Onco-critical Care

An Evidence-based Approach

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Nishkarsh Gupta
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Editors

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Foreword

Cancer is not new to humanity, and its evidence has been described in the Chinese and Arabic medical writings. Taking a look at the present times, it is clear that the cancer epidemic is engulfing the world including India. The natural course of the disease has changed over the last decade. With the increase in the number of patients presenting with malignancy, and associated vast clinical and financial implications, early detection and prompt management is required to reduce morbidity and mortality. Also, the need for critical care healthcare services is expanding. We need dedicated professionals with skill, knowledge, and expertise in managing cancer patients not only in the outpatient department and operation theatre but also in ICUs. There are many factors which work against timely response from critical care specialists. Firstly, there is a huge gap between demand and supply of critical care specialists especially those trained to handle oncological cases. Secondly, the technology and huge cost involved in taking care of onco-critical cases puts an extra burden on healthcare set-ups. And perhaps the most important factor is that onco-critical care does not exist as subspeciality in our country to date. Most critical care organizations have not acknowledged this lack of access, do not have an oncologic section and allocate minimal space for lectures in their curriculum about the specific problems only seen in these populations. There is an urgent need to develop a robust and organized response along with evidence-based approach to manage onco-critical patients. This textbook edited by Dr Vinod Kumar, Dr Nishkarsh Gupta and Dr Seema Mishra elucidates all the important theoretical and practical aspects pertaining to research and management of patients in oncological set-up who need critical care support in a concise and precise manner. From an Indian perspective, this

textbook is first of its class. It would be of great help to all the residents and clinical practitioners who are involved in the management of cancer patients. I would like to extend my best wishes and congratulate Dr Vinod Kumar and all the authors to come up with this idea and bringing out a much-needed evidence-based textbook highlighting all the aspects regarding onco-critical care.

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Preface

Critical care in cancer patients is complex and different from routine care for non-malignant patients. These patients are immunocompromised, malnourished and have specific concerns due to cancer-related complications, treatment-related toxicities, and severe infections. The intensivist must understand about pathophysiology, diagnosis, and management of common cancer-related issues. The optimal management of cancer patients requires expertise in oncology, critical care, and palliative medicine. There is a dearth of books explaining about critical care needs of cancer patients comprehensively. So, we felt the need for a book that is comprehensive and provides insight into the care of cancer patients in the intensive care unit.

This book contains 43 chapters. Each chapter has been prepared by experts in the field of critical care. It contains chapters on basic intensive care starting with the organization and design of the Oncocritical care unit followed by staffing and admission and discharge criteria. As these patients are immunocompromised and prone to infections, we had included chapters on infection control practices, antibiotic stewardship programmes, and sepsis management. This is followed by chapters on fluid and electrolyte management and blood transfusion. A sizeable number of patients are transferred to ICU for the management of complications due to chemotherapy and radiotherapy. Some of the oncosurgical procedures like CRS-HIPEC, head and neck surgery, thoracic surgery, and major abdominal surgeries necessitate intensive care for optimal management in the postoperative period as these surgeries involve extensive surgical resection with major fluid shift and intraoperative inotropes and vasopressor.

Few oncology patients with extensive disease may reach the spectrum of best supportive care when definitive treatment is not feasible. So, we had included chapters on palliative care which will help in decision making regarding initiation of palliation and end-of-life care. Overall, we had tried to cover diverse topics which confront intensivists in oncology ICU. This book will provide an evidence-based approach to postgraduate students and practitioners to understand about critical care needs of patients suffering from malignancies. It will help them develop critical thinking and encourage discussion toward improving the overall care of the patients and their families. This book will fulfil the needs of the postgraduate MD anaesthesia, DM Oncoanaesthesia, fellows in critical care, fellows in Onco-anaesthesiology, fellows in Onco-critical care, MSc (nursing) in critical care students to provide systemic care to the patients.

New Delhi, India — Vinod Kumar

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About the Editors

Vinod Kumar is additional professor in the Department of Onco-Anaesthesia & Palliative Medicine at Dr BRA IRCH, All India Institute of Medical Sciences (AIIMS), New Delhi, India. He received his training in anaesthesia from PGIMER, Chandigarh, India. Dr Kumar has a teaching experience of 12 years and guides MD (palliative medicine) and DM (onco-anaesthesiology) residents for research. He has many publications in peer-reviewed national and international journals to his credit and has edited a book. Dr Kumar is a reviewer for various national and international journals. He is a member of national anaesthesia, airway, and palliative care societies. He is an invited faculty for various national and international conferences.

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Design and Organization of Oncology ICU

1

Renu, Vinod Kumar, and Nishkarsh Gupta

1.1 Introduction

The incidence of cancer is rising and overall survival of cancer patients is improving due to advancement in chemotherapeutic regimens and surgical options [1]. So, more patients will require intensive care in future due to cancer related complications, treatment toxicities and severe infection. Designing an ICU for oncology patient is significant as these patients are malnourished, immunosuppressed and tend to require prolonged hospitalization compared to general population [2]. An ICU (intensive care unit) is a complex and highly specialized division of a hospital for the purpose of treatment of seriously ill people. It is meticulously designed, located, built and furnished. It is a division with a dedicated nursing, medical and ancillary staff who are tuned to the requirement of the specialty. It has its own policies, protocols, and standard operative procedures to take care of critically ill patients [3].

