



## What is an intensive care unit? A report of the task force of the World Federation of Societies of Intensive and Critical Care Medicine



John C. Marshall, MD <sup>a,m,\*</sup>, Laura Bosco, BSc <sup>b</sup>, Neill K. Adhikari, MDCM <sup>c</sup>, Bronwen Connolly, PhD <sup>d</sup>, Janet V. Diaz, MD <sup>e</sup>, Todd Dorman, MD <sup>f</sup>, Robert A. Fowler, MD <sup>c</sup>, Geert Meyfroidt, MD <sup>g</sup>, Satoshi Nakagawa, MD <sup>h</sup>, Paolo Pelosi, MD <sup>i,m</sup>, Jean-Louis Vincent, MD, PhD <sup>j,m</sup>, Kathleen Vollman, RN <sup>k</sup>, Janice Zimmerman, MD <sup>l,m</sup>

<sup>a</sup> Departments of Surgery and Critical Care Medicine, St Michael's Hospital, Toronto, Canada

<sup>b</sup> Faculty of Medicine, Queen's University, Kingston, Canada

<sup>c</sup> Sunnybrook Health Sciences Centre, Toronto, Canada

<sup>d</sup> Guy's and St Thomas' NHS Foundation Trust, London, UK

<sup>e</sup> California Pacific Medical Center, San Francisco, USA

<sup>f</sup> Johns Hopkins University School of Medicine, Baltimore, USA

<sup>g</sup> University of Leuven, Leuven, Belgium

<sup>h</sup> National Center for Child Health and Development, Tokyo, Japan

<sup>i</sup> University of Genoa, Genoa, Italy

<sup>j</sup> Université Libre de Bruxelles, Brussels, Belgium

<sup>k</sup> Advancing Nursing LLC, Northville, MI, USA

<sup>l</sup> Houston Methodist Hospital, Houston, TX, USA

<sup>m</sup> World Federation of Societies of Intensive and Critical Care Medicine

### ARTICLE INFO

### ABSTRACT

Since their widespread introduction more than half a century ago, intensive care units (ICUs) have become an integral part of the health care system. Although most ICUs are found in high-income countries, they are increasingly a feature of health care systems in low- and middle-income countries. The World Federation of Societies of Intensive and Critical Care Medicine convened a task force whose objective was to answer the question "What is an ICU?" in an internationally meaningful manner and to develop a system for stratifying ICUs on the basis of the intensity of the care they provide. We undertook a scoping review of the peer-reviewed and gray literature to assemble existing models for ICU stratification. Based on these and on discussions among task force members by teleconference and 2 face-to-face meetings, we present a proposed definition and classification of ICUs. An ICU is an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency. Although an ICU is based in a defined geographic area of a hospital, its activities often extend beyond the walls of the physical space to include the emergency department, hospital ward, and follow-up clinic. A level 1 ICU is capable of providing oxygen, noninvasive monitoring, and more intensive nursing care than on a ward, whereas a level 2 ICU can provide invasive monitoring and basic life support for a short period. A level 3 ICU provides a full spectrum of monitoring and life support technologies, serves as a regional resource for the care of critically ill patients, and may play an active role in developing the specialty of intensive care through research and education. A formal definition and descriptive framework for ICUs can inform health care decision-makers in planning and measuring capacity and provide clinicians and patients with a benchmark to evaluate the level of resources available for clinical care.

© 2016 Elsevier Inc. All rights reserved.

### 1. Introduction and overview

Florence Nightingale is widely credited with the establishment of the precursor of the contemporary intensive care unit (ICU). During the Crimean War in 1854, she and a team of nurses created an area of the military field hospital that could provide more intensive nursing

care for the most severely injured soldiers. From the time of Nightingale to the mid-1950s, intensive care was primarily intensive nursing care. With the development of techniques of hemodialysis and the widespread introduction of mechanical ventilation after World War II, the contemporary model of the ICU began to take shape [1]. Ibsen in Denmark first used prolonged mechanical ventilation to support victims of the polio epidemic of 1952 and created the first intensive care unit in 1953 [2]. Intensive care units were established in France in 1954 [3], in

E-mail address: [marshallj@smh.ca](mailto:marshallj@smh.ca) (J.C. Marshall).

Baltimore in 1957 [4], and in Toronto in the late 1950s as discrete geographic areas within the hospital that brought together developing technologies for organ support such as positive pressure ventilation, hemodialysis, and invasive cardiovascular monitoring. Within a decade, the ICU had become an essential element of hospital-based health care, and intensive care emerged as a distinct medical subspecialty [5].

