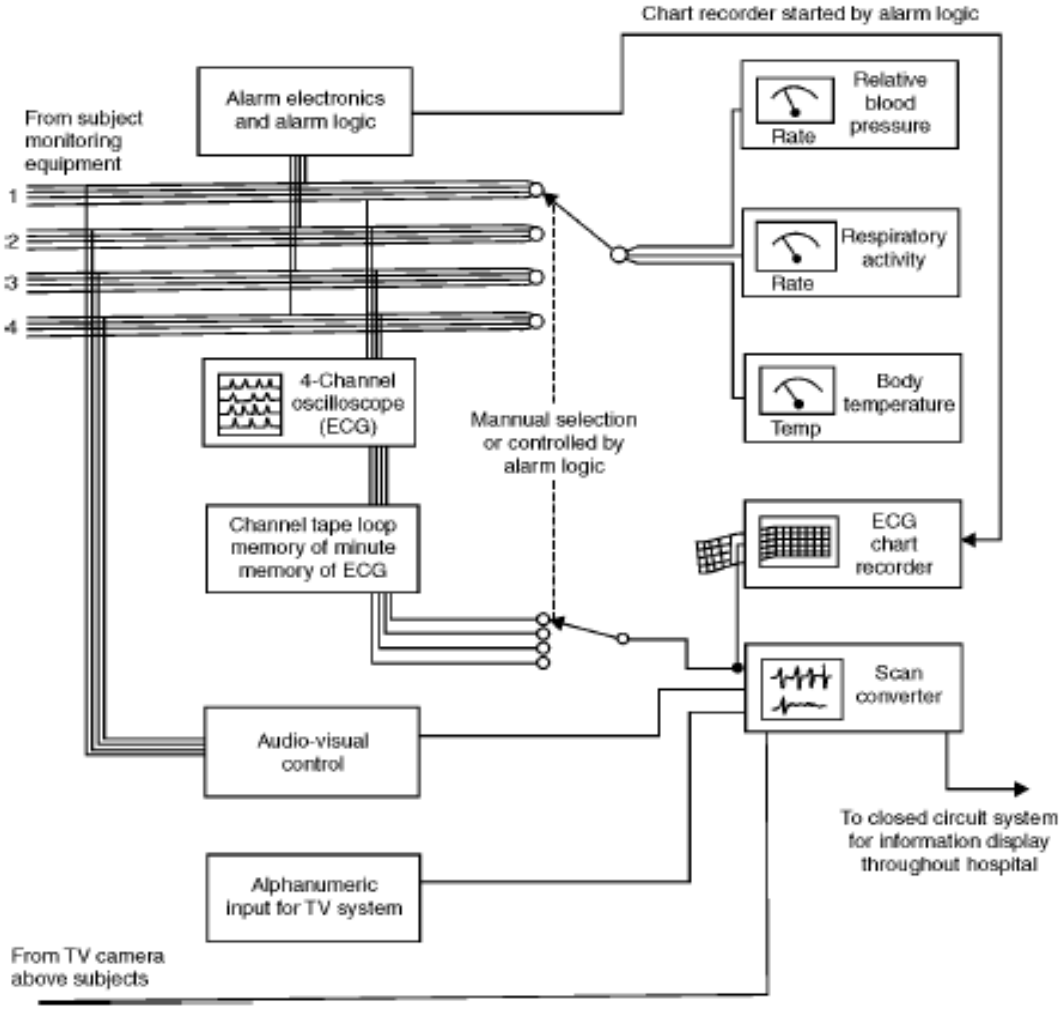

Fig. 17.3. Shows the central monitoring station for ICU beds.