**Ms.Rajeswari.R**
**Professor in MSN Dept,**
**ICON.**

# CRITICAL CARE UNIT SET UP INCLUDING EQUIPMENTS, SUPPLIES

## 1. Introduction

Critical care (also known as Intensive Care) is the multiprofessional healthcare specialty that cares for patients with acute, life-threatening illness or injury. Critical care can be provided wherever life is threatened - at the scene of an accident, in an ambulance, in a hospital emergency room, or in the operating room. Most critical care today, however, is delivered in highly specialized intensive care units (ICU). Various terminologies like Critical Care Unit (CCU), Intensive Therapy Unit (ITU), Coronary Care Unit (CCU) may be used to describe such services in a hospital.

Critical care nursing is the field of nursing with a focus on the utmost care of the critically ill or unstable patients. Critical care nurses can be found working in a wide variety of environments and specialties, such as emergency departments and the intensive care units.Critical care nurses provide a high level of skilled nursing for total patient care and often facilitate communication between all of the people involved in the care of the patient. Their expertise and continuous presence allows early recognition of subtle, but significant, changes in patient conditions, thereby preventing worsening conditions and minimizing complications that arise from critical illness. Because of their close contact with the family and the patient, critical care nurses often serve as the patient's advocate and become integral to the decision-making process of the patient, family, and critical care team.

## 2. Key terms

**Intensivist**: (also known as Critical Care Specialist) is a doctor with subspecialty training, or equivalent qualifications, in critical care. An intensivist directs the care of critically ill and injured patients and works in collaboration with other health care professionals necessary for the care of patients in critical care units.

## 3. Definition

***Critical care:***

The specialized care of patients whose conditions are life-threatening and who require comprehensive care and constant monitoring, usually in intensive care units.

***Critical Care Nursing:***

Critical care nursing is that specialty within nursing that deals specifically with human responses to life-threatening problems. A critical care nurse is a licensed professional nurse who is responsible for ensuring that acutely and critically ill patients and their families receive optimal care.

A specially equipped hospital area designed for the treatment of patients with sudden life-threatening conditions. CCUs contain resuscitation and monitoring equipment and are staffed by personnel specially trained and skilled in recognizing and immediately responding to cardiac and other emergencies.

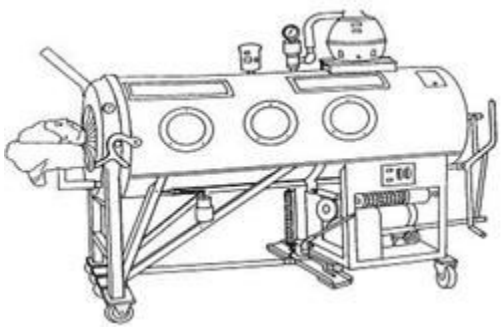
## 4. Historical Background

The idea of intensive care stems back to the era when better understanding of the human physiology and the process of death occurred. Understanding the function of oxygenation and that life is an oxidation process led to put emphasis on the respiratory support and oxygen inhalation. Lavoisier (1743-1794) stated “Respiration is a process of combustion, in truth very slow, but otherwise exactly like that of charcoal.” The reason may be different but many cultures used insufflations of respiratory system with air as effort of resuscitation. In the medical distant history there are many stories of resuscitation of the apparently dead.

Figure 1: The bellows used to blow air in order to start a fire. SalehIbnBouhlah and Royal Human Society used similar bellows and Royal Society for resuscitation of drowned persons (Al Jasser 1987)

So did the Society of resuscitation of drowned person 1769, and the Royal Human Society 1776 in efforts to resuscitating the drowned apparently dead. Automatic artificial ventilation of the lungs during chest surgery was known since 1896. Chevalier Jackson in America popularized laryngoscopy and intubation in the first quarter of the 20$^{th}$ century. Cecil Drinker and his brother Philip developed a positive and negative pressure generating tank respirator and was used successfully on a child in Boston children hospital. In 1948, muscle relaxants were introduced to anesthesia practice and anesthesiologists used to assist the intubated, partially paralyzed patient who had respiratory depression gained a great experience. In 1952, the polio epidemic in Copenhagen left many patient paralyzed and medical students were allocated to ventilate these patients continuously by hand (due to shortages of tank ventilators). They were using a self inflating bag and one way valve on an intubated patient. Bjorn Ibsen established the first intensive care unit in Copenhagen in 1953. The chronic patients who survived this epidemic were ventilated in negative pressure chamber “Iron Lungs' till their natural death.

Figure 2: The iron lung apparatus used to produce artificial ventilation by producing a negative pressure around the chest and abdomen while the face is exposed to the atmosphere, which helped to draw air to the lungs. Obviously it was difficult to nurse the patients, but nevertheless some patient spend their life within it and they were able to speak, eat and even watch television.



In the sixties of the 20$^{th}$ century, another development happened when physicians realized that the early preventable death from myocardial infarction was due to the occurrence of arrhythmias. These hearts may survive the initial hyper-excitability stage if the arrhythmia was monitored and treated in time. The purpose of monitoring of myocardial infarction patients during the first 24, 48, &72 hours after the infarct is aimed at looking for these developments. Appreciation of the value of the intensive care setting made it imperative to extend its use to other class of patients and today we can count more than 20 subspecialties.

Figure 3: Various pictures, of modern intensive care unit, showing: (3a) the nursing station at KKUH, (3b) An intubated patient is ventilated, using modern intermittent positive pressure ventilation method.

## 5. Types of CCUs

### 5.1 Based on the specialty

- Neonatal intensive-care unit (**NICU**)
- Special Care Nursery (**SCN**)
- Pediatric intensive-care unit (**PICU**)
- Psychiatric intensive-care unit (**PICU**)
- Coronary care unit (**CCU**)
- Cardiac Surgery intensive-care unit (**CSICU**)
- Cardiovascular intensive-care unit (**CVICU**)
- Medical intensive-care unit (**MICU**)
- Medical Surgical intensive-care unit (**MSICU**)
- Surgical intensive-care unit (**SICU**)
- Overnight intensive recovery (**OIR**)
- Neurotrauma intensive-care unit (**NICU**)
- Neurointensive-care unit (**NICU**)
- Burn wound intensive-care unit (**BWICU**)
- Trauma Intensive care Unit (**TICU**)
- Surgical Trauma intensive-care unit (**STICU**)
- Trauma-Neuro Critical Care (**TNCC**)
- Respiratory intensive-care unit (**RICU**)
- Geriatric intensive-care unit (**GICU**)
- Mobile Intensive Care Unit (**MICU**)
- Post Anaesthesia Care Unit (**PACU**)

