

Multidisciplinary Management of Critically Ill Patients in Acute Care Settings-An Updated Review

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Abstract:

Background: Critically ill patients experience rapid physiological deterioration that demands coordinated multidisciplinary care. Modern critical care extends beyond the ICU, incorporating early detection of clinical decline, advanced organ support, structured referral pathways, and post-ICU rehabilitation. Surgical, medical, and allied health teams play essential roles in ensuring continuity, stabilization, and recovery.

Aim: To provide an updated, comprehensive review of multidisciplinary management strategies for critically ill patients across the continuum of care—from early recognition and ICU admission to organ support and long-term recovery.

Methods: This narrative review synthesizes contemporary evidence and clinical practices described across major domains of critical care: organizational design, referral criteria, levels of care, postoperative surgical management, organ support (respiratory, cardiovascular, renal, neurological, gastrointestinal), sepsis management, delirium prevention, early mobilization, and post-ICU follow-up. The review integrates physiological principles, established care bundles, and current international guidelines.

Results: Multidisciplinary collaboration improves early recognition of patient deterioration, enhances diagnostic precision, and enables timely intervention. Structured ICU systems—with levels of care, rapid response teams, targeted bundles, and advanced monitoring—optimize outcomes across respiratory, cardiovascular, renal, and neurological domains. Evidence supports early sepsis treatment, lung-protective ventilation, restrictive transfusion strategies, and early mobilization. Post-ICU recovery services significantly reduce readmissions and long-term disability.

Conclusion: An integrated, system-wide approach is essential for managing critically ill patients. Early recognition, coordinated multidisciplinary involvement, evidence-based organ support, and structured follow-up collectively reduce morbidity, mortality, and long-term impairment. Critical care must extend beyond ICU walls, emphasizing prevention, communication, and patient-centered decision making.

Keywords: Critical care, multidisciplinary management, ICU, organ support, sepsis, postoperative care, early recognition, respiratory support, hemodynamic management, post-ICU recovery.

Introduction:

Critical care constitutes a specialized domain of medical practice dedicated to the management of patients experiencing life-threatening illness or those at substantial risk of rapid physiological deterioration. It addresses acute disruptions in vital organ function that demand continuous observation, timely intervention, and advanced therapeutic support. The intensive care unit serves as a defined clinical environment designed to deliver this level of care through enhanced nurse-to-patient ratios, continuous physiological monitoring, and access to sophisticated technologies that sustain failing organ systems. Such infrastructure exists to reduce morbidity and mortality by stabilizing physiological instability and preventing secondary complications [1]. Despite its association with a specific physical location, critical care extends beyond the structural confines of the intensive care unit. Effective management begins before ICU admission through early recognition of clinical decline, implementation of rapid response systems, and proactive escalation of care. Prevention strategies, structured early warning scores, and coordinated communication between departments reduce avoidable deterioration and improve outcomes. During the ICU stay, care must remain multidisciplinary and patient centered, integrating expertise from physicians, nurses, pharmacists, respiratory therapists, and allied health professionals. After discharge, structured follow-up and rehabilitation are essential to address the physical, cognitive, and psychological consequences of critical illness. When recovery is no longer achievable, the same framework must ensure dignified, high-quality palliative care that aligns with patient values and goals [1][2]. The fundamental objectives of intensive care management include restoration and maintenance of physiological stability, delivery of advanced organ support, and definitive treatment of the underlying pathological process. Optimization of oxygen delivery, hemodynamic stability, fluid balance, and metabolic control forms the physiological foundation of care. Organ support modalities such as mechanical ventilation, renal replacement therapy, and vasoactive infusions are implemented while clinicians simultaneously investigate and treat the precipitating disease. Shared clinical responsibility between the admitting specialty team and the dedicated critical care team ensures continuity, accountability, and integration of disease-specific expertise with critical care proficiency [2].

The Surgeon on ICU

The surgeon plays a central role in the multidisciplinary management of critically ill surgical patients. Although day-to-day physiological optimization may be directed by the critical care team, definitive knowledge of the operative pathology and procedural details remains with the surgical team. This expertise is essential when addressing complications such as anastomotic leaks, hemorrhage, intra-abdominal sepsis, or postoperative organ dysfunction. Surgeons provide guidance on wound assessment, timing of re-intervention, management of surgical drains, and interpretation of imaging findings in the context of operative anatomy. Their contribution directly influences diagnostic precision and therapeutic decision-making [1]. Postoperative management within the intensive care setting requires coordinated planning regarding nutrition, fluid therapy, thromboprophylaxis, and anticoagulation strategies. Surgical patients frequently present with altered physiology due to operative stress, blood loss, or infection. Determining the appropriate timing of enteral feeding, balancing bleeding risk against thromboembolic prevention, and identifying early signs of surgical site complications require surgical judgment integrated with critical care monitoring. Effective collaboration ensures that physiological stabilization does not occur in isolation from the underlying surgical condition. Strategic decisions concerning overall goals of care demand shared leadership between the surgeon and the critical care physician. Discussions regarding prognosis, potential need for reoperation, likelihood of recovery, and anticipated quality of life require transparent communication with patients and their families. When treatment effectiveness becomes uncertain or burdensome interventions outweigh potential benefit, both teams must participate in evaluating limitations

of therapy. Recognition of treatment futility, transition to comfort-focused care, and respect for patient autonomy rely on collaborative deliberation grounded in clinical evidence and ethical responsibility [1][2].

