

# Guidelines for Intensive Care

## Unit Design

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# **Guidelines for Intensive Care Unit Design**

Guidelines/Practice Parameters Committee of the  
American College of Critical Care Medicine  
Society of Critical Care Medicine

## **Introduction**

The year 1983 marked the expiration of the Hill-Burton Act, a 1947 Federal regulation that provided funding and oversight for the design and construction of hospitals and other healthcare facilities (1). Since 1983, this oversight has been carried out by each individual State. In addition, organizations such as the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the National Fire Prevention Association (NFPA) have independently developed minimum standards for healthcare institutions. Although the standards set by these non-State agencies are technically considered non-binding, many governmental and private reimbursement organizations require compliance to qualify for reimbursement.

The design of intensive care units (ICUs), or the modification of existing units, requires not only a knowledge of regulatory agency standards, but also the expertise of critical care practitioners who are familiar with the special needs of this patient population. In 1988, the Society of Critical Care Medicine (SCCM) developed guidelines for the design of ICUs (2). The following is a revised version comprising a consensus opinion that encompasses a review of the medical, nursing and architectural literature from 1975 to the present as it pertains to ICU design and function, together with the opinions of experts in the field of critical care medicine and architecture represented by SCCM, AACN and others.

An optimum ICU design is described. Essential and optional components are identified. Periodic revisions of these guidelines can be expected as the practice of critical care evolves.

## **The Design Team**

ICU design should be approached by a multidisciplinary team consisting of, but not limited to, the ICU medical director, the ICU nurse manager, the chief architect, hospital administration, and the operating engineering staff (3). The chief architect must be experienced in hospital space programming and hospital functional planning; the engineers should be experienced in the design of mechanical and electrical systems for hospitals, especially critical care units. The design team should be expanded as appropriate by adding members of other hospital departments working with and/or in the critical care unit, to assure that the design meets its intended function. In addition, environmental engineers, interior designers, staff nurses, physicians, and patients and families may be asked for comments on how to provide a functional and user-friendly environment. The developmental team should assess the expected demands on the proposed ICU based on an evaluation of its sources of patients, admission and discharge criteria, expected rate of occupancy, and services provided by other area hospitals. The ability to provide specific levels of care must be determined by analyzing physician resources, staff resources (nursing, respiratory therapy, etc), and the availability of support services (laboratory, radiology, pharmacy, etc.) (4).

## **Floor Plan and Design**

Overall ICU floor plan and design should be based upon patient admission patterns, staff and visitor traffic patterns, and the need for support facilities such as nursing stations, storage, clerical space, administrative and educational requirements, and services that are unique to the individual institution. Eight to twelve beds per unit is considered best from a functional perspective (3,5,6). Each healthcare facility should consider the need for positive- and negative-pressure isolation rooms within the ICU. This need will depend mainly upon patient population and State Department of Public Health requirements.

Each intensive care unit should be a geographically distinct area within the hospital, when possible, 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 Radiology Department (7).

**Patient Areas.** Patients must be situated so that direct or indirect (e.g. by video monitor) visualization by healthcare providers is possible at all times. This permits the monitoring of patient status under both routine and emergency circumstances. The preferred design is to allow a direct line of vision between the patient and the central nursing station. In ICUs with a modular design, patients should be visible from their respective nursing substations. Sliding glass doors and partitions facilitate this arrangement, and increase access to the room in emergency situations.

Signals from patient call systems, alarms from monitoring equipment, and telephones add to the sensory overload in critical care units (8). Without reducing their importance or sense of urgency, such signals should be modulated to a level that will alert staff members, yet be rendered less noxious. The International Noise Council has recommended that noise levels in hospital acute care areas not exceed 45 dB(A) in the daytime, 40 dB(A) in the evening, and 20 dB(A) at night. (The A-weighted decibel scale filters out lower frequency sounds and more closely represents the range of the human ear) (9). Notably, noise levels in most hospitals are between 50-70 dB(A) with occasional episodes above this range (10). For these reasons, floor coverings that absorb sound should be used, keeping infection control, maintenance, and equipment movement needs under consideration. Walls and ceilings should be constructed of materials with high sound absorption capabilities. Ceiling soffets and baffels help reduce echoed sounds. Doorways should be offset, rather than being placed in symmetrically opposed positions, to reduce sound transmission. Counters, partitions, and glass doors are also effective in reducing noise levels.