Intensive care continues to evolve, from a specialty defined by a discrete area of the hospital to one defined more broadly by the capacity to provide rapid resuscitative and supportive care where it is needed—on the hospital ward by dedicated outreach teams, in the emergency department, and even in the prehospital setting. At the same time, it is becoming a discipline that addresses the needs of its survivors through rehabilitation and through post-ICU follow-up clinics. Finally, it has also embraced the limitations of health care technologies and is placing increased emphasis on its role in providing dignified compassionate care at the end of life.

The World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM)—a federation of close to 80 professional societies representing the clinicians from around the world who care for critically ill patients—struck a task force whose remit was to develop a globally applicable answer to the question “What is an ICU?” The conclusions of that process are presented here.

## 2. Methods

In 2014, the Council of the WFSICCM decided to strike multinational task forces to address key issues in the organization and delivery of intensive care; one of these was to answer the question “What is an ICU?” Invitations were sent to the approximately 80 professional societies that make up the WFSICCM to nominate representatives to serve on these task forces. Additional task force members were selected on the basis of their interest and expertise in the particular themes addressed. The members of this task force are listed in Appendix A.

We used a number of complementary methods to develop this report. One author (LB) undertook a detailed scoping review to identify available definitions from the biomedical and gray literature. We convened 2 face-to-face meetings during 2015 (in Brussels and Seoul) and held further discussions by conference call and e-mail. On the basis of these interactions, we established a descriptive framework and an initial draft document that were further modified and refined by iterative feedback from members of the task force and of the Council of the WFSICCM.

## 3. Global disparities in critical care capacity

A broadly useful definition of intensive care must take into consideration the international variation in capacity to provide care for the acutely ill. Each year, approximately 164 000 patients are admitted to ICUs in England, Wales, and Northern Ireland; of these, 79% survive to leave hospital (<https://www.icnarc.org/Our-Audit/Audits/Cmp/Reports/Summary-Statistics>). In the United States, there are approximately 4 million ICU admissions per year, and annual critical care expenditures amount to \$81.7 billion or 0.66% of the gross domestic product [6]. Comparative data for low- and middle-income countries are unavailable. However, for every 100 000 people in the country, Germany has to 24.6 ICU beds, Canada 13.5 ICU beds, the United Kingdom 3.5 ICU beds, South Africa 8.9 ICU beds, Sri Lanka 1.6 ICU beds, and Uganda 0.1 ICU bed [7]. In the developing world, ICUs are found almost exclusively in large urban areas; Boston in the United States has 45 times as many ICU beds per 100 000 population as Kumasi in Ghana [8].

These disparities reflect striking disparities in health care delivery around the world. Fewer than 70 of the 191 member states of the United Nations meet the World Health Organization recommendations for a national blood program to support blood transfusions (World Health Organization. Blood safety for too few. Press Release, WHO/25 April

2000). Common diagnostic blood tests such as arterial blood gases, creatinine, and serum electrolyte estimations are often unavailable in major cities of sub-Saharan Africa [9], and microbiological investigations are rare and typically unreliable [10]. Two-thirds of the world's population lacks adequate access to medical imaging [11], and because of financial constraints and infection risks, there is often no access to invasive monitoring [12]. Even more basically, regular access to potable water and electricity cannot be guaranteed in the capital cities of many developing countries and even less so available in rural areas, which house up to 80% of the population [13]. A reliable oxygen supply remains a critical problem for hospitals in developing countries, and lack of oxygen is still a cause of death in Africa, including some capital cities [14].

## 4. What is intensive care?

Intensive care, also known as *critical care*, is a multidisciplinary and interprofessional specialty dedicated to the comprehensive management of patients having, or at risk of developing, acute, life-threatening organ dysfunction. Intensive care uses an array of technologies that provide support of failing organ systems, particularly the lungs, cardiovascular system, and kidneys. Although the specialty has developed expertise in the comprehensive management of disorders such as sepsis and the acute respiratory distress syndrome, its common expertise is the pathophysiology and support of organ dysfunction more than the specific management of the diseases responsible for the acute illness; the primary goal of intensive care is to prevent further physiologic deterioration while the underlying disease is treated and resolves.

Training models for physicians providing intensive care have been the focus of another task force of the WFSICCM (Amin et al, *J Crit Care*, 2016;35:223–228). In some countries, intensive care is a distinct medical specialty, with a dedicated training program that starts following graduation from medical school. More commonly, aspiring intensivists obtain additional expertise in intensive care after completing specialist training in another discipline, for example, anesthesia, surgery, pulmonology, emergency medicine, or pediatrics. In some countries, the 2 paths coexist. To define intensive care as a multidisciplinary specialty is to recognize that although its practitioners share common expertise in the management of acute organ system insufficiency, they may also come from various specialty backgrounds that provide additional clinical expertise.