Organization of Critical Care Services

The organization of critical care services extends beyond the physical boundaries of the intensive care unit and reflects a system-wide responsibility to identify, stabilize, and appropriately escalate care for acutely ill patients. Modern critical care delivery operates within a structured framework that integrates ward-based surveillance, timely referral pathways, specialist consultation, and ethical decision making. This structure aims to reduce avoidable deterioration, ensure equitable access to advanced therapies, and allocate resources responsibly. Effective organization depends on communication between frontline clinicians, specialty teams, and dedicated critical care physicians, supported by institutional policies that standardize escalation processes while preserving individualized clinical judgment. Prevention represents a central pillar in contemporary service design. The concept often described as critical care without walls recognizes that physiological decline frequently begins outside the ICU environment. Delays in recognition contribute to cardiac arrest, emergency intubation, and unplanned admissions associated with worse outcomes. Early warning scoring systems and track and trigger models have been widely implemented across hospital systems to identify subtle abnormalities in vital signs before catastrophic decompensation occurs. These systems translate deviations in respiratory rate, heart rate, blood pressure, oxygen saturation, and level of consciousness into aggregated scores that mandate escalation according to predefined thresholds. Their value lies not only in detection but also in prompting early senior review, structured reassessment, and timely therapeutic intervention [1][2].

Rapid optimization on general wards requires skilled staff who can initiate fluid resuscitation, oxygen therapy, antimicrobial treatment, and hemodynamic monitoring while awaiting specialist input. Medical emergency teams and critical care outreach services support this process by providing bedside expertise, assisting with invasive procedures, and reinforcing education among ward personnel. Outreach models also contribute to continuity of care for patients recently discharged from the ICU who remain vulnerable to relapse. By strengthening ward capabilities, hospitals may reduce preventable ICU admissions and improve overall patient safety. Referral and admission to the intensive care unit represent complex clinical and ethical decisions. Senior clinicians from both the admitting specialty and the critical care team must participate in these discussions. The central question is whether escalation to advanced organ support aligns with the patient's best interests and realistic prospects for recovery. Prognostic scoring systems have been developed to estimate mortality risk based on physiological parameters, underlying pathology, age, and comorbid disease. While these tools inform population-level benchmarking, they do not reliably predict outcomes for individual patients in acute scenarios. Clinical context, trajectory of illness, and response to initial treatment remain essential considerations. Increasing attention has focused on frailty as a determinant of outcome in critically ill patients, particularly in perioperative settings. Frailty reflects diminished physiological reserve and vulnerability to stressors independent of chronological age. The Clinical Frailty Scale assigns a numerical value from one to nine corresponding to baseline functional independence and activity level prior to illness. Higher scores correlate with increased mortality among surgical patients [1]. Nevertheless, the scale has limitations. It lacks validation in individuals younger than sixty-five years and should not be applied indiscriminately to patients with stable long-term disability or learning disability. Frailty assessment therefore complements but does not replace comprehensive clinical evaluation.

Each emergency referral to critical care requires structured reflection on several fundamental issues. Clinicians must determine whether the underlying pathology is potentially reversible through available interventions. They must assess whether the patient possesses sufficient physiological reserve to tolerate invasive therapies such as mechanical ventilation, vasoactive support, or renal replacement therapy. Consideration of likely recovery includes not only survival but also the anticipated quality of life from the patient's perspective. Prior expressed wishes, advance directives, and discussions with family members must inform decisions, particularly when patients lack decision-making capacity. These elements transform admission decisions from purely technical judgments into ethically grounded deliberations [2]. Admission to the ICU exposes patients to interventions that may be painful, invasive, and psychologically distressing.

Mechanical ventilation, sedation, invasive lines, and continuous monitoring carry both benefit and burden. Clinicians must weigh the principle of beneficence, defined as the probability of meaningful recovery, against non maleficence, which requires avoidance of unnecessary suffering. Autonomy poses challenges because many critically ill patients cannot communicate preferences at the time of deterioration. Justice also shapes decisions, as critical care resources are finite and must be allocated fairly across populations. Balancing these principles demands experienced clinical leadership and individualized assessment rather than rigid adherence to protocol. Critical care admissions generally fall into two broad categories. Planned admissions involve patients identified as high risk who require proactive monitoring and optimization surrounding major interventions. Examples include individuals undergoing complex surgery who may develop hemodynamic instability, respiratory compromise, or exacerbation of chronic comorbidities. Planned postoperative critical care facilitates early detection of complications, structured analgesia, fluid management, and organ support where necessary. This anticipatory strategy aims to prevent deterioration rather than respond to it [2][3].

