Surgical Intensive Care

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Abstract

Patients admitted in surgical intensive care units require attention and care by a team with exceptional technical skills, knowledge and experience, who are motivated to serve these patients with utmost dedication and without motive and regard for self. Surgical critical care generally involves spirit of team work, mutual consultation and strategy to extricate the patient from ill health. Patients who require admission for intensive care include gravely injured patients with polytrauma, postoperative high-risk patients, patients with severe sepsis and multiple organ dysfunction and patients with diverse kinds of associated disorders threatening life. Patients with immediately life-threatening conditions must be admitted in intensive care units for resuscitation and revival without delay. These specific units must be adequately staffed and equipped. The surgical intensive care units must take the responsibility for training and extending expertise in managing the critically ill patients to the new generation of doctors for improving and maintaining the standards of intensive care and taking intensive care to new heights. The source of light must not flicker and experience must be disseminated and shared with the new generation. Senior consultants should be intimate with daily developments in intensive care units and continue to work and guide the patient care as a matter of duty and example. The culture of intensive care should be cordial, efficient, speedy and harmonious. Surgical intensive care demands healthy outcome and patients should not get afflicted with intensive care unit associated complications.

INTRODUCTION

Patients admitted in surgical intensive care units require attention and care by a team with exceptional technical skills, knowledge and experience, who are motivated to serve these patients with utmost dedication and without motive and regard for self. Surgical critical care generally involves spirit of team work, mutual consultation and strategy to extricate the patient from ill health. Patients who require admission for intensive care include gravely injured patients with polytrauma, postoperative high-risk patients, patients with severe sepsis and multiple organ dysfunction and patients with diverse kinds of associated disorders threatening life. Patients with immediately life-threatening conditions must be admitted in intensive care units for resuscitation and revival without delay. These specific units must be adequately staffed and equipped. The surgical intensive care units must take the responsibility for training and extending expertise in managing the critically ill patients to the new generation of doctors for improving and maintaining the standards of intensive care and taking intensive care to new heights. The source of light must not flicker and experience must be disseminated and shared with the new generation. Senior consultants should be intimate with daily developments in intensive care units and continue to work and guide the patient care as a matter of duty and example. The culture of intensive care should be cordial, efficient, speedy and harmonious. Surgical intensive care demands healthy outcome and patients should not get afflicted with intensive care unit associated complications.

AIM AND ROLE OF CRITICAL CARE UNIT

Critically ill patients in hospitals are managed in specialized care units to enable them to receive focused multidisciplinary intensive care all the times as long as required. Critically ill patients are managed exclusively in a restricted zone so that their care is not compromised because of wider attention being given to other patients in busy general wards. These critically ill patients who are dependent on others for their recovery require management in an undisturbed environment by dedicated and trained personnel that should be able to undertake effective care of patients and also capable of performing required procedures on them. Patients in surgical intensive care units are admitted generally following severe trauma, shock, major surgery and life-threatening disorders. High-risk patients and elderly patients on absolute dependency are candidates for hospitalization in critical care units, too.

The patients in critical care units have to face distress due to pain, anxiety, discomfort, disturbances, immobility, invasive catheters, tubes and also due to dependency on strangers, besides facing attitudinal and communicational problems

with staff. The role of the chief intensivist in critical care management is of paramount importance as his job requires crucial coordination with different specialists, supervision of prompt and continuous care, ensuring logistic support, maintenance of smooth operability of equipment, preservation of discipline and adherence to a strict code of work ethics and liaison with hospital managers. The dedicated staff in intensive care units must be energetic, intelligent, skilled, experienced, knowledgeable and relentless dependable workers. Prolonged ICU stay can adversely affect the health status by increasing the risk of infection, complications, and, possibly mortality1. The aim of surgical intensive care is to restore the deranged body functions to normal and to transfer the patient to the general ward.

CRITICAL CARE IN CENTRAL NERVOUS SYSTEM INVOLVEMENT

Patients admitted in critical care units may be in different stages of altered consciousness from mild confusion to deep coma which may lead to brain death when all cerebral functions cease despite maximal efforts for revival after raising PaCO2 >60mm Hg for 30 seconds. One must exclude drugs, hypoglycemia, hyperglycemia, electrolyte imbalance as the cause of CNS impairment. Brain death can be confirmed by EEG, brain scan and transcranial Doppler ultrasound. Cerebral arteriography confirms the absence of circulation, a procedure rarely required or indicated and seldom practiced. Consciousness may be impaired due to cerebrovascular accidents, trauma, infections, intracranial tumors, drugs and metabolic dysfunction. The CNS assessment and resuscitation should proceed simultaneously. Glasgow coma scale is an ideal scoring system to ascertain the neurological status of the patient. Consciousness is affected by damage to mid brain and reticular activating system. Pupillary dilatation may occur due to local injury, effect of anticholinergic drugs, anoxia and uncal herniation when it is accompanied with altered sensorium. Absence of eye movements may be due to damage to cortical centers and the brain stem which can be checked by cold caloric test. The test involves instillation of 50ml of ice-cold water into the ear with raised head which may result in nystagmus and slow eye movements towards the instilled ear. A fixed deviation may indicate the hemispheric lesion on that side. The integrity of the cortical centre and brain stem function can also be checked by doll's eye movement or cervico-ocular reflex by turning the head to one side and observing the conjugate eye movement to the contralateral side. This is suggestive of an intact brain stem. Motor deficit indicates contralateral cerebral lesion. Decorticate response is shown by flexion of arms and extension of legs whereas the decerebrate response is shown by extension of both arms and legs reflecting poor outcome. Regular neurological observations should be undertaken including the measurement of pupillary size and reaction, limb power, and recording of Glasgow Coma Scale2.