Intensive care is not just a clinical specialty but a system of care delivered by a skilled interprofessional team that includes physicians, nurses, respiratory therapists, physiotherapists, pharmacists, microbiologists, social workers, ethicists, spiritual care, and many others.

The definition of an ICU bed varies around the world, and even within a single health care system, and is heavily shaped by public health priorities and regulatory requirements, as well as by economic factors, including resource availability and approaches to hospital and physician reimbursement. A number of professional bodies and health care funders have sought to enumerate the specific features that make care intensive and so differentiated the care provided within an ICU from that delivered throughout a health care facility (Table 1).

As the discipline of intensive care has matured, its scope has broadened. Intensivists and other critical care practitioners now play an active role in the resuscitation of acutely unstable patients in the emergency department or on the hospital ward, and in the rehabilitation of survivors of critical illness. Their expertise extends beyond the treatment of the patient to the support of the family, the provision of compassionate care at the end of life, and developing societal preparedness for future crises. Originally defined by the geographic locale where care was provided, intensive care has become a specialty without walls. Yet central to its success is the availability of a dedicated space where patients with acute organ dysfunction can be cared for by a skilled team of health care providers and often for an extended period. That capacity is the focus of our report.

**Table 1**  
Definitions of an ICU.

|   |      |  |
|---|------|--|
| The Intensive Care Society (UK) ( <a href="http://www.ics.ac.uk/ics-homepage/guidelines-and-standards/">http://www.ics.ac.uk/ics-homepage/guidelines-and-standards/</a> ) | 2013 | An ICU is a specially staffed and equipped, separate, and self-contained area of a hospital dedicated to the management and monitoring of patients with life-threatening conditions. It provides special expertise and the facilities for the support of vital functions and uses the skills of medical, nursing, and other personnel experienced in the management of these problems.   |
| Smith and Nielsen [21]  | 1999 | A service for patients with potentially recoverable conditions who can benefit from more detailed observation and invasive treatment than can safely be provided in general wards or high-dependency areas.  |
| Society of Critical Care Medicine [22]  | 1999 | ICU serves as a place for monitoring and care of patients with potentially severe physiological instability requiring technical and/or artificial life support. The level of care in an ICU is greater than that available on the floor or intermediate care unit  |
| Haupt et al [23]  | 2003 | Provide services and personnel that ensure optimal care to critically ill patients   |
| Royal College of Anaesthetists ( <a href="https://www.rcoa.ac.uk/accs/intensive-care-medicine">https://www.rcoa.ac.uk/accs/intensive-care-medicine</a> )                  | 2009 | Intensive care medicine, also referred to as <i>critical care medicine</i> , is that body of specialist knowledge and practice concerned with the treatment of patients with, at risk of, or recovering from potentially life-threatening failure of one or more of the body organ systems. It includes the provision of organ system support; the investigation, diagnosis, and treatment of acute illness; systems management and patient safety; ethics; end-of-life care; and support of families.   |
| Valentin and Ferdinande [16]  | 2011 | The ICU is a distinct organizational and geographic entity for clinical activity and care, operating in cooperation with other departments integrated in a hospital. The ICU is preferably an independent unit or department that functions as a closed unit under the full medical responsibility of the ICU staff in close concert with the referring medical specialists. It has a defined geographical location concentrating the human and technical resources, such as manpower, professional skills and competencies, technical equipment, and the necessary space. |
| College of Intensive Care Medicine of Australia and New Zealand Minimum Standards for Intensive Care Units. College of Intensive Care Medicine (2011)                     | 2011 | An ICU is a specially staffed and equipped, separate, and self-contained area of a hospital dedicated to the management of patients with life-threatening illnesses, injuries, and complications, and monitoring of potentially life-threatening conditions. It provides special expertise and facilities for support of vital functions and uses the skills of medical, nursing, and other personnel experienced in the management of these problems.   |
| Joint Faculty of Intensive Care Medicine of Ireland and Intensive Care Society of Ireland National Standards for Adult Critical Care Services, p1-19 (2011)               | 2011 | Critical care units provide life-sustaining treatment for critically ill patients with acute organ dysfunction due to potentially reversible disease. It is the purpose of the unit to support the patient's failing organs and diagnose and treat the underlying cause. Patients at risk of organ dysfunction due to chronic disease processes may also benefit from critical care in the perioperative period or other temporary reversible circumstance, eg, after trauma.  |

## 5. What is an ICU?

A global definition of an ICU must acknowledge the wide international variability that currently exists in the capacity to care for the sickest patients in the health care system. In describing the elements that make care intensive and in grouping these to stratify ICUs on the basis of their capacity to provide that care, we recognize that intensive care is not an absolute concept but rather a relative one defined in relation to the realities of a particular health care system that can vary depending on available resources and approaches to care.