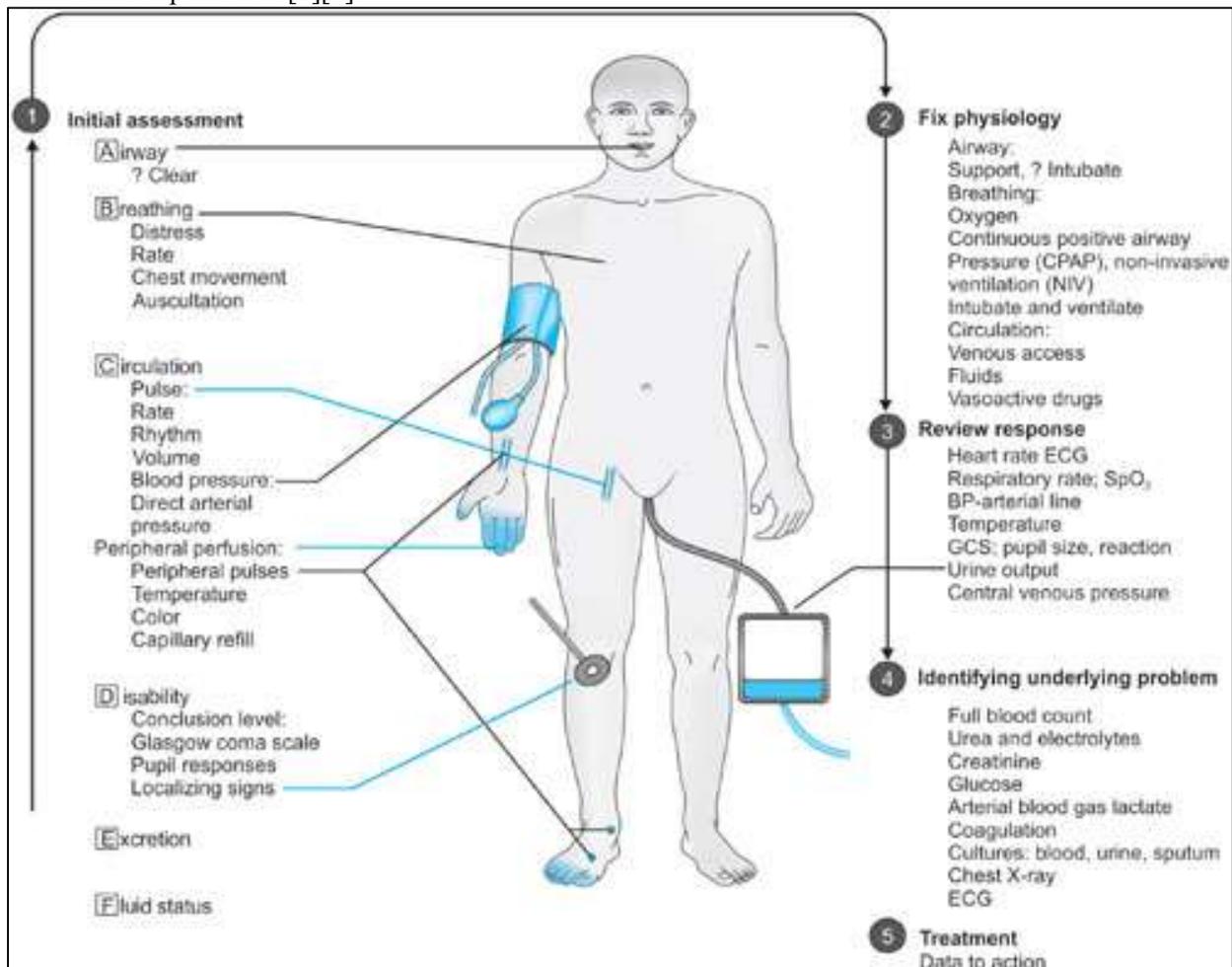


Fig. 1: Critical Ill Patients.

Emergency admissions involve patients with established or imminent organ failure requiring immediate support of vital functions. Such cases include septic shock following intra-abdominal infection, severe respiratory failure requiring invasive ventilation, or circulatory collapse necessitating vasopressor therapy. These admissions are frequently unplanned and occur after rapid physiological decline. They often demand simultaneous resuscitation, diagnostic clarification, and initiation of definitive therapy. Outcome data illustrate differences between these groups. Surgical patients admitted for planned postoperative monitoring demonstrate lower acute hospital mortality compared with emergency surgical admissions and non-surgical

medical patients. Recent data from the United Kingdom estimated mortality rates of 2.4 percent for planned surgery, 13.6 percent for emergency surgery, and 27 percent for non-surgical patients [2]. These figures highlight the prognostic advantage of anticipatory care and early optimization while also emphasizing the severity of illness among unplanned medical admissions. Effective organization of critical care services therefore requires integration of prevention strategies, structured referral pathways, ethical deliberation, and outcome evaluation. Systems must promote early recognition, support timely intervention, and ensure that admission decisions reflect both clinical evidence and patient centered values [1][2][3].