1.2 ICU Design

1.2.1 Location

ICU should be located above ground floor. It should be adjacent to operation theatre and emergency department. Pharmacy, pathology, radiology suite, sterile supplies,

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infection control and blood bank should be in the same building. Corridors, elevators, and ramps should be large enough to allow for bed/trolley mobility. The ICU should have a single entry/exit point that is manned [4, 5].

1.3 ICU Design and Bed Space

Beds may be arranged in U or L shape with nursing counter in the centre.

In the patient care area, 150–200 square feet for every bed is recommended. The ICU ought to have 100–150% additional space to accommodate stockpiling, nursing station, patient/specialists/staff area, and attendant's quarters, showing region, relative's region, and bathrooms. There should be a buffer space between the area for patient attendants and the area for medical professionals [6].

1.4 Single-Occupancy Cubicles/Rooms

The patient care area should be between 200 and 250 square feet. Depending on demands and bedside treatments such as ECMO, RRT, and so on, it may be beneficial to create one or two larger rooms or sections. It is advised that 10% (one to two) of the isolation rooms be used to treat immunocompromised and/or infected patients. There should be 20% more space in these rooms. Two rooms/cubicles/beds may be separated by a partition for the privacy of patients. Standard curtains are commonly used in ICUs to soften the aesthetics of the environment; however, they may become dirty or misplaced, impairing privacy.

An indestructible permanent or removable partition made of aluminum, wood, or fiber can be used to divide two rooms. Permanent partitions, on the other hand, may limit the ability to temporarily increase floor area if required. Electronic windows may be offered while designing. The glass or fiber of these windows is transparent when the switch is off and opaque when the switch is on. Installation of such window is expensive although cost may decrease in future. Transparent windows help in elevating the mood of the patient and help him in orientation with time [7].

1.5 Requirement of ICU Beds in Hospital as per Norms

Number of intensive care beds required in a tertiary care facility can range from 5 to 25% of absolute medical clinic beds, depending on the facility's specialty. ICUs with less than six beds are inefficient, and they may not provide enough clinical training or exposure to the ICU's skilled HR. It is difficult to operate an ICU with a bed strength of more than 12, and severe issues in management and result may occur. If more than 12 beds are needed, a second ICU may be built. As a result, overall bed strength in the ICU is advised to be between 8 and 12 [8].

1.6 Panels at the Head-End and at the Pendant

How to plan bedside design is one of the most crucial decisions. The two most prevalent methods are head-end wall panels or free-standing/hanging systems (power columns), which are typically suspended from the ceiling. Each one can be permanent or mobile and adjustable. It can occur on patient's right or left side. Flexibility is typically a good thing. Panels on head wall systems do not allow patients to move freely due to dangling wires and tubes.

Though hanging pendants appear to be more scientific, but head-end panels are used in the majority of ICUs in India. Pendants, rather than head-end panels, may be scrutinized by new ICU planners. Power columns that are adaptable can rotate or move from side to side. Power column mounts are frequently adjustable as well. Ceiling-mounted, movable, rotatory devices can help clear the debris from the floor and free up a lot of space. However, if the weight of the power column cannot be structurally supported, then this may not be feasible. It is recommended that the monitoring equipment be situated at eye level. Doctors and nurses may suffer from persistent head tilting, which can cause cervical neck pain and problems.

In the ICU, getting to the top of the bed in an emergency and weaving through different tangled wires is a common problem. At the same time, the patient should not feel hemmed in or surrounded by apparatus, nor should he or she be frightened unnecessarily. So, bed should be kept at least 2 feet away from the head wall. For that, a wooden plank which is 2 feet wide and 6 inches thick should be placed between wall and head end of the bed.

It will keep the bed away from the wall and provide a space for caregivers to stand in the event of an emergency without causing too many problems. A fixed ring of lines connected together can be used to route lines.

1.7 Isolation Rooms

Ten percent of the beds (1 or 2) may be utilized as isolation rooms for patients with febrile neutropenia, GVHD, and other post-stem cell transplant problems. Each patient should be given an alarm bell with both sound and light indications, and he should be trained how to use it when necessary. These isolation rooms usually have an anteroom or airlock lobby which acts as a barrier against potential loss of pressurization, controls entry and exit of air and provides a control area for transfer of supplies without contaminating the patient care area. An anteroom can be shared between.

1.8 Negative Pressure Isolation Room

There is requirement for patients infected/suspected with organisms transmitted through airborne droplets of <5 μm in diameter. In these rooms, windows are kept closed. Outside of the room, the air pressure is higher than within the room. In this way, potentially contaminated air or other potentially dangerous particles will not

migrate outside into uncontaminated areas when the door is opened. Pressure differential of 2.5 Pa is kept between the two. An externally directed airflow into the room comes from neighboring areas, such as corridors and anterooms, in a clean to filthy direction. Room air should be vented to the outside, but if filtered with a HEPA filter, it can be recirculated [9]. A minimum of 12 air changes are required per hour and one must maintain a minimum 0.01-inch water column (WC). An airflow difference of 150–200 cubic feet per minute 9CFM) should be there to maintain pressure difference in a well-sealed room. They should be located at the entry of the entry of the ICU so that these patients do not have to pass through the other patient areas. A negative pressure room should have a hand wash basin preferably with hands free operation, ensuite shower and toilet, self-closing door, supply air ducts independent of the rest of the building.

