Intensive Care Units:

Design, Location, Staffing Ancillary Areas, Equipment

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It is not uncommon, in small country hospitals, to have a recess or small room leading from the operating theatre, in which the patients remain until they have recovered, or at least recovered from the immediate effects of the operation—*Florence Nightingale in "Notes on Hospitals," 1863.*[1]

THE CONCEPT of intensive care has developed from experience in recovery rooms, in anesthetic work, and in early specialized units in different fields of medicine (*e.g.*, bulbar poliomyelitis, in Los Angeles before 1950[2]; barbiturate poisoning cases, Copenhagen, 1943[3]). Between the First and the Second World Wars special units were created in some German hospitals (Abteilung für Frisch-operierte und Schwerkranke).[4] It was mainly during and after the Second World War, however, that the idea of special surveillance units became commonly accepted as a part of hospital care.

In 1949 the Operating Room Committee for the New York Hospital asserted: "Today it can be stated categorically that an adequate recovery room service is a necessity to any hospital undertaking modern surgical therapy."

Development went further. The philosophy of the recovery room service—constant surveillance and concentration of qualified staff and therapeutic equipment resources—embraced not only the newly-operated-upon patient, but also every patient from every part of the hospital who was seriously ill.[5] The poliomyelitis epidemic in 1952[6, 7, 8] gave impetus to the extension of respirator treatment of all patients with severe respiratory difficulties[9-12] and led to a concentration of this treatment in the special units.[12-16]

Thus, the early recovery room, which in many hospitals provided surveillance of newly-operated-upon patients as well as intensive and specialized treatment of any patient seriously ill, often did not have the facilities for dealing with the double burden. Experience since then has provided the basis for design of new, larger units, some radically new, *e.g.*, the circular 12-bed unit at the Methodist Hospital, Rochester, Minnesota, designed by Ellerbe & Company (fig. 1).

The new units have different names—Acute Care Unit, Shock Unit, Special Care Unit,[17] Resuscitation Unit, Emergency Clinic,[18] Respiratory Care Unit.[15] To clear up confusion in definition, to promote development, and to make recommendations for the future, many countries have, or have had, committees on a national, society or multidisciplinary basis, *e.g.*, Great Britain,[19] the United States,[20] Sweden,[21] Belgium,[22] Hungary[23] and Norway.[24]

Definition of Intensive Care

In the literature, "intensive care" often means a combination of recovery-room service and intensive therapy. For fruitful discussion it is important to distinguish between close observation of the patient, heavy-duty nursing and proper intensive therapy.

INTENSIVE OBSERVATION

The Recovery Room (RR) can be called an intensive observation area for the postoperative patient, just as the Coronary Care Unit (CCU) is an intensive surveillance area for the patient with myocardial infarction. The main purpose of the unit is—by close observation of the patient—to give adequate therapy in time to prevent complications.

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Heavy-duty Nursing

The patient in need of heavy-duty nursing is not at a critical stage, but requires more nursing personnel than the ordinary ward can supply, closer observation of usual clinical values, or more simple therapeutic procedures.[25]

Intensive Therapy

In an Intensive Therapy Unit (ITU) patients who, during a period of critical illness, require strict supervision, extraordinary care, special qualified staff and, very often, mechanical aids to support vital functions, are treated. The patient may require artificial ventilation, treatment for shock, cardiac monitoring, pacemaking, peritoneal or hemodialysis, biochemical correction of severe metabolic disorders, and special protection against infection.

National Policy

A working group appointed by the National Board of Health in Great Britain estimated in 1962 that in most acute hospitals about 2 per cent of medical and surgical patients may receive treatment in an Intensive Care Unit (ICU), although in some hospitals the figure may be as high as 5 per cent.[26] At the XIIIth International Hospital Congress in Paris, in 1963, the figure was stated to be 3–4 per cent.[27] In the United States, Saklad, who has had more than 12 years experience with well-organized, special-care service, concluded some years ago that the number of patients in his units equalled about 8 per cent of total admissions to the hospital; he believed that this figure would be closer to 10 per cent in the future.[28] According to the policy of his hospital, special care is a combination of heavy-duty nursing, intensive observation and intensive therapy.

In Denmark, J. Jörgensen has stated that Danish General District Hospitals are unable to provide proper ITU.[25] He recommends a unit supplemented with heavy-duty-nursing beds. In Sweden about 80 per cent of the hospitals have some form of intensive care. This, however, says very little. A figure which gives a better idea of the situation is that intensive care in 1966 accounted for 1.6 per cent of the total bed capacity for acute somatic diseases. It was estimated that the percentage would rise to 2.9 in 1970 and to 3.2 in 1975. These figures for intensive care refer to a combination of recovery room service and intensive therapy. A committee of experts of the Swedish National Board of Health recently has published the following policy decisions [21]:

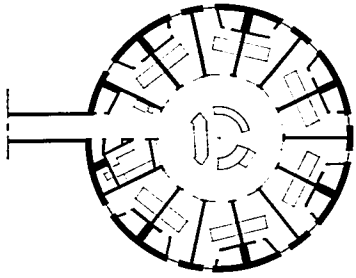

Fig. 1. Circular intensive-care unit at Methodist Hospital, Rochester, Minnesota.

