State of Kuwait
Ministry of Health
Infection Control Directorate
Task Force Group for Designs and
Constructions of Health Care Facilities

Guidelines for

Intensive Care Unit's Design

2008

CONTENTS

Introduction

The design of health-care facilities has undergone substantial changes in large part because patients with impaired host defenses now represent an increasing proportion of hospitalizations. As a result, both design and renovation of these facilities present unique challenges and opportunities for infection control professionals, who are often the only clinical staff associated with construction projects. Early involvement in the process can facilitate appropriate communication and protect patient safety.
To minimize the risk for infection in hospitalized patients, infection control professionals should participate in facility design from a building's inception .This allows for identifying potential infection control issues early and provides an opportunity to design solutions prospectively Ultimately, while time-consuming, participation in hospital design, construction and renovation can serve as a marker of how infection control professionals improve the quality of patient care.

Why have guidelines?

Due to the recent changes in the field of critical care and the recent direction of the Ministry of Health to renovate old Intensive Care Units and to construct new units to match changes in the populations and technical advancements in the field, these guidelines are a must to direct these efforts towards constructing a safe and efficient intensive care unit and environment both for patients and health care staff.

The importance of these guidelines came into our prospective especially in the absence of previous or current national guidelines for the construction of intensive care units.

Technical codes, standards, and regulations of hospital environmental systems and utilities are basic requirements for hospital design. Since they are subjected to constant revision, it is essential to contact regulatory agencies for up-to-date information before ICU designs are finalized.

What is a critical patient and why is ICU needed?

- There are two aspects to define the critically ill patient:
  - **First**: the issue of monitoring for those patients in unstable physiological situation in whom small changes in organ function may lead to a serious deterioration in the overall body function with irreversible organ system damage or death.
  - **Second:** the need for special treatment. This may be intermittent or continuous. This treatment may be directed at curing the patient or sustaining the patient such as life support.
- The size and type of the critical care unit would be determined by the standards and functional program of the hospital which would provide either all types of critical care or sophisticated highly specialized units, therefore the form of the intensive care would follow its intended function.

Layout & sitting

Site & location

- The ICU should be a separate unit within the hospital with access to the emergency department, operating theatre, recovery room, surgical and medical wards and diagnostic radiology department.
- Space arrangement shall include provisions for immediate access of emergency equipments from other departments.
- There should be easy access to the high dependency unit(s). This has advantages to both units as a step-up or (more usually) step-down facility, and for patient evacuation in the event of fire or decanting in the event of closure.
- Access to the main pathology laboratories is less important because of the development of near-patient laboratory facilities, such as fully automated blood-gas and electrolyte analyzers, or portable chemistry equipment.
- Careful sitting of departments can help to minimize the distances patients are moved. Where there is a lot of patient flow, large lifts and extra-wide corridors are mandatory.
- Those hospitals which receive or transfer patients to and from specialist units in other hospitals, or who receive frequent transfers from outside the hospital, must consider the position of the ICU in relation to ambulance or helicopter access, this may require dedicated external access.

Open & closed system

- There are two widely recognized systems of arrangement of patient beds and services in the intensive care units, open and Closed models:

  Open System:
  Most old ICUs have been designed on the recovery room model, with the head of the bed against the wall. Utilities such as oxygen, compressed air, vacuum and electricity are also delivered from the wall at the head of the bed. Unfavorably, they are commonly blocked by the position of the patient.

  Closed system:
  Modern ICUs are built like operating rooms with a patient's bed away from the wall or in the case of a private cubicle in the middle of the room. Utilities can be delivered from a power column that stands at one corner of the head of the bed or from an overhead boom (pendants) as they are in an operating room.

- Other critical care centers define their ICUs as "open" or "closed" or a combination of both types based on the type of health care team and services provided:

  In the open system, nursing, pharmacy, and respiratory therapy staff are ICU based. On the other hand, the caring physicians of the ICU patient may have obligations at a site distant from the ICU such as operating room.

