Hussein et al. *SECI Oncology* 2015
DOI: 10.18056/seci2015.3

Implication of Hypoalbuminemia in Early Postoperative Complications

Abdel-Fattah Abdel-Sattar Hussein[1], Khaled M. Fares[2], Mohammed A.M. Mostafa[2], Sahar A. Mohamed[2], Hosney B. Hamed[3], Amal M. Gomaa Hagras[2]

[1] Department of Anesthesia, Intensive Care, and Pain Management National Cancer Institute, Cairo University.
[2] Department of Anesthesia, Intensive Care, and Pain Management South Egypt Cancer Institute, Assiut University.
[3] Department of Clinical Pathology, South Egypt Cancer Institute, Assiut University.

Correspondence should be addressed to Amal Morad Gomaa at Department of Anesthesia, Intensive Care, and Pain Management South Egypt Cancer Institute, Assiut University, Egypt, amal.hagras@gmail.com

Published 17 March 2015

Abstract

Background: Serum albumin is a marker of nutrition and inflammation. Currently, hypoalbuminemia is used as a marker of inflammation and a predictor of outcome in post-surgical patients. It is associated with increased morbidity and mortality in patients having surgery for cancer disease.

Objectives: to evaluate the implication of hypoalbuminemia on early postoperative complications in major cancer surgery.

Methods: 40 patients undergoing elective major cancer surgery were included in the study. Patients were divided according to their serum albumin level into two groups. Group I: with serum albumin >35 g/L and Group II: with serum albumin ≤ 35 g/L. Major postoperative complications and length of stay in ICU (Intensive care unit) were documented.

Results: Postoperative complications were higher in number and percentage in group II (serum albumin ≤ 35 g/L) compared to group I (serum albumin > 35 g/L). Furthermore, the length of ICU was significantly longer in group II (serum albumin ≤ 35 g/L) (9.60±3.59 days) compared to group I (serum albumin > 35 g/L) (6.95±0.69 days) (P= 0.002).

Conclusion: The current study revealed that preoperative hypoalbuminemia increases the risk of postoperative complications and length of stay in ICU after major cancer surgery, as such, accounts for high proportion of ICU budget.

Introduction

The prevalence of protein-energy malnutrition in surgical patients is high, ranging from 10% to 54%. The correct assessment of the nutritional status of such patients is crucial since malnourishment is a risk factor for morbidity and mortality [1]. The identification of patients with a high surgical risk is essential in the operative indications and decisions, often limited by the potential morbidities and mortality related to the procedure. Hence, the clinical and laboratory parameters which may point out higher risk for postoperative complications are important [2]. Malnourishment is reported in 40% to 50% of hospitalized patients, with higher risk factor for postoperative infections and healing complications in patients who undergo major surgeries [3]. Hypoalbuminemia (serum albumin less than 3.5 g/dL) often reflects malnourishment [4].

Malnutrition also impairs cell mediated immunity and resistance to infection [5]. In hypoalbuminemia, alteration in cytokine metabolism especially impairs interleukin-1 activity and defects in the complement system have also been detected. Therefore, in the hypoalbuminemic group, surgical site infections and remote infections such as pneumonia were commonly found [6]. Hypoalbuminemia is one of the risk factors for anastomotic dehiscence in colorectal surgery and healing remains a process depending more on the patient than on any aspect of the surgical technique [7]. Although extreme hypoalbuminemia by itself was associated with increased ICU (Intensive care unit) and postoperative stay, complications were the greatest predictor of resource use such as postoperative stay, ICU stay, and NPO (Nil per Os) days [8]. Sepsis, need for vasopressors and need for mechanical ventilation was observed more frequently in patients with serum albumin concentrations <20 g/L, suggesting that low albumin levels may increase the incidence of organ dysfunction and infections in critically ill patients with cancer [9].

The aim of this work is to evaluate the implication of hypoalbuminemia in early postoperative complications.

Patients and Methods

This is a prospective observational study that was carried out in the Intensive Care Unit of South Egypt Cancer Institute (SECI-ICU), Assiut University, Assiut, Egypt. After Institutional Ethics Committee approval and written informed consent, 40 patients underwent elective major oncological surgery were included in the study. Preoperative serum albumin was measured and these patients were divided according to their serum albumin level into two groups. Group I: with serum albumin >35 g/L and Group II: with serum albumin ≤ 35 g/L.