**Central Station.** A central nursing station should provide a comfortable area of sufficient size to accommodate all necessary staff functions. When an ICU is of a modular design, each nursing substation should be capable of providing most if not all functions of a central station. There must be adequate overhead and task lighting, and a wall mounted clock should be present. Adequate space for computer terminals and printers is essential when automated systems are in use. Patient records should be readily accessible. Adequate surface space and seating for medical record charting by both physicians and nurses should be provided. Shelving, file cabinets and other storage for medical record forms must be located so that they are readily accessible by all personnel requiring their use. Although a secretarial area may be located separately from the central station, it should be easily accessible as well (7).

**X-ray Viewing Area.** A separate room or distinct area near each ICU or ICU cluster should be designated for the viewing and storage of patient radiographs. An illuminated viewing box or carousel of appropriate size should be present to allow for the simultaneous viewing of serial radiographs. A "bright light" should also be available.

**Work Areas and Storage.** Work areas and storage for critical supplies should be located within or 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 sink with hot and cold running water. Countertops must be provided for medication preparation, and cabinets should be available for the storage of medications and supplies. If this area is enclosed, a glass wall or walls should be used to permit visualization of patient and ICU activities during medication preparation, and to permit monitoring of the area itself from outside to assure that only authorized personnel are within.

**Receptionist Area.** Each ICU or ICU cluster should have a receptionist area to control visitor access. Ideally, it should be located so that all visitors must pass by this area before entering. The receptionist should be linked with the ICU(s) by telephone and/or other intercommunication system. It is desirable to have a visitors' entrance separate from that used by healthcare professionals. The visitors' entrance should be securable if the need arises.

**Special Procedures Room.** If a special procedures room is desired, it should be located within, or immediately adjacent to, the ICU. One special procedures room may serve several ICUs in close proximity. Consideration should be given to ease of access for patients transported from areas outside the ICU. Room size should be sufficient to accommodate necessary equipment and personnel. Monitoring capabilities, equipment, support services, and safety considerations must be consistent with those provided in the ICU proper. Work surfaces and storage areas must be adequate enough to maintain all necessary supplies and permit the performance of all desired procedures without the need for healthcare personnel to leave the room.

**Clean and Dirty Utility Rooms.** Clean and dirty utility rooms must be separate rooms that lack interconnection. They must be adequately temperature controlled, and the air supply from the dirty utility room must be exhausted. Floors should be covered with materials without seams to facilitate cleaning.

The clean utility room should be used for the storage of all clean and sterile supplies, and may also be used for the storage of clean linen. Shelving and cabinets for storage must be located high enough off the floor to allow easy access to the floor underneath for cleaning.

The dirty utility room must contain a clinical sink and a hopper both with hot and cold mixing faucets. Separate covered containers must be provided for soiled linen and waste materials. There should be designated mechanisms for the disposal of items contaminated by body substances and fluids. Special containers should be provided for the disposal of needles and other sharp objects.

**Equipment Storage.** An area must be provided for the storage and securing of large patient care equipment items not in active use. Space should be adequate enough to provide easy access, easy location of desired equipment, and easy retrieval. Grounded electrical outlets should be provided within the storage area in sufficient numbers to permit recharging of battery operated items.

**Nourishment Preparation Area.** A patient nourishment preparation area should be identified and equipped with food preparation surfaces, an ice-making machine, a sink with hot and cold running water, a countertop stove and/or microwave oven, and a refrigerator. The refrigerator should **not** be used for the storage of laboratory specimens. A hand washing facility should be located in or near the area.

**Staff Lounge.** A staff lounge must be available on or near each ICU or ICU cluster to provide a private, comfortable, and relaxing environment. Secured locker facilities, showers and toilets should be present. The area should include comfortable seating and adequate nourishment storage and preparation facilities, including a refrigerator, a countertop stove and/or microwave oven. The lounge must be linked to the ICU by telephone or intercommunication system, and emergency cardiac arrest alarms should be audible within.

**Conference Room.** A conference room should be conveniently located for ICU physician and staff use. This room must be linked to each relevant ICU by telephone or other intercommunication system, and emergency cardiac arrest alarms should be audible in the room. The conference room may have multiple purposes including continuing education, housestaff education, or multidisciplinary patient care conferences. A conference room is ideal for the storage of medical and nursing reference materials and resources, VCRs, and computerized interactive and self-paced learning equipment. If the conference room is not large enough for educational activities, a classroom should also be provided nearby.