INVESTIGATIONS AND MANAGEMENT OF COMATOSE PATIENTS

The following investigations are needed to manage the comatose patient:

1. Arterial blood gas analysis to exclude metabolic acidosis, hypoxia and hypercarbia.
2. Computed tomography/MRI to exclude intracranial pathology.
3. Complete hemogram.
4. Blood sugar, blood urea and serum creatinine levels.
5. Serum electrolytes.
6. ECG and Echocardiography.
7. Lumbar puncture to exclude meningitis and encephalitis.
8. Blood and urine screening for drugs as the cause of coma.

MANAGING A PATIENT IN COMA

The comatose patient should be intubated to ensure airway protection and to safeguard the integrity of the cervical spine. The head should be raised to 30o to reduce intracranial tension. Hyperventilation should ensure a PaCO2 between 35 to 40mm Hg. Serum osmolality and electrolytes are to be kept within normal range. A comatose patient requires care of the airway, maintenance of breathing and restoration of circulation by infusion of appropriate fluids and drugs like vasopressors or inotropes if required. Raised intracranial pressure should be reduced by rapid infusion of intravenous Mannitol. Mannitol (0.25-1g/kg usually as a 20% solution) has traditionally been used to elevate plasma osmolality and reduce brain edema in the setting of intracranial hypertension. Hypoglycemic coma should be treated by IV infusion of 50ml 50% glucose which would not cause any harm to a patient if he is in coma due to hyperglycemia. Narcotic overdose will result in shallow breathing and hypotension and Naloxone up to 2mg should be given. Benzodiazipine overdose should be managed by giving 50g of activated charcoal by oral route. Fever and seizures raise intracranial pressure and therefore should be controlled. Seizures may harm the patient physically and should be controlled by IV Phenytoin 1000mg. Status epilepticus should be controlled by IV Diazepam or Propofol.

PAIN MANAGEMENT AND SEDATION

Appropriate palliation of pain begins with the use of effective strategies for recognizing, evaluating and monitoring pain3. Intensity of pain can be assessed by Numeric Rating Scale and Visual Analogue Scale. Tolerance for pain varies from patient to patient and therefore patients should be treated sympathetically and with compassion. Sympathetic attitude makes the patient confident and relaxed mentally. Patient's attitude and posture should be readjusted frequently to make him comfortable. Tubes, catheters and drains should be carefully positioned for his comfort. The ICU patients on mechanical ventilators require sedation and analgesia in order to tolerate the endotracheal tube, to lie down in the same position for a long time to prevent dysynchrony with the ventilator, to tolerate many of the procedures for optimization of oxygenation and for patient safety4. Analgesia should be effective, quick to act, lasting and without side effects. Use of appropriate analgesics postoperatively may be necessary. Non-steroid anti-inflammatory drugs like Diclofenac and Acetaminophen are useful. Epidural analgesia after abdominal surgery has proved to be promising but care should be taken to remove the catheter after 48-72 hours. Light opioids should be exhibited initially and stronger opioids like morphine and pethidine can be used only if pain remains unrelenting. Caution should be used in giving Morphine particularly in the elderly, as it may cause respiratory depression. Infants and children should not be given opioids. Morphine as such should not be used in biliary tract disease as it causes spasm of the sphincter of Oddi. Combination of NSAID and light opioids should be tried before resorting to stronger opioids. The ICU patient, besides being in confinement, may also be afflicted with pain and anxiety. He is trapped in an environment with ongoing ceaseless activities. In ICU settings, patients are subjected to transportation, investigations and various procedures. Mechanical devices and equipments most often are operational. All these activities disturb the patient and make him restless. Therefore patients should ideally be monitored and managed by personalized care in noiseless partitioned chambers where they are excluded from noisy surroundings and at the same time are under direct observation. Movement of personnel, maintenance of silence and prevention of noise from any source is of paramount importance. Besides pain relief, the patient should be kept calm and comfortable by use of appropriate hypnotics and sedatives. These drugs should not make the patient drowsy and should not interfere with the patient's response to examination and questioning when needed. The patient should be preferably alert when aroused. Sedatives alone cannot relieve pain, therefore analgesics and sedatives are complimentary to each other. The useful sedatives to name are Diazepam, Lorazepam and Midazolam. Analgesics and sedatives should be used with caution in patients with hepatic and renal dysfunction. Propofol may be used as short duration hypnotic selectively, but may cause hypotension and is costly and therefore not preferred.