Levels of Care

Modern critical care medicine encompasses a wide spectrum of advanced monitoring systems and organ support technologies designed to sustain life in the presence of acute physiological failure. The availability and complexity of these interventions vary according to institutional design, staffing structure, and the scope of specialized services within each hospital. Critical care units are therefore categorized into defined levels that reflect the intensity of monitoring, the degree of organ support provided, and the nurse-to-patient ratio required to deliver safe and effective care. This stratification allows hospitals to allocate resources appropriately while ensuring that patients receive support proportional to the severity of their illness. Respiratory support represents one of the most frequently utilized components of critical care. In many units, high flow oxygen therapy and high flow nasal cannula systems are routinely applied to manage hypoxemic respiratory failure. Continuous positive airway pressure delivered via nasal interface, hood, or mask provides noninvasive ventilatory support for selected patients, while noninvasive ventilation offers greater assistance in cases of hypercapnic or mixed respiratory failure. Invasive mechanical ventilation remains central to intensive care practice and may include advanced strategies such as recruitment maneuvers and prone positioning to improve oxygenation. Percutaneous tracheostomy facilitates prolonged ventilation and airway protection, while bronchoscopy with broncho alveolar lavage supports diagnostic and therapeutic interventions. Specialized centers may provide extra corporeal carbon dioxide removal and extra corporeal membrane oxygenation for refractory respiratory failure, as well as oscillatory ventilation in selected cases [3][4][5].

Cardiovascular monitoring and support are equally fundamental. Standard intensive care management includes precise intravenous fluid administration, vasopressor and inotropic therapy to maintain perfusion, and invasive hemodynamic monitoring through arterial and central venous catheters. Advanced cardiac output monitoring techniques such as pulse contour analysis systems including LiDCO and PiCCO, esophageal Doppler assessment, and pulmonary artery catheterization provide detailed insight into circulatory status. Bedside echocardiography, both transthoracic and transesophageal, enhances diagnostic accuracy in shock states. In highly specialized units, mechanical circulatory support devices such as intra-aortic balloon pumps, ventricular assist devices, and extracorporeal membrane oxygenation expand therapeutic options for severe cardiac failure. Renal support commonly includes renal replacement therapies delivered as continuous veno venous hemofiltration, hemodiafiltration, or intermittent hemodialysis depending on clinical context and hemodynamic stability. Neurological monitoring ranges from structured neurological observations and electroencephalographic assessment to intracranial pressure monitoring and targeted temperature management. Advanced neurocritical care units may incorporate jugular venous oximetry, transcranial Doppler ultrasonography, cerebral microdialysis, and direct cerebral tissue oxygenation monitoring to optimize cerebral perfusion and metabolism. Gastrointestinal support involves enteral and parenteral nutrition, including immune enhancing formulations, along with intra-abdominal pressure monitoring in patients at risk of abdominal compartment syndrome. Certain specialized centers provide molecular adsorption recirculating systems for liver failure. Additional modalities such as plasma exchange, neuromuscular monitoring, and neuraxial analgesia broaden the therapeutic repertoire of modern units [4][5].

Within this framework, two principal levels of inpatient critical care are recognized. The high dependency unit, often designated as level 2 care, provides close observation and single organ support excluding invasive mechanical ventilation. Patients admitted to this setting require enhanced surveillance but do not necessitate one to one nursing. Respiratory management may include non-invasive ventilation and frequent

arterial blood gas analysis. Cardiovascular support may involve low dose vasopressors and invasive arterial pressure monitoring. Renal care emphasizes meticulous fluid balance assessment and selected renal replacement therapies. The high dependency environment serves as an intermediate step between general wards and full intensive care, facilitating early intervention for patients at risk of deterioration. The intensive care unit, or level 3 care, delivers comprehensive multi organ support and advanced monitoring that demands continuous attention from a dedicated critical care nurse for each patient. Respiratory management encompasses both invasive and non-invasive ventilation, with access to extracorporeal membrane oxygenation or carbon dioxide removal in specialized centers. Cardiovascular support includes sustained vasopressor and inotropic infusions, sophisticated cardiac output monitoring, and mechanical circulatory devices such as intra-aortic balloon pumps and ventricular assist systems. Renal replacement therapies are routinely administered for acute kidney injury or fluid overload. Neurological support extends to intracranial pressure monitoring, electroencephalography, and advanced cerebral monitoring techniques. This tiered organization ensures that patients receive care aligned with illness severity while preserving critical resources. Clear delineation between high dependency and intensive care services enhances patient safety, supports timely escalation or de-escalation of therapy, and promotes efficient utilization of advanced technologies within modern healthcare systems [1][2][3].