### 5.2 Based on the functions/purposes

**a) Academic Vs. Nonacademic**

**Critical Care Centers**

Level I and II centers may have anacademic mission through affiliationwith a medical school, nursing school, orother health services educational programs.The critical care physician andnursing leadership as well as pharmacistsand respiratory therapists of these centersrequire sufficient protected time toparticipate in scholarly activity (clinicaland/or basic research, case reports) andto foster an environment of critical thinking.They should have the appropriateknowledge and teaching skills to participatein on-site education of critical carenursing staff, physicians in training, andstaff physicians. Nonacademic centers should maintain a commitment to remainingcurrent with changes in the fieldof critical care. They should encourageand provide protected time for all criticalcare personnel to participate in continuingeducation activities and maintaincurrent certification in appropriate areasof expertise.

**b) Open Vs. Closed ICUs**

Some critical care centers define theirICUs as "open" or "closed" or a combinationof both types of units. In the opensystem, although nursing, pharmacy, andrespiratory therapy staff are ICU based,the physicians directing the care of theICU patient may have obligations at a sitedistant from the ICU such as outpatientand inpatient areas and the operatingroom. They may or may not choose toconsult an intensivist to assist in management.In some of these ICUs, criticalcare consultation is mandatory for all patients.In the closed system, care is providedby an ICU-based team of criticalcare physicians, nurses, pharmacists, respiratorytherapists, and other healthprofessionals. A variety of studies reportedin the literature have documented more favorable outcomes when ICU patientsare managed in a closed systemcompared with an open system. Thesestudies should be interpreted cautiously.

Regardless of the type of system used,the ACCM recommends that the intensivistand the ICU patient's primary carephysician and consultants proactivelycollaborate in the care of all patients. Inboth systems, an intensivist must begiven the authority to intervene and directlycare for the critically ill patient inurgent and emergent situations. Ideally, all orders regarding an ICUs patient'scare should be channeled through a unitbasedintensivist (and his or her physicianor physician extender team if applicable)to ensure optimal care and tominimize redundant or conflicting approachesto care. If these principles arefollowed, the distinctions between openand closed units and the divisive implicationsassociated with the use of theseterms wither away.

**c) Intermediate (Step-Down,Transitional) Care Units**

These types of units may be useful andare dependent on types of patients servedby the hospital, types of staff available tomanage patients in these units, and geographicrealities of the hospitals' intensivecare unit areas. They have advantagesand disadvantages depending onwhether they are freestanding in a hospitalarea distant from the ICU, adjacent tothe ICU, or integrated within the ICU. Intermediate care units may not beappropriate for all critical care centers.

6. **Members of critical care unit**

- ***Intensivists (Critical Care Specialists)***

Physicians who are board certified in a medical specialty, such as surgery, internal medicine, pediatrics, or anesthesiology, and who also receive special education, training, and subspecialty certification specifically in critical care.

- ***Critical care nurses***

Critical care nurses provide a high level of skilled nursing for total patient care and often facilitate communication between all of the people involved in the care of the patient.

- ***Pharmacist or Clinical Pharmacologist***

A pharmacist or clinical pharmacologist is a certified specialist in the science and clinical use of medications.

- ***Registered Dietitian***

A registered dietician is a vital part of the medical team that consults with physicians, nurses, therapists, and family members in the ICU. The registered dietician works to improve the nutritional health and promotes recovery of the critical care patient.

- ***Social Worker or Patient Care Co-ordinator***

A social worker is a licensed professional that works with the ICU interdisciplinary team to provide a link between treatment plans for the critical care patient and family members.

- ***Respiratory Therapist or ICU technicians***

Respiratory therapists work with the critical care team to monitor and promote airway management of the critical care patient. This may include: oxygen therapy, mechanical ventilation (breathing machine) management, aerosol medication therapy, cardio-respiratory monitoring, and patient and caregiver education.

- ***Physiotherapist and Occupational Therapist***

The physical therapist provides services that restore function, improve mobility, relieve pain, and prevent or limit permanent physical disabilities. The occupational therapist is trained to make a complete evaluation of the impact of the disease on the activities of the critical care patient at home, in work situations, and recreational activities. Both members work cooperatively with other disciplines of the healthcare team to reduce physical and psychological disability of the patient.

## 7. Critical care unit setup

### 7.1 Description Of An Intensive Care Unit

These units are special units where the effort is concentrated in one locality in the hospital and where the care of patients who are deemed recoverable but who need supervision and need or likely to need specialized techniques by skilled personnel. Among this specialized technique we can enumerate continuous artificial ventilation, supporting the circulation, management of shock and renal dialysis. The utilization of this unit in the management of critically ill patient improved the outcome by reduction in expected mortality up to 60%.

The Units have the following major characteristics:

(1) Space, equipment and working staff

(2) Continuous service and care all around the clock 24 hours including all the following: Instantaneous monitoring of cardiovascular parameter, respiratory function, renal

function and the nervous system status. These settings are not seen in any other place in the hospital. The patient's categories that can benefit from this unit are;

- Patients of myocardial infarction who usually need continuous cardiovascular monitoring. Patients who needs artificial ventilation, cardiovascular support and renal support.
- Patients with major metabolic disturbances like patient with uncontrolled diabetes mellitus or patient after major abdominal surgeries.
- Patients with major trauma like patients with head injuries, chest injuries and other multiple injuries.
- Disaster medicine victims who are affected by multiple injuries.

### 7.1 A. Physical environment

#### (i) Space and layout

There is tendency that the space per bed to be near 20 $m^2$ and similar space for services totaling 40 $m^2$. As for cubicles the space should be 30 $m^2$. There should be adequate light natural white or pink white. There should be central air conditioning and warming. There should also be feasibility to have some entertainment as soft music or television.

#### (ii) Equipment

**Intensive care unit** (ICU) equipment includes patient monitoring, respiratory and cardiac support, **pain management** , emergency resuscitation devices, and other life support equipment designed to care for patients who are seriously injured, have a critical or life-threatening illness, or have undergone a major surgical procedure, thereby requiring 24-hour care and monitoring. In the unit a provision of central medical gases supplies like oxygen and Entonox, vacuum for suction instruments should be present. Electrical outlets are needed to facilitate the use of electrical apparatus. Washbasin and monitoring trays are also needed.