1.9 Positive Pressure Isolation Room

They are needed to prevent contagious disease away from immunocompromised patients like those with cancer and/or transplants. These rooms should contain more supply air than exhaust air. These room require at least 12 air changes per minute and must have a difference of 0.01 inch WC positive pressure differential to ensure protection form airborne contamination. In relation to the corridor, there is a positive air flow i.e., flow of air from the room to the adjacent outside space. HEPA filter must be used if air is recirculated.

1.10 ICU Heating, Ventilation, and Air Conditioning System

Air conditioning is necessary to regulate temperature, humidity, and air flow in the intensive care unit. Temperature should be maintained with a focus on the patients' and ICU personnel's comfort. A temperature range of 16–25 °C is found to be suitable [10].

1.11 Utilities

In order to satisfy the needs of the patients and critical care team in both regular and emergency scenarios, oxygen, water, electrical power, compressed air, environmental control systems, vacuum, and lighting system must all ensure compliance with regulatory and accreditation agencies. A utility column is the best source of oxygen, electrical power, vacuum (freestanding, ceiling mounted, or floor mounted),, and compressed air which should also house temperature and lighting controls. Utility columns, when placed correctly, allow simple access to the patient's head and, if necessary, emergency airway care. It is possible to provide utility services on the head wall if utility columns aren't feasible.

1.12 Electrical Services

The ICU should have its own power backup that starts immediately in the event of a power loss. This electricity should be enough to keep the ICU equipment running and maintain the temperature despite the fact that most of the vital ICU equipment have battery backup. Stabilization of the voltage is also required. In the ICU, an UPS (uninterrupted power supply) system is preferred.

At least 50% of electrical outlets with proper labelling are connected to a continuous power source (UPS). An ICU's electrical panel, which should be located in the utility room, should contain a circuit breaker for each receptacle or cluster.

If the ICU does not have an UPS (uninterrupted power supply), there should be at least four UPS points on each panel, as well as a suitable number of lights and computers [11].

1.13 Lighting

Typical nursing duties, such as charting, can be carried out using general overhead illumination plus ambient light, while encouraging a comforting atmosphere for patients. No more than 30 foot-candles (fc) of total brightness should be used [12].

Lighting controls should be placed on variable-control dimmers situated directly outside the room. This allows for night-time illumination adjustments from outside the room, minimizing sleep interruption during patient surveillance. For long periods of time, night lighting should not exceed 6.5 fc, and for short periods of time, it should not exceed 19 fc.

1.14 ICU Noise Level

The International Noise Council advises that noise levels in ICUs be kept to a minimum of 45 decibels during day, 40 decibels in the evening, and 20 decibels at night [13].

1.15 Furniture and Furnishing

The countertops and furnishings should be durable enough to survive a lot of usage, as well as easy to clean and maintain. Metal to metal fasteners should be used for connections.

The fabric should be sturdy, colorfast, static-resistant, and flame if feasible, and countertops should be solid, nonporous, and stain-resistant. Patient's surrounding can be made comfortable by allowing him to keep few modest personal objects.

1.16 Coverings for the Floor, Walls, and Ceiling

Floors should be easy to maintain, non-slippery, durable, and sound absorbing while also increasing the aesthetic feel of the place. Carts and beds should be able to roll over it without difficulty.

1.17 Walls

Walls should be durable, easy to clean and maintained. It should be flame and mildew resistant. To minimise abuse and noise while simultaneously facilitating patient mobility and ambulation, door stoppers and handrails should be properly placed.

1.18 Ceiling

Ceiling is the most visualized surface by the patient. It is important that the ceiling be stain-resistant and break-proof in order to prevent eye strain from bright spotlights or fluorescent lighting [14].

1.19 Water Supply

There should be provision for clean water as hand washing, storage tanks, water filtration, and drinking water is required in the ICU [15].

1.20 Waste Disposal

An alcohol-based antimicrobial rapid hand wash solution should be accessible on every bed, so that the caregiver (doctor, nurse, relative or paramedic) can wash their hands before they touch the patient. For fear of spreading foul odors and infections, no material/dirty linen/soiled linen should be permitted to linger in the ICU for lengthy periods of time and should be disposed of as soon as feasible. Linen that has become soiled should be replaced on a regular basis and at predetermined intervals.

1.21 Central Nursing Station

Central nursing station is the soul of ICU. At this place, all of the resident physicians, nurses, and other support workers gather to discuss information and maintain track of records. All computers and digital information systems, as well as stationery, registers, and other documents, are housed here. Patients must be seen from this area regardless of whether the nurse is seated or standing, hence taller chairs are typically necessary. The central monitoring system is desirable in the oncology ICU as it connects a series of patient monitors together and back to a central monitor.

1.22 Storage

It's crucial to select what should be kept by the bedside, at the nursing station and in the nursing store. Supplies which are required often and urgently should be easily available and easy to locate. While keeping a big inventory can be costly and waste precious time. Making supplies more accessible may improve their utilization. Some overly careful or astute employees may seek to hide or hoard them. Designs that are both cost-effective and efficient are required. Ideas from nursing staff and ICU technicians should be pooled while designing space for storage.