Post Critical Care

Discharge from the intensive care unit marks a transition in location, not a conclusion of clinical responsibility. Survivors of critical illness often experience persistent physical weakness, cognitive impairment, and psychological distress that extend far beyond the acute phase of treatment. These sequelae may include reduced exercise tolerance, neuropathy, impaired memory, anxiety, depression, and features consistent with post-traumatic stress. As survival rates improve, the long term burden carried by patients and families has become increasingly visible [3]. Recognition of these outcomes has reshaped the responsibilities of critical care teams, prompting structured follow up systems that aim to monitor recovery and address preventable complications. Many institutions now implement formal in patient follow up by critical care outreach teams after ICU discharge. These services review physiological stability, medication plans, nutritional strategies, and rehabilitation needs while supporting ward staff in managing complex patients. Early post discharge review reduces the risk of unrecognized deterioration and unplanned readmission. In addition, specialized Recovery after Critical Illness clinics provide multidisciplinary outpatient assessment. These clinics evaluate functional capacity, neurocognitive status, psychological health, and social reintegration. They create opportunities to educate patients about their illness trajectory, clarify misconceptions about intensive care experiences, and coordinate referrals to physiotherapy, occupational therapy, and mental health services. Comprehensive post critical care management acknowledges that recovery occurs across months rather than days. Early mobilization strategies initiated during ICU admission continue on the ward and after discharge. Nutritional rehabilitation addresses catabolic muscle loss. Psychological screening identifies patients who require targeted intervention. This longitudinal approach reduces long term disability and improves quality of life.

Sepsis remains one of the most significant contributors to critical illness worldwide. It accounts for substantial morbidity and mortality and affects a large proportion of intensive care admissions either as the primary diagnosis or as a complication during hospitalization. Sepsis is defined as life threatening organ dysfunction caused by a dysregulated host response to infection [3]. This definition emphasizes organ injury rather than isolated inflammatory markers. Septic shock represents a subset characterized by persistent hypotension despite adequate fluid resuscitation and elevated serum lactate above 2 mmol per liter, reflecting profound circulatory and metabolic disturbance. Diagnostic criteria include mean arterial pressure below 65 mmHg requiring vasopressor therapy in addition to hyperlactatemia. The earlier reliance on systemic inflammatory response syndrome criteria has been abandoned because inflammatory responses alone may reflect appropriate physiological reactions rather than pathological dysregulation [4]. Over the past decade, survival from sepsis in developed healthcare systems has improved significantly. This progress aligns with widespread adoption of standardized management frameworks promoted by international initiatives such as the Surviving Sepsis Campaign [5]. Early recognition remains fundamental. Clinicians

must identify subtle physiological changes including tachypnea, hypotension, altered mental status, and reduced urine output. Prompt balanced resuscitation with intravenous fluids supports perfusion while avoiding fluid overload. Rapid identification of the infection source through imaging, laboratory evaluation, and clinical assessment guides definitive treatment. Timely source control through surgical or procedural intervention prevents ongoing contamination. Early administration of effective antimicrobial therapy reduces pathogen burden and improves survival. Hemodynamic stabilization with vasopressors, consideration of adjunctive therapies, and meticulous supportive care complete the structured approach. Post critical care services therefore intersect closely with sepsis management. Survivors of septic shock frequently experience prolonged weakness and cognitive dysfunction. Coordinated follow up ensures that improvements in acute survival translate into meaningful long term recovery [3][4][5].

Critical Care Organ Support

Effective organ support in critical care demands a structured systems based approach that integrates continuous physiological data, laboratory results, imaging findings, and clinical examination. Critically ill patients often present with failure of multiple organ systems, requiring coordinated interventions delivered with precision and consistency. To standardize practice and improve outcomes, groups of evidence based interventions have been organized into care bundles. When applied collectively rather than in isolation, these bundles reduce complications and mortality by promoting reliability in essential aspects of care. Airway and respiratory management remain central to critical care practice. A substantial proportion of patients require advanced respiratory support at some stage of their admission. Decisions regarding escalation to mechanical ventilation require careful timing. Premature intubation exposes patients to avoidable risks, while delayed intervention during progressive respiratory failure increases morbidity and mortality. Advanced technology must not replace fundamental respiratory therapy, which includes effective positioning, secretion management, physiotherapy input, and optimization of analgesia. High flow oxygen therapy has become widely integrated across perioperative, ward based, and intensive care settings. This modality delivers warmed and humidified oxygen at high flow rates through a nasal or facial interface using an air oxygen blender. Flow rates may reach 60 liters per minute at a controlled fraction of inspired oxygen. Physiologically, high flow systems reduce work of breathing, generate low levels of positive end expiratory pressure, and facilitate washout of anatomical dead space. Humidification preserves mucosal integrity, enhances comfort, and supports secretion clearance. High flow nasal cannula therapy has demonstrated benefit in severe acute hypoxic respiratory failure compared with conventional face mask oxygen and non-invasive ventilation in selected populations [6].

Non-invasive ventilation provides ventilatory support without endotracheal intubation. It delivers positive airway pressure through a tight fitting interface using continuous positive airway pressure or bi level positive airway pressure modes. Continuous positive airway pressure maintains constant pressure throughout the respiratory cycle, improving oxygenation through alveolar recruitment, reducing shunt, and decreasing cardiac afterload. Bi level systems allow separate inspiratory and expiratory pressures, augmenting tidal volume and reducing respiratory muscle fatigue. Successful application depends on patient cooperation, intact airway reflexes, hemodynamic stability, and absence of contraindications such as untreated pneumothorax or inability to manage secretions. Non-invasive ventilation is established in cardiogenic pulmonary edema and acute exacerbations of chronic obstructive pulmonary disease, and its role has expanded into selected cases of asthma, pneumonia, postoperative respiratory failure, and ventilator weaning. Surgical consultation may be necessary when recent upper gastrointestinal or head and neck procedures increase the risk of air leakage or surgical emphysema under positive pressure. Invasive mechanical ventilation requires tracheal intubation and secure airway control. Airway management in critically ill patients presents greater complexity than elective anesthesia due to physiological instability, anatomical challenges, environmental constraints, and urgency. Indications for intubation include airway obstruction, loss of protective reflexes, hypoxic or hypercapnic respiratory failure, optimization of oxygen delivery in shock states, control of cerebral perfusion, and facilitation of pulmonary toileting or bronchoscopic procedures. Thorough preparation, equipment readiness, and clear communication of airway strategy are essential to reduce adverse events [6].