## 1. Patient Monitoring Equipment

**Purposes of Monitoring**

Monitoring permits to:

- To monitor the heart electrical activities and other related output.
- To measure various blood pressures from arterial or venous side. In certain situation the calculation of cardiac output and to measure other cardiac indices are performed to guide patient's management.

### ***ECG Monitoring***

3-lead sets contain right-arm, left-arm, and left-leg leads, each 1 meter (3.3 ft) in length. 5-lead sets contain all 5 leads. Right-arm, left-arm, and chest leads are short (1 m/3.3 ft). Right-leg and left-leg leadsare long (1.6 m/5.3 ft). 5-lead lead sets can also be customized by using any mix of replacement leads.

**Colour codes for ECG monitoring**

| Lead | AAMI (U.S.) (AHA/IEC Code 2) | | IEC (Europe) (DIN 13401/IEC Code 1) | |
|---|---|---|---|---|
| | Lettering Color | | Lettering Color | |
| Right arm | RA | White | R | Red |
| Left arm | LA | Black | L | Yellow |
| Chest | V | Brown | C | White |
| Right leg | RL | Green | N | Black |
| Left leg | LL | Red | F | Green |

- ***SPo2 monitoring***

**Pulse oximetry** is a non-invasive method allowing the monitoring of the oxygenation of a patient's hemoglobin. A sensor is placed on a thin part of the patient's body, usually a fingertip or earlobe, or in the case of an infant, across a foot. Light at red (660nm) and infrared (940nm) wavelengths is passed sequentially through the patient to a photodetector. The changing absorbance at each of the two wavelengths is measured, allowing determination of the absorbances due to the pulsing arterialblood alone, excluding venous blood, skin, bone, muscle, fat, and (in most cases) fingernail polish. Based upon the ratio of changing absorbance of the red and infrared light caused by the difference in color between oxygen-bound (bright red) and oxygen-unbound (dark red or blue, in severe cases) blood hemoglobin, a measure of oxygenation (the percentage of hemoglobin molecules bound with oxygen molecules) can be made.

- **Intracranial pressure monitor**

It 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). These devices warn of elevated pressure and record or display pressure trends. Intracranial pressure monitoring may be a capability included in a physiologic monitor.

- **Apnea monitor**

Continuously monitors breathing via electrodes or sensors placed on the patient. An apnea monitor detects cessation of breathing in infants and adults at risk of respiratory failure, displays respiration parameters, and triggers an alarm if a certain amount of time passes without a patient's breath being detected. Apnea monitoring may be a capability included in a physiologic monitor.

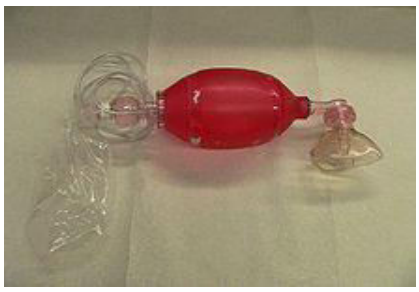
## 2. Life support and emergency resuscitative equipment

Intensive care equipment for life support and emergency resuscitation includes the following:

### Ventilation

Beside each bed a separate ventilator capable of working continuously and exclusively on one patient till his recovery and capable of generating all types of mode of ventilation the patient may need during his acute illness should be present.

**Types of ventilators**



SMART BAG MO Bag-Valve-Mask Resuscitator

Ventilators come in many different styles and method of giving a breath to sustain life. **Hand controlled** — Manual ventilators such as Bag valve masks and anesthesia bags require the user to hold the ventilator to the face or to an artificial airway and maintain breaths with their hands.

### Mechanical ventilators

Mechanical ventilators typically require power by a battery or a wall outlet (DC or AC) though some ventilators work on a pneumatic system not requiring power.

- **Transport ventilators** — These ventilators are small, more rugged, and can be powered pneumatically or via AC or DC power sources.

- **Intensive-care ventilators** — These ventilators are larger and usually run on AC power (though virtually all contain a battery to facilitate intra-facility transport and as a back-up in the event of a power failure). This style of ventilator often provides greater control of a wide variety of ventilation parameters (such as inspiratory rise time). Many ICU ventilators also incorporate graphics to provide visual feedback of each breath.

- **Neonatal ventilators** — Designed with the preterm neonate in mind, these are a specialized subset of ICU ventilators which are designed to deliver the smaller, more precise volumes and pressures required to ventilate these patients.
- **Positive airway pressure ventilators** ($\mathbf{P_{AP}}$) — These ventilators are specifically designed for non-invasive ventilation. this includes ventilators for use at home for treatment of chronic conditions such as sleep apnea or COPD.

  - **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 is hung on an intravenous pole placed next to the patient's bed.

  - **Crash cart**

    Also called a resuscitation or code cart. This is a portable cart containing emergency resuscitation equipment for patients who are "coding." That is, their **vital signs** are in a dangerous range. The emergency equipment includes a defibrillator, airway intubation devices, a resuscitation bag/mask, and medication box. Crash carts are strategically located in the ICU for immediate availability for when a patient experiences cardiorespiratory failure.

  - **Intraaortic 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 (heart attack), or patients awaiting organ transplants. Intraaortic 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.

**3. Diagnostic equipment**

The use of diagnostic equipment is also required in the ICU. Mobile x-ray units are used for bedside radiography, particularly of the chest. Mobile x-ray units use a battery-operated generator that powers an x-ray tube. Handheld, portable clinical laboratory devices, or 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.

**4. Other ICU equipment**

Disposable ICU equipment includes urinary (Foley) catheters, catheters used for arterial and central venous lines, Swan-Ganz catheters, chest and endotracheal tubes, gastrointestinal and nasogastric feeding tubes, and monitoring electrodes. Some patients may be wearing a posey vest, also called a Houdini jacket for safety; the purpose is to keep the patient stationary. Spenco boots are padded support devices made of lamb's wool to position the feet and ankles of the patient. Support hose may also be placed on the patient's legs to support the leg muscles and aid circulation.

**7.1 B. Psychological environment**

**1. Staffing**

Technical staff is needed. It is composed of two head nurses working in shifts. Medical residents on call should be provided. Consultants are in charge of the ICU to manage and organize consultation between other subspecialties in the hospital and do the patient rounds in the morning and evening. There should be one nurse per bed covering 24 hours shift and there

should be a team of respiratory therapists and physiotherapists. There are also needs for laboratory assistant, porters, and other manual workers.