> The operating theater shall have a recovery-room service.
>
> Generally, on an average, most hospitals will need 4 per cent of the number of beds in the clinics which make use of the unit for intensive therapy.
>
> More than 15 beds in one ITU is not recommended.
>
> There is no reason for a special ITU smaller than five beds, unless it is in a highly specialized clinic.
>
> If, in a very large hospital, more than one ITU is needed, there should be the greatest possible integration and flexibility among the units, and they should be placed close to each other.

Recommendations from the Author's Experience

The number of beds and the type of intensive care offered will vary according to the size, function and specialization of the hospital. Each hospital must have intensive care units designed for its specific needs and purposes, for the population area it is to serve, the types of clinics which refer patients, and local conditions.

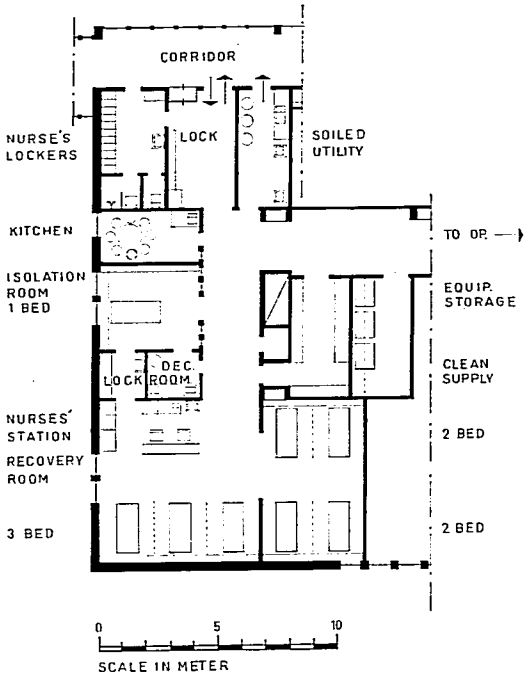

FIG. 2. Combined recovery room, postoperative and intensive-therapy unit in the Gynecological-Obstetrical Clinic (120 beds) at Danderyd Hospital. (Architects, HLLS. Medical adviser, P. E. Wiklund.)

In the *small hospital,* 100–200 beds, intensive care can be given in a recovery room supplemented with one, two or more isolation rooms for postoperative care, intensive observation and intensive therapy (fig. 2).

The *middle-sized hospital* will have a separate recovery room and an ICU with a number of beds which correspond to 2–6 per cent of the acute beds of the hospital. The ICU can be a smaller intensive therapy unit or a larger unit for combined intensive therapy, intensive observation and heavy-duty nursing. In this way, many small hospitals will have ICU's as large as those of larger hospitals with ITU's which provide only nursing and therapy within the above-mentioned definition of intensive therapy (fig. 3).

The *large hospital* will have one or more ITU's, situated close to special observation units—IOU's—for heavy-duty nursing and surveillance of patients who require more than average nursing care and observation (CCU, dialysis treatment units, etc.). Very large hospitals are usually provided with special ITU's for children, neurosurgery and thoracic surgery. The need for intensive care facilities can thus be scheduled according to the number of acute beds in the hospital, as shown in table 1.

General Design

Recovery Room

The design of a recovery room will not be discussed in detail here. Stated in summary,