The factors that make clinical care intensive and that delineate the provision of that care as separate from routine clinical care can be classified into 5 domains.

### 5.1. Physical space

Although critical care is increasingly delivered outside the physical confines of an ICU, the presence of a discrete geographic locale within a hospital or health center where the sickest patients can be cared for is central to the definition of an ICU. A discrete physical space enables the concentration and efficient sharing of technologies and expertise so that all patients benefit maximally. Detailed design considerations are beyond the scope of this report and are described in greater detail elsewhere [15–17].

The physical space of an ICU should be large enough to comfortably accommodate the desired number of ICU beds. Each bed needs access from all sides to allow patient assessment and treatment and effective and reliable implementation of infection control measures. Ideally, each patient should be cared for in a single-bed room [18]. Each room should have a sink and incorporate design features to accommodate and provide easy access to supportive devices such as a ventilator and dialysis machine, as well as monitors. Oxygen and a suction system, preferably from a built-in system, should be available, and a source of natural light is desirable. Individual beds and rooms should be arranged in such a way that they are visible from a central nursing station and, where possible, should have sufficient space to allow family members to visit and even participate in the care of the patient. The ICU ideally will have one or more negative-pressure rooms, with the capacity for

isolating patients with airborne infections. Separate areas should be available for mixing and dispensing medications and for cleaning and storing used devices such as bronchoscopes and ventilator circuits.

A central nursing station should reproduce data from individual patient monitors. A capacity to record and interpret patient data over time must be available, whether in paper or electronic record form. Multiple computer stations should ideally be available to provide access to electronic medical records, as well as to facilitate communications and permit access to bibliographic databases. One or more seminar rooms and sleeping facilities for on-call staff should be available in immediate proximity to the ICU. Finally, a waiting area for family members and a quiet room where patient updates can be provided to family and loved ones are central to effective ICU communications.

### 5.2. Support and monitoring technology

The ability to perform continuous monitoring of patient physiologic status is a key factor differentiating intensive care from ward-based hospital care. Monitoring may be noninvasive (transcutaneous oxygen saturation, noninvasive monitoring of heart rate and blood pressure, or continuous electrocardiogram or electroencephalogram monitoring) or invasive (hemodynamic monitoring, monitoring of intracranial pressure). Data should be continuously displayed so that they are readily accessible to all involved in caring for the patient, and recorded so that clinicians can monitor trends and respond appropriately.

Respiratory support available within the ICU may range from supplemental oxygen delivered by mask or high-flow oxygen system to conventional and nonconventional modes of mechanical ventilation; in some ICUs, this may include extracorporeal membrane oxygenation (ECMO) or carbon dioxide removal. Hemodynamic support is largely pharmacologic and guided by data generated from continuous monitoring of hemodynamic parameters; additional modes of support include cardiac pacing, mechanical cardiac support with intraaortic balloon counterpulsation or ventricular assist devices, and ECMO to provide tissue oxygenation. Renal support in the form of intermittent or continuous renal replacement therapy is commonly needed, as is nutritional support provided enterally using a feeding tube or parenterally. There