  In the closed system, care is provided by an ICU based team of critical care physicians, nurses, pharmacists, respiratory therapists and other health professionals.

Size and Number of beds

- The recommended number of beds in a critical care center is dependent on the desire of the critical care team for immediate or delayed bed availability. The suggested formula for the determining the need of ICU beds is based on the past use figures and previous ICU occupancy.
- This calculation is based on the following :

  Number of beds = average census + (square root of average census) x Z

  Z= a constant dependent on the probability (*P*) of having an ICU bed available.

  Average census = average daily census of previous ICU bed occupancy

P	Z
99%	2.33
95%	1.65
90%	1.28
85%	1.044
80%	0.804

- The decision on the probability of bed availability depends on other hospital resources such as the capacity and function of the emergency department, the operating theater or the recovery rooms. ICU target is a probability of 90-95% bed availability.
- The general recommendation is that general ICUs should have average bed occupancy of 60-70% (British Medical Journal, 1970). Units which persistently run with occupancies of more than 70% are too small (i.e. require more facilities) while those units running occupancies of less than 60% are too large and require fewer beds. Larger ICUs could be expected to maintain a higher level of occupancy, yet still be able to accommodate unexpected referrals.
- It was estimated that 12% of the total number of acute beds in a hospital should be provided for intensive care, with an additional allocation for any specialist services on site. Setting the baseline requirement is now exceptionally difficult because of changes in working practices and case mix.

Patient Areas

- Adequate separation of beds is a major aspect of infection control. In any multi-bed area, beds should be positioned to maximize patient privacy. This may preclude 'facing' beds.
- 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. 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.
- Patient modules should be designed to support all necessary healthcare functions.
- The floor space allocated for each bed must be sufficient to accommodate all equipment and personnel that might be necessary to meet patient care needs.
- The beds should be 2.5 - 3 meters apart, to allow free movement of staff and equipment, reducing risk of cross contamination. Ideally, a sharps container should be within easy access of each bed. Ward-type ICUs should allow at least 20-22.5 m² of clear floor area per bed and 2.5m of unobstructed corridor space beyond the working area. ICUs with individual patient modules should allow at least 25 m² per room (assuming one patient per room), and provide a minimum width of 5 meters, excluding ancillary spaces (anteroom, toilet, storage).
- 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 and clear to the staff responding to the emergency.
- 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.
- 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.
- 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.

Isolation cubicles

- A minimum ratio of 1 cubicle: 6 bed spaces are required. However, in some circumstances, the ratio may need to be much higher, as in burns units. There may be an increasing need for cubicles because of the growth in numbers of immune-compromised patients or infectious cases (e.g. methicillin resistant Staphylococcus aureus). Various physical arrangements are possible.
- There are two types of Isolation that are practiced in all clinical areas of the hospital including the intensive care unit:
    - **Source isolation**: used for the isolation of infectious patients, airborne infections being the most concerning in this case. This type of isolation requires negative air pressure (air moving into the room).
    - **Protective isolation**: used for the protection of immune-compromised patient from sources of infection that could cause devastating infections in such patients. This type of isolation requires positive air pressure (air moving to the outside)
- Isolation rooms should each contain at least 25 m² of floor space plus an anteroom.
- Each anteroom should contain at least 3 m² to accommodate hand-washing, gowning, and storage.
- Ensuite toilet should be provided.
- Rooms shall have a permanently installed mechanism to monitor the air pressure status of the room when occupied by a patient according to the type of isolation required (protective or airborne isolation). However when possible two rooms (one with negative and the other with positive pressure) should be provided.
- At least one air borne infection isolation room for the care of one single patient should be provided, the number of such room shall be determined based on infection control risk assessment.
- Such room shall have an area for hand washing, gowning and storage of clean and soiled materials located directly outside the entry door.
- The walls, ceiling and floor (including penetrations) of this room shall be well sealed so as to prevent the leakage of air from inside the room to the adjacent environment.
- The exit doors of the airborne infection isolation rooms shall have self closing devices to prevent the door from remaining open after use.
- All surfaces should be washable and durable.