Supplies should be categorized by activity and their usage such as chest trays, central lines, skin care trays, catheterization trays, and intracranial pressure tray, etc. They can be named or color-coded.

JCAHO now mandates secure storage when pharmaceuticals are maintained at the bedside; these stores can contain disposables, medicines, injections, records, and tabs etc. Using trolleys for supplies at the bedside loaded for different subgroups of patients, including as medical, surgical, cardiac patients, and trauma, who all have different demands, can help save space in the room. Staff nurses may have received special training to provide such care and tasks.

1.23 Communications

The patient cubicles, staff station, conference rooms, staff lounge and staff-overnight stay rooms should all have a voice intercommunication system. The plan may additionally contain supply spaces and a visitors' lounge/waiting room. Connections to important departments including the blood bank, radiology, pharmacy, and clinical laboratories should be created whenever possible. There should be a way to communicate internally and externally in the event of a system failure which is in addition to conventional telephones available in each ICU.

1.24 Wash Basins and Scrubs

Near the staff station and patient bed areas, handbasins and clinical hand-washing facilities are required. It is recommended that there be one clinical hand-washing station for every two patient beds, and one for every patient's room or cubicle.

1.25 Support Areas for Staff

Doctors duty rooms (male and female), nurses lounge, medication counters, changing rooms, meeting room for discussion of medical professionals and family meeting, toilets, janitor room, pantry, equipment room (mobile X-ray, USG) and utility rooms for dirty and clean utility should be provided.

1.26 Waiting Area

A separate waiting area for patient's family member is must with seating arrangement. Lockers, prayer area, food, beverages, drinking water, and rest rooms should be provided. There should be a separate interview room and a separate waiting area for anxious relatives, as well as overnight rooms for relations, should be provided.

Provision for renal replacement therapy (RRT) should be there as some of the cancer patients may need during their care. For this one RRT (HD/CRRT) bed with RO/de-iodinated water supply outlets should be set aside for HD machines.

1.27 The ICU's Equipment

The least fundamental equipment necessary for the ICU's successful and safe operation is known as essential equipment. While desired equipment is that which will improve the ICU's ability to manage patients and provide high-quality care. Below are the list of equipment required in setup of ICU. This list is not all inclusive.

- ICU equipment ICU bed with mattress,
- Air mattress,
- ICU ventilator,
- non-invasive ventilation mask,
- high flow nasal cannula,
- Stretcher trolley,
- Chair for staff and relatives,
- Procedure trolley,
- emergency crash cart,
- linen cart, multiparameter monitor,
- Computer,
- intravenous stand,
- syringe pump, infusion pump, sequential compression device.

1.28 Conclusion

Care delivery costs, clinical outcomes, and organizational performance are all influenced by critical care facility architecture. For organizations participating in design and construction projects, consultants with experience will connect with customers and make important design choices based on the best available evidence.

References

1. SEER stat fact sheet: cancer of any site. Seer.cancer.gov. Accessed 2 Feb 2022.
2. Koch A, Checkley W. Do hospitals need oncological critical care units? J Thorac Dis. 2017;9(3):E304–9.

3. Rungta N, Zirpe KG, Dixit SB, Mehta Y, Chaudhry D, Govil D, et al. Indian Society of Critical Care Medicine experts committee consensus statement on ICU planning and designing, 2020. Indian J Crit Care Med. 2020;24(Suppl 1)
4. American Institute of Architects Committee on Architecture for Health and the U.S. Department of Health and Human Services—Guidelines for Construction and Equipment/Hospital and Medical Facilities. AIA Press, 1996.
5. Marshall JC, Bosco L, Adhikari NK, Connolly B, Diaz JV, Dorman T, et al. What is an intensive care unit? A report of the task force of the world Federation of Societies of intensive and critical care medicine. J Crit Care. 2017;37:270–6.
6. Chaudhury H, Mahmood A, Valente M. Advantages and disadvantages of single versus multiple occupancy rooms in acute care environments: a review and analysis of the literature. Environ Behav. 2005;37:760–86.
7. Bracco D, Dubois M-J, Bouali R, Eggimann P. Single rooms may help to prevent nosocomial bloodstream infection and cross-transmission of methicillin-resistant Staphylococcus aureus in intensive care units. Intensive Care Med. 2007;33:836–40.
8. Williams SV. How many intensive care beds are enough? Crit Care Med. 1983;11(6):412–6.
9. Lee SY, Choi SH, Park JE, et al. Crucial role of temporary airborne infection isolation rooms in an intensive care unit: containing the COVID-19 outbreak in South Korea. Crit Care. 2020;24:238.
10. Minvielle E, Dervaux B, Retbi A, Aegerter P, Boumendil A, Jars-Guincestre MC, et al. Culture, organization, and management in intensive care: construction and validation of a multidimensional questionnaire. J Crit Care. 2005;20:126–38.
11. Wunsch H, Gershengorn H, Mayer S, Claassen J. The effect of window rooms on critically ill patients with subarachnoid hemorrhage admitted to intensive care. Crit Care. 2011;15:R81.
12. Hamilton D, Thompson D. What's new in ICU design? Critical Connections, Society of Critical Care Medicine; 2005. p. 1–10.
13. Grumet GW. Pandemonium in the modern hospital (editorial). N Engl J Med. 1993;328:433–7.
14. O'Connell NH, Humphreys H. Intensive care unit design and environmental factors in the acquisition of infection. J Hosp Infect. 2000;45:255–62.
15. Andreas Valentin and Patrick Ferdinande (ESICM Working Group on Quality Improvement): Recommendations on basic requirements for intensive care units: structural and organizational aspects Intensive Care Med 2011;1(37):1575–1587.