**Table 2**  
A proposed classification of ICUs.

|   | Level 1  | Level 2  | Level 3  |
|---|--|--|--|
| Therapeutic capacity                          | Physiologic stabilization and short-term support of mild organ dysfunction   | Basic support of failing organ function  | Complex, comprehensive support and management of organ dysfunction   |
| Personnel                                     | Physicians with some experience in critical care available at least during the day<br>Experienced nurses provide 24/7 care<br><br>Other personnel available<br><br>Nurse-patient ratio higher than on ward; preferably 1:4 or 1:3 (1 nurse for 4 patients)<br>Daily rounds; ad hoc structure<br><br>Variable engagement in critical care continuing professional education<br>Variable access to other medical specialties in hospital | Physicians with ICU training or comparable experience present during day and available at night<br>Nurses have extra training or comparable experience in critical care and provide 24/7 care<br>Variable inclusion of allied health personnel—respiratory therapists, physiotherapists, dieticians, pharmacists, etc—as part of ICU care team<br>Nurse-patient ratio appropriate to patient needs but usually no less than 1:3<br>Formal daily ICU rounds with physicians and nurses<br>Engagement in continuing professional education<br>Ready access to respirologists, nephrologists, cardiologists, infectious disease specialists, general surgeons<br>Invasive monitoring of blood pressure and central venous pressures as dictated by patient status<br>Blood gas analyzer immediately available | Physicians with formal ICU training on call 24/7; immediate in-hospital availability of medical staff with ICU experience<br>Nursing staff with specialist ICU training provide 24/7 care<br>Allied health personnel—respiratory therapists, physiotherapists, pharmacists, dieticians, etc—as regular members of ICU team<br>Nurse-patient ratio appropriate to patient needs and no less than 1:2<br>Formal multidisciplinary ICU rounds daily and as needed based on patient complexity and acuity<br>Regular engagement in continuing medical/nursing education<br>Rapid access to and variable engagement of full complement of medical and surgical consultant specialists |
| Monitoring capacity                           | Noninvasive or minimally invasive monitoring—transcutaneous oxygen saturation, cardiac monitoring, urine output  | Dedicated geographic area with central monitoring station  | Advanced hemodynamic monitoring (cardiac catheterization, ultrasonography, etc); advanced monitoring of pulmonary, cerebral, and other physiology as directed by clinical needs<br>Blood gas analyzer and stat lab associated with ICU   |
| Unit design and organ support                 | Dedicated geographic area<br>Capacity for oxygen therapy and noninvasive respiratory support   | Dedicated geographic area with central monitoring station<br>Basic mechanical ventilatory support, pharmacologic support of cardiovascular function, intermittent renal replacement therapy, parenteral nutrition  | Dedicated geographic area with individual patient care areas and central monitoring station<br>Advanced ventilator and hemodynamic support, continuous renal replacement therapy, capacity for tracheostomy and other basic surgical procedures<br>Capacity for isolation of patients needing contact or airborne precautions  |
| Integration within the hospital               | Defined geographic area only   | Ad hoc interactions with other acute care areas such as emergency department   | Outreach team(s), integration with step-down or high-dependency unit; close collaboration with emergency department  |
| Research and education                        | Ad hoc activity<br>Basic quality improvement program   | Organized educational activities for staff<br>Formal quality improvement program<br>Ad hoc engagement in clinical research   | Formal educational programs for staff<br>Formal quality improvement program<br>Active involvement in clinical research<br>Training of residents and fellows as available   |
| Responsiveness to regional and societal needs | Ad hoc only, but available and responsive in event of disaster<br>Formal policy outlining criteria for patient transfer to higher level ICU  | Serves as resource for critically ill patients within hospital   | Referral resource for community and district hospitals and for other ICUs<br>Disaster preparedness plan and capacity   |

The criteria within each stratum should be regarded as guidelines: specific criteria will vary with regional resources and capabilities as well as with different clinical needs; and for an ICU to be classified at a certain level, it must meet most, but not all, of the suggested criteria.

is a continuous need to relieve pain and anxiety and to prevent and treat delirium.

The specific monitoring and support capabilities of a particular ICU will depend both on available resources and on the nature of the patient population served—in hospitals with subspecialty ICUs, a neurosurgical ICU will look different from a burn unit or a transplant ICU.

**5.3. Human resources**

The clinical team providing care in an ICU is specially qualified, interdisciplinary, and interprofessional. The care it provides is more intensive than that provided elsewhere in the hospital by virtue of a more intense and more immediate interaction between members of the team and the critically ill patient.

Ideally, members of both the medical and nursing teams will have advanced specialty qualifications in intensive care medicine, as well as ample experience in the care of the critically ill. In addition to physicians and nurses, team members may include nurse practitioners, respiratory therapists who manage the mechanical ventilator, physiotherapists who support mobility and rehabilitation, a nutritionist skilled in the enteral and parenteral feeding needs of complex patient populations, a

pharmacist with particular expertise in drug-drug interactions and optimal dosing in the critically ill patient, a social worker who can support the needs of both patient and family, and many others including microbiologists to assist with the diagnosis and management of infection and spiritual care personnel to support patients and families during a time of crisis.

Patient acuity necessitates that medical staff be immediately available to manage emergencies and to make a myriad of decisions in a rapidly changing clinical situation. Even during the day when more medical staff are available, it is important that the number of patients each physician is responsible for is constrained so that adequate attention is given to the needs of each. Continuous nursing care is also essential, and provided at a nurse to patient ratio that is higher than elsewhere in the hospital, and appropriate to the current needs of the particular patient. The optimal ratio will, as well, be dictated by the availability of other support personnel including nursing assistants and respiratory therapists. The nurse to patient ratio may, in some jurisdictions, be dictated by legislation or labor contracts.

Coordination of a large interdisciplinary team requires a well thought out administrative structure with a designated medical director as well as a nursing director who will coordinate staffing and care needs and establish policies and priorities for ongoing patient care.

#### 5.4. Critical care services provided

An ICU is also defined by the services it provides beyond the immediate demands of individual patient care.