Modern ventilators provide multiple modes tailored to individual physiology. Patients may receive fully controlled ventilation, assisted spontaneous breathing, or hybrid strategies. Weaning represents the gradual reduction of ventilatory support to permit safe extubation. During daily review, clinicians assess oxygen requirements, fraction of inspired oxygen, positive end expiratory pressure levels, spontaneous breathing activity, and overall readiness for liberation from the ventilator. Advanced techniques such as prone positioning improve oxygenation and may confer mortality benefit in severe acute respiratory distress syndrome. Extracorporeal carbon dioxide removal and extracorporeal membrane oxygenation offer rescue therapy for refractory respiratory or cardiorespiratory failure in specialized centers. Mechanical ventilation carries inherent risks. Ventilator induced lung injury may arise from excessive airway pressures, high tidal volumes, repetitive alveolar collapse and reopening, and inflammatory mediator release. Lung protective ventilation strategies derived from acute respiratory distress syndrome management have become standard practice [7]. These strategies target tidal volumes of 6 to 8 milliliters per kilogram of ideal body weight, limit plateau pressures to 30 centimeters of water or less, and apply sufficient positive end expiratory pressure to prevent alveolar collapse. Complications extend beyond pulmonary injury. Intubation may cause dental trauma or vocal cord damage. Equipment malfunction and contamination pose additional hazards. Ventilation itself can induce hemodynamic instability, oxygen toxicity, and ventilator associated pneumonia. Prolonged immobilization and sedation increase risk of pressure injury, muscle weakness, venous thromboembolism, delirium, and gastrointestinal bleeding. To mitigate these risks, ventilator care bundles have been implemented. Core components include elevation of the head of the bed between 30 and 45 degrees, daily sedation interruption with assessment of extubation readiness, prophylaxis against peptic ulcer disease, and prevention of thromboembolic events. Respiratory support decisions rely on continuous clinical assessment supported by arterial blood gas analysis, chest radiography, and computed tomography when indicated. Lung ultrasound has emerged as a valuable bedside tool for detecting pleural effusion, pneumothorax, consolidation, and pulmonary edema without radiation exposure or patient transfer. Integration of technology with vigilant clinical evaluation ensures that organ support remains precise, responsive, and aligned with evolving patient physiology [5][6][7].

Cardiovascular Support

Cardiovascular support in critical care focuses on preserving adequate tissue perfusion and ensuring sufficient oxygen delivery to vital organs. Circulatory failure represents a common pathway in many life threatening conditions, including sepsis, trauma, major surgery, and cardiogenic shock. Effective haemodynamic management requires continuous reassessment of physiological variables and timely intervention guided by evolving clinical data. The primary objectives are restoration of effective circulating volume, optimization of cardiac output, and maintenance of appropriate vascular tone. These goals are achieved through structured fluid management and the judicious use of vasoactive medications. Haemodynamic monitoring in critically ill patients presents substantial challenges. Circulatory disturbances often involve complex interactions between macrocirculatory parameters such as blood pressure and cardiac output, and microcirculatory dysfunction affecting tissue level oxygen exchange. Clinicians must synthesize information derived from patient history, clinical examination, urine output, serum lactate levels, and invasive or non-invasive monitoring systems. Traditional pressure based measurements include arterial blood pressure and central venous pressure monitoring. Flow based assessments evaluate cardiac output and stroke volume. Although pulmonary artery flotation catheters once served as a standard tool for advanced haemodynamic evaluation, their routine use has declined outside specialized cardiac intensive care units due to procedural risks and lack of consistent outcome benefit. Less invasive technologies have gained prominence. Arterial pulse contour analysis systems and oesophageal Doppler devices estimate stroke volume and cardiac output using derived algorithms. Because these measurements are calculated rather than directly measured, their clinical value lies in dynamic assessment. For example, observing changes in stroke volume during a fluid challenge can help determine fluid responsiveness. Bedside echocardiography has become an essential component of haemodynamic evaluation. Many intensive care physicians now perform focused echocardiographic examinations to assess ventricular function, preload

status, valvular abnormalities, and pericardial pathology. This modality enhances diagnostic precision and guides individualized treatment strategies [7].