- **Nurse patient ratio – 1: 1.**
- **ICU nurse manager**

**Qualifications of the nursing staff in ICU**

**An RN (registered nurse) with;**

- BSN or preferably an MSN degree.
- Certification in critical care or Equivalent graduate education
- With at least 2 yrs experience
- Working in a critical care unit.

**2.Patient management-**The patient on intensive care (like any other patient under treatment) has the right to considerate and respectful care. This is guaranteed by most guidelines and consensus opinion in most intensive care professional societies.

The patient should obtain complete current information concerning his/her diagnosis, treatment and prognosis in clear terms. Also to receive information necessary to give informed consent prior to the start of any procedure and or treatment. The patient may refuse treatment as far as permitted by law, and to be informed of the medical consequences of his or her action. The patient is entitled to complete privacy concerning his/her own medical care program, and that all communications and records pertaining to his or her care should be treated as confidential.

The hospital makes reasonable responses to the requests of a patient, to obtain information about relationship of his or her hospital to other health care and educational institutions insofar as his or her care is concerned and patients should be advised if the hospital proposes to engage in or perform human experimentation affecting his or her care or treatment,

The patient deserves reasonable continuity of care, and explanation of his/her bill and hospital rules and regulations applied to his/her conduct as a patient.

**3.Costs**

No doubt the life of a patient does not follow consideration of money. To regain one's life from illness is a very rewarding experience. But the intensive care medicine is demanding because of the use of the sophisticated instruments, disposable items to prevent cross infection and to reduce the rate of infection. Also there is the consideration of utilizing the expertise of highly competent individuals with high salaries in order to keep them on the staff; all made the cost per bed an expensive cost. The statistics differ from country to countries and the minimal requirement of the intensive care, which are accepted. So the cost may range from SR 1000 - 20000 per bed per day.

**8. LEVELS OFCARE-** It is recommended that all hospitalsdetermine the level of critical care servicesoffered in keeping with their missionand goals as well as regional needsfor this service. Three levels of care areproposed to accommodate universitymedical centers, large community hospitals,and small hospitals with limited criticalcare capabilities.

**8.1 Level I critical care:**

These criticalcare centers have ICUs that providecomprehensive care for a wide range of disorders requiring intensivecare. They require the continuousavailability of sophisticatedequipment, specialized nurses, andphysicians with critical care training.Support services includingpharmacy services, respiratorytherapy, nutritional services, pastoralcare, and social services arecomprehensive. Although most ofthese centers fulfill an academicmission in a teaching hospital setting,some may be community hospitalbased.

**8.2 Level II critical care:**

Level II criticalcare centers have the capabilityto provide comprehensive critical care but may not haveresources to care for specific patientpopulations (e.g., cardiothoracicsurgery, neurosurgery, trauma).Although these centers maybe able to deliver a high quality of

care to most critically ill patients,transfer agreements must be establishedin advance for patients with specific problems. Theintensive care units in level IIcenters may or may not have anacademic mission.

**8.3 Level III critical care:**

Hospitalsthat have level III capabilities havethe ability to provide initial stabilizationof critically ill patients butare limited in the ability to providecomprehensive critical care.

Thesehospitals require written policiesaddressing the transfer of criticallyill patients to critical carecenters that are capable of providingthe comprehensive criticalcare required (level I or level II). These facilities may continueto admit and care for a limitednumber of ICU patients forwhom care is routine and consistentwith hospital and communityresources.Cooperation between hospitals andprofessionals within a given region is essentialto ensure that appropriate numbers of level I, II, and III units are designated.A duplication of services may leadto underutilization of resources and underdevelopmentof skills by clinical personnel,and it may be costly. State andfederal governments should be encouragedto enforce the appropriate distributionof critical care services within a regionand to participate in thedevelopment of referral and transfer policies.Standards for interfacility transfershave been delineated in a collaborativepublication by the Society of Critical CareMedicine and the American Association of Critical Care Nurses. In these standards,reference is made to federal andlocal laws.

## 9. HOSPITAL RESOURCES FORLEVEL I, II, AND III CRITICALCARE CENTERS

### 9.1 Level I Critical Care Centers

**I. Medical staff organization**

**A**. A distinct critical care organizationalentity (department, division,section, or service) exists.

1. Privileges (both cognitive andprocedural) for physicianspracticing critical care medicineare approved by theMedical Staff CredentialsCommittee based on previoustraining and experience as definedby the medical staff.2. A section of the medical staffbylaws delineates the regulationsgoverning the grantingof critical care privileges andmonitoring the critical careactivities of privileged staff.3. Budgetary activities relatingto unit function, quality assurance,

and utilization revieware conducted jointly by membersof the medical, nursing,pharmacy, and administrativestaff.4. A critical care representativeserves on the Medical Staff ExecutiveCommittee.

**B**. The critical care services for thecenter are led by a critical carephysician who meets the definitionof an intensivist andwho has the appropriate time, expertise,and commitment tooversee the care of critically illpatients within the hospital.

**C**. ICU patient management is directedby a staff level physicianwho fulfills all of the following:

1. Is privileged by the medicalstaff to have clinical managementresponsibility for criticallyill patients.

2. Has board certification in criticalcare medicine.

3. Sees the patient as often asrequired by acuity but at leasttwice daily.

4. Is either the patient's attendingphysician or a consultantwho provides direct managementof critically ill patients.

**D**. ICU medical staff membersshould participate on the institution'sbioethical committee.

**II. Organization of ICUs**

**A**. A physician director who meetsguidelines for the definition of anintensivist is required.

**B**. Specific requirements for the unitdirector include the following:

1. Training, interest, and timeavailability to give clinical, administrative,and educationaldirection to the ICU.

2. Board certification in criticalcare medicine.

3. Time and commitment tomaintain active and regularinvolvement in the care of patientsin the unit.

4. Expertise necessary to overseethe administrative aspects ofunit management includingformation of policies and procedures,enforcement of unit policies,and education of unit staff.

5. The ability to ensure the quality,safety, and appropriateness ofcare in the ICU.

6. Availabilityto the unit 24 hrs a day,7days a week for both clinical andadministrative matters.

7. Active involvement in localand/or national critical care societies.

8. Participation in continuing educationprograms in the field ofcritical care medicine.

9. Hospital privileges to performrelevant invasive procedures.

10. Active involvement as an advisorand participant in organizingcare of the critically ill patient inthe community as a whole.