Within the hospital, the ICU provides the capacity to care for acutely unstable patients—to evaluate, resuscitate, and support the patient using the most advanced facilities that the hospital can provide. However, an ICU also plays a role in the larger health care system. It may serve as a referral center for smaller hospitals that lack ICU facilities. In a larger community, it may provide specialty services not available in other ICUs—neurological support and monitoring, advanced trauma care, management of complex respiratory failure, etc. Conversely, units capable of providing an intermediate level of care, variously known as *high-dependency units*, *step-down* or *step-up units*, and *intermediate care units*, can provide support and monitoring to patients who do not need the full spectrum of ICU supportive care; these are appropriately considered an element of an integrated intensive care program.

Increasingly, the ICU team is taking a larger role in the management of patients on the hospital wards or in the emergency department. Outreach teams provide consultative services on the wards and assist medical and surgical teams in managing clinical situations where more intensive, timely, and coordinated interventions can prevent deterioration and a need for ICU admission. For example, sepsis teams provide support in the initial management and support of unstable patients with sepsis.

Increasingly, survivors of ICU care are being seen following hospital discharge in dedicated follow-up clinics that not only ensure continuity of care following devastating illness but provide important insight into the long-term sequelae of that illness [19,20].

Finally, critical care practitioners gain substantial expertise in supporting patients and their families through the process of death and dying when it has become apparent that continuing intensive care can do nothing more than prolong the process of dying, and this skill is frequently harnessed not only during the dying process but also in early discussions to clarify patient wishes and perspectives at the end of life or in the face of a significant risk of death.

#### 5.5. Research, education, and quality improvement

A functional ICU, like any other specialized component of the health care system, has an inherent obligation to continuously improve patient care based on an ongoing evaluation of the shortcomings of the care it provides and the changing knowledge base that informs best care. This is the domain of continuous quality improvement. It also has a responsibility to contribute to the processes of evaluating best care on the one hand and sharing that information on the other; these are the domains of research and education, respectively. The extent to which an ICU can engage in quality improvement, research, and education will vary; nonetheless, engagement in these processes should be an aspirational goal of all ICUs for they lead inexorably to better patient care and improved clinical outcomes.

### 6. What is an ICU?

We propose the following definition of an intensive care unit. **An intensive care unit (ICU) is an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of acute organ system insufficiency. Although an ICU is based in a defined geographic area of a hospital, its activities often extend beyond the walls of the physical space to include the emergency department, hospital ward, and follow-up clinic.**

### 7. Toward a classification of ICUs

We propose a categorization of ICUs based on a variety of parameters that reflect the potential of the unit to provide excellent and expert care to the most acute seriously ill patients. Stratification is based on 12 variables:

1. Availability of skilled medical personnel
2. Availability of skilled nursing personnel
3. Availability of other specialists—respiratory therapists, physiotherapists, pharmacists, nutritionists, etc
4. Capacity to monitor acutely ill patients
5. Availability of resources for the support of failing organ function
6. Design and structure of the physical space
7. Integration with ICU outreach services—in the emergency department and hospital ward, as well as services for follow-up of discharged patients
8. Presence of formal educational and professional development services for staff
9. Presence of dedicated house staff and role as a center for training expert personnel
10. Capacity for research and quality improvement activities
11. Role in acting as a referral service for the hospital, the community, and the country
12. Ability to scale up services in response to a natural or human-made disaster or pandemic outbreak.

Most frameworks for classifying ICUs use a numeric scale, with 3 being the top level. We have followed this precedent and classify ICUs as **primary**, **secondary**, and **tertiary** (Table 2).

#### 7.1. Primary (level 1) ICU

The most basic level ICU is staffed by medical doctors who have experience in critical care but may not have formal training. They are readily available at least during the day, and medical expertise is accessible at night. Nurses have some ICU experience with or without additional training, and the nurse to patient ratio is higher than it is on a regular ward of the same facility. Other specialists are available within the hospital but not necessarily a part of the ICU team. The unit has the capacity to monitor vital signs noninvasively on an intensive basis, to monitor transcutaneous oxygen saturation, and to provide continuous electrocardiogram monitoring. Organ support is limited to the provision of supplemental oxygen by mask or by noninvasive positive pressure ventilation or short-term invasive mechanical ventilation; simple mechanical ventilation may also be available for the care of stable chronically ventilated patients. A level 1 ICU consists of a dedicated space within the hospital. There is no formalized outreach service, and educational activities for staff are sporadic; no formal training program for intensivists is in place. The unit has a basic quality improvement program, but may not regularly participate in research, and is a referral service for patients from within the hospital only. There is no formal plan for surge capacity management. A plan outlining criteria for transfer of patients to higher-level more specialized centers should be in place.