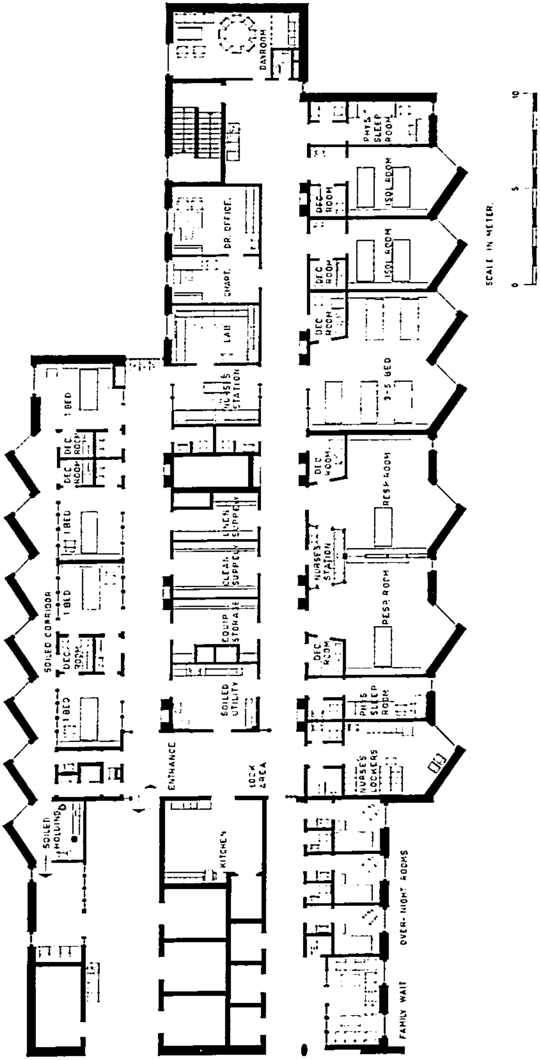

FIG. 3. A 15-bed intensive-care unit for intensive therapy, intensive observation and heavy-duty nursing at Löwenströmska Hospital, Sweden, a 300-bed hospital. (Architect, A. Tengbom. Medical advisers, P. E. Wiklund and W. Duvernoy.)

TABLE 1. Intensive-care Facilities According to the Number of Acute Beds in Hospitals

Number of Acute Beds	Intensive-care Facilities	
100	Recovery room with 1–2 isolation rooms for intensive therapy	
200	Recovery room with 3–4 isolation rooms for intensive therapy	
300–400	Recovery room	ICU with 10–15 beds for heavy-duty nursing and intensive therapy *or* ITU with 6–8 beds
500	Recovery room	ICU with 12–15 beds for intensive observation and intensive therapy *or* ITU with 10 beds + IOU (CCU)
600 or more	Recovery rooms	ITU's (general, pediatries, neurosurgery, thoracic surgery) + IOU's (CCU, dialysis treatment unit. etc.)

this part of the intensive care area is a post-anesthesia and postoperative unit where the patient is *observed* closely until the possibility of development of asphyxia, shock or other complications requiring ventilatory or circulatory resuscitation is no longer a threat. The recovery room should be connected directly with the operating unit. The dimensions of the former can be determined by the fact that approximately 1½–2 beds are required per operating theater, with a minimum of five beds, or alternatively, 5–7 per cent of the surgical beds in the hospital. It is an advantage to have an open-style recovery room, but with the area divided into several sections. The beds should be so located that the nurse can view all patients from the working area as well as from the nurses' desk.[5, 16]

CORONARY CARE UNIT

Nor is it the purpose of this paper to discuss the design and equipment of a CCU—the intensive surveillance area for the cardiac patient. It must be stressed, however, that if possible the CCU should be adjacent to the ITU, or at least inside the intensive care area, because prompt treatment and cooperation between anesthesiologist and cardiologist are vital for a coronary patient in distress; it is also an advantage to be able to utilize the different service facilities readily available in the intensive care area, such as locker rooms, family waiting room, equipment storage room, conference room, etc. In small hospitals a combined ICU and coronary surveillance unit, with several single-bed cubicles, is more practical, as outlined above, since this promotes interchangeability and better staffing. In that case every effort should be made to keep the noise level low in the isolation room. Glass partitions for nurse supervision is essential, but opaque curtains must also be provided when privacy is needed.

INTENSIVE THERAPY UNIT

Location. Most existing ITU's have been developed in connection with operating theaters and recovery rooms. In new construction, the ITU ought to be separated from the recovery room but in contiguity with these areas, the emergency room and the delivery unit. Because the ITU demands round-the-clock service from the radiology department and the laboratories, it is an advantage to have it located near these services (fig. 4).

If more than one ITU is needed, such units should be placed close to each other and to the coronary surveillance unit. In this way, an "acute-24-hour-a-day hospital" is created inside the hospital.

Planning the Bed Area. The size and layout of the unit depends on the number of beds and must be tailored to the needs and size of the specific hospital it is to serve.[29] Only after these considerations have been satisfactorily taken into account should attention be directed to the shape of the unit. For purposes of discussion, one ITU with eight to ten beds will be regarded as reasonable for a Community General Hospital. Such a unit corresponds to

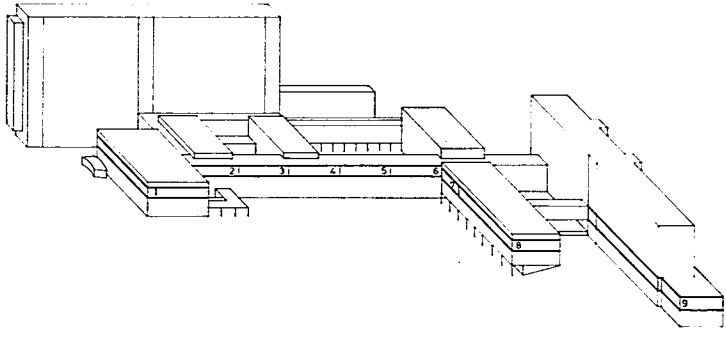

FIG. 4. Relationships between different sections of the intensive-care area at Danderyd Hospital. *Left*, central operating unit; *right*, gynecology and obstetrics department. 1, central operating unit. 2, recovery room. 3, intensive therapy unit. 4, anesthesia offices. 5, intensive therapy unit for infected cases. 6, dialysis treatment area. 7, postoperative unit. 8, operating unit of the gynecology department. 9, obstetrics department.

