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A PROSPECTIVE, RANDOMIZED, OBSERVATIONAL, CLINICAL COMPARISON OF PULMONARY INDICES VS NON-PULMONARY PARAMETERS TO WEAN PATIENTS FROM INVASIVE VENTILATORY SUPPORT

Anaesthesiology

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ABSTRACT

Background : The premise of this study design is based on the fact that patient's metabolic status plays an important role in weaning off a patient from mechanical ventilation. So, we have tried to assess the relative importance of different pulmonary indices of weaning while we also made an attempt to find out the significance of non-pulmonary weaning indices, absolutely as well as relatively

Materials And Methods : Total 90 patients [divided randomly into 4 groups with 15 patients in group 1,2,3each (named Pulmonary group) while group 4 comprised of 45 patients(named Non-pulmonary group] of either sex between the age groups of 16 to 60 years requiring mechanical ventilation. While pulmonary indices were calibrated on pre-set numerical values based on several texts, the non-pulmonary group was assigned a composite score system for quantification purpose.

Results : For results, we analyzed the 90 patients in 2 groups namely Pulmonary and Non-Pulmonary (45 in each group). The incidence of positive weaning was 77.78% in non-pulmonary groups. The percentage of positive weaning status was maximum in RSBI subgroup (66.7%) in the pulmonary group. There was a significant mean value of composite non-pulmonary score above which a positive outcome could be predicted in both pulmonary and non-pulmonary groups. On regression analysis P/F ratio significantly affected positive outcome on the overall patients , the significance being 0.033. Also, the non-pulmonary variables taken together were also found to significantly affect the positive outcome in total number of patients, significance being 0.001.

Conclusion :

- On sub-group analysis of pulmonary group, there were non-significant differences between the subgroups with respect to incidence of weaning.
- Overall incidence of weaning is higher in non-pulmonary group compared to pulmonary group, but the difference is non-significant (p=0.11)
- The non-pulmonary variables (composite score) affect significantly the incidence of weaning in pulmonary group.
- On whole model (pooled: n=90), regression analysis shows non-pulmonary variables (composite score) and PF ratio are significant contributors to the incidence of weaning while RSBI and Trigger are non-significant; Further, the non-pulmonary variables (composite score) are more significant than PF ratio.

KEYWORDS

P/F = PaO2 / FiO2, RSBI= Rapid Shallow Breathing Index

INTRODUCTION :

Intensivists must be judicious of the time of weaning a patient off from mechanical ventilation lest the patient should suffer the risks of premature attempts or lose the benefits of timely weaning. Weaning indecis are quantitative tools used to avoid the detrimental consequences of a failed weaning attempt, rapidly identify patients who are potentially ready for spontaneous breathing, and therefore, accelerate the process of liberation from mechanical ventilation, which is usually preceded and ended with extubation.[1-4]

Clinical weaning indices designed to predict the weaning potential are most frequently based on pulmonary factors. Vital capacity (VC), inspiratory pressure and minute ventilation have been routinely employed as predictors of weaning outcome. However, many physiological and mechanical factors also have impact on weaning but are often overlooked. The importance of trying to inculcate non-pulmonary indicators lies in the understanding of the fact that liberation of a patient from assisted breathing depends on the entire (including but not limited to metabolic) physiology and not respiratory physiology alone. Correction of one physiology might have a decisive impact on other systems too[5]

Recently, ashift of point of view of from conventional pulmonary indices to non-conventional markers that are obtained from hematology, urine output, etc.can be attributed to the fact that the patient now is being viewed in light of multi-organ involvement and its impact on the prognosis.[6-9]

Anemia is a frequent accompaniment of critical illness. The vast majority of patients admitted to the ICU are anemic at some point in their hospital stay, and more than one-third of them will receive transfused blood. Critical illness can lead to hypermetabolic states and if nutritional support is inadequate or delayed, patients are at immediate risk of malnutrition[40]

This study suggests use of non-pulmonary weaning indices, which assess the influence of factors such as blood albumin and hemoglobin on the weaning success. It is a comparison between pulmonary and non-pulmonary weaning markers and makes an attempt at finding the absolute and relative importance of non non-pulmonary factors in patient outcome in the ICU.