#### 7.2. Secondary (level 2) ICU

A level 2 ICU is staffed by physicians with specialty training in medicine, surgery, anesthesia, pediatrics, emergency medicine, and other disciplines who may also have formal ICU training; alternatively, staff may have dedicated intensive care training. Staff are present or immediately nearby during the day, and promptly available by phone or in person to handle crises during evenings and weekends. Nursing care is provided around the clock by nurses having some special qualifications in intensive care; the nurse to patient ratio is higher than in other areas of the hospital but typically no less than 1:3. Allied health care professionals are part of the ICU team or readily available, and a commitment

to interprofessional practice is reflected in regular multidisciplinary rounds. Continuous monitoring of vital signs is available, including the invasive monitoring of blood pressure, central venous pressure, and transcutaneous oxygen saturation (SpO<sub>2</sub>). A blood gas analyzer should be immediately available. Modalities of organ support include endotracheal intubation and positive pressure ventilation, the administration of vasoactive medications, and renal replacement therapy. Facilities are available for family members, and educational programs for staff are in place. A level 2 ICU has a formal quality improvement program, with regular review of practices and complications. It serves as a referral center for local hospitals that lack dedicated ICU facilities.

### 7.3. Tertiary (level 3) ICU

A level 3 ICU provides state-of-the-art care to the sickest critically ill patient. It is staffed by medical doctors with specialty training in critical care—either as a stand-alone specialty or following full training in another specialty—with 24-hour in-house coverage by a staff physician, nurse practitioner or equivalent, or critical care trainee. Nursing care is provided by nurses with additional training in critical care, and the nurse to patient ratio is typically 1:1 or 1:2, at least during the day, and guided by patient severity. Additional trained staff contribute to the care of patients, including respiratory therapists, physiotherapists, pharmacists, nutritionists, and microbiologists. Multidisciplinary rounds are conducted daily. A full spectrum of ICU monitoring and support is available, including invasive mechanical ventilation, invasive hemodynamic monitoring and support, and renal replacement therapy. Other specialty services such as ECMO and invasive neurologic monitoring may be available. A level 3 ICU frequently serves as a teaching unit for intensive care trainees and participates actively in quality improvement activities and in clinical research. It serves as a regional referral center for critically ill patients and is expected to have in place plans for pandemics and other emergency situations where an acute increase in demand might be expected. The unit has isolation facilities for patients needing contact or airborne precautions. It has an integrated outreach program that can provide support to patients on the ward or in the emergency department. Ideally it has a formal ICU follow-up program.

## 8. Challenges and limitations

Our goal is to create descriptive criteria that are relevant throughout the world, recognizing that access to resources is highly variable and that within any given country or region, cultural and professional values and priorities impact heavily on what defines an ICU. Our descriptions should be seen as both aspirational and minimal. We recognize that in many parts of the world, it may be difficult to meet even the criteria for a level 1 ICU. We do not mean to diminish the efforts of those who work with what is available but rather to empower practitioners to educate decision-makers about the minimal level of resources that the global community deems necessary to provide care for the critically ill patient. Equally, we do not wish to suggest to resource-rich areas that they might do less and still meet standards of excellence. Independent of the constraints of resources, our guiding principle is to provide the best and most equitable care possible.

## 9. Conclusions

An ICU is more than a geographic locale, although it presupposes a dedicated area within the hospital where the sickest patients can be managed by a specialized multidisciplinary professional team. As the specialty of intensive care matures, its domain expands to include prehospital and emergency care, care of sicker patients on the hospital ward, and the rehabilitation and follow-up of patients who have received intensive care services.

The capacity for providing intensive care varies with regional needs and available resources, and so standards will vary from one country to the next. Importantly, a higher-level ICU should be able to provide education for fledgling intensivists and critical care nurses and to participate in research and quality improvement programs.

The stratification we propose is provided as a guideline for discussion. We recognize that national and regional realities will clash with some of the suggestions we have made. However, we hope that this template might contribute to a fuller consideration of how health care resources can be harnessed to enhance the care of critically ill patients around the world.

## Conflicts

The authors have no relevant financial or academic conflicts of interest to declare.

## Acknowledgments

This work was supported in part by a grant from the Canadian Institutes for Health Research and by the WFSICCM.

