

Intensive Care Unit Set Up in Low Resource Countries: An Overview of Basic Essentials

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Abstract

Setting up an intensive care unit is a daunting challenge especially in developing countries in terms of design, equipment, staff requirements, and other resources. Despite these intimidating challenges, there is however a need to provide critical care for patients in these settings. The availability of more specialized surgeries such as neurosurgery and cardiothoracic surgery and the need for advanced trauma care in most of our centers add to the urgent need for the provision of which is tailored to our environment. The aim of this review is to provide a practical overview on how to establish efficient intensive care unit in low resource countries.

Introduction

The intensive care unit (ICU) has evolved over the years. Its birth was based on the Crimean war experience where it was observed that the severely injured recovered when they were selectively cared for. These observations led to the isolated care for the critically ill and subsequently the development of various intensive care units. Although the ICU has a semblance to the general ward, it however differs greatly in terms of procedures, personnel, patients and cost of care. It is a known fact that intensive care services are limited worldwide. Most invasive monitoring and nursing care provided in ICU cannot be done efficiently in the ordinary ward.

The ICU is meant for potentially recoverable cases that often require more than one organ support with facilities that are not available in the ordinary ward. "It is not a relaxation spot for politicians as it obtains in many centers or a place for the terminally ill who are not recoverable like end stage cancer."

An overview of the general structure of intensive care unit.

Intensive care unit can be an entire hospital. It could also be a more specialized unit for instance, an age-based unit for children, adult and the elderly. It could also be departmental based unit for example intensive care unit for neurosurgery, trauma, obstetrics and gynecology, internal medicine and for post operative care. The trend in intensive care services is now toward the

provision of sub-specialist care for example paediatric, surgical, neuro, medical, burns, plastic post operative and infectious disease ICU etc. These sub units could run within an ICU complex.⁵

Generally, hospitals are required to run an ICU which accommodates 1% of their total bed space.⁸ Most intensive care units have the main ICU and a high dependency unit (HDU). The HDU is for the management of patients who require organ support but do not necessarily need mechanical ventilation. It is an integral part of ICU, especially the ones operated in University Teaching Hospitals.

The number of patients requiring more specialized care and advanced life support has increased over the years.¹ There is therefore the need to expand and improve on already existing ICU facilities incorporating international best practices to meet the growing need of patients. The ICU is often an integral part of anaesthesia departments in West Africa countries. Thus, improving and upgrading ICU services in this region will enhance training of resident doctors and the provision of better care for patients. Although this is capital intensive, the benefit far outweighs the cost implication in all ramifications. .

The availability of ICU in some Teaching Hospitals in Nigeria is amongst what attracts supernumerary doctors seeking to fulfill their postgraduate training in anaesthesia to these centers. However, this comes at a cost both for the trainees and their parent institutions. Nevertheless, most existing facilities at these centers need improvement to be able to cater for the training of these postgraduate resident doctors.

An ICU generally requires a floor plan of good architectural design and good attractive durable disinfect-able interior decorations. The shape can take any topology like star, rectangle or pyramid. Durable roofing sheet is also required to prevent frequent repairs and thus disruption of ICU services. Screed wall will allow for wall washing and disinfection as necessary which is part of infection control strategies in the unit. The floor requires non slippery attractive floor tiles which are laid in such a way that there are no dips among them to avoid serving as reservoir for infection. These tiles should be durable, strong, able to withstand heavy equipment and frequent cleaning with disinfectants and detergents. Appropriate wall colours that blend with the clothing and fittings in the unit would provide a conducive environment for staff and patients. Flecks of wall paints, leaking pipes, leaking pump, dangling materials on the floor are not only irritating but are sources of hospital acquired infection that is a worldwide challenge for patients in ICU. White Plaster of Paris (POP) ceilings are often used in ICU, the colour should blend with other fittings. Doors are usually made of durable double swing or long lasting sliding neat doors made from disinfect-able materials like metals. The door could be of various colours like gray or green colour. The ICU should be located in a place that is serene but easily accessible to all service areas within a beautified environment. Preferably, it should be located in a storey building overlooking a beautiful green garden, lawn, or water fountain. A dust proof, transparent, airtight window is preferable. However, because of various uncertainties in developing countries such as unstable electric supply continuously locked glass sliding windows could be used. The frame should be made of rust resistant, disinfect-able materials. The main ICU work area should be wide enough to accommodate the nurse's station, walk way, the bed space, inter bed space, bed lockers, bed tables, monitors, suction equipment, defibrillators and other equipment spaces. It should have an entrance door for clean material and an exit door for dirty materials.