METHODOLOGY:

Design of Study: Prospective, randomized, observational, clinical comparison

After getting approval from Ethical Committee of Motilal Nehru Medical College and associated hospitals, Prayagraj, Uttar Pradesh and obtaining written and informed consent from the patient's representative attendant, the study was conducted in the anesthesiology intensice care unit of the department of Anaesthesiology and critical care in the Swarup Rani Nehru Hospital affiliated with Motilal Nehru Medical College, Prayagraj, Uttar Padesh for a period of one year.

Inclusion criteria:

- Age- 16-60 years
- Either sex
- Requiring mechanical ventilation

Exclusion criteria:

- GCS < 6
- Grossly malnourished
- Severely anemic (Hb gm% < 7)
- Presence of multi organ failure

Patient once given a trial of weaning was not included in the study a second time irrespective of the outcome of the trial.

The patients were randomly divided into 4 groups based on allocation

of weaning indices.

Coding of indices:
Pulmonary weaning indices

	Score	1	2	3	4
A	P/F Ratio	220-229	230-239	240-249	>=250
B	RSBI	>125	110-125	100-109	90-99
C	Trigger (cm of H2O)	-1	-1.1 to -3	-3.1 to -5	<-5

Non-pulmonary weaning indices

	Score	1	2	3	4
a	Serum Hemoglobin	8-8.9	9-9.9	10-10.9	>=11
b	Serum creatinine	>=1.5	-	-	<1.5
c	Serum Albumin	1.5-2.49	2.5-3.49	3.5-4.49	>=4.5

Composite score= score (a+b+c) or score (A+B+C)
Low composite score: <=6
High composite score: >6

Groups described, therefore, were as follows:

Group	Score Of Primary Weaning Index Being Applied	Indices From Which Composite Score Would Be Derived For Comparison
Gr. 1	P/F Ratio	Hb, Sr. Creatinine, Sr. Albumin
Gr. 2	RSBI	Hb, Sr. Creatinine, Sr. Albumin
Gr. 3	Trigger	Hb, Sr. Creatinine, Sr. Albumin
Gr. 4	Composite Score of Non- Pulmonary Weaning Indices	P/F Ratio, RSBI, Trigger

Group 1, 2 and 3 comprised of 15 patients each while Group 4 comprised of 45 patients.
The method of application of the indices was as follows:
One patient was given a trial of weaning based on the group which the patient had been assigned to randomly. Therefore, a patient could be assigned either P/F ratio or RSBI or Trigger (which are the pulmonary indices) or the composite non-pulmonary weaning index group. Thus, based on this allocation there were a total of 4 groups. Then, if a patient was being weaned off using a pulmonary index e.g. P/F Ratio, the current value of all the pulmonary and non-pulmonary indices of that patient were also noted, given scores as given above and added to give a composite value.

Pulmonary index- composite score of the pulmonary indices calculated

Non-pulmonary index- composite score of non-pulmonary weaning indices calculated

Thus, the outcome of the patient was viewed in light of pulmonary and non-pulmonary weaning indices. Hence, comparison of the two forms of indices was done in each group.

Baseline values for attempting weaning in each group:
Gr 1- P/F ratio >= 238
Gr 2- RSBI <= 115
Gr 3- Trigger <= -2 cm of water
Gr 4- Composite Score >= 8

Weaning was applied only after improvement in basic pathology as indicated by labs and clinically.

Successful weaning was termed as patient being off ventilator for greater than 120 minutes with a normal ABG at 30 minutes, 60 minutes and 120 minutes after discontinuation of ventilator support.

Predictive usefulness of individual criterion was, hence, evaluated and compared in each group.