11. Active participation in the educationof unit staff.

12. Active participation in the reviewof the appropriate use ofICU resources in the hospital.

**C**. A nurse manager is appointed toprovide precise lines of authority,responsibility, and accountabilityfor the delivery of high-quality patientcare. Specific requirementsfor the nurse manager include thefollowing:

1. An RN witha BSN or preferably an MSNdegree.

2. Certification in critical care orequivalent graduate education.

3. At least 2 yrs experience workingin a critical care unit.

4. Experience with health informationsystems, quality improvement/risk managementactivities, and healthcare economics.

5. Ability to ensure that criticalcare nursing practice meets appropriate standards.

6. Preparation to participate inthe on-site education of criticalcare unit nursing staff.

7. Ability to foster a cooperativeatmosphere with regard to thetraining of nurses, physicians,pharmacists, respiratory therapists,and other personnel involvedin the care of criticalcare unit patients.

8. Regular participation in ongoingcontinuing nursing education.

9. Knowledge about current advancesin the field of criticalcare nursing.

10. Participation in strategic planningand redesign efforts.

**III. Physician availability**

**A**. Several studies have suggested thata full-time hospital staff intensivistimproves patient care and efficiencyas summarized in a recent review.

**B**. Ideally, 24-hr in-house coverageshould be provided by intensivistswho are dedicated to the care of ICUpatients and do not have conflictingresponsibilities.

**C**. If this ideal situation is not possible,24-hr in-house coverage by experiencedphysicians (board-eligible/certified surgeons, internists, anesthesiologists,or emergencymedicine physicians) who are notintensivists is acceptable whenthere is appropriate backup and supervision.

This arrangement requiresan intensivist to be on calland physically present in the hospitalwithin 30 mins for complex orunstable patients.

**D**. The intensivist should be able toreturn95% of pages within 5mins and ensure that a FundamentalCritical Care Support (FCCS)course-trained physician or physicianextender reaches the ICU patient within 5 mins.

**E**. Physicians (staff and/or fellows) orphysician extenders covering the critical care units in house shouldhave advanced airway managementskills and Advanced Cardiac LifeSupport qualifications. Training inthe FCCS course sponsored by theSociety of Critical Care Medicineis highly desirable.

**F**. Ideal intensivist-to-patient ratiosvary from ICU to ICU depending onthe hospital's unique patient population.Hospitals should have guidelinesfor these ratios based on acuity,complexity, and safetyconsiderations.

**G**. The following physician subspecialistsshould be available and be ableto provide bedside patient carewithin 30 mins:

1. General surgeon or traumasurgeon
2. Neurosurgeon
3. Cardiovascular surgeon
4. Obstetric-gynecologic surgeon
5. Urologist
6. Thoracic surgeon
7. Vascular surgeon
8. Anesthesiologist
9. Cardiologist with interventionalcapabilities
10. Pulmonologist
11. Gastroenterologist
12. Hematologist
13. Infectious disease specialist
14. Nephrologist
15. Neuroradiologist (with interventionalcapability)
16. Pathologist
17. Radiologist (with interventionalcapability)
18. Neurologist
19. Orthopedic surgeon

**IV. Nursing availability**

Care Unit nursing requirements

**A**. All patient care is carried out directlyby or under supervision of atrained critical care nurse.**B**. All nurses working in critical careshould complete a clinical/didacticcritical care course before assumingfull responsibility for patient care.

**C**. Unit orientation is required beforeassuming responsibility for patientcare.

**D**. Nurse-to-patient ratios should bebased on patient acuity according towritten hospital policies.

**E.** All critical care nurses must participatein continuing education.

**F**. An appropriate number of nursesshould be trained in highly specializedtechniques such as renal replacementtherapy, intra-aortic balloonpump monitoring, andintracranial pressure monitoring.

**G**. All nurses should be familiar withthe indications for and complicationsof renal replacement therapy.

**V. Respiratory care personnel requirements**

**A**. Respiratory care services should beavailable 24 hrs a day, 7 days a week.

**B**. An appropriate number of respiratorytherapists with specializedtraining must be available to theunit at all times. Ideal levels of staffingshould be based on acuity, usingobjective measures whenever possible.

**C**. Respiratory care therapists shouldfollow guidelines specified in"Critical Care Delivery in the Intensive Care Unit: Defining Clinical

**D**. Therapists must undergo orientationto the unit before providingcare to ICU patients.

**E**. The therapist must have expertise inthe use of mechanical ventilators includingthe various ventilator modes.

**F**. Proficiency in the transport of criticallyill patients is required.

**G**. Respiratory therapists should participatein continuing education andquality improvement related totheir unit activities.

**VI. Pharmacy services requirements**

Critical care pharmacy and pharmacistservices are essential in the ICU.A position paper on recommendationsfor these services has been published bythe ACCM and the American College of Clinical Pharmacy.

**A**. A "ready to administer" (unit dose)drug distribution system, intravenous admixture services, and ata minimum a medication informationsystem or computerized physician order entry are essential.

**B**. The ability to supply immediatemedications and admixtures in atimely fashion is essential. A criticalcare pharmacy satellite is desirablefor at least part-time coverage, butfull-time coverage is optimal.

**C**. A medication use system that createsand maintains patient medicationprofiles, interfaces with patientlaboratory data, and alerts users todrug allergies, maximum dose limits,and drug-drug and drug-food/nutrient interactions is essential.

**D**. Registered pharmacists, dedicatedto the ICU, should be available toevaluate all drug therapy orders, reviewand maintain medication profiles,monitor drug dosing and administrationregimens, evaluateadverse reactions and drug/drug interactions,give drug and poison information,and provide recommendationon cost containment issues.

**E**. Availability of a clinical pharmacistdedicated to the ICU with a specializedrole in activities such as criticalcare therapeutics, nutritional supportformulations, cardiorespiratoryresuscitation therapeutics, andclinical research projects is desirable.

**F**. Pharmacists should participate regularlyon rounds with the intensivistand the critical care team, providedrug therapy-related educationto critical care team members, andtake part in multidisciplinary quality activity committees.

**G**. Pharmacists should implement andmaintain policies and proceduresrelated to safe and effective use of medications in the ICU.

**H**. It is essential that the pharmacisthave the qualifications and competencenecessary to provide pharmaceuticalcare in the ICU. This maybe achieved by a variety of meansincluding advanced degrees, residencies,fellowships, or other specialized practice experience.