ICU Staffing, Models, and Outcomes in Onco-Critical Care Unit

2

Saurabh Vig, Anuja Pandit, and Swati Bhan

2.1 Introduction

The 'Intensive Care Unit' (ICU) in any hospital houses critically ill patients and is specifically designed, staffed and equipped to monitor and manage the life threating illnesses and other complications which may be seen in critically sick patients [1]. Thus, an ICU is a area of the hospital which is cost intensive to maintain and operate and requires precise management to be economically viable for any hospital.

Historically, the concept of a designated area for the management of critically ill patients has developed with major historical events of the world. The World War 1 saw the development of the so called 'shock wards' for the resuscitation of soldiers in hypovolemic shock with colloids and crystalloids. This progressed to surgical wards with the onset of blood transfusion and surgeries for management of wounds sustained in the battlefield. The concept of a 'respiratory unit' with mechanical ventilatory support emerged during the polio epidemic which saw widespread use of ventilators for respiratory support [2]. Organ specific based intensive care was first described in neurosurgery as 'brain teams' looking after the perioperative care of neurosurgical patients [3].

With the progress of medicine and development of various medical and surgical branches ICUs in the present-day scenario are super specialized units where medical or surgical patients requiring intensive round the clock monitoring and management are admitted. ICU's are graded into three levels (level 1, 2 and 3) on the basis of the size and speciality of the hospital housing these units [4]. The basic guidelines on skeletal and structural formation of an ICU according to the level of care the number of beds to be housed, number of beds in a chamber, the spacing and

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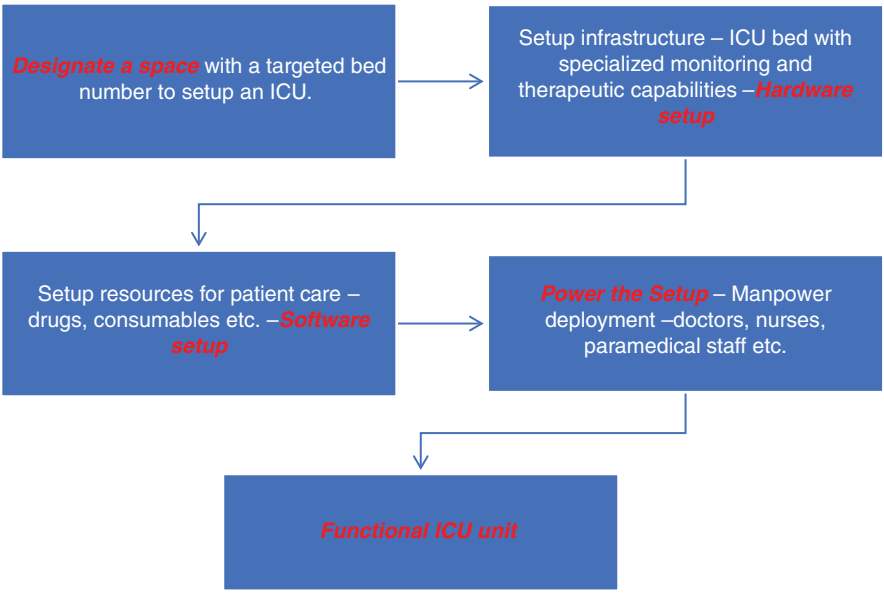

Fig. 2.1 Showing the basic steps of designing and operating a ICU

distance between the beds, the equipment's required for proper functioning of an ICU according to its level of care are well defined in litrature [4].

Majority of the ICUs in the developed as well as developing nations are designed and operated in the basic steps as outlined in Fig. 2.1.

2.1.1 Staffing Patterns in ICU—Current Concepts and Practices –

Doctors or intensivists, nursing and other para medical staff like physiotherapists, phlebotomists, cleaning staff, equipment in charge, store in charge etc. are integral to the functioning of any ICU.

Worldwide critical care society guidelines insist on a fixed nursing ratio for ICU patients [1, 4, 5], a nurse patient ratio of 1:1 for ventilated and other critically ill patients and a ratio of 1:2 or 1:3 for less sick patients. However, literature does not exactly specify the staffing pattern and numbers for doctors or intensivists for proportion of patients in any ICU. A statement released in 2013 from the Society of Critical Care Medicine states that intensivist patient ratio less favourable than 1:14 negatively impacted patient care, teaching training and staff wellbeing [6]. However, this statement has not been implemented as a standard guideline by the various critical care societies around the world. The reason behind this is that an ICU trained doctor or an 'Intensivist' is a scarce manpower resource all over the world in all types of medical systems be it a government sponsored institute or a private medical centre or hospital.