**Visitors' Lounge/Waiting Room.** A visitors' lounge or waiting area should be provided near each ICU or ICU cluster. Visitor access should be controlled from the receptionist area. One and one-half to two seats per critical care bed are recommended. Public telephones (preferably with privacy enclosures) and dining facilities must be available to visitors. Television and/or music should be provided. Public toilet facilities and a drinking fountain should be located within the lounge area or immediately adjacent. Warm colors, carpeting, indirect soft lighting, and windows are desirable (11,12). A variety of seating, including upright, lounge, and reclining chairs, is also desirable. Educational materials and lists of hospital and community-based support and resource services should be displayed. A separate family consultation room is strongly recommended.

**Patient Transportation Routes.** Patients transported to and from an ICU should be transported through

corridors separate from those used by the visiting public. Patient privacy should be preserved and patient transportation should be rapid and unobstructed. When elevator transport is required, an oversized keyed elevator, separate from public access, should be provided.

**Supply and Service Corridors.** A perimeter corridor with easy entrance and exit should be provided for supplying and servicing each ICU. Removal of soiled items and waste should also be accomplished through this corridor. This helps to minimize any disruption of patient care activities and minimizes unnecessary noise. The corridor should be at least 8 feet in width. Doorways, openings, and passages into each ICU must be a minimum of 36 inches in width to allow easy and unobstructed movement of equipment and supplies. Floor coverings should be chosen to withstand heavy use and allow heavy wheeled equipment to be moved without difficulty (13).

## **Patient Modules**

Patient modules should be designed to support all necessary healthcare functions. The JCAHO requires that the floor space allocated for each bed be sufficient to accommodate all equipment and personnel that might be necessary to meet patient care needs (14). Each State Department of Public Health should be consulted for specific guidelines related to square footage per bed, or space required between beds. Ward-type ICUs should allow at least 225 square feet of clear floor area per bed. ICUs with individual patient modules should allow at least 250 square feet per room (assuming one patient per room), and provide a minimum width of 15 feet, excluding ancillary spaces (anteroom, toilet, storage). Isolation rooms should each contain at least 250 square feet of floor space plus an anteroom. Each anteroom should contain at least 20 square feet to accommodate hand-washing, gowning, and storage. If a toilet is provided, it must be private.

A cardiac arrest/emergency alarm button must be present at every bedside within the ICU. The alarm should automatically sound in the hospital telecommunications center, central nursing station, ICU conference room, staff lounge, and any on-call rooms. The origin of these alarms must be discernable.

Space and surfaces for computer terminals and patient charting should be incorporated into the design of each patient module as indicated. Storage must be provided for each patient's personal belongings, patient care supplies, linen and toiletries. Locking drawers and cabinets must be used if syringes and pharmaceuticals are stored at the bedside. Personal valuables should not be kept in the ICU. Rather, these should be held by Hospital Security until patient discharge.

Every effort should be made to provide an environment that minimizes stress to patients and staff. Therefore, design should consider natural illumination and view. Windows are an important aspect of sensory orientation, and as many rooms as possible should have windows to reinforce day/night orientation (11). Drapes or shades of fireproof fabric can make attractive window coverings and serve to absorb sound. Window treatments should be durable and easy to clean, and a schedule for their cleaning must be established. If drapes or shades are not a viable option, consider the use of exterior overhangs, louvers, or tinted or reflective glass to control the level of lighting. If windows cannot be provided in each room, an alternate option is to allow a remote view of an outside window or skylight.

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. Televisions must be out of reach of patients and operated by remote control. If possible, telephone service should be provided in each room.

Comfort considerations should include methods for establishing privacy for the patient. Shades, blinds, curtains, and doors should control the patient's contact with his/her surroundings. A supply of portable or folding chairs should be available to allow for family visits at the bedside. An additional comfort consideration is the choice of color scheme for the room, which should promote rest and have a calming effect. To provide for visual interest, one or more walls within patient view may be selected for an accent color, texture, graphic design or picture (12). Advice from environmental

engineers and designers should be sought to deinstitutionalize patient care areas as much as possible.

## **Utilities**

Each intensive care unit must have electrical power, water, oxygen, compressed air, vacuum, lighting, and environmental control systems that support the needs of the patients and critical care team under normal and emergency situations, and these must meet or exceed regulatory and accreditation agency codes and standards (1,14-17). A utility column (free-standing, ceiling mounted, or floor mounted) is the preferred source of electrical power, oxygen, compressed air and vacuum, and should contain the controls for temperature and lighting (3,18-20). When appropriately placed, utility columns permit easy access to the patient's head to facilitate emergency airway management if needed. If utility columns are not feasible, utility services may be supplied on the head wall. **Note:** Technical codes, standards, and regulations for hospital environmental systems and utilities are subject to constant revision. It is essential to contact regulatory and accrediting agencies for up-to-date information before ICU designs are finalized.