Inclusion criteria: All cancer patients undergoing elective major cancer surgery and requiring ICU admission > 24 hours were evaluated.

Exclusion criteria: Patients with ICU stay of <24 hours , no preoperative mechanical bowel preparation**,** previous intra-abdominal surgery, recurrent tumor, liver cirrhosis or jaundice**;** patients undergoing laparoscopic surgery; patients undergoing palliative tumor resection or adjacent organ resection and acute complicated conditions such as colonic obstruction or perforation were excluded from the study

All the patients provided routine perioperative care with antibiotic prophylaxis, multimodal analgesia, DVT prophylaxis and early mobilization.

After surgery, patients were monitored daily for major postoperative complications, including, Acute Respiratory Distress Syndrome (ARDS), sepsis, multiorgan dysfunction syndrome (MODS), renal failure, heart failure, respiratory failure, pneumonia/respiratory tract infection, major thromboembolic event, wound infection / dehiscence, anastamotic leak, fistula formation, and in-hospital mortality cause of death were documented. Furthermore, the length of stay in the ICU was measured as the number of days from admission up till discharge from the ICU.

Rigid objective criteria were established defining each complication to avoid subjective bias. Fistulae were radiographically documented. Pneumonia was documented by positive sputum culture of clear clinical and radiographic evidence of consolidation. The presence of a wound infection was defined by culture and operative or spontaneous drainage of purulent materials. A wound dehiscence is diagnosed when operative re-closure of the wound is required. Acute kidney injury (AKI) was defined as a 50% or 0.3 mg/dL increase in plasma creatinine above baseline level. Respiratory failure was defined as the requirement of mechanical ventilation beyond 24 h. after surgery. Circulatory insufficiency when unstable blood pressure requiring extra fluid or cardiac stimulant. ARDS was diagnosed as by recent Berlin definition of ARDS by The ARDS Definition Task Force [10]. The details of this definition are shown in Appendix A. Presence of sepsis was diagnosed according to the criteria of American College of Chest Physicians / Society of Critical Care Medicine (ACCP/ SCCM) [11], which can be found in Appendix B.

Statistical analysis

A data entry file, using EXCEL® 2007 program, was detected. Data were processed and analyzed using SPSS® ver.19. The frequencies, percentages, mean and standard deviation were computed. t- test was used to compare quantitative data between the two groups. Chi-square test was used to compare qualitative data between the two groups. P-value of < 0.05 was considered as significant.

Results

There were no significant differences between the two groups in demographic data as regards age, sex, weight and height (P>0.05) (Table 1). The diagnosis and type of surgeries included in the study is shown in Table 2. Postoperative complications and in hospital mortality were higher in number and percentage in group II compared to group I. In group I, there were 2 patients (10%) had pneumonia/ respiratory tract infection, one patient (5%) had respiratory failure; one patient (5%) had renal failure and one patient (5%) had wound infection/ dehiscence. In group II, there were 7 patients (35%) had pneumonia/ respiratory tract infection, 7 patient (35%) had respiratory failure, 2 patient had acute respiratory distress syndrome (10%),1 patient (5%) had heart failure, 2 patients (10%) had renal failure, 1 patient (5%) had major thromboembolic events, 3 patients (15%) had wound infection /dehiscence, 4 patients (20%) developed fistula, 4 patients (20%) complicated by sepsis and 2 (10%) had multiple organ dysfunction syndrome . There were 3 patients died postoperatively in hospital, 2 of them died from MODS and one patient died from sepsis (Table 3). Also, when comparing the two groups the increase in the length of stay was proved to be statistically significant in group II (9.60 ± 3.59 days) compared to group I (6.95 ± 0.69 days) (P = 0.002) (Table 4).