To understand the dynamic concept of staffing an intensivist in ICU and its related outcomes one first needs to understand the working modes of ICU and patient care delivery, as these models call for different types of staffing for smooth running of the ICU.

2.2 Working Modes of an ICU

ICU is an interwoven and complex organisation which deals with patients from various specialities. There are multiple stakeholders for each patient right from the primary physician, the intensivist in the ICU to the various doctors which may called for their speciality reference. The primary stakeholder may be the intensivist or the primary care physician depending on the working model of the ICU. The staffing patterns, duty hours of the ICU and the role of a trained intensivist varies according to the working model adopted by the ICU.

The various working models described for ICU's are summarized in Table 2.1.

Table 2.1 Summarizing working models for an ICU [7]

Working Model	Closed ICU	Open ICU	Semi closed ICU	Semi open ICU.
Salient features	Admission and discharge rights only with the intensivist All decisions on patient care and management are taken by the critical care team The initial physician becomes only an observer with no active role in patient management Practised predominantly in ICU'S in Europe and Australia Can easily be applied and practised in 'academic institutes	Admission and discharge—any physician with hospital admission rights can admit the patient directly to the ICU Primary care provider—management and decision making remains in the hands of the primary care provider ICU just provides a place of intensive monitoring (eg. vasopressor infusion and invasive monitoring), better nursing care etc	Hybrid model between closed and open model Admission rights—anyone can admit the patient in ICU Management—critical team is automatically consulted and comanages all patients with the primary physician	Hybrid model between closed and open model Anyone with admitting rights can admit a patient Critical team is consulted for all patients *but* all patients are not comanaged

(continued)

Table 2.1 (continued)

Working Model	Closed ICU	Open ICU	Semi closed ICU	Semi open ICU.
Advantages	Unidirectional flow of command and a single decision-making team for the patient, thus no confusion in medical decision making	Primary physician is the decision maker—thus continuity of care is maintained Less labour intensive and not dependent on critical care specialist	Aims at best of both open and closed system—i.e., continuity of care with primary physician and specialist care by the intensivist	Opinion of critical care is sought initially and then whenever require leaving the entire decision making on the primary physician
Drawbacks	Most labour intensive of all the systems	The specialized care of an intensivist trained in managing critically ill patients is missing Primary physician may not be expert in certain ICU procedures and techniques (ventilatory management, bedside procedures)	Two managing teams (primary physician and the intensivist) may lead to conflict of ideas and thoughts and may delay or negatively impact clinical decisions	Daily involvement of a critical care specialist is missing

2.3 Staffing of an ICU

After a basic understanding of the working models of ICU its is quite clear that the closed model of ICU will be the most labour intensive with respect to employing trained intensivists, the open system will be the least labour intensive with no involvement of the intensivist and the semi closed and semi open will be somewhat in between of the two, with the semi closed system requiring more staff than the semi open as intensivists comanage all cases in semi closed whereas are consulted only on need basis in semi open system.

Staffing a closed or semi closed ICU with intensivists would be economically more costly on any hospital system. From an administrative point of view the costs incurred to staff a closed or semi closed ICU should be supported by positive patient outcomes. The earliest concrete evidence in this regard was given by Pronovost and

co-workers in their systematic review published in 2002 addressing the question of relation between ICU physician staffing and patient outcomes [8]. In this paper ICU physician staffing and patient related outcomes like length of stay (LOS), mortality etc. were studied from 1965 to 2001. They grouped the generated data into a '*low intensity staffing model*' where intensivist or the ICU physician is not directly involved in patient care or is only electively consulted (an open or semi open model of ICU care). The second group was '*high intensity staffing model'* where an intensivist was the primary care provider or was mandatorily involved and comanaged all patient (closed or semi closed model of ICU care). They concluded that the high intensity staffing was associated with a lower hospital mortality, lower ICU mortality and lower LOS in the ICU and thus translated into better patient outcomes.

The '*Leapfrog Group'* a consortium of purchasers and providers of health care [9], this group aims to improve healthcare system outcomes, minimize preventable errors, rate the various healthcare systems of America and aims to bring about a system of transparency in the functioning of healthcare in America. This group issues guidelines and sets standards for health care systems housing ICU for staffing and functioning of the ICU.

The Leapfrog group in their 2021 document on ICU physician staffing (IPS) [10] state that—the quality of care in an ICU is broadly determined by (a) whether "intensivists" are providing care and (b) model of care delivery in the ICU (open vs. closed ICU). The Leapfrog group defines 'Intensivist' as a board-certified physician additionally certified in the speciality of critical care medicine. A physician eligible for a subspecialty certification in critical care may be a specialist in medicine, emergency medicine, anaesthesia or paediatrics.

The Leapfrog group IPS safety standard guidelines with an aim to minimize preventable errors and enhance positive outcomes in patient care can be summarized as [10]—

1. Certified intensivists to be present on site to exclusively manage (closed model) or comanage (semi-closed model) all the patients in medical or surgical ICU for optimum outcomes.
2. The onsite intensivist to be present for a period of 8 h per day in the day time for 7 days a week for exclusive clinical care in the ICU.
3. When intensivist is not present onsite or working via telemedicine—more than 95% of calls/texts/messages from the ICU are to be returned and answered to within 5 min.
4. An onsite 'Effector' i.e., a trained medical person to carry out order given by the intensivist (when not present on site or working via telemedicine) to be present on site and physically reach any patient within 5 min to carry out orders given by the intensivist.