MAINTENANCE OF AIRWAY AND BREATHING

Protection of airway and maintenance of breathing is the most essential step in resuscitation and life support. The airway may be compromised due to numerous factors including head injury, foreign bodies, blood clots, secretions, dentures, fall of tongue in bilateral mandibular fractures and cervical hematoma. Comatose patients should be intubated for ventilatory support and maintenance of oxygenation. This measure prevents aspiration of secretions and regurgitated fluid. Endotracheal intubation is one of the main sources of nosocomial infections in SICU due to dislodgement of biofilm on it and colonization of lung tissue by organisms. Endotrachael intubation may cause pressure and volutrauma in addition to pressure necrosis of trachea. Therefore, as far as possible oxygen saturation should be maintained by less invasive methods like (CPAP) applied by a snugly fitting mask. The ventilation can be maintained by pressure supported ventilation or volume cycled ventilation. The patient on ventilatory support may require muscle relaxants to paralyse the respiratory muscles for synchronization between the patient and the ventilator. The ICU patient may develop respiratory failure with resultant anxiety, tachypnea, tachycardia, hypoxia and cyanosis. Patients with full stomach or disorders of the aero-digestive tract may develop aspiration pneumonitis with mortality up to 50%. Aspiration may cause airway obstruction, chemical and bacterial pneumonitis with resultant sequestration of protein-rich fluid in alveoli which requires bronchoscopic aspiration, antibiotics and ventilatory support. The patient should be weaned from ventilatory support as soon as he is able to support his breathing satisfactorily. Prolonged immobilization in bed may cause atelectasis, alveolar collapse, pneumonitis and hypoxemia. Other complications encountered in ICU are pulmonary embolism, deep vein thrombosis, fluid overload, cardiac failure, pulmonary edema, catheter- and drain-related sepsis and multiple organ failure. Fluid overload manifests as breathlessness, crepts in lungs, hypoxemia and distended neck veins. Elderly high-risk patients are more prone to develop complications due to

existence of co-morbidities.

MAINTENANCE OF CARDIOVASCULAR FUNCTION

Critically ill patients in surgical intensive care units may require hemodynamic support. A commonly encountered life-threatening condition is shock due to diverse causes. Shock results in inadequate tissue perfusion and the clinical picture depends upon the severity and duration of shock. Shock classically presents with feeble pulse, cold clammy skin, hypotension, tachycardia, bradypnea, hypoxemia, confusion, low urine output and metabolic acidosis. Warm septic shock is an exception, where the patient continues to maintain normal vital parameters despite compromised tissue perfusion and is pointed out by presence of metabolic acidosis and hence the importance of conducting blood gas analysis in affected patients. For urgent resuscitation and management the cause of shock has to be ascertained. Shocked patients require immediate resuscitation and simultaneous primary survey. Common causes of shock are blood or fluid loss, sepsis, anaphylaxis, cardiac dysfunction, adrenocortical insufficiency and metabolic disorders. The basic principle of managing shock is to treat its cause and maintain tissue perfusion. As the causes of shock are of diverse nature, each condition has to be managed accordingly. First and foremost in intervention is restoration of airway, breathing and circulation. This implies that the patient may require endotracheal intubation, control of hemorrhage, transfusion of blood and infusion of crystalloids to restore normal pulse, blood pressure, skin color and urine output. The patient may require inotropic support to raise the blood pressure. Drugs like dopamine, dobutamine or pressor agents should only be given after adequate hydration. In order to distinguish cardiogenic shock from hypovolemic shock, a bolus of 500ml of crystalloid can be infused rapidly to see the response. Immediately life-threatening conditions, like tension pneumothorax, heamothorax and pericardial tamponade remain the priority for intervention. Septic shock must be managed by resuscitation with intravenous fluids, elimination of the source of infection and antibiotics. Transfusion of fresh blood in cases of septic shock will only be beneficial and therefore should be used.

Hemodynamic monitoring for critically ill patients can be done with arterial catheters, central venous catheters and pulmonary artery catheters. These monitoring devices are invasive and are not without complications which include catheter-induced sepsis, knotting of catheters and injury to vessels, pneumothorax and dislodgement. These techniques are now gradually being replaced with newer techniques which are non-invasive and more informative. Resuscitation end points include the end tidal CO2, measurement of gastric mucosal pH, base deficit and arterial lactate levels. The gastric tonometer measures the pH of the stomach and values greater than 7.3 show the positive result of resuscitation. Shock causes ischemic insult to gut early and is last to recover after resuscitation. Compromised integrity of gut mucosa permits translocation of toxins and organisms into the peritoneal cavity and is responsible for hastening exaggerated inflammatory response and multiple organ involvement.