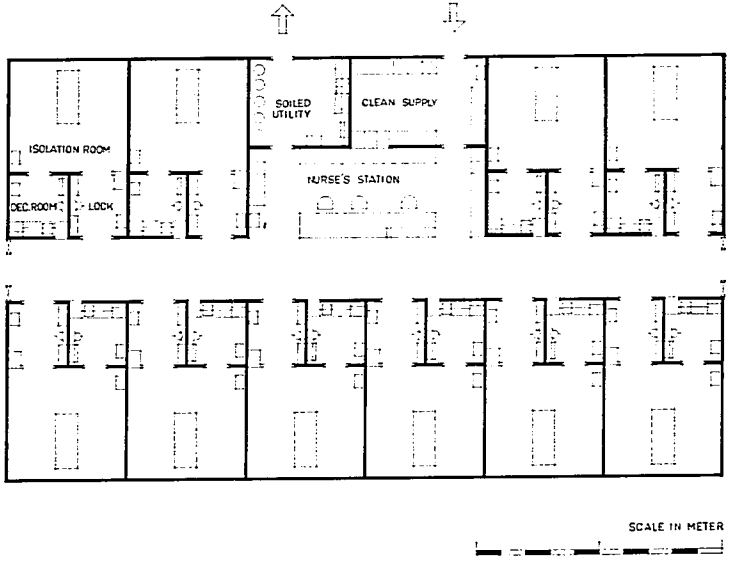

FIG. 5. A 10-bed intensive therapy unit with all beds in isolation rooms. The unit is one of four, planned for the new Huddinge Hospital, Sweden, a 1,600-bed hospital. (Architects, HLLS. Medical advisers, Å. Wåhlin, O. von Dardel, P. E. Wiklund.) (Permission for reproduction obtained from authors.[a])

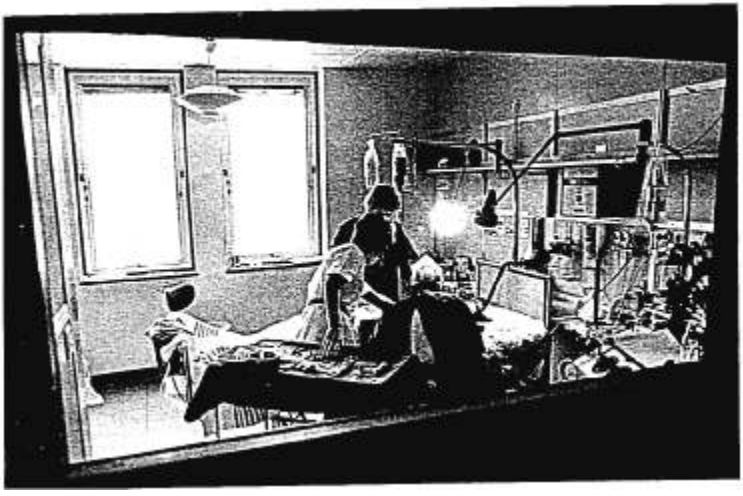

FIG. 6. An isolation room.

a hospital with 400–500 beds in the clinics served by the unit, assuming that the operating theaters have recovery rooms for postoperative care and that there is a coronary surveillance unit for coronary-care patients. The ITU must provide at least two or three times as much space as is needed in general patient care.[29] Different types of intensive-therapy patients—diseases and injuries—require different bed areas. It is advisable to make the patient area as flexible as possible if the requirements of widely-differing patients are to be met.

Of the two basic types of design—the large open ward and the single-room accommodation—the trend is towards single-room accommodations.[25, 20] It must be stressed that the demand for space and isolation possibilities must be higher than for conventional wards. Isolation of patients liable to infection or already infected, in properly designed individual rooms, is essential, at least as a first step to control cross-infection in the ITU.[16] Moreover, the intensive-therapy patient is not necessarily unconscious. The conscious patient is disturbed by the activity, light and noise in an open unit shaped like a recovery room. Sometimes there are psychological implications in a patient's knowing that he is so seriously ill as to be housed in the ITU. Better care can be given such a patient in an isolated room segregated from other intensive-therapy patients so that the psychological distress of any one patient does not affect the others (fig. 5).

From this point of view the provision of all beds in single rooms can be regarded as an ideal, but extravagant, solution. It should be borne in mind that this solution requires many nurses, which most hospitals cannot afford, and it may also be impractical in a not-too-specialized unit. If one must compromise, then it may be reasonable to arrange for at least 50–60 per cent of the bed capacity in isolation facilities.

