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Editors
Kapil Zirpe
Subhal Dixit
Sushma K Gurav
Balasaheb Pawar

CRITICAL CARE MEDICINE MCQs PRACTICE BOOK



SECOND EDITION

Forewords
Yatin Mehta
Shirish Prayag

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Contents

Chapter 1: Overview of MCQs Based Critical Care in India 1
Deepak Govil, Shubhendu Bajpai

Chapter 2: Airway Management 4
Abdul Samad Ansari, Ujwala Mhatre, Rajiv J Shah

Chapter 3: Cardiopulmonary Resuscitation 13
Balkrishna D Nimavat

Chapter 4: Shock and Resuscitation 27
Palepu B Gopal

Chapter 5: Mechanical Ventilation 45
Sachin Gupta, Deeksha Singh Tomar

Chapter 6: Respiratory System **54**
Balasaheb Pawar

Chapter 7: Hemodynamic Monitoring 60
Harish MM, Suhail S Siddiqui, Jacob George Pulinilkunnathil, Sudhindra P Kanavehalli

Chapter 8: Infection Control 92
Ripenmeet Salhotra, Supradip Ghosh

Chapter 9: Infectious Diseases 104
Rajeev Soman, Neha Gupta

Chapter 10: Gastrointestinal System 114
Ajith Kumar AK, Nithya CA

Chapter 11: Nutrition 124
Subhal Dixit, Khalid Ismail Khatib

Chapter 12: Endocrine and Metabolic System 131
Anand Tiwari

Chapter 13: Neurocritical Care 142
Sunil Karanth, Gaurav Kakkar

Chapter 14: Trauma 166
Sushil Kumar Yadav

Chapter 15: Cardiovascular System 179
Divyesh Patel

Chapter 16: Renal 191
Sunitha Binu Varghese

Chapter 17: Toxicology 198
Omender Singh, Anish Gupta, Deven Juneja

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Chapter 18: Obstetric Critical Care 215
Prasanna Pradip Murudwar

Chapter 19: End-of-Life/Ethics/Transplant 226
Jignesh Shah, Moturu Dharanindra

Chapter 20: Oncology 242
Deven Juneja, Anish Gupta, Omender Singh

Chapter 21: Hematology 253
Abhijit Baheti

Chapter 22: Postoperative Critical Care 266
Sushma K Gurav

Chapter 23: Tropical Diseases 277
Dhruv Chaudhary

Chapter 24: Critical Care Pharmacology 2019 285
Natesh Prabhu R

Chapter 25: HRCT Thorax 301
Balasaheb Pawar

Chapter 26: Chest X-Ray 311
Subhal Dixit, Khalid Ismail Khatib

Chapter 27: Arterial Blood Gases 320
Sushma K Gurav

Chapter 28: USG and ECHO 325
Shrikant Srinivasan

Exam Paper 341
Khalid Ismail Khatib

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CHAPTER 7

Hemodynamic Monitoring

Harish MM, Suhail S Siddiqui, Jacob George Pulinilkunnathil, Sudhindra P Kanavehalli

QUESTIONS

1. **A 28-year-old male patient without any comorbid conditions admitted to ICU with history of fever and breathing difficulty. On evaluation his respiratory rate 39/min, blood pressure 118/66 mm Hg, temperature 101°F. P/F ratio was 150, initially tried on noninvasive ventilation and because he worsened clinically, he got intubated and started on mechanical ventilation as per ARDSNET protocol. In the meantime his blood pressure dropped to 84/46 mm Hg, he was inserted with invasive lines and initiated on FloTrac® monitor. His SVV-16%, SV 66 mL/beat, CO 2.6 L/min. Based on the clinical scenario which of the following is the further management option in terms of hemodynamic support?**
   a. Because SVV is more than 10% patient is likely to be fluid responsive, hence will give fluid challenge
   b. SVV value is not a reliable indicator of fluid responsiveness in the current scenario
   c. Since the patient is having low cardiac output, he needs to be started on Dobutamine
   d. Will check the IVC diameter to assess the fluid responsiveness
2. **In relation to passive leg rising (PLR) test, which of the following is *correct*?**
   a. To start with patient should be started from supine position
   b. PLR is unreliable in patients with spontaneous breathing
   c. It is mandatory to have real time cardiac output monitoring, while assessing fluid responsiveness
   d. Transthoracic ECHO is the best way to assess fluid responsiveness, as it is noninvasive and easy to perform
3. **A 44-year-old lady admitted with history of fever, burning micturition. On evaluation her urine shows 20–30 pus cells with total counts of 18,000 with more than 70% of neutrophils. Clinical diagnosis of urosepsis was made in the due course of management, her BP dropped to 86/43 mm Hg. After initial bolus of 1.5 L of crystalloids her blood gas shows lactate of 4 mmol/L. She is on minimal sedation and ventilated in pressure support mode. On re-examination she is confused, BP is 85/35 mm Hg, HR is 115 bpm (sinus tachycardia), SpO_2 is 95% on 60% oxygen. Because of persistent shock even with on-going resuscitation, decision was taken to initiate advanced hemodynamic monitoring. Which among the following is the best to predict fluid responsiveness at this clinical scenario?**

