**Supplementary material**

**Design and Equipment of Pulmonary Intensive and Intermediate Care Units**

**Siting**

Pulmonary Intensive Care Units (PICU) and Intermediate Care Units (PIMCU) should be sited close to the department from which patients are admitted and with a functional connection plan relating to urgency. Complementary connections must be ensured towards the services: sterilisation, laboratories, radiology, and the pharmacy, as well as towards the general entrance for the access of relatives.

**Internal configuration**

The rooms and areas must be adapted to the type and volume of the activities provided.

**Hospitalisation.**

**Hospital rooms**. The PICU/PIMCUs can be structured with single or multiple rooms. A multiple room configuration ensures more effective management of the spaces assigned to the operating unit and closer surveillance of patients, and also facilitates the mobility of personnel and equipment. In order to favour care and reduce the risk of airborne transmission between patients, a suitable distance must be maintained between beds (2.5 m).

Inpatient areas should ensure isolation and maintenance of both negative and positive pressure as needed. Single rooms prepared as isolation areas (for infectious or immunosuppressed patients), should preferably be situated at the end of the ward.

For adequate patient management the head of the bed should be easily accessible for operational procedures and not be positioned against a wall. An equipped suspended ceiling bar must be used for the distribution of medical gases and electricity, and for housing equipment. This solution reduces the presence of equipment trolleys around the bed and cables on the floor, favouring both care and adequate cleaning, a fundamental condition for the prevention of infections.

It is also advisable to have a telephone connection, hands-free intercom, TV, connection to the computer network and CCTV camera for each bed.

All the rooms must be equipped with perfectly sealed, double-glazed windows in order to favour natural lighting of the environment and orientation of the patient. Natural daylight is essential for both patients and operators.

Moreover, it is recommended that the hospital rooms be equipped with a thermometer and hygrometer.

**Control centre**. This is a functionally separate area from that of the ward, from which direct visual inspection of patients must be possible. Its serves for both care and administration.

The desk must house the centralised monitoring station (centralized bed station) and therefore be equipped with computers connected to the network, one computer connected to the internal hospital network, a monitor and preferably closed-circuit TV, telephones, fax, intercoms, interphones, an alarm repeater, etc.

This area must be equipped with a satellite pharmacy, a refrigerator with a thermograph for storing thermolabile drugs and blood products, a lockable safety deposit for drugs, a sink and large work surfaces (this can be the area for preparing infusions and dressings), shelving, ergonomic chairs, therapy trolley, emergency trolley, trolley for files (patients’ printed material, medical iconography documentation, reports).

**Additional areas**

* **The head nurse’s station** with computers connected to the network, telephone lines, interphones and an emergency alarm repeater; intercoms with control area and connected with each hospital bed (for relatives/patient communication).
* **Equipment areas** **(depot, disinfection, washing, storage)**
* **Service areas (clean, dirty)** storage of linen and sterile materials, and used linen and other waste, respectively, completely separate and with independent accesses;
* **Medical staff area** with computers connected to the network, a monitor for the visualisation of diagnostic images, desks equipped with telephone lines, interphones and an emergency alarm repeater;
* **Filter-corridors;**
* **Bathrooms,** separate for staff and patients;
* **Visitors’ area;**
* **Room for the doctor on call;**
* **Kitchen.**

Rooms outside the ward and/or in common with other operating units:

* **Changing rooms;**
* **Secretary’s office/archives;**
* **Meeting room.**

**Additional internal configuration**

1. To guarantee a good acoustic quality of the department, architectural solutions (location of the department), technological-building solutions (soundproofing properties of wall and ceiling covering materials, soundproofing characteristics of windows, etc.) and plant type solutions (distribution of the treated air in the room) must all be adopted. The tolerated noise limits are 40 dB in the daytime and 30 dB at night

2. The ward must be equipped with washbasins in the bathroom and hospital areas, with the water supply activated using no-touch devices, detergents and antiseptics for hand washing in containers that cannot be topped up, and suitable drying materials.

3. The doors must be adequately sized for the type of transit (depending on the areas: passage of beds and/or equipment, linen, drug supplies and devices, waste, etc.), ensuring easy opening in critical areas [1].

**Structural Requirements**

The total surface area of the operating unit must be 2.5-3 times the total ward area for PICUs and at least twice the total ward area for PIMCUs, to be divided into the following areas (in addition to the ward area):

* + filter area for patients;
  + filter area for hospital staff;
  + room for infected patients equipped with a filter area (at least one single hospital room also suitable for housing patients requiring negative-pressure respiratory isolation);
  + room for medical staff (work room);
  + room for doctor on call (nearby);
  + work room for the nursing staff;
  + storage room for medical devices and other clean material (suitably sized for the storage of equipment);
  + storage room for dirty material, equipped with a sink;
  + staff bathrooms;
  + staff changing rooms (also centralised);
  + area for disinfection/washing of equipment/materials equipped with sinks, medical gas connections, vacuum deposit, electricity sockets);
  + head nurse’s room;
  + secretarial or administrative area (this function must be guaranteed);
  + ward kitchen with adjacent room for storing food distribution trolleys;
  + nursing workstation equipped with a monitoring unit.

The following must also be provided:

* + visitors’ waiting room (immediately outside the operating unit);
  + relatives’ reception area (preferably immediately outside the operating unit).

The following conditions must be satisfied: at least 15 m2/bed (for pre-existing structures), 20 m2/bed for single rooms and 16 m2 for multiple rooms (for newly designed structures).

Multiple rooms must be structured in such a way as to guarantee patient privacy.