The recommendations have been made in line and based on the evidence generated in the sentinel paper on ICU staffing by Pronovost et al. [8].

2.4 Physician Staffing Models of an ICU

Basic 3 models are described for ICU staffing [7], these are mainly—

(a) Academic model
(b) Modified academic model
(c) Open model.

The salient features of each with its advantages, drawbacks, cost benefit analysis for the hospital are summarized in Table 2.2.

2.4.1 Outcomes with Different Staffing Models

While relatively clear that the academic model will have the maximum benefit and positive impact on patient outcomes, 24-h intensivist on floor versus day time intensivist followed by on call/ telemedicine was a matter of debate. Literature on patient outcome in the recent years has shed light on this question.

Table 2.2 Table describing various physician staffing models for ICU setup

Staffing model	Academic model	Modified academic model	Open model
Salient features.	A team of attending consultant and resident trainees 24 h on floor of the ICU Default model for closed ICU and large teaching institutes	24-h coverage by a certified intensivist not necessarily on ICU floor during this period Physician assistants (PA) and advanced practice providers (APP) on floor of the ICU 24 h a day in shifts to carry out orders of the intensivist within 5 min as per Leapfrog guidelines	Consulting intensivist only when required and do not take over or comanage patients In line with Open or semi open ICU setup May be used mainly by small Level I ICU units
Advantages	Maximum coverage and theoretically minimal chances of lapses in patient care	Better utilization of the scarcest manpower i.e., certified intensivist The concept of 'Telemedicine' can be implemented with this model	Minimal costs to the institution
Draw backs	Resource heavy and maximum costs for the system Difficult to find faculties for night shifts and resident trainees for 24-h shift duties Poor work life balance for doctors	The PA's and APP's have to be trained in common ICU procedures like lumbar puncture, ventilator management, central line placement etc. for optimal care High risk procedures like intubations, intercostal drain placement etc. may still need on site specialist backup	Not in line with the Leapfrog guidelines Poor patient outcomes and inconsistent care

In an official systematic review and metanalysis on night time intensivist staffing sone by the American Thoracic Society concluded that Night time intensivist staffing did not have any superior outcome in mortality and length of hospital stay as compared to day time dedicated intensivist coverage [11]. Similar conclusions were echoed in a retrospective study in over 65,000 patients, night time intensivist ICU staffing had a positive impact on outcomes when applied to low intensity ICU care and had no impact on outcomes when applied on day time intensivist covered ICU setups [12].

To conclude, a high intensity (closed or semi closed) staffing model definitely improves overall outcomes as compared to low intensity staffing but the same cannot be said for night time intensivist in all types of ICU's. with advanced in medical care and communication techniques especially with the advent of telemedicine the evidence in favour of night time intensivist has declined in recent literature.

The future of telemedicine in ICU looks promising, a systematic review and metanalysis on impact of telemedicine on patient outcomes collected data from 13 eligible studies from 35 ICU's and included 41,000 patients. This study concluded that tele ICU coverage was associated with lower ICU mortality and LOS but did not translate into lower in hospital mortality or shortened LOS [13]. In the same year a prospective stepped clinical practice study by Craig M Lily and co-workers on 6290 patients in 7 ICU's showed that implementation of a tele ICU was associated with reduced in hospital mortality and reduced hospital LOS [14]. The key feature in this study which led to its success was that the tele ICU consult providers had full independence in patient care and could order any necessary interventions just as an in-house intensivist.

Thus, the ideal staffing system of an ICU would be a closed type of ICU with high intensity 24-h in-house intensivist. However, keeping in mind the limited available certified intensivists in any medical system and literature clearly showing day time high intensity staffing to be equally effective the most practical system in any ICU setup be it a teaching hospital or a private setup would be a closed or semi-closed type of ICU with high intensity day time staffing with a physician patient ratio of not more than 1:14 and well-trained PA's or APP's for night time cover. Telemedicine can be practised in a robust manner with all decisions and responsibilities resting on the shoulders of intensivist in charge and a well trained on ground medical staff.

2.5 Burnout Among Intensivists

An ICU is a highly stressful workplace with a high-pressure environment. Such work conditions put the workforce both physicians and paramedical staff under extreme stress and make them prone for burnout [15].

Various factors which put the ICU physicians under extreme stress and at risk of burnout are [15–17]—

- Long working hours and shift timings.
- Regular night shifts with no time for family.

- Sick patients with poor outcomes thus poor work satisfaction.
- Poor overall staffing, high physician patient ratios thus poor quality of work.
- Minimal time for research and teaching owing to busy ICU schedules.
- Females are especially at greater risk of experiencing severe burnout symptoms as the juggle for work life balance and raising children etc. is more on the shoulders of females.
- Paediatric/neonatal ICU physicians reported more burnout symptoms.