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a. Measuring the central venous pressure and continue to fluid bolus till it becomes more than 14 cm H_2O
b. Insertion of a pulmonary artery catheter and pulmonary artery occlusion pressure measurement
c. Measuring the inferior vena cava using echocardiography
d. Response of esophageal Doppler to passive leg raising

4. **A 36-year-old male shifted to ICU from the ward with history of fever and breathing difficulty, on evaluation he was confused, blood pressure 86/46 mm Hg, heart rate 126 beats/minute, 90% saturation on 6 L of oxygen with respiratory rate of 36 per minute and was also having perianal discharging sinus. He was initiated on high flow nasal oxygen and given initial fluid bolus of 1.5 liter. In view of clinical deterioration invasive lines are taken, in relation to his further fluid management which of the following is false?**
   a. Fluid responsiveness is frequently defined as an increase in CVP (≥15% from baseline) with a fluid challenge
   b. Fluid challenge: Give 500 mL of crystalloid (or 250 mL colloid) over 10–15 minutes and observe effect
   c. A patient whose stroke volume increases following a fluid challenge is on the ascending limb of the Frank-Starling (FS) curve
   d. A marked rise in CVP with fluid challenge indicates a failing ventricle
5. **A 65-year-old-male chronic smoker presented to ICU with acute onset of chest pain and sweating, his ECG showed significant ST segment elevation across anterior leads with positive troponin. While on the therapy he collapsed suddenly with hypotension, his echocardiography suggested severe mitral valve rupture with mitral regurgitation. As a hemodynamic mechanical support intra-aortic balloon pump (IABP) was initiated. Which among the following is not correct in relation to IABP?**
   a. Systolic blood pressure usually decreases during IABP use
   b. The balloon inflates immediately following the dicrotic notch on the arterial waveform
   c. The balloon deflates during isovolumetric contraction of the left ventricle
   d. IABP insertion is absolutely contraindicated in patients with bleeding manifestation
6. **A 58-year-old man was posted for elective major abdominal surgery. As part of intraoperative hemodynamic monitoring, he was initiated on esophageal Doppler. Initial esophageal Doppler measurements include a flow time corrected (FTc) of 260 ms, which rises to 320 ms following a 500 mL fluid challenge and his peak velocity value is 115 cm/second. In relation to his readings what is the further line of fluid management?**
   a. A low FTc always indicates more fluid is required
   b. This patient has compromised cardiac contractility
   c. FTc is a marker of afterload and preload in this patient
   d. Dobutamine should be started at this point as to improve the vital organ perfusion
7. **When any patient is started on esophageal Doppler following assumptions are made when determining stroke volume *except*?**
   a. 70% of total cardiac output passes the probe
   b. The ascending aorta runs parallel to the esophagus

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c. The diameter of the aorta is constant throughout systole
d. The values of stroke volume remains constant irrespective of the position of esophageal Doppler probe, as the chances of error are less

8. Following are the parameters of a patient in shock (transpulmonary thermodilution: volume view) while on controlled ventilation with 8 mL/kg tidal volume and with sinus rhythm. Extravascular lung water (EVLW) 2 mL/kg, global end diastolic volume (GEDV) 350 mL/kg, stroke volume variability (SVV) 18%, stroke volume index (SVI) 65 mL/b/m^2. What is the further line of management in relation to fluid?
a. As the patient is having good stroke volume index no further fluid administration is required
b. Given value of EVLW suggest patient is not having any extravasation hence still more fluid can be given
c. As the value of GEDV suggest volume depletion, with SVV more than 15% he is a right candidate for further fluid administration
d. At this point he does not require any fluid therapy irrespective of the values of volume view