Isolation Rooms. The most common complaint about ITU with rooms consisting of cubicles is insufficiency of space.[28] An isolation room should be large enough to provide adequate uncluttered space around the bed for the equipment and the large number of personnel sometimes involved in nursing and emergency care (fig. 6). An isolation room

with an area of 22 to 24 square meters (240 to 260 square feet) is adequate for any situation. The large isolation room makes it unnecessary to have a special operating room inside the unit. Tracheostomy or hemodialysis can be performed safely in the room if there is enough space. The large isolation room meets the requirements of widely differing patients. If not occupied by an infected patient or one liable to infection, it can be used as a two-bed room for minor cases, *e.g.*, barbiturate poisoning, that can be treated successfully within three or four days without risk of infection.

Each isolation room should contain a lock-chamber, a buffer between the corridor and the isolation room, for changing coats, masks, caps and shoes, washing hands, and so on,[16] as well as a decontamination room where instruments and equipment are decontaminated and the infected patient's soiled linen is put into plastic bags before disposal. The decontamination room should be equipped with a small bedpan-flushing attachment for cleaning bedpans and for disposing of fluids. In this room, equipment for cleaning the isolation room can be stored. It is an advantage if soiled linen and equipment, even in plastic bags or decontaminated, can be transported without passing through the other bed areas.

Multiple-bed Area. If the eight- to ten-bed unit has four or five isolation rooms, the rest of the bed area can be laid out with an open section in front of the nurses' desk. For each bed in this section an area of 8 to 9 square meters (85 to 100 square feet) must be allowed (fig. 7). The open section, 5 × 7 meters (16 × 25 feet), shaped like a recovery room, can accommodate four patients. The more intensive and specailized the treatment, the larger the area required per bed. Thus, the open section, generally with four beds, may be fully occupied with two or even one patient when plenty of working space is required, for example, during the first hours of treatment of a patient severely injured in a traffic accident.

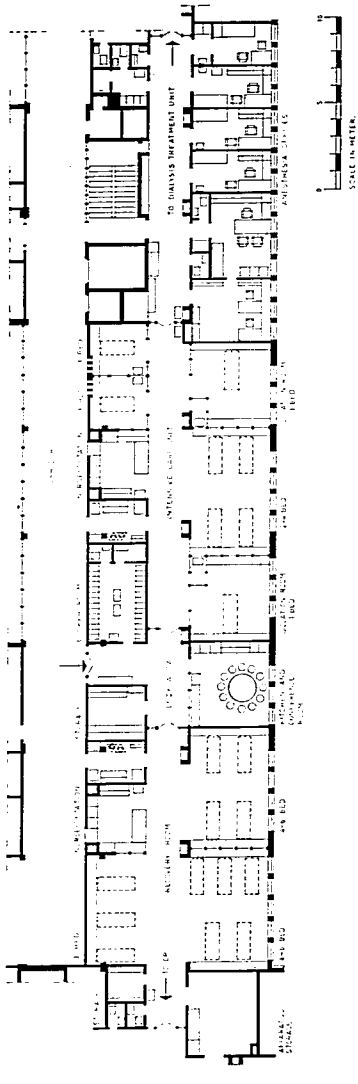

FIG. 7. Plan of recovery room, intensive-care unit and anesthesia offices at Danderyd Hospital. The intensive-care unit has isolation rooms and a multiple-bed area. (Architects, HLLS. Medical adviser, P. E. Wiklund.)

FIG. 8. Nurses' desk.

Nurses' Station. Regardless of the arrangements preferred, several features may be universally applicable. The so-called nurses' station, which may also frequently serve as the place where the physicians work, should be so arranged that all patients can be constantly observed, either directly or by television (fig. 8).[16] The desk should be large enough to provide sufficient working space for several people, and to accommodate the central monitoring equipment, charts and an acoustically shielded telephone booth. With reference to the description of equipment in table 2, it is obvious that the nurses' station must have a wide working area, perhaps divided into several sections for monitoring, charting and preparation of materials. In larger units with a number of isolation rooms it is better to have several nurses' stations. The nurses' station should be centrally located, but the head nurse requires a separate accommodation shielded as much as possible from the patient areas, away from the busy area, where, in quiet surroundings, she can talk with relatives and members of the staff. An accommodation should also be planned where the physicians can dictate and write reports.

Work Area. Ample space is required for the working area and the utility rooms. As a rule, total bed space in the unit should equal the total working area.[30] The total ITU area is two and a half to three times the size of the bed area.[21] Centrally connected with, or in, the nurses' station there should be a preparation area with drugs, parenteral solution flasks, blood, emergency supplies, sterile tray sets, etc.[22] Service facilities should include soiled and clean utility rooms. Clean and soiled supply areas should be physically separated. The clean supply should be the core for the receipt, storage and preparation of materials used in patient care, but a key requirement is the availability of equipment close to where it is used; materials can be further distributed to the nurses' station or to the isolation rooms. A double-door, pass-through cabinet, leading into the isolation room permits routine restocking of clean supplies and sterile tray sets from outside.[32] The cabinet is kept stocked with basic supplies and other special items according to each patient's specific requirements.