**VII. Other personnel:**

A variety of otherpersonnel may contribute significantlyto the efficient operation ofthe ICU. These include unit clerks,physical therapists, occupationaltherapists, advanced practice nurses,physician assistants, dietary specialists,and biomedical engineers.

**VIII. Laboratory services**

**A**. A clinical laboratory should beavailable on a 24-hr basis to providebasic hematologic, chemistry,blood gas, and toxicologyanalysis.

**B**. Laboratory tests must be obtainedin a timely manner, immediatelyin some instances.“STAT” or “bedside” laboratoriesadjacent to the ICU or rapidtransport systems (e.g., pneumatic tubes) provide an optimumand cost-effective settingfor obtaining selected laboratory tests in a timely manner. Point-of-care technologymay be used to obtain rapid laboratory results.

**IX. Radiology and imaging services:**

Transport to distant non-ICU sites forradiologic procedures has beenshown to be associated with changesin physiologic status that requiredcorrective therapeutic intervention in 68% of patients. Therefore,guidelines for intrafacility transfershould be followed for radiologic proceduresperformed distant from the ICU bedside. The following diagnosticand therapeutic radiologicprocedures should be immediatelyavailable to ICU patients, 24 hrs perday.

**A**. Portable chest radiographs affectdecision making in critically illpatients. They lead to therapeuticchanges in 66% of intubated patientsand 23% of non-intubated patients.

**B**. Interventional radiologic capabilitiesshould be available includinginvasive arterial and venousdiagnostic and therapeutic techniques,percutaneous access tothe renal collecting system andbiliary tract, percutaneous gastrostomy,and percutaneousdrainage of fluid collections.

**C**. Computed tomography and computedtomography angiography.

**D**. Duplex Doppler ultrasonography.

**E.** Magnetic resonance imaging andmagnetic resonance angiography.

**F**. Echocardiography (transthoracicand transesophageal).

**G**. Fluoroscopy.

**X. Services provided in unit:**

An ICU hasthe capability of providing monitoringand support of the critically ill patient.To do, so the ICU is prepared to providethe following:

A. Continuous monitoring of theelectrocardiogram (with high/low alarms) for all patients.

B. Continuous arterial pressure monitoring(invasive and noninvasive).

C. Central venous pressure monitoring.

D. Transcutaneous oxygen monitoringor pulse oximetry for all patientsreceiving supplemental oxygen.

E. Equipment to maintain the airway,including laryngoscopes andendotracheal tubes.

F. Equipment to ventilate, includingambu bags, ventilators, oxygen,and compressed air.

G. Emergency resuscitative equipment.

H. Equipment to support hemodynamicallyunstable patients, includinginfusion pumps, bloodwarmer, pressure bags, and bloodfilters.

I. Beds with removable headboardand adjustable position, specialtybeds.

J. Adequate lighting for bedside procedures.

K. Suction.

L. Hypo/hyperthermia blankets.

M. Scales.

N. Temporary pacemakers (transvenousand transcutaneous).

O. Temperature monitoring devices.

P. Pulmonary artery pressure monitoring.

Q. Cardiac output monitoring.

R. Continuous and intermittent dialysisand ultrafiltration.

S. Peritoneal dialysis.

T. Capnography.

U. Fiberoptic bronchoscopy.

V. Intracranial pressure monitoring.

W. Continuous electroencephalogrammonitoring capability.

X. Positive and negative pressure isolationrooms.

Y. Immediate access to information:medical textbooks and journals, drug information, poison controlcenters, personnel phone and pagingnumbers, personnel schedules,patient laboratory and test data,and medical record information.

**XI. ICU policies and procedures:**

The followingmust be available to all ICUpersonnel and must be updatedyearly. Many of these areas have beenaddressed by Guidelines and PracticeParameters Committee of the ACCM.

A. Admission and discharge criteriaand procedures.

B. Policies for intra- and interfacility transport.

C. A total quality management/continuous quality improvementprogram is required that addressessafety, effectiveness, patient-centeredness, timeliness,efficiency, and equity as outlinedby the Institute of Medicine.Programs should specifically addressappropriate Agency forHealthcare Research and Quality indicators.

D. A list of hospital staff who areprivileged for procedures/skillsused in the ICU.

E. End-of-life policies (e.g., documentationof “do-not-resuscitate”orders).

F. Guidelines for determining braindeath.

G. Organ donation protocols.

H. Restraint and sedation protocols.

**XII. Telemedicine capability:**

The abilityto operate regional ICUs throughtelemedicine capabilities (eICUs, virtual ICUs) is desirable.

### 9.2 Level II Critical Care Centers

Level II Centers are unable to providecritical care for specific areas of expertise.For example, level II centers may lackneurosurgical expertise, a cardiac surgical program, or a trauma program. Nevertheless,these centers provide comprehensivecritical care for their uniquepatient population. Therefore, with exceptionof services and personnel in theareas of expertise that they lack, thesecenters have the same organizationalstructures as outlined for level I centers.These centers require policies and proceduresthat address transport to a level I center when appropriate. Criteria fortransfer should be specific and readilyavailable to hospital personnel so thatdelays in definitive care are avoided.

### 9.3 Level III Critical Care Centers

Because level III centers are limited intheir ability to provide comprehensivecritical care, their usually small intensivecare units focus on the stabilization ofpatients before transfer to a comprehensivecritical care center (level I or II). Asa result, the guidelines outlined previouslyfor level I and II centers, althoughdesirable, are not always applicable. Level III centers require an on-site physician 24hrs/day who can manage emergencies,can secure the airway, can establish rapidintravenous access, is qualified in AdvancedCardiac Life Support, and, if notsubspecialty trained in critical care medicine, has taken the FCCS course. Itis desirable that level III centers addressthe frequency with which these educationalactivities are updated. It is commonand acceptable for emergency physicians,anesthesiologists, generalinternists, and general surgeons to fulfillthis role. A critical care trained nurse andrespiratory therapist should be availableon site, 24 hrs per day. Essential pharmacyservices should be provided. Withthe exception of highly specialized services,basic services for stabilizing, monitoring,and treating critically ill patients should be available. Detailedtransport policies and expertise inthe transport of patients are essential for these centers. Although new and inneed of additional validation, telemedicine-driven ICU care should be consideredas a surrogate for on-site intensivistdriven care.

## 10. Training and education of staffs

Most critical care nurses in the U.S. are registered nurses. Due to the unstable nature of the patient population the LPN/LVNs are rarely utilized in a primary care role in the intensive care unit. However, with proper training and experience LPN/LVNs can play a significant role in providing exceptional bedside care for the critically ill patient.