9. In relation to measurement of cardiac output by thermodilution technique which of the following is true?
a. A pulmonary artery catheter is the mandatory requirement
b. Tricuspid regurgitation will always underestimate the cardiac output
c. Volume of the injectate will make difference cardiac output measurement
d. Tricuspid regurgitation will always overestimate the cardiac output

10. A 58-year-old male came with acute onset of chest pain, he was diagnosed with severe anterior wall myocardial infarction, with on-going medical therapy he was floated with pulmonary artery catheter. In this particular scenario which of the following condition will not overestimate pulmonary artery occlusion pressure (PAOP) as compared to left ventricular end-diastolic pressure (LVEDP)?
a. Mitral stenosis
b. Mitral regurgitation
c. Massive pulmonary embolism
d. Catheter tip in West zone III

11. In relation to the working principle of invasive blood pressure measurement, which of the following is true?
a. The catheter connecting the arterial cannula to the transducer should be short, stiff, and narrow to reduce resonance
b. Bubbles and clots cause under damping
c. The resonant frequency of the system should be less than 10Hz
d. The primary harmonic of the system is 1–2 Hz

12. When we measure cardiac output using arterial pressure wave in a patient who is on positive pressure ventilation, which of the following statement is true?
a. Pulse pressure variation (PPV) is better indicator than systolic pressure variation (SPV) in terms of predicting fluid responsiveness

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b. Pulse pressure is directly proportional to stroke volume in all the clinical conditions without any errors
c. The maximum fall in systolic pressure coincides temporally with the peak inspiratory pressure
d. The cardiac output measured using arterial pressure waveform is a reliable guide to fluid therapy in all the clinical conditions

13. A 40-year-old man presents with fever, cough with expectoration and shortness of breath. On examination his room air SpO_2 was 75%. ABG showed PaO_2 of 45, $PaCO_2$ of 31. His BP was 90/60 mm Hg. Auscultation revealed crackles bilaterally and CXR showed infiltrates bilaterally. His screening echo revealed good cardiac function with normal sized chambers with EF 60% and collapsing IVC. A diagnosis of ARDS was made and patient was managed with HFNC with FiO_2 of 65% after which his SpO_2 picked up to 92%. Which of the following is true regarding hemodynamic management in this patient?

a. Dynamic indices of fluid responsiveness like pulse pressure variation is more accurate than other methods
b. IVC collapsing >55% during expiration and resuming size during inspiration is a good indicator of hypovolemia
c. PLR test is the best method to assess fluid responsiveness
d. High lactates will invariably tell that patient needs fluid resuscitation

14. Which of the following best defines septic shock in terms of hemodynamic assessment?

a. Preserved ejection fraction (EF) with low cardiac output (CO) with normal to increased systemic vascular resistance (SVR)
b. Normal to low EF with normal to high CO with normal to low SVR
c. Elevated EF with high cardiac output with normal to high SVR
d. Low EF with normal to low CO and normal to low SVR

15. Which of the following is/are true in relation to mini fluid challenge test?

a. Giving 100 mL of crystalloid over 1 minute
b. Giving 100 mL of colloid over 1 minute
c. Test is easy to perform with good practicality at the bedside
d. It can be considered positive even when there is rise in CVP after giving fluid, hence does not require real time cardiac output monitoring

16. Which of the following is most correct regarding central venous oxygen saturation ($ScvO_2$) and mixed venous oxygen saturation (SvO_2)?

a. In normal individuals SvO_2 is less than $ScvO_2$
b. Changes in the SvO_2 will reflect changes in the cardiac output, if hemoglobin, arterial oxygen saturation (SaO_2) and oxygen uptake (VO_2) remains constant
c. The relation between $ScvO_2$ and SvO_2 will remain constant in all the clinical status
d. Currently robust data available to positively suggest using $ScvO_2$ and SvO_2 as target for fluid resuscitation

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17. A 28-year-old male came with history of fever and breathing difficulty since 2 days, he was already partially treated in other hospital on outpatient basis. In the ER his BP was 82/46 mm Hg, heart rate 134 beats/minute, ABG showing severe metabolic acidosis with lactate of 5.4 mol/L. In relation to his hemodynamic monitoring and initial resuscitation, which of the following is true?