The following requirements are recommended for airborne infection isolation room:

- Central or point-of-use HEPA (99.97% efficiency) filters capable of removing particles 0.3 μm in diameter for supply (incoming) air
- Pressure differential of 2.5 Pa (0.01-in. water gauge) with other ICU areas.
- Airflow differential >125 cfm supply versus exhaust depending on anteroom air flow direction (pressurized versus depressurized)
- Sealed room with approximately 0.5-sq. ft. leakage
- Air moves into the room from adjacent areas
- All air exhausted directly to outdoors
- Monitoring the air pressure status
- Minimum total of 12 air changes per hour (ACH)
- Minimum of 2 air changes from outdoor air
- No re-circulation of air by means of room units but air may be re-circulated within

Individual isolation rooms if HEPA filters are used.
- Anteroom airflow patterns exhaust to outside or HEPA-filtered if re-circulated.
- Temperature is 24°C

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 side corridor (clean) 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 another side corridor (dirty). This helps to minimize any disruption of patient care activities and minimizes unnecessary noise.
- The corridor should be at least 2.4 meters in width.
- Doorways, openings, and passages into each ICU must be a minimum of 1 meter 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.

Reception 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 (could be locked) if the need arises.

Staff clothing change areas

- Appropriate areas shall be provided for male and female personnel (cleaners, technicians, nurses, and doctors) working within the ICU for cloth changing, lockable lockers, showers and toilets. At least one wash hand basin and a drinking water facility are necessary.
- At present, the ratio of female: male nursing staff in many ICUs is 2:1. Changing facilities should be provided on the unit at the rate of about 0.75 m^2 /nurse with a minimum of 15.5m^2 for female staff and 7.5 m^2 for male.
- Separate staff shower facilities and WCs should be available in each changing room. Both the changing room and lockers must be individually lockable.

Central station

- A central nursing station should provide a comfortable area of sufficient size to accommodate all necessary staff functions.
- Depending on the design of the unit, nursing substations 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.
- Allocation should be made for the connections required by patient information network / system, which is available in the facility.
- There shall be direct or remote visual observation between nurse station and all patient bed in the critical care unit.

Work Areas:

Medication Station

- There should be a separate medication area of at least 4.65 m² 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, also to permit monitoring of the area itself from outside to assure that only authorized personnel are within.
- Area for storage for critical supplies should be located within or immediately adjacent to each ICU.
- Alcoves should be provided for the storage and rapid retrieval of crash carts and portable monitor/defibrillators.

Hand washing sinks

- Hand washing sinks shall be convenient to nursing stations and patient bed areas.
- At least one hand washing basin is needed for each cubicle and its anteroom to minimize transfer of infection. In the open area, sinks may be shared by every other bed.
- Wash hand basins at each entry to the unit are required.
- Hand washing sinks must be of cleanable and disinfect-able material such as stainless steel.
- Hand-washing sinks should be deep and wide enough to prevent splashing, preferably equipped with elbow, knee, foot, electronic sensors or sonar-operated faucets
- The sink should have rounded corners to allow easy cleaning and prevent accumulation of water and bacteria.
- Hand washing stations should be sized to minimize the splashing of water. High side panels may also be used.
- The water source should be high enough level not to come in contact with the person's arm during the procedure of hand washing and not far from the edge so that the person does not lean on the edge of the sink and contaminate his clothing.
- It is preferred that hand washing solution to be dispensed with hands free apparatus.
- Coarse filters shall be installed to filter the water used in hand washing station.