**Electrical Power** (21). Electrical service to each ICU should be provided by a separate feeder connected to the main circuit breaker panel that serves the branch circuits in the ICU. The main panel should also be connected to an emergency power source that will quickly re-supply power in the event of power interruption. Each outlet or outlet cluster within an ICU should be serviced by its own circuit breaker in the main panel. It is critical that the ICU staff have easy access to the main panel in case power must be interrupted for an electrical emergency.

Grounded 110 volt electrical outlets with 30 amp circuit breakers should be located within a few feet of each patient's bed (22). Sixteen outlets per bed are desirable. Outlets at the head of the bed should be placed approximately 36 inches above the floor to facilitate connection, and to discourage disconnection by pulling the power cord rather than the plug. Outlets at the sides and foot of the bed should be placed close to the floor to avoid tripping over electrical cords.

**Water Supply.** The water supply must be from a certified source, especially if hemodialysis is to be performed. Zone stop valves must be installed on pipes entering each ICU to allow service to be turned off should line breaks occur. Hand-washing sinks deep and wide enough to prevent splashing, preferably equipped with elbow-, knee-, foot-, or sonar-operated faucets, must be available near the entrances to patient modules, or between every two patients in ward-type units. This is a critical component of general infection control measures (23). When a toilet is included in a patient module, it should be equipped with bedpan cleaning equipment, including hot and cold water supplies and a spray head with foot control. In addition, when toilets are present, environmental control systems must be modified (see below).

**Oxygen, Compressed Air and Vacuum.** Centrally supplied oxygen and compressed air must be provided at 50 to 55 psi from main and reserve tanks, and installation must follow NFPA standards (24). At least two oxygen outlets per patient are required. One compressed air outlet per bed is required; two are desirable. Connections for oxygen and compressed air outlets must occur by keyed plugs to prevent the accidental interchanging of gases. Audible and visible low and high pressure alarms must be installed both in each ICU and in hospital engineering. Manual shut-off valves must be located and identified in both areas to permit interruption of the supplies in case of fire, excessive pressure, or for repair purposes.

At least three vacuum outlets per bed are required. The vacuum system must maintain a vacuum of at least 290 mm Hg at the outlet farthest away from the vacuum pump. Audible and visual alarms must indicate a decrease in vacuum below 194 mm Hg (25).

**Lighting** (26). General overhead illumination plus light from the surroundings should be adequate for routine nursing tasks, including charting, yet create a soft lighting environment for patient comfort. Total luminance should not exceed 30 foot-candles (fc). It is preferable to place lighting controls on variable-control dimmers located just outside of the room. This permits changes in lighting at night from outside the room, allowing a

minimum disruption of sleep during patient observation. Night lighting should not exceed 6.5 fc for continuous use or 19 fc for short periods.

Separate lighting for emergencies and procedures should be located in the ceiling directly above the patient and should fully illuminate the patient with at least 150 fc shadow-free.

A patient reading light is desirable, and should be mounted so that it will not interfere with the operation of the bed or monitoring equipment. The luminance of the reading lamp should not exceed 30 fc.

**Environmental Control Systems.** Suitable and safe air quality must be maintained at all times. A minimum of six total air changes per room per hour are required, with two air changes per hour composed of outside air. For rooms having toilets, the required toilet exhaust of 75 cubic feet per minute should be composed of outside air. Central air-conditioning systems and recirculated air must pass through appropriate filters. Air-conditioning and heating should be provided with an emphasis on patient comfort. For critical care units having enclosed patient modules, the temperature should be adjustable within each module.

### **Physiologic Monitoring**

Each patient module must have monitoring capabilities that include the analysis and display of one or more electrocardiographic leads, at least three fluid pressures, and direct or indirect measures of arterial oxygen levels. These must be displayed both in analog and digital formats by providing visual wave forms and numeric interpretations of rate, and maximum/minimum and mean values as appropriate. Every monitoring system must have the capability of recording on paper at least two analog waveforms simultaneously in dual channel format. This need not occur at the bedside. Alarms should indicate critical values by both audible and visual means. Alarms must be easily audible and non-defeatable (27).

Bedside monitoring equipment should be located to permit easy access and viewing, and should not interfere with the visualization of or access to the patient. The bedside nurse and/or monitor technician must be able to observe the monitored status of each patient at a glance. This goal can be achieved either by a central monitoring station, or by bedside monitors that permit the observation of more than one patient simultaneously. It should be noted that neither of these methods are intended to replace bedside observation.