Rhythm dysfunction

Rhythm dysfunction in critically ill patients can lead to cardiac arrest if not managed expeditiously. In such an eventuality, the patient should be subjected to cardioversion with 360 Joules on three short intervals along with cardio-pulmonary resuscitation and injection of adrenaline 1mg every 4 minutes and administration of anti-arrhythmic drugs like amiodarone and procainamide. A heart rate less than 60 beats/min with QRS widening in ECG is an indication of heart block and the patient should be administered Inj. Atropine 0.6 to 1mg. Other common dysrhythmias are paroxysmal supraventricular tachycardia and atrial fibrillation. The cause of dysrhythmia has to be identified and treated accordingly. Atrial ectopic foci should be managed by B-blockers or calcium channel blockers but antiarrhythmic measures with drugs may not always be rewarding. Ectopic atrial fibrillation can be treated successfully with radiofrequency ablation which may rarely result in pulmonary venous hypertension due to pulmonary ostial stenosis. Patients with poor ejection fraction should be given amiodarone or diltiazem. Paroxysmal supraventricular tachycardia with poor ejection fraction may be treated with Digoxin. Arrhythmias may also be caused by conditions like cardiac ischemia, fluid and electrolyte imbalance, hypoxemia, acidosis and pulmonary embolism. Adequate cardiac output has to be restored by optimising preload, afterload and myocardial contractility. Maintaining fluid and electrolyte balance in elderly with associated diseases like cardiac failure and respiratory dysfunction is difficult. In a well hydrated hypotensive patient commonly used drugs are dopamine, epinephrine and norepinephrine. Dopamine is used to increase mean arterial pressure. It also improves circulation to heart, kidneys and brain. Low doses of dopamine (5ug/kg/min) improve renal and mesenteric perfusion but higher doses cause peripheral vasoconstriction and increased myocardial work.

RISK FACTORS FOR SURGERY

The patient must be assessed thoroughly for fitness to undergo surgery and anesthesia as per ASA (American Society of Anesthesiologists) protocol. A healthy young adult will have no risk for undergoing surgery. However, a patient will be at high risk for surgery due to associated diseases or adverse environmental factors like extreme cold. Old age, too, is a risk factor for surgery not due to altered physiology but due to presence of co-morbidities like diabetes mellitus, respiratory and renal diseases, ischemic heart disease and its complications. Such patients must be stabilized before being subjected to elective surgery. Elective surgery should be postponed till the risk factors are managed. A patient with coronary artery disease should be managed by angioplasty or bypass grafting. Similarly, cardiac failure should be managed by medication. A patient with myocardial infarction should wait for surgery for at least six months unless emergency nature of disease demands immediate intervention. Risk factors which require attention are cardiovascular disorders, metabolic diseases, compromised liver and renal functions, poor nutritional status, obesity, smoking and diabetes mellitus. Obese patients must lose weight by exercises and dietary modification. Smokers must be dissuaded from smoking at least two weeks before surgery. Diabetics are more prone to develop deep vein thrombosis, pulmonary complications, cardiovascular events and hypertension. In life-threatening emergency situations, risk factors must be controlled as far as possible, valuable time should not be lost in time-consuming invasive investigations and the patient must be assessed only for vital parameters and basic investigations followed by on-table alert monitoring.

NUTRITIONAL SUPPORT IN A SURGICAL PATIENT

Patients undergoing surgery should be nutritionally optimized. Excess weight should be reduced by dietary advice. Ascertaining body mass index (BMI) by the following equation guides the clinician and the patient to adopt measures for necessary nutritional modifications in overweight and underweight patients.

BMI = Wt in kg/Ht in meters2

A patient with a body mass index below 18.5 needs nutritional support and a person with a BMI more than 30 needs weight reduction to avoid complications associated with obesity. A patient with a body mass index of 15 is at risk of postoperative mortality. A patient, in whom enteral feeding has to be held up for a week, will require nutritional support. An undernourished patient, a cancer patient, a patient who has undergone major surgery like pancreatico-duodenectomy, hepatic surgery, major gut resection and patients with postoperative high-output gut fistula will require nutritional support. The ideal route for nutritional support is oral alimentation with or without a device to deliver it. Oral alimentation is natural, comfortable and physiological, which maintains mucosal gut integrity, IgA production and normal gut flora. Enteral nutrition can also be delivered by nasogastric tube or jejunostomy. Parenteral nutrition can be given through a central or peripheral route depending upon the estimated duration of alimentation. Parenteral nutrition should meet all the fluid and calorie requirements with all the components of carbohydrates, amino acids, lipids, electrolytes, trace elements and vitamins.