Special procedure room

- If a special procedures room is desired, it should be located within, or immediately adjacent to ICU.
- One special procedures room may serve several ICUs in close proximity.
- Easy access for patients transported from areas outside the ICU should be considered.
- 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.

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 available to allow for the simultaneous viewing of serial radiographs.
- A "bright light" should also be available.

Satellite Laboratory

- All ICUs must have available 24-hour clinical laboratory services.
- 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.
- If necessary similar satellite areas for radiology, respiratory therapy & pharmacy **s**ervices could be allocated to provide the needs of ICU activities.
- The laboratory area should be at least 15 m² in size. Facilities should include blood gas analysis (tension and saturation), hemoglobin and electrolyte measurement. Adequate bench space is needed with at least 12 electric points, a sink, specimen fridge, freezer and centrifuge.
- Consideration should be given to providing a system for fume extraction. Uninterruptible power supply is needed for at least the blood gas machine. A communication system must be available. It would be appropriate to have adequate space for a computer terminal within this complex.

Ancillary & Specific support areas

Storage areas:

Equipment Storage area (for equipment and supplies)**:**

- 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.
- Storage areas for portable X-ray equipment, stretchers, fracture tables, warming devices auxiliary lamps etc. these areas shall be out of corridors and traffic.
- **Medical gas storage facilities:** should provide additional separate storage of reserve gas cylinders necessary to complete at least one day procedures and must comply with rules of national fire authority**.**
- All storage shall be at a height which is easily accessible.
- A total floor area of at least 5 m²per bed is needed, with shelves, cupboards, drawers, wall rail and bins. The furniture store requires at least an additional 15 m²: actual need is dependent upon local case mix, e.g. need for tank ventilators, spinal beds, pediatric incubators etc. X-ray/imaging equipment bay close to or within the complex. Floor area should exceed 4.5 m².
- Larger units will need separate accommodation for laying up trolleys, etc. At least 10 m² is needed, adjacent to the immediate consumables store**.**

Emergency equipments storage

Space that is easily accessible to the staff shall be provided for emergency equipment such as a cardiopulmonary resuscitation (CPR) cart

Clean utility room (clean work room)

- The clean utility room should be used for the storage of all clean and sterile supplies, also it may be used for the storage of clean linen and when clean materials are assembled within the ICU prior to use.
- Shelving and cabinets for storage must be located high enough off the floor to allow easy access to the floor underneath for cleaning.
- There must be adequate temperature control.
- This room should not be used for food preparation.
- It shall contain a work counter, a hand washing station and storage facilities for clean supplies.

Clean Lenin storage

- There shall be a designated area for clean Lenin storage. This may be within the clean workroom, a separate closet, or an approved distribution system in the hospital.
- If a closed cart system is used, storage maybe in alcove. It must be out of the path of normal traffic and under staff control. This should be adjacent to the patient area. 2m² of floor space is needed for each bed. This area may be reduced if laundry turn-around is rapid (twice daily top-up service).

Dirty utility room (soiled work room)

- The dirty utility room must contain a clinical sink, a flushing rim, drainer, a slop hopper or other provisions for disposal of liquid waste with hot and cold mixing faucets.
- Bed pan washers (flusher disinfectors) should be installed in this room (used to clean and disinfect bed pans, urinals and suction bottles). Racks for bedpan storage should be provided.
- A separate space for covered containers must be provided for temporarily storage of soiled linen and waste materials. The floor space required will be at least 2m².
- Special containers should be provided for the disposal of needles and other sharp objects.
- There shall be space to wash down trolleys, containers of dirty linen, rubbish and dirty instrument.
- The room shall not have direct connection with patient's area.
- It shall contain a hand washing station, with hot and cold mixing faucet.
- The room shall have a work counter
- This room shall be physically separate from the clean workroom.
- The air supply from the dirty utility room must be exhausted to the outside and not re-circulated within the ICU
- These areas may be separate: a total area of 20m² is needed

House keeping room

- House keeping facilities shall be provided for the exclusive use of the ICU and there shall be provision for storage of supplies and house keeping equipment.
- It should be 6-8m² of floor space for every 8 beds, with at least two electrical outlets and a sink/sluice.
- It shall be immediately adjacent to the ICU

Nourishment Preparation Area (Pantry)

- 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, 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.
- **Ice machine** should be provided from self dispensing ice makers to provide ice for treatment and patient use.