Weight-bearing surfaces that support monitoring equipment should be sturdy enough to withstand high levels of strain over time. It should be assumed that monitoring equipment will increase in volume over time. Therefore, space and electrical facilities should be designed accordingly.

**Electrocardiogram.** One or more electrocardiographic leads should be displayed continuously. Computerized rate and waveform analysis must, at a minimum, recognize and alarm for asystole, ventricular tachycardia and fibrillation, and preset maximum/minimum heart rates. Memory functions for operator recall of arrhythmias are desirable.

**Fluid pressures.** Monitoring equipment should have the capacity for two or more simultaneous pressure displays in analog format. In addition, maximum, minimum, and mean values should be displayed digitally. Alarms should indicate critical values for all three digitally displayed parameters.

**Respiratory parameters.** Each bedside station must have the capability of providing a continuous measure of arterial oxygen levels. Pulse oximetry and transcutaneous pO<sub>2</sub> measurements are presently the preferred modalities of oxygen monitoring. End-tidal CO<sub>2</sub> or transcutaneous pCO<sub>2</sub> measurements may be used for carbon dioxide monitoring as needed. Respiratory rate monitoring should be available for patients at risk for apnea.

**Miscellaneous physiologic parameters.** Newer monitoring systems have the ability to record and display temperature, respiratory rate, ST segment amplitude, non-invasive cardiac output, mixed-venous oxygen

saturation, continuous EEG, and other physiologic parameters. These parameters may be added to monitoring capabilities as needed.

**Cardiac output and derived variables.** The bedside measurement of thermodilution cardiac output, and the availability of mathematically-derived indices of hemodynamic and respiratory performance, have become almost universal in ICUs. These are felt by most critical care practitioners to be invaluable tools for patient management. The capability for providing these functions is strongly encouraged.

### **Computerized Charting**

Computerized patient charting is becoming increasingly popular in ICUs. These systems provide for "paperless" data management, order entry, and nurse and physician charting. If and when a decision is made to utilize this technology, it is important to integrate such a system fully with all ICU activities. Bedside terminals facilitate patient management by permitting nurses and physicians to remain at the bedside during the charting process. To minimize errors, monitored data can be recorded automatically. In addition, when these systems are properly interfaced with existing hospital data systems, data retrieval (laboratory results, x-ray reports, etc.) can be performed at the bedside. Remote data transmission capabilities (to offices, on-call rooms, etc.) are desirable to facilitate continuity in patient management.

### **Voice Intercommunication Systems**

All ICUs should have an intercommunication system that provides voice linkage between the central nursing station, patient modules, physician on-call rooms, conference rooms, and staff lounge. Supply areas and the visitors' lounge/waiting room may also be included in the system. When appropriate, linkage to key departments such as blood bank, pharmacy and clinical laboratories should be included.

Some types of communication, such as personnel tracking and non-emergency calls, may best be accomplished using visual displays (e.g. numerics or color-coded lights) that eliminate unnecessary noise.

In addition to standard telephone service for each ICU, which should provide hospital-wide and external communications capabilities, there should be a mechanism for emergency internal and external communications when normal systems fail (e.g. during power failures).

### **Satellite Laboratory**

All ICUs must have available 24-hour clinical laboratory services (4). When this service cannot be provided by the central hospital laboratory, a satellite laboratory within or immediately adjacent to the ICU(s) must serve this function. Satellite facilities must be able to provide minimum chemistry and hematology testing, including arterial blood gas analysis.

### **Physician On-Call Rooms**

When in-house physician services are provided on a 24-hour basis, on-call rooms should be available close to the ICU(s). Toilet and shower facilities should be provided. On-call rooms must be linked to the ICU(s) by telephone and/or voice intercommunication system. In addition, cardiac arrest/emergency alarms must be audible in these rooms.

### **Administrative Offices**

It is often desirable to have office space available adjacent to the ICU(s) for medical and nursing management and administrative personnel. These offices should be large enough to permit meetings and consultations with ICU team members and/or patients' families. Additional office space may be allocated for staff development personnel, clinical specialists, and social services, as applicable. The ability to place these individuals in close proximity to an ICU may facilitate an integrated and broad-based team approach to patient management.

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These guidelines, originally published by the Society of Critical Care Medicine in 1988 and presented herein in revised form, have been reviewed and approved by the Council of the Society of Critical Care Medicine. These guidelines reflect the official opinion of the Society of Critical Care Medicine and should not be construed to reflect the views of the specialty boards or any other professional medical or nursing organization.

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