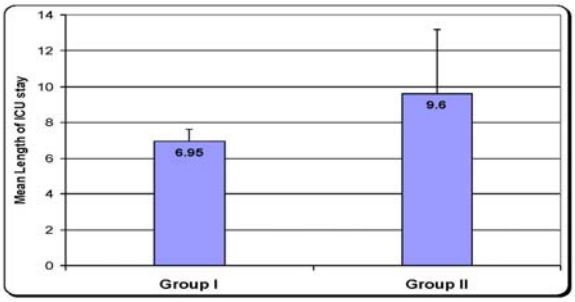

Figure (1): Length of stay in ICU/ day

Table (1): Patient's Personal characteristics

	Group I serum albumin > 35 g/L. **(n= 20)**	**Group II** serum albumin ≤ 35 g/L. **(n= 20)**	**P-value**
Age (year):			
Mean ± SD	53.35 ± 12.31	58.45 ± 9.08	0.386
Range	27.0 - 70.0	45.0 - 75.0	
Sex: No. (%)			
Male	9 (45.0%)	8 (40.0%)	0.749
Female	11 (55.0%)	12 (60.0%)	
Weight (kg):			
Mean ± SD	64.60 ± 14.01	56.80 ± 5.73	0.058
Range	40.0 – 95.0	50.0 – 70.0	
Height (cm):			
Mean ± SD	166.95 ± 8.33	162.60 ± 6.18	0.084
Range	150.0 - 180.0	150.0 - 175.0	
PO serum albumin(mg/dl)			
Mean ± SD	39.45 ± 2.87	30.66 ± 3.99	0.000*
Range	35.0 – 45.0	22.0 – 35.0	

Data were expressed by mean ±SD, range, number and percentage
PO preoperative
P-value comparison between groups (t- test)
* Statistically significant difference

Table (2): The diagnosis and type of surgeries included in the study

Number of patients	**Diagnosis**	**Surgery**
7	Stomach cancer	Subtotal gastrectomy and gastrojeojonostomy
6	Esophageal cancer	Total esophagectomy and gastric pullup
6	Colon cancer	3 Right hemicolectomy and 3 Left hemicolectomy
11	Rectal cancer	Anterior resection of Dixon
2	Hypopharyngeal cancer	Total pharyngolaryngectomy
6	Pancreatic cancer	Whipple operation
2	Bladder cancer	Orthotopic bladder reconstruction

Table (3): Postoperative complications in group I and II

	Group I serum albumin > 35 g/L. **(n= 20)**		**Group II** serum albumin≤ 35 g/L. **(n= 20)**		**P- value**
	No.	**%**	**No.**	**%**	
Pneumonia/ respiratory tract infection	2	10.0	7	35.0	0.130
Respiratory failure	1	5.0	7	35.0	0.048*
ARDS	0	0.0	2	10.0	0.468
Heart failure	0	0.0	1	5.0	1.000
Renal failure	1	5.0	2	10.0	1.000
Major thromboembolic events	0	0.0	1	5.0	1.000
Wound infection/ dehiscence	1	5.0	3	15.0	0.598
Fistulas	0	0.0	4	20.0	0.114
Sepsis	0	0.0	4	20.0	0.114
MODS	0	0.0	2	10.0	0.468
In-hospital mortality	0	0.0	3	15.0	0.230

Data were expressed by number and percentage
P-value comparison between groups (Chi-square test)
* Statistically significant difference
ARDS= Acute respiratory distress syndrome
MODS= Multiple organ dysfunction syndrome

Table (4): Length of stay in ICU/ day

	Group I serum albumin > 35 g/L. **(n= 20)**	**Group II** serum albumin ≤ 35 g/L. **(n= 20)**	**P-value**
Mean ± SD	6.95 ± 0.69	9.60 ± 3.59	0.002*
Range	5.0 - 8.0	7.0 - 20.0	

Data were expressed by mean ±SD and range
P-value comparison between groups (t-test)
* Statistically significant difference

Discussion

Serum albumin is a good and simple predictor of surgical risk and has a close correlation with the degree of malnutrition [4]. It has the highest positive predictive value of all the nutritional assessment methods for predicting associated complications and mortality [14].

In our study postoperative complications were higher in number and percentage in group II (serum albumin ≤ 35 g/L) compared to group I (serum albumin > 35 g/L). Also, serum albumin ≤ 35 g/L was associated with statistically significant increase in the mean length of stay in ICU (p= 0.002).

The result of our study were in agreement with, Lohsiriwat et al. [6] who demonstrated a higher rate of overall postoperative complications and a longer hospital stay associated with hypoalbuminaemia. A more recent study was conducted by Chandrasinghe et al. [15] showed a significant association between a low preoperative serum albumin of less than 35 g/ L, with a reduction in overall survival for patients undergoing surgery for rectal cancer. They concluded that Albumin can be used as a cost effective and a sensitive marker to predict survival in rectal cancer compared to other available inflammatory markers.