The following must be ensured:

* + seamless, non-scratchable floor, wall and ceiling surfaces that can be treated with disinfectants and are joined with rounded corners;
  + doors and corridors inside the operating unit wide enough to manoeuvre beds;
  + wall units and/or ceiling beams for supporting equipment and devices that allow easy access, manoeuvring and cleaning.

The nursing station must provide a good view of patients.

The distance between two beds must not be less than 1.5 m (for pre-existing structures) or 2.5 m (for newly designed structures).

Adequate space must be provided behind the bedheads to allow for care operations (tracheal intubation, central venous catheterisation, bronchoscopy, etc.) [1].

**Technological Requirements**

**Installations**

* + Air-conditioning system that guarantees:
  + Internal winter and summer temperatures between 20 and 24°C;
  + Winter and summer relative humidity between 40 and 60%;
  + A number of air changes per hour (external air without recirculation) equal to 6-10 ACH, with a minimum of 10 ACH in the area used for the temporary storage of dirty materials and at least 12 ACH for isolation room/area (with the use of HEPA filtration of the incoming air, if re-circulated) [2-5];
  + Purification of the air through semi-absolute filters capable of retaining particles with a diameter of 5 microns;
  + Air speed in the ward areas not exceeding 0.8 m/sec.
  + Centralised aspiration system (vacuum) capable of guaranteeing a minimum aspiration pressure of 500 mmHg (40 L/min for each inlet);
  + Centralised medical gas unit;
  + Alarm system for signalling medical gas shortages;
  + Fire detection system;
  + Alarm system for electrical installations.

The following equipment must be present in the operating unit:

* + life-sustaining and life-support mechanical ventilators (at least 1 per bed, including additional emergency ventilator depending on the case mix and number of beds);
  + operating lamp for each bed;
  + aspirators for bronchial suction;
  + a defibrillator (preferably with transcutaneous cardiac pacing);
  + monitor for viewing diagnostic images;
  + refrigerators for storing drugs and blood products;
  + external cardiac stimulator;
  + bronchoscopy;
  + readily available X-ray device;
  + weighing system for bedridden patients (*desirable for PIMCU*);
  + equipment for transporting critical patients on gurneys including monitor/defibrillator with ECG, Non-invasive Blood Pressure Amplifier; oximeter, oxygen bottle, portable respirator;
  + emergency trolley;
  + at least one electricity socket per X-ray device per hospital ward;
  + 1 sink every 4 beds, with non-manual opening taps and disposable towels for pre-existing structures (1 every 2 beds for newly designed structures; 1 per bed for single rooms);
  + blood gas analyser;
  + ultrasound scanner;
  + patient lifter;
  + aids for preventing bedsores;
  + patient thermoregulation systems;
  + availability in the structure of hemofiltration/dialysis devices (*only for PICUs*);
  + modules or systems for the release of humidified and heated high-flow oxygen therapy;
  + electrical continuity system for monitoring systems and equipment designed to support vital functions.

The following equipment must be present for each bed:

* + 1 warning system (1 per single room, 1 per ward);
  + a light source;
  + electricity sockets (16-20 for PICU; 10 for PIMCU)
  + vacuum sockets: at least 2 per bed (*3 desirable for PICU*);
  + O2 sockets: at least 3 per bed (*4 desirable*) for PICU; at least 2 per bed (3 desirable) for PIMCU;
  + Compressed air sockets: 2 per bed (*3 desirable for PICU*);

The medicinal gas and vacuum connections must be marked with specific colours and not be positioned at eye level to avoid facial injuries in case of disconnection.

* + Mechanical ventilator with humidifier equipped with various ventilation modes, fitted with standardised alarm systems for user safety;
  + bed equipped with the possibility of assuming the *Trendelenburg* and *anti-Trendelenburg* positions, fitted with anti-decubitus aids;
  + manual ventilation system;
  + aspiration system;
  + at least 3-4 infusion pumps per bed (syringe and volumetric pump as required);
  + One enteral feeding pump per bed.

**Monitoring equipment**

* + monitor for detecting vital parameters and parameter trends, with acoustic and visual alarms, simultaneous viewing on the display of at least 4 of the following:
  + ECG;
  + Non-invasive BP;
  + At least two invasive pressure channels (*for PICU*);
  + Pulse oximeter;
  + monitoring of ventilation:
  + capnometry;
  + volumes,
  + pressure;
  + frequency;
  + % of O2 in the inhaled mixture (*available*);
  + cardiac output and derivative values (*available* for PICU);
  + temperature (central and cutaneous);
  + additional monitoring (*desirable for PICU*):
  + respiratory function;
  + detection of arrhythmias;
  + possibility of online recording of electrocardiographic tracing;
  + analysis of the ST-T waveform;
  + indirect calorimetry;
  + computerized system for analysing and processing monitored data (*desirable*).

**References**

1. Renda T, Arcaro G, Baglioni S, Brunetti G, Carlucci A, Carlucci B, et al. Respiratory intensive care unit: 2018 update. Rassegna di Patologia dell’Apparato Respiratorio 2018 Dec;33(6):306-32.
2. World Health Organization. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance, 13 March 2020. Available from: <https://apps.who.int/iris/handle/10665/331446>.
3. Saran S, Gurjar M, Baronia A, et al. Heating, ventilation and air conditioning (HVAC) in intensive care unit. Crit Care. 2020;24:194.
4. Alhazzani W, Møller MH, Arabi YM, Loeb M, Gong MN, Fan E, et al. Surviving sepsis campaign: guidelines on the management of critically ill adults with coronavirus disease 2019 (COVID-19). Intensive Care Med. 2020 May;46(5):854-87.
5. Center for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings. Available from: https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html.