a. Patient should be checked for fluid responsiveness before administering fluid bonus
b. A rise in lactate in sepsis and septic shock is always due to tissue hypoperfusion
c. Studies showed that targeting lactate as resuscitation marker is superior to targeting central venous oxygen saturation
d. Vasopressors should be started when patient is on ongoing fluid resuscitation when he is not able to maintain mean arterial pressure

18. Which of the following is true regarding hemodynamic monitoring tools?

a. The CVP and PAOP parallel each other closely in patients with EF >50%.
b. PAOP is a better predictor of myocardial performance than LV end diastolic volume (LVEOV)
c. An inverse correlation has been demonstrated between CO and SvO_2
d. Cardiac filling pressures appears to be a reliable indicator of preload than intravascular lung volume

19. Which of the following is false regarding Pv-aCO_2 (partial pressure difference of venoarterial carbon dioxide) gap?

a. It is determined by the conjunction of macro- and/or microvascular blood flow, the total CO_2 production (both aerobic and anaerobic), and the complex relationship between CO_2 partial pressures and CO_2 blood contents (Haldane effect)
b. Pv-aCO_2 should be considered as a marker of tissue perfusion and tissue hypoxia
c. An increased Pv-aCO_2 usually suggests a "low" or "insufficient" cardiac output. However, during severe inflammatory conditions, alterations in functional capillary density and heterogeneity of microvascular blood flow could also account for venous CO_2 accumulation
d. An elevated Pv-aCO_2 should encourage clinicians to optimize the cardiac output, especially when lactate levels are increased and clinical signs of hypoperfusion are present

20. In relation to cardiac output monitoring in critically ill patients, which of the following is false?

a. "Normal" cardiac output value among critically ill patients is 2.5–5 L/minute
b. Determining whether or not a cardiac output is adequate for a patient must include an assessment of tissue perfusion and the presence of compensatory mechanisms
c. Recent data suggest that normalizing cardiac output to supraphysiological level increased the mortality among critically ill patients
d. If cardiac output is inadequate, treatments can be aimed at one or more of its four determinants depending on the specific underlying causes and patient status: preload, afterload, myocardial contractility, and heart rate

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21. In relation to end expiratory occlusion test, which of the following is correct?

a. To consider the test to be positive there should be increase in stroke volume or cardiac output by about >15% from the baseline
b. The time required to achieve positive result with end expiratory occlusion test will be at least 5 seconds
c. Percentage change in the pulse contour is a better predictor of fluid response when we do end expiratory occlusion test
d. Patient should be paralyzed and should not have any spontaneous breathing efforts while doing the test

22. In terms of hemodynamic manifestation of septic which of the following will not fit?

a. Hypovolemia is always absolute in septic shock
b. Sepsis induced cardiomyopathy may be primary or secondary
c. Inadequate oxygen extraction due to intracellular (probably mitochondrial) abnormalities
d. Septic shock will manifest most commonly with cardiac output and compromised systolic function

23. A 28-year 60 kg female, with type 1 diabetes mellitus met with an accident and sustained injury to her forearm. Initial management was of little benefit and she developed fever after 2 days with pus discharge. Next day she presented to accident and emergency department and on examination there: PR: 130/min, regular, BP: 104/50 mm Hg, Oral temperature: 103 F, RR: 28/min, peripheries were cold to touch and she is disoriented. ABG showed: Metabolic acidosis with raised lactates (lactates: 5). All of the following statement about the case are true *except*:

a. Raised lactates are usually the biochemical marker of tissue dysoxia
b. Absence of hypotension precludes diagnosis of shock
c. Urine output monitoring is required in the case
d. Cold peripheries and disorientation are suggestive of shock in this patient

24. The above mentioned patient was given 2 liters of Ringer's lactate and broad spectrum intravenous antibiotics. However, her clinical condition deteriorated and she got intubated and was started on controlled mechanical ventilation [Volume control mode, Tidal volume (Vt): 6 mL/kg of predicted body weight (PBW), Respiratory rate (RR): 24/min, PEEP: 8 FiO_2: 50%]. An arterial line and central line was inserted and urinary catheterization was also done, monitors showed sinus tachycardia, CVP of 12, PPV (pulse pressure variation) of 18%. Her urine output dropped to 10 mL per hour for 2 hours, and the ABG showed lactates of 4 mmol/L. Identify the true statement for the case:

a. Dopamine is the first choice of vasopressor in such cases as it will increase urine output by acting on dopaminergic receptors
b. High CVP precludes fluid resuscitation
c. Dobutamine should be started to bring the lactates down
d. Fluid resuscitation should be continued in view of high PPV