Fluid management remains a cornerstone of cardiovascular resuscitation. The immediate aim is restoration of adequate intravascular volume to support organ perfusion. However, critical illness frequently involves endothelial injury and increased capillary permeability, leading to interstitial fluid accumulation. Excessive fluid administration may therefore produce tissue oedema that impairs oxygen diffusion, compromises pulmonary function, and contributes to abdominal compartment syndrome. Observational data associate cumulative positive fluid balance during intensive care admission with worse outcomes [8]. Clinicians must therefore balance the need for resuscitation against the risks of fluid overload. Accurate monitoring of input, output, daily weight, and laboratory markers informs ongoing adjustments. The choice of intravenous fluid remains an area of debate. Balanced crystalloid solutions are widely used for resuscitation in sepsis due to favorable physiological profiles. Blood products play a central role in trauma and hemorrhagic shock. When colloid solutions are considered, albumin is regarded as a safe option in selected populations such as patients with sepsis or advanced liver disease [9]. Synthetic starch solutions are generally avoided because of nephrotoxic effects and potential association with increased mortality [10]. Gelatin based solutions lack convincing evidence of clinical benefit. Red blood cell transfusion strategies have evolved toward restrictive thresholds. In stable critically ill patients, transfusion is typically deferred until haemoglobin falls below 70 grams per liter, and then administered in single unit increments with reassessment after each unit [11]. Higher transfusion thresholds may be appropriate in the presence of active bleeding or significant ischemic heart disease. This individualized approach minimizes transfusion related complications while maintaining adequate oxygen carrying capacity.

Vasoactive medications provide pharmacological support when fluid therapy alone fails to restore adequate perfusion. Vasopressors increase systemic vascular resistance through stimulation of vascular smooth muscle contraction, thereby elevating arterial pressure. Common agents include norepinephrine, epinephrine, phenylephrine, metaraminol, dopamine via alpha adrenergic effects, and vasopressin through V1 receptor activation. Inotropes enhance myocardial contractility and increase cardiac output. Frequently used agents include dobutamine, epinephrine, dopamine via beta adrenergic activity, milrinone as a phosphodiesterase inhibitor, and levosimendan, which increases myocardial sensitivity to calcium. In septic shock, haemodynamic management often requires sequential escalation. Initial aggressive fluid resuscitation is followed by vasopressor therapy, commonly beginning with norepinephrine and supplemented by vasopressin when higher doses are required. Hydrocortisone may be introduced to reduce vasopressor dependency in refractory cases. When myocardial dysfunction contributes to persistent hypoperfusion, temporary inotropic support such as dobutamine may improve cardiac performance. Cardiovascular support in critical care therefore demands continuous integration of monitoring data, physiological reasoning, and timely therapeutic adjustment. Precision in fluid administration and careful titration of vasoactive drugs remain central to improving outcomes in patients with circulatory failure [9][10][11].

Central Nervous System

Admission to the intensive care unit is frequently necessitated by alterations in neurological status, most commonly a reduction in the level of consciousness. This is routinely quantified using the Glasgow Coma Scale (GCS), which allows clinicians to assess the degree of neurological impairment systematically. Patients presenting impaired consciousness are at high risk of airway compromise, and their care requires intensive monitoring and rapid intervention. The critical care environment provides a framework for such high-level surveillance, with staffing ratios and monitoring capabilities designed to detect and respond to deterioration promptly. Neuroprotective strategies are essential for patients with primary intracranial or spinal pathology, including traumatic brain injury, ischemic stroke, intracranial hemorrhage, or spinal cord ischemia. These strategies demand a multisystem approach in which precise ventilatory management and haemodynamic optimization are central, ensuring cerebral perfusion is maintained while secondary injury is minimized. Advanced monitoring techniques, such as intracranial pressure measurement, continuous EEG, and neuromonitoring, support clinical decision making by providing real-time information on

cerebral physiology. Extracranial insults, including systemic infection or hemodynamic instability, can precipitate secondary brain injury. Interventions such as targeted temperature management and avoidance of hyperthermia have demonstrated improved neurological outcomes in patients recovering from out-of-hospital cardiac arrest [12].

Renal Support

Acute kidney injury is a prevalent and serious complication in critically ill populations, affecting up to two-thirds of patients admitted to the ICU. It represents a significant therapeutic challenge given the high mortality associated with renal dysfunction in critical illness, reported between 40 and 50 percent. The Kidney Disease: Improving Global Outcomes (KDIGO) criteria provide a standardized framework for classifying AKI severity based on changes in serum creatinine and urine output. Pre-renal factors, including hypotension, sepsis, and low cardiac output, frequently initiate renal injury, while intrinsic renal damage from nephrotoxic medications or systemic inflammation can exacerbate dysfunction. Post-renal obstruction is rare but should be systematically excluded. Management emphasizes early detection, optimization of intravascular volume, haemodynamic support, and elimination of contributing etiologies. Severe cases necessitate renal replacement therapy to maintain fluid and electrolyte homeostasis, remove metabolic wastes, and support acid-base balance. Techniques such as intermittent haemodialysis and continuous veno-venous haemofiltration are widely employed, with CVVH favored in the UK for hemodynamic stability. Optimal dosing remains under discussion, though current recommendations suggest 25–30 mL/kg/h for most patients. Vascular access requires a large-bore central venous catheter, and anticoagulation, increasingly citrate-based, is necessary to maintain circuit patency and reduce bleeding risk [11][12].