A severely ill or traumatized patient will require additional calories because of hypercatabolic state. Such patients will need nutrition with at least 40kcal/kg per day. Nutritional support is also required during a prolonged period of illness. Nutritional support cannot eliminate the body protein breakdown after trauma or surgery as a part of metabolic response but meets the normal physiological and additional requirements of the body. Devices used to deliver the nutritional support are not without complications. The nasogastric tube itself is a source of infection and can result in aspiration, blockage, dislocation and local injury. Jejunostomy tubes, too, can get dislocated and cause spillage of gut contents into the peritoneal cavity. Parenteral nutrition is a source of thrombophlebitis. Catheters delivering parenteral nutrition may get blocked, can traumatise the vessel and even can get fractured. Central venous catheterization may also cause hemothorax or hydrothorax. Anemia, particularly in elderly patients, should be corrected by transfusion of packed cells and oral administration of iron supplements and dietary modification.

OTHER RISK FACTORS

Patients undergoing surgery should be strictly advised to stop alcohol and drug abuse if any. Similarly, past history of illnesses and their treatment must be clearly brought out. Failure to elicit history of drug use before surgery can bring calamity to the patient and distress to the operating team. Some patients are not forthright in revealing their drug history for fear of loss of prestige or consequent postponement of surgery.

GASTROINTESTINAL COMPLICATIONS

Commonly encountered gastrointestinal complications in the

surgical intensive care unit (SICU):

- Paralytic ileus
- Abdominal compartment syndrome
- Intestinal fistula
- Stress ulcers

Paralytic ileus

Paralytic ileus after major abdominal surgery may last for 3 to 5 days and generally occurs in patients with bacterial peritonitis, following pancreatic surgery, prolonged mechanical intestinal obstruction and due to narcotics. Other important causes of paralytic ileus are pancreatitis, electrolyte imbalance, retroperitoneal hemorrhage and pneumonia. It is difficult to distinguish paralytic ileus from small-bowel obstruction. Paralytic ileus presents with distension of the abdomen, vomiting and abdominal discomfort without colicky pain. The gut is silent in ileus. Patients with postoperative intestinal obstruction should be observed for 72 hours unless there is a strong clinical indication for immediate re-exploration. Those who require laparotomy generally have a painful distended abdomen with absolute constipation even after 72 hours. Postoperative intestinal obstruction occurs due to bands and adhesions in 70% of cases. The patient should be resuscitated with intravenous fluids and an electrolyte imbalance is to be corrected. All measures should be adopted to avoid injury to the gut during surgery. The gut should be kept moist with wet pads during the whole procedure. Generally, paralytic ileus resolves without complications.

Abdominal compartment syndrome

The normal intra-abdominal pressure is 0cm of water. An intra-abdominal pressure rising above 15cm of water can result in cardiac, respiratory and renal failure. The patient's life must be saved by resorting to early intervention and return to the operating theatre. Abdominal compartment syndrome affects the blood supply of intra abdominal contents and results in ischemia of gut.

Intestinal fistula

Encounter with intestinal fistula is an agonizing experience both for the patient and surgeon. Intestinal fistulas generally occur following surgery on gut, particularly after gut anastomoses, lysis of adhesions, pancreatic surgery and due to technical mistakes. Fistulas present externally in case the drains are in place and may also present as leakage of gut contents from the operated site. A fistula may have high or low output depending upon the amount of discharge of gut contents. Fistulous discharge results in protein loss, fluid and electrolyte imbalance, sepsis, skin excoriation, pain and burning sensation at the site of contact with skin, besides inflicting adverse psychological effects on the patients. Postoperative mortality in such cases is between 15 to 20 percent. Discharge from small-gut fistulas is yellow in color with a peculiar smell. The controlled fistula without intraperitoneal leakage is manageable, but fistulas with intraperitoneal leakage result in sepsis, abscess formation and intense intra-abdominal inflammatory reaction. Therefore, laparotomy in cases with intraperitoneal involvement becomes mandatory to clean the peritoneal cavity and insert drains. Patients with low-output fistulas with less than 100ml discharge per day can also be supported by oral alimentation. Patients with high-output fistulas require total parenteral nutrition, antibiotics, vitamins, minerals and skin care. A low-output fistula is likely to close with passage of time. A gut fistula is unlikely to close if the patient has distal gut obstruction, the track is epithelialised or a foreign body is in the fistula track. These patients will require re-operation after an interval of 4 to 6 weeks when the local inflammation and sepsis have settled. Surgery for intestinal fistula including closure of fistula or resection and anastomoses in the midst of inflammation, sepsis and friability of tissues is bound to be unrewarding, which prolongs morbidity with possibility of mortality as well. Surgery for gut fistula is challenging and must be adequately planned and well timed for successful outcome.

Stress ulcers

Gastric stress ulcers in intensive care units may occur in 25% of cases following cranio-cerebaral injuries, coagulopathies, burns and in those on prolonged ventilatory support, and 10% of these patients may bleed. Stress ulcers occur as a result of action of acid on ischemic mucosa of the stomach. Stress ulcers can be prevented by use of proton pump inhibitors, H2-receptor antagonists and sucralfate by oral route in doses of 1g every six hours. Sucralfate forms a protective coating over the gastric ulcer and thus prevents it from bleeding. Proton-pump inhibitors abolish the gastric acid secretion whereas H2-receptor antagonists reduce acid secretion and therefore, proton-pump inhibitors are preferred.