Heys et al. [16] in the earliest available study of 481 patients with colon and rectal cancer demonstrated a significant association between preoperative serum albumin and survival in large bowel cancer. Pre-operative hypoalbuminemia is an independent risk factor for postoperative complications following rectal cancer surgery. Hypoalbuminemic patients also have a non-statistically significant tendency to delayed recovery of postoperative bowel function. Low serum albumin may be used as a simple and low-cost prognostic tool to predict the risk of adverse surgical outcomes [17].

Cheng-Chou et al. [18] conducted a study to determine the relation of preoperative malnutrition and postoperative outcomes of cancer colon patients were reported that hypoalbuminemia is an independent risk factor for postoperative mortality, morbidity, as well as complications related to wounds, lungs, urinary system, and anastomosis, but not the gastrointestinal system or other complications. They concluded that hypoalbuminemia is a predictor of poor surgical outcomes of colon cancer patients. It is also a poor prognosis factor for long-term survival of colon cancer patients after curative operation.

Malnutrition also impairs cell mediated immunity and resistance to infection [5]. In hypoalbuminemia, alteration in cytokine metabolism especially impairs interleukin-1 activity and defects in the complement system have also been detected. Therefore, in the hypoalbuminemic group, surgical site infections and remote infections such as pneumonia were commonly found [6]. Roxburgh and McMillan [19] in a review looking in to role of the systemic inflammatory response (SIR) in predicting survival for patients with cancer using biochemical or haematological markers recognised hypoalbuminaemia to be significant as an inflammatory marker along with C-reactive protein (CRP), neutrophils and lymphocyte/ platelet ratio .

Hypoalbuminaemia is associated with poor tissue healing, decreased collagen synthesis in surgical wounds or at anastomoses, and impairment of immune responses, such as macrophage activation and granuloma formation [20]. Therefore, wound infection, remote infections such as pneumonia, and anastomotic leakage are commonly observed in hypoalbuminaemic patients [21].

Our results were in agreement with an early study conducted by Gibbs et al. [22] and demonstrated that hypoalbuminemia preoperatively or pretrauma is independently associated with the development postoperative complications, especially the development of infective complications. In upper gastrointestinal cancer surgery, low preoperative serum albumin levels have significantly correlated with anastomotic leak as well as major morbidity and in-hospital mortality [23].

A more recent study by Lohsiriwat et al. [17] found that in hypoalbuminemic patients, wound infection, remote infections such as pneumonia, and anastomotic leakage, were commonly found. In a large multi-center study by Hennessey et al. [24] the authors determined hypoalbuminemia (defined as albumin level 35 g/dL) to be an independent predictor of surgical site infection in patients undergoing colorectal surgery which is applied to our work.

The mechanisms of increase in infectious etiologies in hypoalbuminemia are multifactorial and likely include impairment of tissue healing, decreased collagen synthesis and granuloma formation. The immune response in hypoalbuminemia is also compromised through impairment of macrophage activation and induction of macrophage apoptosis [5, 20]. These factors together could explain the higher risk

of surgical site infections in hypoalbuminemic patients [12]. Furthermore, more recently, Thieme et al. [13] found a significant association between low serum albumin and non-infectious complications.

Patients at nutritional risk have higher complication rates after surgery for colorectal cancer. Especially, malnutrition increases the rate of anastomotic leakage and wound infection. Malnutrition was also a significant risk factor for the length of hospital stay [25].

A meta-analysis was performed of observational clinical studies evaluating the relationship between serum albumin level and occurrence of acute kidney injury. This meta-analysis provided an evidence that hypoalbuminemia is a significant independent predictor of both acute kidney injury and of death following of acute kidney injury development [26]. A more recent study conducted by Slivio et al. [27] concluded that sepsis, need for vasopressors and need for mechanical ventilation was observed more frequently in patients with serum albumin concentrations <20 g/L, suggesting that low albumin levels may increase the incidence of organ dysfunction and infections in critically ill patients with cancer.

Shitanshu et al. [12] concluded that albumin level below 3 g/dL help identify a high-risk surgical population. Although the causes of low albumin are multifactorial, identification of this subset of patients and aggressive optimization of nutritional status preoperatively or using alternative treatment strategies for patients who are extremely high risk for open surgery may improve surgical outcomes in this population.