Rest area, lounge for staff, report preparation area, and toilet facilities

- 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.
- These lounges shall contain furniture for rest , area for food and drinks preparation
- The area should include comfortable seating and adequate nourishment storage and preparation facilities, including, T V, computer, a refrigerator, a countertop stove and/or microwave oven and toilet with hand washing facilities.
- The furniture should be easily washable and non dust forming or collecting. Wooden furniture is not allowed.
- The lounge must be linked to the ICU by telephone or intercommunication system, and emergency cardiac arrest alarms should be audible within.
- Separate or combined lounge for male and female staff shall be provided.
- Report preparation area shall be provided and shall be accessible from the lounge area.

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 call system.
- Cardiac arrest alarms should be audible in the room.
- The conference room may have multiple purposes including continuing education, house staff education, or multidisciplinary patient care conferences.
- A conference room is ideal for the storage of medical and nursing reference materials and resources such as 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.

Physician on call room

- When in-house physician services are provided on a 24-hour basis, on-call rooms should be available close to or within 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.

Visitors lounge, waiting area

- Families and visitors to critical care unit often wait for a long period of time including overnight stay, under high stressful situations. They tend to congregate at unit entries to be readily accessible to staff interaction.
- Design shall address such issues as privacy, atmosphere, and aesthetics for all involved in the care and comfort of patients in critical care units.
- A visitors' lounge or waiting area should be provided near each ICU or ICU cluster.
- Visitor access should be controlled from the receptionist area.
- The recommended number of seats for each critical care bed is 1.5-2 visitor seats.
- A variety of seating, including upright, lounge, and reclining chairs, is also desirable.
- Public telephones (preferably with privacy enclosures) and dining facilities must be available to visitors.
- Television and/or radio should be provided.
- Public toilet facilities and a drinking fountain should be located within the lounge area or immediately adjacent.
- Warm colors, indirect soft lighting, and windows are 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.

Administration office

- 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.

Specific requirements

Air quality requirements

- Suitable and safe air quality must be maintained at all times. A minimum of 12 total air changes per room per hour are required, with 2 air changes per hour composed of outside air.
- Central air-conditioning systems and re-circulated air must pass through appropriate filters
- Minimum efficiency rating value (MERV) is 30% for the first filter , 90% for the second filter bed.
- Air conditioning and heating should be provided with an emphasis on patient comfort. If any maintenance activities involving the air supply system in the ICU, the infection control department should be informed and the work in the ICU should only resumed with the permission of infection control department after the collection of the appropriate environmental samples.
- For rooms having toilets, the required toilet exhaust of 2.12 cubic meter per minute should be composed of outside air.

Recommended specifications of Air Supply in different areas of the ICU

Area designation	Air movement relationship to adjacent area	Minimum air change of outdoor air per hour	Minimum total air change per hour	All air exhausted to outdoors	Re-circulated by means of room units	Relative humidity %	Design temperature
Critical and intensive care	-	2	12	-	No	50-65	21-24°C
Airborne infection isolation room	In	2	12	Yes	No	-	24°C
Airborne infection isolation anteroom	In/out	-	10	Yes	No	-	-
Procedure room	Out	3	15	-	no	30-60	21-24°C
Janitor room	In	-	10	Yes	No	-	-
Bathroom	In	-	10	-	-	-	24°C
Clean linen storage	Out	-	2	-	-	-	10°C
Corridor/ dirty room	In	-	10	Yes	No	-	16°C