An elbow operated tap with a liquid dispensed soap and a wash hand basin should be at the entrance and exit doors of the ICU. A continuous running tap is required for regular hand washing with soap and water. Preferably, an electric hand drier should be located close to the wash hand basin. Or a fresh clean single use hand towels should be provided which could be of disposable paper or cotton towels. Hand sanitizer (alcohol base system) should also be available at each patient bedside.^{9,10}

The nurses' station in an ICU could be circular in shape with chairs and electric sockets. Each patient bed side should have at least five electric wall sockets for plug in equipment and an extension box. However, other options include a ceiling socket or a column socket mounted on specific column that are located close to each bed.⁹

An ICU requires adequate lighting, and electric power supply that supports the ventilators, suction machines, and other equipment like X-ray machines, ultrasound machines, defibrillators etc. Solar power system is ideal for constant power supply for the unit. However, inverters with automatic switch over and adequate batteries could help provide alternative source of power in the event of power outage. Other electricity support apart from electricity from the national power grid like unit generators, general hospital generators, and particularly, automatic current switch over should always be available. Equipment such as mechanical ventilators with inbuilt batteries is also essential in the ICU which is often crucial especially in ventilator dependent patients. In addition, surge protectors are important requirements in the unit to prevent current fluctuations from damaging electrical equipment.

Adequate lighting is also necessary for common procedures in the ICU such as central venous cannular placement, medication and various interventions. High output bright energy saving white lamps will suffice in providing light in the unit. Although central air conditioning unit is ideal, in developing countries, multiple split unit air conditioning that purifies the air it circulates is easier to maintain. The air flow should be at least 15 air changes per hour.

The ICU should have a pantry with light sockets, microwaves, refrigerators and kitchen cabinets for processing of patients' food and an eating area for personnel on duty. There should be a separate general staff toilet, patient's toilet, and bathing room. The nurses toilet, bathing room, resident doctors toilet and bathing room should be attached to their respective furnished rooms with bed, refrigerators, tables, chairs, air conditioner and library. A supervising nurse office should be separated from the general nurse's room.

Outside the work area, there should be a separate office or room for the consultant (attending physician) in charge of ICU. Conference room, procedure room, cleaners and porter's room, sluice room, dirty linen and washing room, packing room with an autoclave should also be provided. Although disposable materials are ideal in ICU, often autoclaving of essential items needed urgently by the unit is required. Other rooms include: bed sheets store, equipment store, sterile room or sterile item store, maintenance officer work area, maintenance officer room, and patient relations waiting area. Patients' relations waiting area should be furnished with chairs, books, television and air conditioner. The changing room for staff, patients, visitors, doctors should be provided preferably at the common entrance to the intensive care unit. The changing room should have a rack for new gowns, masks, caps shoe covers and ICU shoes. For an open ICU, a side room with transparent windows is often added for cases requiring barrier nursing. There should also be a receptacle for dirty gowns, caps, shoe covers, and shoes. Rooms should also be provided for medical record personnel, mini pharmacy and mini laboratory for point of care testing.

A receptionist could be stationed at the entrance of the unit to direct human traffic, clean up the room and provide fresh material, ensure used item are disposed or autoclaved if necessary. A swing door with lock is required for the main entrance to ICU. A security officer could be required per shift to man the entrance and ensure visitors comply with all regulations.

Human resources

Staffing is another area of concern in an ICU set up. There should be a supervising consultant in charge of the unit. In the absence of the supervising consultant, the head of department of

anaesthesia in such system could coordinate the activities in the unit. There are also other consultants who cover the unit on a daily basis. Resident doctors, nursing staff, porters, cleaners, messengers are personnel on whom ICU's main activities primarily revolve. The cleaners, messengers, and porters run shift duty like the nursing staff thus making the overhead personnel cost high. There should be at least one consultant, excluding the supervising consultant, one senior registrar (specialist registrar) and one intending specialist registrar to cover a seven bedded ICU per day.¹⁰

One to two nurses per patient is advocated in ICU because of the intense functional nursing care required.^{12,13} A seven (7) bedded ICU will thus require eight (8) nurses per shift including the supervising nurse who should be ICU trained. Twenty-four nurses will be required per day. At least 15 of these nurses should be young, agile, enthusiastic, healthy nursing officer with post nursing qualification in ICU nursing. Male nurses are preferable especially for assistance in cardiopulmonary resuscitation where cardiac compression is required. Leave period, sick off, days off and casual leave allowances should be accommodated and added to determine the actual nursing staff requirement. A total of 30 nurses are thus required for a 7 bedded ICU. Poorly staffed ICU is as good as an open ward. It is associated with intense work. Most staff will abdicate ICU duties in such scenarios. Those who endure get ill often from stress and burnout which could have negative effects on patients care.¹⁴

In addition, two porters, two cleaners, and two messengers per shift are required for effective ICU set up. The porters are responsible for lifting and transfer of patients to various facilities within and outside the ICU. The health assistant should regularly mop the floors and toilets, disinfect the bed tables, lockers, and clean up the wall. The nurse assistant helps with washing of equipment and autoclaving including washing of gowns, and shoes. Furthermore, she can also be involved in the sending and retrieval of laboratory results and pharmacy materials when these items are required urgently especially when there is disruption in telecommunication services.