Conclusion

The current study revealed that preoperative hypoalbuminemia increases the risk of postoperative complications and length of stay in ICU after major cancer surgery, as such, accounts for high proportion of ICU budget. Some limitations are present in this study, including lack of follow up of patients after discharge from ICU and from hospital and small number of patients studied in a single institution, limiting the globalization of the conclusions. We believe that the results of this study give reasons for raising attention about using serum albumin level as a simple and low-cost prognostic tool to predict the risk of adverse surgical outcome and consequently, decreasing the incidence of postoperative complications and ICU stay.

Abbreviations

ICU: Intensive care unit
NPO: Nil per Os
AKI: Acute kidney injury
ARDS: Acute respiratory distress syndrome
MODS: Multiple organ dysfunction syndrome
DVT: Deep venous thrombosis
SIR: Systemic inflammatory response
CRP: C-reactive protein
ACCP/ SCCM: American College of Chest Physicians / Society of Critical Care Medicine

References

[1] Pedrosa IV, Burgos MGPA, Souza NC, Morais CN.: **Aspectos nutricionais em obesos antes e após a cirurgia bariátrica.** Rev Col Bras Cir. 2009, **36**(4):316-22.

[2] Haupt W, Holzheimer R G, Riese J, Klein P, Hohenberger W.: **Association of low preoperative serum albumin concentrations and the acute phase response.** Eur J Surg.1999, **165**(4):307-13.

[3] Franch-Arcas G.: **The meaning of hypoalbuminaemia in clinical practice.** Clin Nutr. 2001, **20**(3):265-9.

[4] Fuhrman MP, Charney P, Mueller CM.: **Hepatic proteins and nutrition assessment**. J Am Diet Assoc 2004, **104**:1258-64.

[5] Reynolds JV, Redmond HP, Ueno N, Steigman C, Ziegler MM, Daly JM, Johnston RB Jr.: **Impairment of macrophage activation and granuloma formation by protein deprivation in mice.** Cell Immunol 1992, **139**:493-504.

[6] Lohsiriwat V, Chinswangwatanak V, Supatra Lohsiriwat S, Akaraviputh T, Boonnuch W, Methasade A, Lohsiriwat D: **Hypoalbuminemia is a predictor of delayed postoperative bowel function and poor surgical outcomes in right-sided colon cancer patients**. Asia Pac J Clin Nutr 2007, **16**(2):213-217.

[7] Testini M, Margari A, Amoruso M, Lissidini G, Bonomo GM.: **The dehiscence of colorectal anastomoses: the risk factors.** Ann Ital Chir 2000, **71**:433-40.

[8] Kenneth A, Elizabeth A, Chance R, Peter G, Ashley P, Stephanie Y, Brock K**: Preoperative Albumin and Surgical Site Identify Surgical Risk for Major Postoperative Complications**. Journal of Parenteral and Enteral Nutrition, 2003, **27**:1–9.

[9] McCluskey A, Thomas AN, Bowles BJ, Kishen R.: **The prognostic value of serial measurements of serum albumin concentration in patients admitted to an intensive care unit.** Anaesthesia 1996, **51**(8):724-727.

[10] The ARDS Definition Task Force: **Acute respiratory distress syndrome: the Berlin definition**. JAMA 2012, **307**(23):2526-2533.

[11] Members of the American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference Committee: American College of Chest Physicians/Society of Critical Care Medicine Consensus Conference: **Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis.** Crit Care Med. 1992, **20**:864–874.

[12] Shitanshu U, Ahmed A, Laurel W, Stephen L, David M, Ryan J, Ellen H: **Preoperative Hypoalbuminemia Is an Independent Predictor of Poor Perioperative Outcomes in**

Women Undergoing Open Surgery for Gynecologic Malignancies. Gynecol Oncol 2013, **131**:416-422.

[13] Thieme RD, Cutchma G, Chieferdecker ME, Campos AC.: **Nutritional risk index is predictor of postoperative complications in operations of digestive system or abdominal wall?** Arq Bras Cir Dig 2013, **26**(4):286-292

[14] Kyle UG, Pirlich M, Schuetz T, Luebke HJ, Lochs H, Pichard C.: **Prevalence of malnutrition in 1760 patients at hospital admission: a controlled population study of body composition.** Clin Nutr 2003, **22**(5):473–81.

[15] Chandrasinghe C, Dileepa S, Sumudu K: **Pre-operative hypoalbuminaemia predicts poor overall survival in rectal cancer: a retrospective cohort analysis**. BMC Clinical Pathology 2013, **13**:12.