Temperature and humidity:

- Temperature and humidity control is essential with an air conditioning unit attached to a monitoring system to carefully regulate both temperature and humidity.
- It is preferred to have a system with the facility to print out and record the parameters in the ICU
- Special air conditioning and voltage regulation shall be provided.
- Temperature shall be maintained between 21-24°C in the ICU with relative humidity should have a minimum 50 %- 65% with 55% being the average recommended. The higher the humidity the higher the chance of electronic sparks developing.
- Humidifiers shall not permit the growth and multiplication of microorganisms. .
- For critical care units having enclosed patient modules, the temperature should be adjustable within each module. Single patient cubicles should have a choice of temperature from 16-27°C
- Other patient areas should be kept at 21-24°C.

Air supply

- Centrally supplied oxygen and compressed air must be provided at 50 to 55 psi from main and reserve tanks, and installation must follow National Fire Protection Authorities (NFPA) standards
- 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
- 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).

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.
- A utility column (freestanding, 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.
- 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.

Walls

- Walls are to be painted with seamless coating material which is bacteriostatic and can tolerate washing with detergents and disinfectants without deterioration of surface bonding (Epoxy - acrylic resin)
- Walls in ICU rooms (instead of painting) could be covered up to the level of 1.2 meters thick flexible vinyl sheeting welded to antistatic floor with round skirting level
- Walls must be smooth without cracks, seams, open joints, crevices or dividers which harbor dust, insects or bacteria and all cut edges should be tapered to the wall to prevent collection of dust
- Walls must be scratch resistant , withstanding wear and tear with fixed smooth trolley height wall protectors along corridors and exit areas
- Wall surfaces should be hard and resist impact, impermeable , stain proof and easy to clean
- Around sinks and wash basins there should be ceramic tile splash back adequately bonded with smooth water proof type of grout
- Walls penetrated by pipes ,ducts and conduits should be tightly sealed to minimize entry of insects and rodents
- Walls and ceilings should be constructed of materials with high sound absorption capabilities.

Floors

- Throughout the ICU the flooring should be 2-5 mm thick flexible, antistatic vinyl sheet. Welded at the seams, to provide a safe continuous water proof surface.
- The antistatic vinyl sheeting should be coved up the wall, to form a 10-15 cm skirting.
- All corners shall be rounded slightly to prevent the harboring of dust and bacteria, and there shall be no cracks or cervices at the seams or at the walls, which may allow pests such as ants and cockroaches into these clean areas.
- Floor coverings that absorb sound should be used, keeping infection control, maintenance, and equipment movement needs under consideration.

Ceiling

- Ceiling shall be smooth, nonporous, scrubbable, non-perforated, without crevices or seams and capable of withstanding harsh chemicals
- Ceiling shall be easily cleanable, non-friable and monolithic.
- Cracks or perforations in these ceilings are not allowed.
- The minimum ceiling height shall be 2.4 meters
- Ceiling in corridors, storage rooms and toilet rooms shall be not less than 2.35 meters.
- Equipment rooms and similar spaces where impact noise may be generated shall not be located directly over the ICU

Sliding Doors

- There shall be double door from the ICU into the theater, and from the ICU through the exit lobby, at least 1.5 meter in width
- Other doors to and from the dirty utility rooms shall be a minimum of 1 meter in width.
- Doors should NOT be manufactures of wooden material.
- All doors shall have a small, high window and shall be electronically operated.
- Doors should be made of washable material which can tolerate washing with detergents and disinfectants.
- 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.

Illumination & lights

- 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).
- The light shall have focus and dimming control**.** 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.
- Lighting should be bright, render colors natural and evenly light spaces.
- Lamp surfaces should be easy to clean and not collect dust.

Drainage system

- Drainage piping shall not be installed within the ceiling or exposed in ICU, central services, and electronic data processing area.
- Floor drains are not to be installed in ICU rooms.

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