## Appendix A. Writing Committee

John C. Marshall, Chair  
 Laura Bosco  
 Neill K. Adhikari  
 Lluís Blanch  
 Rob Fowler  
 Jorge Hidalgo  
 Atul Kulkarni  
 Norman Lufesi  
 Geert Meyfroidt  
 Satoshi Nakagawa  
 Paolo Pelosi  
 Assem Abdel Razek  
 Hidenobu Shigemitsu  
 Murat Sungur  
 Oloan Tampubolon  
 Yoshito Ujike  
 Necmettin Unal  
 Jean-Louis Vincent  
 Kathleen Vollman  
 Bambang Wahyuprajitno  
 Janice Zimmerman

## References

- [1] Lassen HC. A preliminary report on the 1952 epidemic of poliomyelitis in Copenhagen with special reference to the treatment of acute respiratory insufficiency. *Lancet* 1953 Jan 3;1(6749):37–41.
- [2] Reisner-Senelar L. The birth of intensive care medicine: Bjorn Ibsen's records. *Intensive Care Med* 2011 Jul;37(7):1084–6.
- [3] Vachon F. Histoire de la réanimation médicale française: 1954–1975. *Reanimation* 2011;20(1):72–8.
- [4] Safar P, Dekornfeld TJ, Pearson JW, Redding JS. The intensive care unit. A three year experience at Baltimore city hospitals. *Anaesthesia* 1961;16:275–84.
- [5] Weil MH, Tang W. From intensive care to critical care medicine: a historical perspective. *Am J Respir Crit Care Med* 2011;183(11):1451–3.
- [6] Halpern NA, Pastores SM. Critical care medicine in the United States 2000–2005: an analysis of bed numbers, occupancy rates, payer mix, and costs. *Crit Care Med* 2010;38(1):65–71.
- [7] Adhikari NK, Fowler RA, Bhagwanjee S, Rubenfeld GD. Critical care and the global burden of critical illness in adults. *Lancet* 2010;376(9749):1339–46.
- [8] Murthy S, Leligdowicz A, Adhikari NK. Intensive care unit capacity in low-income countries: a systematic review. *PLoS One* 2015;10(1):e0116949.
- [9] Mundy CJ, Bates I, Nkhoma W, Floyd K, Kadeweke G, Ngwira M, et al. The operation, quality and costs of a district hospital laboratory service in Malawi. *Trans R Soc Trop Med Hyg* 2003;97(4):403–8.
- [10] Gray IP, Carter JY. An evaluation of clinical laboratory services in sub-Saharan Africa. *Ex africa semper aliquid Novi? Clin Chim Acta* 1997;267(1):103–28.

- [11] Mollura DJ, Azene EM, Starikovskiy A, Thelwell A, Iosifescu S, Kimble C, et al. White paper report of the RAD-AID conference on international radiology for developing countries: identifying challenges, opportunities, and strategies for imaging services in the developing world. *J Am Coll Radiol* 2010;7(7):495–500.
- [12] Smith ZA, Ayele Y, McDonald P. Outcomes in critical care delivery at Jimma University specialised hospital. *Ethiopia Anaesth Intensive Care* 2013;41(3):363–8.
- [13] Dare L, Buch E. The future of health care in Africa. *BMJ* 2005;331(7507):1–2.
- [14] L'Her P, Tchoua R, Hutin R, Soumbou A, Yos P, Saissy JM. The problem of oxygen in developing countries. *Med Trop (Mars)* 2006;66(6):631–8.
- [15] Thompson DR, Hamilton DK, Cadenhead CD, Swoboda SM, Schwindel SM, Anderson DC, et al. Guidelines for intensive care unit design. *Crit Care Med* 2012;40(5):1586–600.
- [16] Valentin A, Ferdinande P. Recommendations on basic requirements for intensive care units: structural and organizational aspects. *Intensive Care Med* 2011;37(10):1575–87.
- [17] Ferri M, Zygun DA, Harrison A, Stelfox HT. Evidence-based design in an intensive care unit: end-user perceptions. *BMC Anesthesiol* 2015;15:57.
- [18] Caruso P, Guardian L, Tiengo T, Dos Santos LS, Junior PM. ICU architectural design affects the delirium prevalence: a comparison between single-bed and multibed rooms\*. *Crit Care Med* 2014;42(10):2204–10.
- [19] Modrykamien AM. The ICU follow-up clinic: a new paradigm for intensivists. *Respir Care* 2012;57(5):764–72.
- [20] Prinjha S, Field K, Rowan K. What patients think about ICU follow-up services: a qualitative study. *Crit Care* 2009;13(2):R46.
- [21] Smith G, Nielsen M. ABC of intensive care. Criteria for admission. *BMJ* 1999; 318(7197):1544–7.
- [22] Guidelines for intensive care unit admission, discharge, and triage Task force of the American College of Critical Care Medicine, Society of Critical Care Medicine *Crit Care Med* 1999;27(3):633–8.
- [23] Haupt MT, Bekes CE, Brill R, Carl LC, Gray AW, Jastremski MS, et al. Guidelines on critical care services and personnel: recommendations based on a system of categorization of three levels of care. *Crit Care Med* 2003;31(11):2677–83.