[16] Heys SD, Walker LG, Deehan DJ, Eremin OE: **Serum albumin: a prognostic indicator in patients with colorectal cancer.** J R Coll Surg Edinb 1998, **43**(3): 163–168.

[17] Lohsiriwat V, Lohsiriwat D, Boonnuch W, Chinswangwatanakul V, Akaraviputh T, Lert-Akayamanee N.: **Pre-operative hypoalbuminemia is a major risk factor for postoperative complications following rectal cancer surgery**. World J Gastroenterol. 2008, **14**(8):1248-51.

[18] Cheng-Chou L, Jeng-Fu Y, Chien-Yuh Y, Jinn-Shiun C, Reiping T, Jeng-Yi W, Chih-Chien CH.: **Low preoperative serum albumin in colon cancer: a risk factor for poor outcome.** Int J Colorectal Dis 2011, **26**:473–481.

[19] Roxburgh CS, McMillan DC: **Role of systemic inflammatory response in predicting survival in patients with primary operable cancer.** Future Oncol 2010, **6**(1):149–163.

[20] Rivadeneira DE, Grobmyer SR, Naama HA, Mackrell PJ, Mestre JR, Stapleton PP, et al.: **Malnutrition-induced macrophage apoptosis**. Surgery 2001, **129**: 617–25.

[21] Kanda M, Fujii T, Kodera Y, Nagai S, Takeda S and Nakao A: **Nutritional predictors of postoperative outcome in pancreatic cancer**. British Journal of Surgery 2011, **98**:268–274.

[22] Gibbs J, Cull W, Henderson W, Daley J, Hur K.: **Preoperative serum albumin level as a predictor of operative mortality and morbidity.** Arch Surg 1999, **134**:36–42.

[23] Kudsk KA, Tolley EA, DeWitt RC, Janu PG, Blackwell AP, Yeary S, King BK.: **Preoperative albumin and surgical site identify surgical risk for major postoperative complications**. JPEN J Parenter Enteral Nutr 2003, **27**:1–9.

[24] Hennessey DB, Burke JP, Ni-Dhonochu T, Shields C, Winter DC, Mealy K.: **Preoperative hypoalbuminemia is an independent risk factor for the development of surgical site infection following gastrointestinal surgery: a multi-institutional study**. Ann Surg 2010, **252**:325–9.

[25] Seung-Jin K, Jun-Gi K, Won-Kyung K, Jin-Kwon L, Seong-Taek O.: **The nutritional risk is a independent factor for postoperative morbidity in surgery for colorectal cancer**. Ann Surg Treat Res 2014, **86** (4): 206-211.

[26] Wiedermann CJ, Wiedermann W, Joannidis M: **Hypoalbuminemia and acute kidney injury: a meta-analysis of observational clinical studies.** Intensive Care Med. 2010, **36**:1657 –1665

[27] Silvio A, Marı´a O, Julia T, Angel H: **Hypoalbuminemia in Critically Ill Patients with Cancer: Incidence and Mortality.** American Journal of Hospice & Palliative Medicine. 2011, **28**(4):253-257.

Appendix A:

Berlin definition of acute respiratory distress syndrome (The ARDS Definition Task Force, 2012)

The Berlin definition of acute respiratory distress syndrome	
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging	Bilateral opacities – not fully explained by effusions, lobar/lung collapse, or nodules
	Respiratory failure not fully explained by cardiac failure of fluid overload.
Origin of edema	Need objective assessment (eg., echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation	
Mild	200 mmHg < PaO2/FIO2 ≤300 mmHg with PEEP or CPAP ≥5 cmH2O c
Moderate	100 mmHg < PaO2/FIO2 ≤200 mmHg with PEEP ≥5 cmH2O
Severe	PaO2/FIO2 ≤100 mmHg with PEEP ≥5 cmH2O

Abbreviations: CPAP, continuous positive airway pressure; FIO2, fraction of inspired oxygen; PaO2, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure; a-Chest radiograph or computed tomography scan; b-If altitude is higher than 1,000 m, the correction factor should be calculated as follows: [PaO2/FIO2_(barometric pressure/760)]; c-This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

Appendix B:

The criteria of Members of American College of Chest Physicians / Society of Critical Care Medicine (ACCP/ SCCM), 1992 include 2 or more of the following:

- Core Temperature >=38°C or <= 36°C.
- Heart Rate >=90bpm.
- Respiratory Rate >=20bpm or PaCO2 <=32mmHg.