The list of contributing Factors is exhaustive and does not end here. However, the important point is that organisations, physicians and other staff working in the ICU should accept this problem and take a head on approach to tackle it. The organisational rules and the administration should be sympathetic to the special concerns of the ICU team and should be aware of how stressful the ICU environment can be and should be flexible in duty hours and leave schedules to facilitate proper break from the work routines for ICU staff. The hospitals should have a psychological support program or counsellors specifically working with the ICU team. Working teams should be made aware the signs and symptoms of burnout so that they can identify and notify if a colleague if feeling under the weather or is in undue work pressure. Such steps, even if taken on microscopic level will bear fruit for every organisation and lead to a healthy and productive workforce.

References

1. IC-1-Minimum-Standards-for-Intensive-Care-Units.pdf. https://www.cicm.org.au/CICM_Media/CICMSite/CICM-Website/Resources/Professional%20Documents/IC-1-Minimum-Standards-for-Intensive-Care-Units.pdf. Accessed 15 June 2021.
2. Henning J, Roberts M, Sharma D, Hoffman A, Mahoney P. Military intensive care part 1. A historical review. J R Army Med Corps. 2007;153(4):283. https://doi.org/10.1136/jramc-153-04-13.
3. Sherman IJ, Kretzer RM, Tamargo RJ. Personal recollections of Walter E. Dandy and his brain team. J Neurosurg JNS. 2006;105(3):487–93. https://doi.org/10.3171/jns.2006.105.3.487.
4. Rungta DN, Govil DD, Nainan DS, Munjal DM. ICU planning and designing in India—guidelines 2010.26.
5. Sharma SK, Rani R. Nurse-to-patient ratio and nurse staffing norms for hospitals in India: a critical analysis of national benchmarks. J Family Med Prim Care. 2020;9(6):2631–7. https://doi.org/10.4103/jfmpc.jfmpc_248_20.
6. Ward NS, Afessa B, Kleinpell R, et al. Intensivist/patient ratios in closed ICUs: a statement from the society of critical care medicine taskforce on ICU staffing. Crit Care Med. 2013;41(2). https://journals.lww.com/ccmjournal/Fulltext/2013/02000/Intensivist_Patient_Ratios_in_Closed_ICUs__A.25.aspx.
7. Chen K, Nates JL. ICU staffing, models, and outcomes. In: Nates JL, Price KJ, editors. Oncologic Critical Care. Cham: Springer International Publishing; 2020. p. 33–42. https://doi.org/10.1007/978-3-319-74588-6_2.
8. Pronovost PJ, Angus DC, Dorman T, Robinson KA, Dremsizov TT, Young TL. Physician staffing patterns and clinical outcomes in critically ill PatientsA systematic review. JAMA. 2002;288(17):2151–62. https://doi.org/10.1001/jama.288.17.2151.
9. About Us. Leapfrog. https://www.leapfroggroup.org/about. Published December 29, 2015. Accessed 27 June 2021.

10. 2021 IPS Fact Sheet_3.pdf. https://ratings.leapfroggroup.org/sites/default/files/inline-files/2021%20IPS%20Fact%20Sheet_3.pdf. Accessed 27 June 2021.
11. Kerlin MP, Adhikari NKJ, Rose L, et al. An official American Thoracic Society systematic review: the effect of Nighttime intensivist staffing on mortality and length of stay among intensive care unit patients. Am J Respir Crit Care Med. 2017;195(3):383–93. https://doi.org/10.1164/rccm.201611-2250ST.
12. Wallace DJ, Angus DC, Barnato AE, Kramer AA, Kahn JM. Nighttime intensivist staffing and mortality among critically ill patients. N Engl J Med. 2012;366(22):2093–101. https://doi.org/10.1056/NEJMsa1201918.
13. Young LB, Chan PS, Lu X, Nallamothu BK, Sasson C, Cram PM. Impact of telemedicine intensive care unit coverage on patient outcomes: a systematic review and meta-analysis. Arch Intern Med. 2011;171(6):498–506. https://doi.org/10.1001/archinternmed.2011.61.
14. Lilly CM, Cody S, Zhao H, et al. Hospital mortality, length of stay, and preventable complications among critically ill patients before and after tele-ICU reengineering of critical care processes. JAMA. 2011;305(21):2175–83. https://doi.org/10.1001/jama.2011.697.
15. Lilly CM, Oropello JM, Pastores SM, et al. Workforce, workload, and burnout in critical care organizations: survey results and research agenda*. *Critical Care Medicine*. 2020;48(11). https://journals.lww.com/ccmjournal/Fulltext/2020/11000/Workforce,_Workload,_and_Burnout_in_Critical_Care.3.aspx.
16. Burns KEA, Fox-Robichaud A, Lorens E, Martin CM. For the Canadian critical care society. Gender differences in career satisfaction, moral distress, and incivility: a national, cross-sectional survey of Canadian critical care physicians. Can J Anes [Journal canadien d'anesthésie]. 2019;66(5):503–11. https://doi.org/10.1007/s12630-019-01321-y.
17. Pastores SM, Kvetan V, Coopersmith CM, et al. Workforce, workload, and burnout among intensivists and advanced practice providers: a narrative review. *Critical Care Medicine*. 2019;47(4). https://journals.lww.com/ccmjournal/Fulltext/2019/04000/Workforce,_Workload,_and_Burnout_Among.8.aspx.