Materials and Equipment

An ICU requires up to date modern equipment and daily consumables. The daily consumables include disinfectants that should be supplied as stock solution and diluted in the procedure room to appropriate concentrations as required. These solutions include methylated spirit, hibitane solutions, phenol, hypochlorate, chlorhexinol solution. Latex disposable gloves should always be available. Syringes, needles of various sizes, infusions, blood giving sets, plasters, and dressing materials should also be available. Disposable containers for sharps, wet or used materials should be provided on daily basis for each patient. Record sheets, laboratory specimen bottles are always needed in the ICU. Others are peritoneal dialysis sets, central venous catheters (adult and children), and arterial line sets.

Each bed in the unit should have a functioning suction machine, syringe drivers, oxygen supply port, at least two multiparameter monitors with one serving as a reserve. The multiparameter monitors should have inbuilt long lasting batteries and should be able to monitor pulse rate, blood pressure, respiratory rate, end-tidal carbon dioxide concentration, arterial blood pressure, central venous pressure, and electrocardiogram (ECG). A co-oximeter is also required for patients with inhalational injury to specifically measure carboxyhaemoglobin and oxyhaemoglobin concentrations separately. Arterial blood gas (ABG) analysis is essential for all patients in ICU. Some patients could require more ABG analyses in a day. An average of five ABG per day has been reported. Wide range, durable; user's friendly ABG machine that is not affected by power surge is required in ICU.¹⁶

Mobile, multi-modal ventilators with inbuilt long lasting batteries, power surge protectors, humidity moisture exchanger (HME), disposable breathing circuit of various sizes, defibrillators, 12 lead diagnostic ECG machine, mobile X-ray, and ultrasound with facilities for Doppler mode for peripheral and deep tissue scanning should be provided for ICU. The ultrasound should support frequency range from 2.5MHz to 20MHz. Most ICU patients could be too unstable to be moved to distant facilities to share ultrasound facilities with regular out patients. A Cardiometer (non invasive cardiac output monitor), oxygen bank, incentive spirometer, oxygen humidifiers, self-inflating bags, mask of various sizes, nebulizers are also needed in ICU.

Supporting Services

Maintenance Services

A dedicated and articulated maintenance unit is required for efficient ICU services. These skilled technicians promptly repair diverse equipment faults in the ICU. Equipment failures could be very destabilizing if not promptly and professionally handled by trained technicians.

Medical Records

There should be a medical record staff who are up to date with the use of computer system. Collations of statistics, provision of medical sheets, and death certificate, should be part of their responsibility. They should operate from the medical record's room in the ICU.

Laboratory Services

All bed side tests that cannot be done in the ICU mini laboratory should be taken to a dedicated support laboratory which includes: histopathology, hematology, chemical pathology, and microbiology. Monthly review of post mortem findings in a conference with the pathologist is essential. Results from these laboratories should be promptly reviewed by the attending pathologists and sent to the unit.. Regular microbiological screening of the ICU is also essential.

Pharmacy Services.

Treatments are constantly being reviewed and changed in the ICU. There should be a dedicated pharmacy unit that supplies intensive care drugs. The pharmacist should be ready to source for urgently needed medications if not immediately available in the pharmacy attached to the unit.

Haemodialysis Unit

Renal dialysis unit should be close to the intensive care unit as most critically ill could require renal dialysis. A dedicated room and machine for the unit should be considered within the unit. A multi-modal dialysis machine that can achieve slow efficient dialysis (SLED) should be a part of the haemodialysis machine reserved for intensive care unit patients.¹⁸

Revenue Unit

Regular visit to the unit by the inpatient revenue unit is essential. Admission deposits and daily cost should be well articulated. A special revolving account should be considered for the unit. A consumable supply outlet located close to ICU can be considered. This could add to the central store general supply of consumable. However their services should be round the clock.

Support Services

Support from general emergency, ambulance services, consultant from other departments is highly recommended. For example, a radiologist could be needed for urgent review of X-rays films. Protocols for management of cases in the ICU, referrals procedures, ambulance services, admission criteria, control of nosocomial infections, and maintenance of harmonious working relationship between workers in the ICU are recurring issues that the supervising consultant should formulate

policy statement on. There should be clear admission criteria, discharge guideline, and protocols for management of cases. Regular meetings with staff and peer review of cases can help improve patients care. Rotation of resident doctors through the various supporting units will not only provide harmony but it will help internalize the various unit protocols and limitations. To encourage this, a sub specialty posting in these areas should be encouraged particularly in radiology, facility maintenance and laboratory medicine.

Finally, ICU is made for the critically ill, it is not synonymous with infectious disease unit, nor is it meant for end of life care. This implies that there should be a clear idea about the type of intensive care that is envisaged. It may appear complex but with basic knowledge of essential equipment, materials, manpower requirements, general structural and functional design, an effective intensive care unit can be set up. However, it should be noted that the intensive care unit is a capital intensive project which has to be rigorously maintained to achieve the desired result.

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