Gastrointestinal Support and Nutrition

Malnutrition is common among ICU patients and significantly affects outcomes, including immune competence, wound healing, and preservation of muscle mass. Critical illness itself exacerbates gastrointestinal dysfunction, impairing nutrient absorption and metabolic homeostasis. Timely nutritional assessment on admission is crucial to identify patients at risk and initiate appropriate interventions. Surgeons and critical care teams must collaboratively determine the timing and modality of nutritional support, weighing early enteral feeding against delayed or parenteral routes. Enteral nutrition, delivered via nasogastric or nasojejunal tubes, is generally preferred and may be augmented with prokinetic agents. Parenteral nutrition is reserved for cases of persistent gut failure and carries its own risk profile. Early enteral nutrition has been associated with improved outcomes, whereas routine early parenteral supplementation lacks definitive benefit [13]. Glycaemic control remains a fundamental component of nutritional management, with relaxed blood glucose targets (≤ 10 mmol/L) to minimize hypoglycaemia associated with intensive insulin therapy [14].

Neuromuscular Considerations

ICU-acquired weakness is a frequent sequela of critical illness, characterized by myopathy, neuropathy, or a combination thereof. Contributing factors include prolonged immobility, sepsis, multiorgan failure, pharmacologic exposure (such as corticosteroids and neuromuscular blockers), and malnutrition. This condition delays weaning from mechanical ventilation, prolongs ICU stays, and predisposes patients to muscle contractures. Early mobilization and intensive physiotherapy are essential strategies to mitigate the impact of ICUAW and support functional recovery.

Sleep and Delirium

Sleep disruption is pervasive in critical care, driven by underlying illness, procedural interventions, sedation, pain, mechanical support, and environmental factors such as noise and light. Strategies to restore circadian rhythm, minimize sleep interruptions, and employ sedation breaks or analgesia-based sedation can improve both short- and long-term outcomes. Delirium, affecting up to 69% of ventilated patients, represents an acute fluctuating cognitive disturbance and an independent predictor of mortality. Daily assessment with validated tools such as the CAM-ICU is recommended. Risk factors include age, preexisting cognitive deficits, sensory impairment, polypharmacy, and systemic derangements. Management involves identification and correction of precipitating causes, prevention of exacerbating

factors, and targeted pharmacologic intervention to ensure patient and staff safety. Postoperative delirium may serve as an early indicator of surgical complications, necessitating heightened vigilance [15][14].

Further Critical Care Considerations

Critical care is inherently multidisciplinary, requiring contributions from physiotherapy, pharmacy, nutrition, microbiology, radiology, psychology, and speech and language therapy. Infection control is paramount, with critically ill patients at heightened risk for multidrug-resistant organisms. Antimicrobial stewardship, aseptic technique, and adherence to protocols for invasive devices are essential components of safe care. Initiatives such as the Matching Michigan project demonstrate that strict adherence to asepsis significantly reduces mortality from central venous catheter infections [16]. End-of-life care requires balancing treatment benefits against patient burden. When further escalation is not in the patient's best interest, limitation or withdrawal of life-sustaining therapy should be undertaken collaboratively with the primary specialty team, incorporating family discussions and, where possible, patient preferences. Organ donation should be considered in all eligible patients, with donation after brain death or circulatory death pathways guided by early physiological stabilization and coordinated multidisciplinary input. The COVID-19 pandemic has underscored the demand for critical care resources, particularly ventilatory support, which is required in approximately 75% of admitted patients. Mortality for critically ill COVID-19 patients remains high, and care focuses on advanced respiratory support, infection management, fluid optimization, thromboprophylaxis, and evidence-based pharmacologic therapy such as dexamethasone [17][18][19]. The associated hypercoagulable state contributes to increased rates of thromboembolic and cerebrovascular complications, further complicating critical care management.

Conclusion:

Critical care management must be understood as a continuous, system-wide process rather than a discrete episode of ICU admission. As this review demonstrates, optimal outcomes are achieved when early detection, rapid intervention, and multidisciplinary collaboration function seamlessly across hospital settings. Early warning systems, rapid response teams, and structured referral pathways ensure that deterioration is recognized before irreversible organ failure develops. Once patients reach the ICU, coordinated care—integrating physicians, surgeons, nurses, respiratory therapists, pharmacists, and allied health professionals—ensures that organ support is delivered safely, effectively, and in alignment with patient-specific needs. Evidence-based bundles for ventilation, sepsis, hemodynamic stabilization, and infection prevention improve survival and reduce complications. Equally important is the recognition that critical illness imposes long-lasting physical, cognitive, and psychological burdens. Post-ICU services, including outreach reviews and recovery clinics, play a pivotal role in identifying preventable complications, restoring functional capacity, and supporting reintegration into daily life. Ultimately, the management of critically ill patients requires a balance of technical expertise, communication, ethical judgment, and long-term continuity of care. By integrating prevention, advanced organ support, and post-discharge rehabilitation, modern critical care systems can significantly enhance patient outcomes and quality of life.

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