A large storeroom is required for bulky equipment, such as respirators, defibrillators, patient lifts, special beds, transportable roentgen apparatus, and oxygen tents. This part of the storage area can be shared with the recovery room and/or other intensive-care units inside the area, and also can be used as a room for clean beds. Free and easy passage to the equipment is essential. No time must be wasted in moving heavy machines if there is an urgent need for a defibrillator or a respirator. Equipment and instruments should be immediately and visibly available.[30]

It is recommended that every hospital with an ITU have a special department for medical apparatus, with qualified technicians who are responsible for the function, maintenance and safety of the increasingly elaborate technical equipment. A practical arrangement is to have a workroom for these technicians, adjacent to the store room, for preparation of materials, minor repairs, and care of technical apparatus, and another room for decontamination, cleaning and sterilizing the apparatus.

Communication Areas. If the ITU is not shaped like an infectious disease ward, with isolation rooms exclusively, the entrance should be an anteroom, an intermediate lock-zone, where staff, specialists, visitors or personnel coming from other parts of the hospital must, before entering the unit, be gowned, don masks and acquire shoe-covers or special color-marked ITU-shoes. This makes everyone aware that he is entering a special area involving a cross-infection hazard. The anteroom should either be large enough to permit easy admission of a patient in an emergency, or there should be a special emergency en-

trance. It should be easy to move the patient from his bed or trolley to the ITU-bed, which is wheeled forward through wide double doors which have metal protective plates and open electronically. Both the corridor and the doors to the isolation rooms should be 1.5 meters (5 feet) wide, to facilitate movement of beds, respirators and roentgen apparatus. In infectious cases this door to the isolation room will be closed after the patient's admission, and the staff will go through the lock-chamber to the isolation room.

The dressing rooms for male and female staff can be adjacent to the entrance to the unit. It must be remembered that the size of the nursing staff (nurses, assistant nurses and orderlies) is more than two to four persons per bed.[22] Therefore, the dressing rooms must be big enough and have a sufficient number of lockers. Every dressing room should have a shower and a toilet.

Offices and Conference Rooms. Offices for physicians and secretaries, a conference room, an on-duty room and a room for relatives can advantageously be planned outside the unit, and as a part of the whole intensive care area. Frequently, relatives wish to stay for long periods close to a patient who is seriously ill. Thus, if the hospital can afford it, it is greatly appreciated if rooms for relatives can be used overnight and offer a telephone and toilet.

All personnel assigned to the ITU should be well trained in the care of the patients and equipment. An in-service educational program can be facilitated if a small library for discussions and lecturing is planned inside the unit. In smaller units, the staff coffee-room and kitchen for the unit can be used for this purpose.

Laboratory Facilities. It is often stressed that laboratory facilities are mandatory. According to the Swedish recommendations every ITU should have access to laboratory service, on a 24-hour basis, from the hospital laboratory. Blood-gas analysis, acid–base determinations, metabolic balance, and electrolyte values should be available immediately at any hour. If the hospital laboratory is unable to do this work the determinations must be made in a special laboratory adjacent to the ITU.

Lighting and Ventilation. Partitions should be made of glass and provided with venetian blinds and opaque curtains. Adequate lighting is essential; the color of the light is very important for proper observation of patients.[33] Light with a bluish tinge should be avoided. Night lighting should be possible for each section; intensity should be variable according to need and controlled by a dimmer or by switching over to special night lighting. Bed lighting suitable for reading should be provided in the isolation room. For each bed in the isolation room, and for every two beds in the multiple-bed area, a ceiling-mounted examination lamp is recommended.

Ventilation and air conditioning for the whole area must be effective. To meet the demand for total isolation of infected patients, or of those particularly liable to infection, each isolation room should have its own ventilation system with a complete air conditioner providing filtered air, humidity, and heating or cooling from the ceiling.[16] Thus, individual temperature controls, as well as a ventilation air-supply inlet and exhaust air outlet, should be provided for each isolation room.

Fittings and Fixtures. Each bed must be supplied with ordinary recovery-room equipment: oxygen outlets for oxygen therapy and for inhalation therapy with aerosols; double outlets for suctioning, with a special bacterial lock on the suction bottle; sphygmomanometer; four electrical outlets; a place for records; wall shelves with a rail upon which equipment and instruments can be mounted (fig. 9).[33] As the unit has many electrical outlets, daily work is facilitated if fuses are placed over each bed or in each section.

As well as in the isolation room, for every three to six beds there must be a "resuscitation panel" or another arrangement with bag and mask for ventilation, a "panic button" to alert the whole unit when cardiac arrest occurs, and outlets for portable roentgenographic apparatus.