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25. A 60-year male, a case of intracranial space occupying lesion (ICSOL) is scheduled for surgery. However, he had to be taken for emergency craniotomy due to neurological deterioration. Intraoperative IV fluids, blood and blood products adequately replaced and patient was brought to the ICU with endotracheal tube on controlled mechanical ventilation [Volume control mode, Tidal volume (Vt): 6 mL/kg of predicted body weight, Respiratory rate (RR): 24/min, PEEP: 8 FiO_2: 50%]. After 6 hours patient became hypotensive and dropped his urine output to 15 mL/hr, Lactates: 4.5 mmol/L, pupils bilaterally equal and reacting to light. Monitor showed PR: 120/min, regular, BP: 90/40 mm Hg, CVP: 13 cm H_2O, PPV: 8%. To decide on giving fluid for resuscitation, which is the correct statement pertaining to the case?

a. PPV of 8 precludes volume infusion
b. Passive leg raising (PLR) test should be done
c. Tidal volume challenge is the test of choice to decide fluid resuscitation in this case
d. CVP of 13 precludes volume expansion

26. All of the statements are true about pulmonary vascular permeability index (PVPI) *except*:

a. Is a parameter given by PICCO/Volume view monitor
b. Normal value is 1–3
c. Is useful to differentiate type of pulmonary edema permeability versus hydrostatic
d. Is ratio of pulmonary blood volume (PBV) to extravascular lung water (EVLW)

27. A 72-year-old 70 kg male patient with no medical comorbidities is admitted to the ICU after extended right hepatectomy. Intraoperative losses have been adequately replaced, and he is currently on controlled ventilation with arterial line in place. Vitals: PR: 110 breaths/min, BP: 110/60 MAP: 77 urine output 50 mL/hr. Two hours later the monitor showed the following vitals: PR: 120/min, BP: 94/55 MAP: 68. His urine output: 40 mL/hr, ABG: pH: 7.34, PCO_2: 48 mm Hg, PO_2: 68 on 40% FiO_2, HCO_3: 23, Lactate 0.76 mmol/L, PPV: 20, abdominal drains: minimal serosanguinous fluid. Which one is correct statement regarding management?

a. Fluid boluses should be given as the patient is fluid responsive
b. Noradrenaline should be started
c. Wait and watch
d. Transfuse blood

28. A 54-year-old male known case of COPD on treatment admitted to ICU with increased cough, with fever, yellowish sputum. On examination: P/R: 124 breaths/min, regular, BP: 120/80 mm Hg, RR: 32/min Chest: B/L rhonchi with left lower zone crepts. 2D echocardiography is not showing any left or right ventricular defect. ABG: pH: 7.36, PO_2: 70 on O_2 mask with 10 lpm O_2, PCO_2: 74, HCO_3: 33, lactate: 3. Started on nebulization with beta 2 agonist, antibiotics and noninvasive ventilation, however did not improve hence intubated and protective lung ventilation started. Currently PR: 160 breaths/min, regular, BP: 100/50 mm Hg, after 1.5 liter crystalloid BP did not improve and started on noradrenaline infusion at 0.3 mcg/kg/min to maintain a MAP of 70, lactates increasing, UOP decreasing: 30-20-15 mL/hr PICCO inserted, CI: 4 GEDV: 450, ELWI: 6, PVPI: 3, SVV: 16. What should be done?

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a. Volume expansion should be done
b. Wait and watch as cardiac index is normal
c. Dobutamine should be started
d. Tidal volume challenge

29. Patient worsened and developed atrial fibrillation with fast ventricular rate noradrenaline minimally increased. Now CI: 6, GEDV: 780, ELWI: 5, PVPI: 2, SVV: 10. Urine output improved and now it is 20–30 mL/hr. Current vitals: PR: 165 breaths/min, irregularly, irregular, how will you assess fluid responsiveness in this patient?

a. Patient is not fluid responsive as SVV is 10
b. Do PLR to assess fluid responsiveness
c. Do tidal volume challenge (TVC) test
d. As the ELWI is in normal range we can give fluids without assessment for fluid responsiveness