Nurses in the US who wish to obtain certification in critical care nursing can do so through a national advisory board, known as the American Association of Critical Care Nurses. This advisory board sets and maintains standards for critical care nurses. The certification offered by this board is known as CCRN. This does not stand for 'Critical Care Registered Nurse' as is popularly believed, but is merely a certification as a critical care nurse for adult, pediatric and neonatal populations.

Registration is a regulatory term for the process that occurs between the individual nurse and the state in which the nurse practices. All nurses in the US are registered as nurses without a specialty. The CCRN is an example of a post registration specialty certification in critical care.

There are also variants of critical care certification test that the AACN offers to allow nurses to certify in progressive care (PCCN), cardiac medicine (CMC) and cardiac surgery (CSC). In addition, Clinical Nurse Specialists can certify in adult, neonatal and pediatric acute and critical care (CCNS). In November, 2007, the AACN Certification Corporation launched the ACNPC, an advanced practice certification examination for Acute Care Nurse Practitioners. None of these certifications confer any additional practice privileges, as nursing practice is regulated by the individual's state board of nursing. These certifications are not required to work in an intensive care unit, but are encouraged by employers, as the tests for these certifications tend to be difficult to pass and require an extensive knowledge of both pathophysiology and critical care medical and nursing practices. The certification, while difficult to obtain, is looked upon by many in the field as demonstrating expertise in the field of critical care nursing, and demonstrating the individual's nurse's desire to advance their knowledge base and skill set, thereby allowing them to better care for their patients.

Intensive care nurses are also required to be comfortable with a wide variety of technology and its uses in the critical care setting. This technology includes such equipment as

hemodynamic and cardiac monitoring systems, mechanical ventilator therapy, intra-aortic balloon pumps (IABP), ventricular assist devices (LVAD and RVAD), continuous renal replacement equipment (CRRT/CVVHDF), extracorporeal membrane oxygenation circuits (ECMO) and many other advanced life support devices. The training for the use of this equipment is provided through a network of in-hospital inservices, manufacturer training, and many hours of education time with experienced operators. Annual continuing education is required by most states in the U.S. and by many employers to ensure that all skills are kept up to date. Many intensive care unit management teams will send their nurses to conferences to ensure that the staff is kept up to the current state of this rapidly changing technology.

### 10.1 Operation

The ICU is a demanding environment due to the critical condition of patients and the variety of equipment necessary to support and monitor patients. Therefore, when operating ICU equipment, staff should pay attention to the types of devices and the variations between different models of the same type of device so they do not make an error in operation or adjustment. Although many hospitals make an effort to standardize equipment—for example, using the same manufacturer's infusion pumps or patient monitoring systems, older devices and non-standardized equipment may still be used, particularly when the ICU is busy. Clinical staff should be sure to check all devices and settings to ensure patient safety.

Intensive care unit patient monitoring systems are equipped with alarms that sound when the patient's vital signs deteriorate—for instance, when breathing stops, blood pressure is too high or too low, or when heart rate is too fast or too slow. Usually, all patient monitors connect to a central nurses' station for easy supervision. Staff at the ICU should ensure that all alarms are functioning properly and that the central station is staffed at all times.

For reusable patient care equipment, clinical staff make certain to properly disinfect and sterilize devices that have contact with patients. Disposable items, such as catheters and needles, should be disposed of in a properly labeled container.

### 10.2 Maintenance

Since ICU equipment is used continuously on critically ill patients, it is essential that equipment be properly maintained, particularly devices that are used for life support and resuscitation. Staff in the ICU should perform daily checks on equipment and inform biomedical engineering staff when equipment needs maintenance, repair, or replacement. For mechanically complex devices, service and preventive maintenance contracts are available from the manufacturer or third-party servicing companies, and should be kept current at all times.

### 10.3Training

Manufacturers of more sophisticated ICU equipment, such as ventilators and patient monitoring devices, provide clinical training for all staff involved in ICU treatment when the device is purchased. All ICU staff must have undergone specialized training in the care of critically ill patients and must be trained to respond to life-threatening situations, since ICU patients are in critical condition and may experience respiratory or cardiac emergencies.

## 11. Health care team roles

Equipment in the ICU is used by a team specialized in their use. The team usually comprises a critical care attending physician (also called an intensivist), critical care nurses, an infectious disease team, critical care respiratory therapists, pharmacologists, physical therapists, and dietitians. Physicians trained in other specialties, such as anesthesiology, cardiology, radiology, surgery, neurology, pediatrics, and orthopedics, may be consulted and called to the ICU to treat patients who require their expertise. Radiologic technologists perform mobile x-ray examinations (bedside radiography). Either nurses or clinical laboratory personnel perform point-of-care blood analysis. Equipment in the ICU is maintained and repaired by hospital biomedical engineering staff and/or the equipment manufacturer.

Some studies have shown that patients in the ICU following high-risk surgery are at least three times as likely to survive when cared for by "intensivists," physicians trained in critical care medicine.

**12. DESIGNING AN ICU (According to Australian Academy of ICU)**

Designing an ICU the team should consist of an intensive care director nursing administrators & supervisors hospital administrators, an architect engineers (electrical, civil, bioengineering, electronics etc) all potential users,environmental engineers, interior designers, staff nurses, physicians, patients and families may be asked for comments.

**DESIGN PNEUMATICS**

Patient care and nursing eating (clean area for food preparation & delivery).unclean (dirty linen & equipment), medication storage, administration (clerking & stationary), teaching, infection control & elimination (sterilization & disinfection),clean area.

Storage visitors (others- bereavement / quiet room, office rooms, duty doctor's room, staff lounge, library etc).

Technical space for a lab, blood gas analyser etc. relatives' waiting room with a telephone, tv, beverage facilities etc.

**LOCATION :**

Location should be a geographically distinct area within the hospital, with controlled access. no through traffic to other departments should occur. supply and professional traffic should be separated from public/visitor traffic.

Location should be chosen so that the unit is adjacent to, or within direct elevator travel to and from, the emergency department, operating room, intermediate care units, and the radiology department.

**BED STRENGTH:**

Bed strength ideally 8 to 12 beds larger areas – difficult to administer and smaller areas not being cost effective 3 to 5 beds per 100 hospital beds for a level iii icu / 2 to 20% of the total number of hospital beds 1 isolation bed for every 10 ICU beds

**BED SPACE & BEDS:**

Bed space & beds 150 – 200 square feet per open bed with 8 feet in between beds.225 – 250 square feet per bed if in a single room.single room – with an anteroom (20 feet) for hand washing, gowning etc beds - adjustable, no head board, side rails and with wheels.