Statistical Analysis:
The data thus obtained was subjected to statistical analysis.

The following tests were used to test for significance :
1. Chi square test for categorical data.
2. Student 't' test for equality of two means in two groups.
3. Binary Logistic Regression analysis to predict the significant factor & $p < 0.05$ was taken as statistically significant

Observations and Results:
1. Comparison of Demographic Variables in Pulmonary& Non Pulmonary Groups
As shown in Table 1, there were no significant differences in the pulmonary and non-pulmonary groups with respect to age, weight, sex and SOFA score at the time of admission. There were a total of 45 patients in each group. Each group had 31 male and 14 female patients. So there was no difference in the 2 groups with respect to sex of the patient. The mean age of the patients in the pulmonary group was 40.4 years and in non-pulmonary group was 39.38 years. Mean weight of the patients was 57.56 kg in pulmonary group and 59.93 kg in non-pulmonary group. The SOFA score of the patients at the time of admission was 6.11 in pulmonary group and 6.20 in non-pulmonary group. These differences in Age, Weight and SOFA score were found to be statistically insignificant.

Table 1

	Pulmonary Group (mean±sd)	Non Pulmonary Group (mean±sd)	't'	'P'	significance
Age (years)	40.4 ± 13.52	39.38 ± 15.22	0.33	0.74	None
Weight (kg)	57.56 ± 10.80	59.93 ± 10.68	1.05	0.30	None
SOFA score	6.11 ± 3.44	6.20 ± 2.84	0.14	0.88	None
Sex	31 Males + 14 Females	31 Males + 14 Females		1.0	None

2. Comparison of Incidence of weaning in Pulmonary & Non Pulmonary Groups
Total number of patients in each group was 45. In the pulmonary group, of the 45 patients, 27 patients were weaned successfully. This was 60% of the total patients in the pulmonary group **as shown in Table 2.** In the non-pulmonary group, a total of 35 patients could be weaned off successfully out of the 45 patients. The incidence of positive weaning was 77.78% in the non-pulmonary group **as shown in Table 2 .**

Table 2

Weaning Status	Pulmonary Group	Non Pulmonary Group
Positive	27 60%	35 77.78%
Negative	18 40%	10 22.22%
Total	45 100%	45 100%
χ=2.54	p=0.11(non significant)	

3. Pulmonary Group - Sub Group Analysis
Within the pulmonary group, there were further 3 sub-groups, each subgroup having 15 patients each. The 3 sub-groups were the PF ratio sub-group, the RSBI sub-group and the Trigger sub group. Of the 15 patients assigned to each sub-group, 53.3% patients were weaned of successfully in the PF ratio sub-group, 66.67% patients were weaned off successfully in the RSBI sub-group and 60% patients had a positive outcome in the Trigger sub-group. This showed that the percentage of positive weaning status was maximum in the RSBI subgroup but this difference was statistically insignificant. **This has been shown in Table 3.**

When the 3 variables of the pulmonary group, i.e PF ratio, RSBI and Trigger, were compared 2 at a time (e.g. PF ratio with RSBI) and tabulated, there was no significant difference among the 2 variables taken at a time with respect to weaning status of the patient. **This has been depicted in Table 4**

Weaning Status	P F Ratio		RSBI		Trigger	
Postive	8	53.3%	10	66.7%	9	60%
Negative	7	46.7%	5	33.3%	6	40%
Total	15	100%	15	100%	15	100%

Table No.3

	χ^2	p value	Significance
PF Ratio v/s RSBI	0.1389	0.71	None
PF Ratio v/s Trigger	0.1357	0.71	None
RSBI v/s Trigger	0.1435	0.70	None

Table No. 4

4.Comparison of Pulmonary & Non Pulmonary Variables in Pulmonary Group (n=45)

The impact of the non-pulmonary variables on patients being weaned off on the basis of pulmonary variables was **calculated and shown in Table 5**. As shown in the table, the PF ratio, RSBI and Trigger had no significant mean value above which the patient could be shown to have a positive outcome. However, the composite score of the non-pulmonary variables when calculated in such patients and subjected to statistical analysis revealed that a mean non-pulmonary composite score of 9.13 could be considered significant to influence the positive outcome of the patients.