ACUTE RENAL FAILURE

Critically ill patients, particularly elderly postoperative cases, must be carefully monitored for fluid, electrolyte and acid base balance. Acute renal failure is not an uncommon complication as part of multisystem disorder and organ failure occurring following massive trauma, sepsis, hypovolemia, fluid and electrolyte imbalance, obstructed

uropathy and surgery thereafter, renal diseases and nephrotoxic drugs including contrast agents. Compared to patients with previously normal renal function, those with pre-existing renal impairment have increased morbidity and mortality manifesting as increased inotropic usage and number of ventilated days, as well as prolonged intensive care and overall hospital stay5. Balanced hydration, avoidance of nephrotoxic drugs, and maintenance of electrolyte and acid/base balance can reduce the mortality to less than 50% of the expected one in such cases. Urine output should not fall below 1ml/kg/hr in an adult male. Urine output less than 300ml/24 hrs with rising blood urea and serum creatinine calls for immediate intervention to correct it. Most often the cause of acute renal failure is hypovolemia compounded by septicemia and multiple organ dysfunction. Hypovolemia can be corrected by IV hydration under CVP control or more advanced esophageal Doppler or blood dilutional studies. However, monitoring of patients by clinical and basic physiological parameters remains the best guide. A well hydrated patient can be further supported by low doses of inotropic agents like dopamine in doses of 5ug/kg/min. In complicated cases like uraemia, fluid overload, electrolyte imbalance, acid/base disorder and uraemic encephalopathy, hemodialysis as renal replacement therapy must be undertaken at the earliest whereas in patients with chronic renal failure peritoneal dialysis can be adequate and rewarding.

SEPSIS IN THE SURGICAL INTENSIVE CARE UNIT

Mortality in the surgical intensive care unit is variable but may extend to more than 29%, whereas mortality due to multiple organ dysfunction is more than 40%. Sepsis in the intensive care unit is more common because of multiple factors. Sepsis depends upon virulence of organisms, their number and ability to resist antibiotics, release of toxins, poor host immune response, coexistent diseases, high-risk surgery, old age, poor nutritional status and preexistent source of infection. Hospital-acquired pneumonia (HAP) and ventilator-associated pneumonia (VAP) remain important causes of morbidity and mortality despite advances in antimicrobial therapy and better supportive care modalities6. Infection in the intensive care unit is generally due to a mixed flora of gram-negative organisms. Sepsis in SICU is closely related to therapeutic invasive procedures like intravenous access, endotracheal intubation and urinary catheterization. Utmost care should be taken to perform these procedures under strict aseptic measures. Venous cannulas, endotracheal tubes and urinary catheters should be cared for on a daily basis and should be changed after every 48-72 hours. Bacterial colonization at the venous puncture site is common and culture of the similar organisms from a blood sample taken from another site confirms sepsis due to organisms introduced from the venous puncture site. Sepsis control should be achieved by elimination of the source of infection, resuscitation by intravenous fluids and by rational and appropriate use of antibiotics. Indiscriminate use of antibiotics for a prolonged period without elimination of the source of infection results in bacterial resistance to antibiotics and prolongs morbidity.

SIRS (Systemic inflammatory response syndrome)
Systemic inflammatory response syndrome following infection manifests itself with two or more of the following:
Temperature > 38oC or < 36oC
Heart rate > 90 beats/min
Respiratory rate > 20/min or PaCO2 < 32 mm Hg
White blood cell count > 12000 or < 4000/mm3
This occurs due to increased cytokine activity, abnormal nitric oxide synthesis, neutrophil sequestration and degranulation, abnormal arachidonic acid metabolism, free radical production and activation of coagulation and complement mechanism.

Sepsis
SIRS + documented infection
Severe sepsis
Sepsis + organ dysfunction or hypoperfusion (lactic acidosis, oliguria or altered mental status)
Septic shock
Sepsis + organ dysfunction + hypotension (systolic blood pressure <90mmHg even after use of vasopressors)

MULTIPLE ORGAN FAILURE AND MULTIPLE ORGAN DYSFUNCTION SYNDROME

Mortality is between 40%-100%. The syndrome involves mitochondrial dysfunction, capillary occlusion and shunting of blood, tissue edema, vascular leakage, leucocyte sequestration, tissue hypoxia and cellular death. Excessive inflammatory response leads to tissue destruction in distant organs resulting in multiple organ failure, which is likely to lead to death. The widespread damage can be brought about by sepsis, trauma, burns or pancreatitis and is compounded by preexistent metabolic disorders, nutritional factors and environmental factors like hypothermia. Patients undergoing major surgery benefit by intraoperative surface warming and maintenance of core body temperature. Intensive insulin therapy in hyperglycemic patients to maintain blood sugar