Provision should be made for radios with earphones or pillow-speakers and for small television sets in isolation rooms. Each bed should have a call system which patients or attendants can use to call the unit. An important factor is that the design should also

TABLE 2. Equipment List

At Patient's Bedside	Always Available (Pass-through Cabinet)	At Nurses' Station	Storerooms
Oxygen outlets with flowmeters and humidifiers.	Inhalation therapy equipment.	Audio and visual alarm for fall of oxygen pressure in central system.	Stock supply of catheters, suction bottles, etc.
Suction outlets with suction units.	Oxygen and suction catheters.		Suction apparatus. Oxygen tents, inhalation therapy equipment.
Disposable catheters.	Containers. Oropharyngeal airways.		Ventilation and peak flowmeter.
(Bedside respiration monitor)	(Conduits and electrodes for monitoring respiratory rate)	(Respiration rate meter)	
Bag and mask for ventilation.	Intubation tray.	Sterile tray sets for tracheostomy and pleural drainage tray.	Respirators. Anesthesia machines.
	Connections for respirator treatment.		Stock supply of endotracheal and tracheostomy tubes, heat and moisture-exchangers, humidifiers.
			Chest-suction bottles.
Sphygmomanometer. Stethoscope.	Emergency drugs.	Emergency supplies and drugs.	Defibrillator.
Oscilloscope for ECG with heart-rate meter. Alarm button.	Special ECG electrodes for continuous monitoring.	Central panel with oscilloscopes, heart-rate meters, audio and visual alarm, recorder.	Pacemaker and pacemaker catheters.
		Sterile tray sets for cut-down, a. and v. pressure, catheters.	
Bedside temperature meter.	Conduits.	Optical thermometer connected with bedside unit.	Hypothermia apparatus.
Wall shelves with rails.	Guide and standard holders to be placed on the rail.		Clock, tray, screen, etc. to be mounted on the rail.
Separate electrical outlet for roentgenographic equipment.			Roentgenographic apparatus.
Equipment necessary for individual care.	Disposable syringes and needles. Infusion sets.	Baskets with disposable syringes, needles, infusion sets.	Sufficient supply of bed linen.
Emesis basin. Paper bag for waste.	I.v. catheters. Gastric tubes.	Medicine cabinet for medications, narcotics and other preparations.	Stock supply of disposable equipment, syringes, needles, drainage tubes, infusion sets, uribags.
Mouth-care tray.	Bedpan. Washbasin.	Refrigerator for biologicals, blood and other preparations.	Stock supply of parenteral solution flasks.
Talcum powder.	Treatment tray, drugs and solutions.	Parenteral solution flasks and electrolytes.	Decontamination solution flasks.
		Sterile tray sets for lumbar puncture, minor surgery, etc.	Special intensive-care beds.
			Antidecubitus mattresses.
			Dripstands.
		Tray set for urethral catherization.	Uribags. Urinometer.
		Equipment for peritoneal dialysis.	Stock supply of peritoneal dialysis solution.
			Artificial kidney.

TABLE 2. (*Continued*)

At Patient's Bedside	Always Available (Pass-through Cabinet)	At Nurses' Station	In Storerooms
Intercommunication system.		Terminal end of call system. Telephone and intercommunication system.	
Television camera.		Television screens.	
Keyboard for patient-data monitoring.		Keyboard and graphic screens for patient-data monitoring.	
		Office supply.	

provide adequate electrical conduit space for future needs.

Monitoring Systems. A monitoring system does not reduce the number of nurses required. Patients ill enough to need intensive therapy will certainly need continuous bedside attendance.[24] But electronic aids can lighten the work, perhaps improve the care and enable prompt registration of vitally important data from the patient. Monitoring should be used as an adjunct and not to replace direct observation.

By far the most reliable indices used in monitoring are temperature and the ECG. With adequate rate meters and alarm systems, preset at thresholds, the ECG can be of real value. The equipment must be comparatively simple for routine work. It is mandatory that the signal can be seen at bedside, on an oscilloscope, as well as at the central nursing station.[16] At bedside the physician and a highly-trained nurse can observe the patient while obtaining information from the physiologic data on the oscilloscope; the effect of any therapeutic measure employed can be seen at once. At the nurses' station the ECG can be discussed; and continuous monitoring, if reliable, gives visual and/or auditory notification of distress, enabling prompt application of resuscitative procedures.

A feedback system for ECG and telemetry can be of use in both the ITU and the CCU, but continuous monitoring of slowly-changing variables such as respiratory rate and blood pressure seems of questionable value. A bedside attendant will obtain equally good data, a routine which also has the advantage of assuring frequent observation of the patient. Transthoracic impedance measurements can easily be obtained, however, by monitoring apparatus from the same electrodes used for the ECG.[35, 36] In this way, changes in fre-

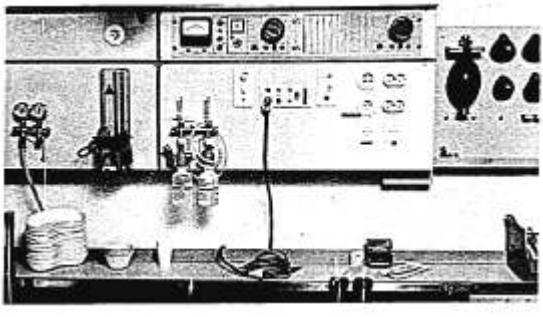

FIG. 9. Fittings and fixtures at the bed.