30. In the abovementioned patient dyselectolytemia corrected, acidosis improved, now PR: 120 breaths/min normal sinus rhythm, lactates normalizing, noradrenaline reduced to 0.05 mcg/kg/min, urine output now 40–50 mL/hour, however 2D echocardiography now shows poor left ventricular ejection function likely septic cardiomyopathy. Line of management:

a. Add dobutamine
b. Wait and watch
c. Add levosimendan
d. Digoxin

31. Dynamic measures of fluid responsiveness based on heart lung interactions (e.g. SVV, PPV, SPV) have limitations of validity in all *except*:

a. Spontaneous breathing
b. Raised intra-abdominal pressure
c. Compliant lungs
d. Bronchopleural fistula with more than 50% volume leak

32. Pick the correct combination:

a. *Septic shock:* Cardiac output high, systemic vascular resistance high, neck veins full
b. *Cardiogenic shock:* Cardiac output low, systemic vascular resistance high, neck veins full
c. *Obstructive shock* secondary to acute pulmonary embolus: Cardiac output high, systemic vascular resistance high, neck veins full
d. *Hypovolemic shock:* Cardiac output low, systemic vascular resistance high, neck veins full

33. Lactate clearance can be used as a marker for adequacy of fluid resuscitation in all *except* in present of:

a. Epinephrine infusion
b. Dobutamine infusion
c. Dopamine infusion
d. Vasopressin infusion

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Kapil Zirpe MD FICCM FCCM is graduated from Shivaji University, Kolhapur (1994) and currently working as the Director and Head of the Neurotrauma Unit and Cadaver Transplant Program at Ruby Hall Clinic, Pune, Maharashtra, India. He is an active member of the steering committee that is responsible for National Accreditation Policy of his hospital (NABH) and is responsible for the maintaining the quality indicators in his ICU. He is the Past President of Indian Society of Critical Care Medicine (ISCCM). He has received honorary fellowship of Indian College of Critical Care Medicine (FICCM) in 2013 and Society of Critical Care Medicine USA (FCCM) in 2016. Dr Zirpe is an established teacher and examiner for IDCCM, IFCCM, fellowship of National Board of Critical Care Medicine and Diploma for Paramedics (PGDMS). He has contributed with chapters in 8 textbooks of critical care medicine. He was honored with President Citation Award for four consecutive years in recognition of his excellent work in the field of critical care medicine.

Subhal Dixit MD FCCM IDCCM FICCM FICP is graduated from Pune University, and currently working as the Director, Critical Care, Sanjeevan Hospital and Manohar Joshi Memorial (MJM) Hospital, Pune, Maharashtra, India. He is a member of the Code Blue and NABH committee that is responsible for National Accreditation Policy of his hospital (NABH) and is responsible for the maintaining the quality indicators in his ICU in MJM and Sanjeevan Hospital. He plays a pivotal role in the development of academic curriculum in critical care medicine at his hospital. He is an established teacher and examiner for IDCCM, IFCCM, Critical Care Courses of ISCCM. Dr Dixit has keen interest in research and has been involved in several important research program done by ISCCM and ESICM. He has contributed abstracts, articles in journals and has participated as a speaker in many national and international meetings. He has worked as Controller, Examination for Indian College of Critical Care Medicine. He has contributed with chapters in textbooks of critical care medicine, and critical care update book. Currently, he is the President of Indian Society of Critical Care Medicine (ISCCM) 2019-2020. He has received honorary Fellowship of Indian College of Critical Care Medicine (FICCM) in 2014 and honorary Fellowship of Society of Critical Care Medicine (FCCM), USA in 2017. He was honored with President Citation Award for 4 times (2013, 2016–2018) in recognition of his excellent work in the field of critical care medicine in India.

Sushma K Gurav MBBS DA DNB (Anesthesia) IDCCM is working as Consultant in Department of Neurotrauma Unit at Ruby Hall Clinic, Pune, Maharashtra, India. She is an active member in carrying Audit of thrombolysis in Stroke, Readmission, visitor's policy during NABH accreditation. She is an active member of the executive committee of Pune ISCCM Branch. Dr Gurav is a renowned teacher and examiner for the Indian Diploma in Critical Care Medicine. Her areas of interest are stroke, infection control, neurointensive care, hemodynamic monitoring, and trauma.

Balasaheb Pawar MD IDCCM is working as Pulmonologist and Intensivist in Department of Intensive Care at Deenanath Mangeshkar Hospital, Pune, Maharashtra, India. He is an active member of Pune ISCCM branch and also a renowned teacher for Indian Diploma of Critical Care Medicine students. His areas of interest are lung infections, bronchoscopy and bronchoscopic interventions, and acute respiratory distress syndrome.

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