levels below 6.1mmol/l helps in controlling sepsis. Infusion of Ringer's solution instead of isotonic saline avoids hyperchloremic acidosis. Impending irreversible shock due to volume deficit and intense hypoperfusion can be avoided by fluid resuscitation with crystalloids or colloids and use of inotropes like dobutamine, dopexamine etc. Patients with systemic inflammatory response syndrome have occult oxygen deficit despite normal vital parameters and use of inotropes may help improve oxygen delivery globally unless tissue hypoperfusion touches a critical low level. Use of these agents is harmful in inadequately hydrated patients and affects myocardial efficiency. Renal output should be maintained at more than 0.5ml/kg per hour, which is an indication of adequate regional tissue perfusion. The most sensitive investigation to predict death and MODS is to determine gut mucosal hypoperfusion and mural acidosis by gastric or sigmoid tonometer. Escape of gut luminal organisms and toxins into circulation results in SIRS and MODS. Other measures which can reduce the risk of MODS include steps to avoid nosocomial infections in intensive care units by hand washing, care of catheter-related sepsis, care of venipuncture sites and endotracheal tubes. Bacterial load in gut should be reduced by selective decontamination to prevent bacterial translocation. Reducing pH of stomach by acid reducing agents may prevent its bacterial colonization and therefore pneumonitis due to aspiration of gastric contents, but this measure may have theoretical significance. Other measures which can improve survival are use of monoclonal antibodies to moderate the effects of TNF and interleukins. Nitric oxide inhalation does improve the outcome in patients with severe adult respiratory distress syndrome and high-altitude pulmonary edema by reducing pulmonary artery pressure and improving pulmonary oxygenation. Non-steroid anti-inflammatory drugs like cyclo-oxygenase inhibitors may reduce tissue damage due to excessive cytokine effects. Activated protein C reduces the risk of death by anticoagulant and anti-inflammatory action in critically ill patients with MODS. Use of immunostimulant feeds, interferon gamma and granulocyte colony stimulating factor may be beneficial in sepsis, too.

HEPATIC DISORDERS

Patients in surgical intensive care units may be admitted due to liver disorders occurring as a result of prolonged alcohol consumption, intravenous drug abuse, hepatitis and sepsis or as a part of multiple organ dysfunction. These patients may have deranged liver function tests with ascites and may head towards hepatic failure and hepatorenal shutdown. Patients with hepatic encephalopathy should be managed by correcting fluid and electrolyte imbalance and by use of lactulose and neomycin. Surgery in jaundiced patients with hepatorenal shutdown has high mortality. It is manifested as uremia and oliguria, urinary sodium <10meq/l and high urinary osmolality. These changes are precipitated by hypovolemia and activation of the renin-angiotensin-aldosterone mechanism. Patients may require renal replacement therapy, restriction of proteins and monitoring for fluid and electrolyte balance. Hepatorenal shut down occurs in patients with hepatic and renal dysfunction. Endothelial factors have been implicated in causation of hepatorenal shut down, too.

DECUBITUS ULCERS

Patients immobilized in beds for prolonged periods may develop decubitus ulcers. Factors responsible for causation of these ulcers include paralysis, prolonged immobilization due to trauma, multiple surgery and lack of care and attention. These ulcers develop at the point of maximum contact and pressure with the bed. Parts generally affected are the lumbo-sacral region, ischial tuberosity, malleoli, trochanteric regions and scapular regions. Decubitus ulcers occur due to ischemia of skin consequent to compromised microcirculation. These ulcers are preventable and are an intensive effort to manage. Meticulous care, counseling, frequent change of posture at regular short intervals and use of special air beds can prevent such ulcers. Vacuum-assisted dressings, too, are beneficial in treating these ulcers. Hyperbaric oxygen under controlled conditions in hyperbaric pressure chambers also have been reported to be of benefit in healing of these ulcers, but instances have occurred in which these ulcers showed deterioration because of cross infection contracted from infected environment in busy pressure chambers.

ANEMIA AND BLOOD TRANSFUSION

Anemia is common among patients admitted in surgical intensive care units. Common causes of anemia are traumatic blood loss, major surgery, extensive burns, chronic blood loss and poor nutritional status compounded by preexistent sepsis. Hemoglobin levels up to 7g/dl and above are tolerated well in a normal state; however, these patients will require blood transfusion if they undergo surgery. Similarly, patients with anemia due to traumatic blood loss, septicemia and nutritional factors also are candidates for blood transfusion. Packed red blood cell transfusion is ideal particularly in elderly patients, as it delivers the same volume of oxygen as whole blood transfusion does and also reduces the load on the heart as compared to whole blood

transfusion. Ongoing hemorrhage in a surgical patient must be controlled to ensure perfusion of vital organs. Massive blood transfusion might lead to complications like coagulopathy, hypothermia, transfusion reaction and transmission of bacterial and viral infections. During ongoing control of bleeding into body cavities, hypotensive resuscitation is beneficial to avoid further blood loss. Hemorrhagic shock must be managed by arrest of hemorrhage, fluid replacement and blood transfusion.
Autologous blood transfusion
Autologous blood transfusion involves transfusion of the patient's own blood to restore the blood volume. It is more useful in patients who may require blood transfusion during cold surgery fixed two to three weeks after the patient has donated his own blood. During surgery on-table collection of blood and transfusion back into the patient is neither popular nor without risk and is not possible on a uniform basis. However, in grave emergencies like ruptured ectopic gestation, blood can be collected from the peritoneal cavity, filtered and collected in sterile containers for transfusion, but the control of hemorrhage remains the most vital step. Blood substitutes are helpful in restoring blood pressure, but are not the ideal alternative for blood transfusion.