FIG. 10. Television screens at nurses' desk.

quency and volume of the thorax can be recorded or processed by analog computing techniques.

The dangers and pitfalls in patient monitoring must always be taken into account. The ECG can obviously be normal on the oscilloscope without any peripheral circulation in the patient, and impedance changes of the thorax can be demonstrated when the patient's airway is blocked. Equipment should be available for determining central venous pressure and urine output, but this is seldom done with an electronic monitoring system.

The use of on-line computers for rapid calculation of various parameters and for immediate information about the patient's condition seems to be the next valuable step in facilitating the work in the ITU,[37] since, among other things, it affords a visual communication device among attendants at the patient's bedside, doctors, nurses, laboratories, etc.

Closed-circuit Television. When working at the central desk, nurses and physicians must be able to supervise the entire unit, including the isolation rooms. With the aid of cameras in isolation rooms it is possible to follow, on television screens, what is happening in these rooms.[16] It must be possible to direct a camera from the desk to survey a patient at all times or, with a zoom lens, to pay close attention to a monitoring instrument, *e.g.*, the pressure gauge on a respirator (fig. 10). Television cameras are of real value for an overall view of the whole department, making it unnecessary for the staff to go in and out of an isolation room repeatedly. This also diminishes the risk of spreading bacterial infection within the unit. A trained nurse and the physician, though not in an isolation room, can keep in touch with what is happening there.

Equipment. Intensive therapy is the result of teamwork between specialists and qualified trained nurses, with utilization of monitoring and emergency equipment for constant observation and immediate emergency treatment, as well as long-term nursing care for critically-ill patients. Equipment lists may be compiled in many different ways. Table 2 offers only some basic arrangements many of which are mentioned above, with the idea that emergency equipment should be in readiness and made available as close to the patient as possible. Emergency equipment should be kept close to where it is most frequently used.

Dialysis Treatment Area. As an ITU logically has the capacity for applying IPPV in respiratory insufficiency, so should it also offer artificial renal dilaysis in its program for treatment of acute renal failure.[28, 29] In many cases, acute dialysis can be performed peritoneally through indwelling nylon cannulae not requiring any special facilities. It is best to perform hemodialysis in a separate specially-designed unit. Unless the hospital has a renal clinic, the ITU will have to assume responsibility for hemodialysis. In this case, the staff

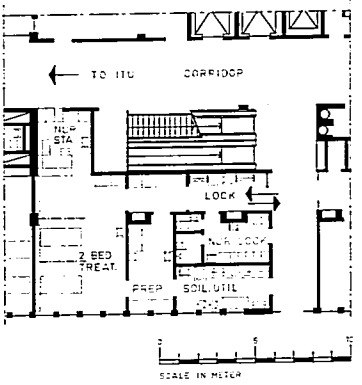

FIG. 11. Dialysis treatment area at Danderyd Hospital. The area is physically separated from, but a part of, the ICU.

must be trained and experienced in this field; otherwise hemodialysis proves to be more of a hazard than a help. If one or two patients undergoing chronic hemodialysis can be cared for in the ITU, continuous experience can be assured. This will not only benefit the acute cases but also help ease the demand for treatment of patients on chronic hemodialysis programs or waiting for renal transplantation (fig. 11). Chronic hemodialysis may be performed inside an isolation room in the ITU, the patients being taken into the unit when treatment is to be carried out. If possible, because of the special care required by these patients and the problems of nosocomial infection involved, this treatment should be concentrated in a specially-planned area, close to, but separate from, the ordinary bed area of the ITU.

Summary

Requirements and installations necessary for intensive care are discussed. Although the purposes and types of units will differ among hospitals, every hospital requires facilities for both intensive observation and intensive therapy. The quality of intensive care given in a recovery room with isolation possibilities, or in a special ITU depends upon the skill and enthusiasm of the personnel. Planning for and organization of better facilities and utilization of modern technology will, however, assist in developing better working conditions and in satisfying hygienic requirements of units of this nature.[40]

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Muscle

PROSTIGMINE AND MESENTERIC FLOW The question is asked whether prostigmine, given to reverse the action of muscle relaxants, has any adverse effects on the healing of an anastomosis of the bowel. Prostigmine, given alone, was found to have a marked depressant effect on the blood flow in the caudal mesenteric arteries of five dogs, partly because of a fall in cardiac output, and partly because of a local effect producing contraction of the bowel muscle. These effects were, however, largely avoided by the use of atropine before prostigmine. An analysis of the clinical cases suggests that there is not, in fact, an increased leak rate in patients given prostigmine, so that the doses of atropine commonly used in anesthetic practice are, in the main, adequate to prevent anastomotic damage. There is, therefore, no evidence to suggest that leaking anastomoses are related to unusually high doses of prostigmine. (*Whitaker, B. L.: Observations on the Blood Flow in the Inferior Mesenteric Arterial System, and the Healing of Colonic Anastomoses, Ann. Roy. Coll. Surg. Eng. 43: 89 (Aug.) 1968.*)