**ACCESSORIES:**

Accessories 3 oxygen outlets, 3 suction outlets (gastric, tracheal & underwater seal), two compressed air outlets and 16 power outlets per bed. storage by each bedside (built in / alcove). Hand rinse solution by each bedside. equipment shelf at the head end (mind the height of the care giver). Hooks & devices to hang infusions / blood bags – suspended from the ceiling with a sliding rail to position. infusion pumps to be mounted on stands / poles.

**INFRASTRUCTURE:**

Infrastructure patients must be situated so that direct or indirect (e.g. by video monitor) visualization by healthcare providers is possible at all times. the preferred design is to allow a direct line of vision between the patient and the central nursing station. modular design – sliding glass doors & partitions to facilitate visibility.

**ENVIRONMENT:**

Environment signals & alarms – add to the sensory overload; need to be modulated. floor coverings and ceiling with sound absorption properties. doorways – offset to minimise sound transmission. light& soft music (except 10 pm to 6 am).

**Lighting** – focussed & central lighting. airconditioning (split / central) – 25 + or – 2 degrees centigrade. cleaning – vacuum cleaning & wet mopping of the floor. fumigation is no longer recommended.

**Natural illumination and view** - windows are an important aspect of sensory orientation; helps to reinforce day/night orientation. window treatments should be durable and easy to clean, and a schedule for their cleaning must be established. Additional approaches to improving sensory

orientation for patients may include the provision of a clock, calendar, bulletin board, and/or pillow speaker connected to radio and television.

**UTILITIES:**

Utilities electrical – adequate sockets (5amps & 15 amps), generator supply & battery back up. medical gas & vacuum pipeline – colour coded and not interchangeable. water from a certified source especially if used for haemodialysis.

**Handwashing areas** – uninterrupted water supply, disposable paper towels / hand drier. telephones& computers for communication.

**Sterilising area** – large water boiler / geyser & exhaust fans. clean and a dirty utility with no interconnection. shelving& cabinets off the ground for storage. waste& sharps disposal. Work areas and storage for critical supplies should be located immediately adjacent to each ICU. Alcoves should provide for the storage and rapid retrieval of crash carts and portable monitor/defibrillators.

There should be a separate medication area of at least 50 square feet containing a refrigerator for pharmaceuticals, a double locking safe for controlled substances, and a table top for preparation of drugs and infusions.

**EQUIPMENT:**

Equipment monitoring equipment therapeutic equipment digital & analogue display audio & visual alarms battery back up& charging regular maintenance (amc)

**PERSONNEL:**

Personnel nurse patient ratio – 1: 1. ICU nurse manager an rn (registered nurse) with a bsn or preferably an msn degree. Certification in critical care or equivalent graduate education with at least 2 yrs experience working in a critical care unit. Experience with health information systems, quality improvement/risk management activities, and healthcare economics.ability to ensure that critical care nursing practice meets appropriate standards. Preparation to participate in the on-site education of critical care unit nursing staff.ability to foster a cooperative atmosphere with regard to the multidisciplinary training personnel involved in the care of critical care unit patients. Regular participation in ongoing continuing nursing education.knowledge about current advances in the field of critical care nursing. participation in strategic planning and redesign efforts

**Medical staffing** – cover for every shift with competence to handle any emergency. ancillary staff – therapists, technicians, radiographers etc.

**PERSONNEL DEVELOPMENT:**

Personnel development in service education programmes debrief sessions – to burn out team building exercises involvement in policy development

**POLICIES & PROTOCOLS:**

Policies & protocols admission, discharge & withdrawal of support.legal& ethical guidelines& MLC policies standing orders, organ donation, infection control surveillance sterilization & disinfection quality control & auditing should be done regularly.

**DOCUMENTATION:**

Documentation conventional electronic medical records (emr) bedside terminals interfaced with existing hospital data systems, data retrieval (laboratory results, x-ray reports, etc.). remote data transmission capabilities (to offices, on-call rooms, etc.)

**OTHER FACILITIES :**

Other facilities bereavement & after care services counselling last office support systems for patient relatives & staff.

## 13. Conclusion

Intensive care is usually only offered to those whose condition is potentially reversible and who have a good chance of surviving with intensive care support. Since the critically ill are so close to dying, the outcome of this intervention is difficult to predict.

## 14. Bibliography


1. Allen, Scott (October 23, 2005), *"Critical Care: The Making of an ICU Nurse."*, The Boston Globe (Boston, MA)
2. Kaplow.R&Hardin.R.S "*Critical care nursing-synergy for optimal outcomes"*, 1st ed(2007), Jones &Barlett Publishers, United Kingdom.

3. Hudak.M; Gallo.B.M&Morton.P.G "*Critical care nursing-A Holistic Approach"*, 7th ed(1997), Lippincott Williams and Wilkins, Philadelphia.
4. Kinney.M.R;Dunbar.S.B, Bunn.J.A.B, Molter.N&Vitello.J.M*"AACN-Clinical reference for critical care nursing"*, 4th ed, (1998), Mosby publications, London.
5. Sole; Klein; &Mosby *"Introduction to critical care Nursing"*, 5th ed (2005), Saunders, Elseiver, Missouri.
6. Mcquillan, Von Rueden; &Hartsock, Flynn &Whales *"Trauma nursing- From resuscitation through rehabilitation",* 3rd edition(2002), W.B Saunders, Philadelphia.
7. Beers, Mark H. & Robert Berkow, eds. *"Merck Manual of Diagnosis and Therapy*", 17th ed.(1999) Merck Research Laboratories.
8. Ignatavicius& Workman *"Medical Surgical Nursing- critical thinking for collaborative care",* 5th ed(2006), Elseiver, Missouri.
9. Steven.M.Lewis; Herbert.M.Weinman "*External medicine"*,1st ed,(2005), Jaypee Publishers, New Delhi.
10. West. K.B "*Clinical procedures for medical assistants",* 7th ed,(2004), W.B Saunders, Elseivers, Missouri.

**Journals**

Savino, Joseph S., C. William Hanson III, and Timothy J. Gardner. "*Cardiothoracic Intensive Care: Operation and Administration."Seminars in Thoracic and Cardiovascular Surgery*12 (October 2000): 362–70.