DEEP VEIN THROMBOSIS

Venous thromboembolic events are considerably more common in hospitalized and severely ill patients than in outpatient setting7, 30% of patients admitted in intensive care units are affected by deep vein thrombosis. Deep vein thrombosis commonly affects lower limbs and can be life-threatening. Basic pathology in causation of deep vein thrombosis is stasis of venous flow, endothelial injury and hypercoaguable state of blood called Virchow's triad. Factors which may result in causation of deep vein thrombosis are prolonged surgery under general anesthesia, major trauma, pelvic surgery, spinal cord injury, chemotherapy, congestive cardiac failure, obesity, old age and use of estrogens. Young patients have a low risk of developing deep vein thrombosis, particularly after surgery of short duration; however, elderly obese patients undergoing surgery with past history of thromboembolism have a high risk of developing deep vein thrombosis. Deep vein thrombosis presents with pain, swelling, calf tenderness and low-grade fever. Deep vein thrombosis can result in fatal pulmonary embolism which manifests itself with tachypnoea, hypertension, hypoxemia and chest pain. Deep vein thrombosis can be diagnosed by Duplex ultrasonography which has more than 95% diagnostic value. Pulmonary embolism is diagnosed by enhanced helical computerized tomography replacing isotope imaging studies. Deep vein thrombosis can be prevented by mechanical and pharmacological methods. Graduated compression stockings and sequential pneumatic compression devices prevent deep vein thrombosis. Once a day, administration of low molecular weight heparin prevents incidence of deep vein thrombosis and has low risk of bleeding as compared to standard heparin which is administered in doses of 5000 units subcutaneously three times a day for five days. Established deep vein thrombosis is treated by subcutaneous injection of standard heparin and doses are controlled by activated partial thromboplastin time (APTT). Simultaneous administration of warfarin prevents further episodes of thrombosis, is continued for three to six months and is monitored by international normalised ratio (INR) which should be maintained between 2.5 and 3.5 times the control value. A massive venous thrombus of the lower limbs can be removed by open thrombectomy. Advanced fibrinolysis of the thrombus can be achieved by infusing fibrinolytic drugs like streptokinase or tissue plasminogen activator. Pulmonary embolism from lower limbs can be prevented by insertion of inferior vena cava filters under radiological control without resorting to open surgery. These filters trap the thrombi in their wires and prevent the occlusion of pulmonary arteries.

Figure 1

For successful outcome, a critically ill patient in SICU is totally dependent on the life support system. The duration of the ICU stay should be optimised to avoid complications and should not be extended needlessly, which would result in complications in the form of nosocomial infections. Prolonged occupation of a bed in the ICU also results in denial of admission to fresh cases who may require intensive care, too.

CONCLUSION

Critically ill patients, particularly with high risk-factors, are totally dependent on others and require sympathetic, dedicated care and monitoring. Intensivists and consultants must work as a team for their survival. The entire attention should be directed towards their revival, resuscitation and salvage till they move out of dependency. Essential steps in critical care involve maintenance of airway, breathing, circulation, sensorium and management of specific diseases. In addition, patients with multitudes of invasive catheters, tubes and cannulas must be kept free from complications and discomfort.

References

1. Gilio AE, Stape A, Pereira CR, Cardose MF, Silva CV, Troster EJ: Risk factors for nosocomial infections in a critically ill pediatric population: a 25 month prospective cohort study. Infect Control Hosp Epidemiol; 2000; 21: 340-342
2. Teasdale G, Jennett B: Assessment of coma and impaired consciousness: a practical scale. Lancet; 1974; 2: 81.
3. Mularski RA: Pain management in the intensive care unit. Crit Care Clin; 2004; 20: 381.
4. Devlin JW: The pharmacology of oversedation in mechanically ventilated adults. Curr Opin Crit Care: 2008; 14: 403-7.
5. Deutsch E, Bernstein RC, Addonizio P, Kussmaul WG: Coronary artery bypass surgery in patients on chronic haemodialysis. A case control study. Ann Intern Med; 1989; 110: 369-72.
6. Porzecanski I, Bowton DL: Diagnosis and treatment of ventilator - associated pneumonia. Chest; 2006; 130: 597-604.
7. Silverstein MD, Heit JA, Mohr DN, Petterson TM, O'Fallon WM, Melton III LJ: Trends in the incidence of deep vein thrombosis and pulmonary embolism: a 25-year population based study. Arch Intern Med; 1998; 158(6): 585-93.

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