Weaning Status	P F Ratio (mean ± sd)	RSBI (mean ± sd)	Trigger (mean ± sd)	a+b+c (mean ± sd)
Postive (n=27)	250.59 ± 19.01	114.44 ± 9.89	-3.49 ± 1.06	9.13 ± 2.14
Negative (n=18)	254.83 ± 15.03	110.56 ± 7.44	3.21 ± 0.86	7.06 ± 1.47
't'	0.79	1.42	0.94	8.81
'p'	0.43	0.16	0.35	0.0
Significance	None	None	None	Significant

Table No. 5.

Comparison of Pulmonary & Non Pulmonary Variables in Non-Pulmonary Group (n=45)

The impact of the pulmonary variables on patients being weaned off on the basis of non-pulmonary variables was **calculated and shown in Table 6**. As shown in the table, the PF ratio, RSBI and Trigger had no significant mean value above which the patient could be shown to have a positive outcome. However, the composite score of the non-pulmonary variables when calculated in such patients and subjected to statistical analysis revealed that a mean non-pulmonary composite score of 10.60 could be considered significant to influence the positive outcome of the patients.

Weaning Status	P F Ratio (mean ± sd)	RSBI (mean ± sd)	Trigger (mean ± sd)	a+b+c (mean ± sd)
Postive (n=27)	241.94 ± 15.87	115.03 ± 7.20	-3.48± 1.19	10.60 ± 0.84
Negative (n=18)	244.40 ± 44.60	118.20 ± 9.95	-3.78 ± 1.65	9.10 ± 0.74
't'	0.28	1.12	0.63	5.06
'p'	0.78	0.26	0.54	0.0
Significance	None	None	None	Significant

Table No.6

Regression Equation of whole model (n=90)

The entire data (of 90 patients) was subjected to regression analysis. In this, the aim was to find out if there was any significance of a parameter (pulmonary or non-pulmonary) on the positive outcome of a weaning attempt on a patient. It was seen that the PF ratio significantly affected positive outcome on the overall patients, the significance being 0.033. Also, the non-pulmonary variables taken together were also found to significantly affect positive outcome in the total number of patients. This significance was found to be 0.001. **These have been depicted in Table 7**.

	β	Wold	'p'	Significance
PF Ratio	-1.981	4.537	0.033	Significant
RSBI	-0.051	0.005	0.941	None
Trigger	2.007	1.446	0.229	None
Non Pulmonary Factors	3.825	11.535	0.001	Significant
Constant	-2.784	1.814	0.178	None

Cox & Shell $R^2 = 0.31$

Table No.7

DISCUSSION:

Freeing a patient from supported ventilation is the final goal of an intensivist.[10-14]. A patient comes to the ICU with an indication for ventilatory support either as a primary indication (as in blunt trauma chest) or as a secondary indication wherein impaired ventilation is the result of a pathology elsewhere that may be pre-exixting or may have evolved during ICU stay.[15-20]. Patient may also have pre-existing co-morbidities that may even get flared up during ICU stay and may need to be treated on more than one line for more than one cause.[20-27]

Hence, the need to identify either a single most important marker or a group of markers (pulmonary, non-pulmonary or a combination) that may help in deciding the time when the patient may be given a trial of weaning from the ventilator is imperative[28-32].This very quest formed the basis of this study.

Khamiees M, et. al (2001)[8], **L. Todorova , et. al** (2004)[1], **Ko R,et al**(2009)[6] suggest the importance of non-pulmonary parameters that can be strong predictors of weaning success or failure.

So, we decided to use certain pulmonary markers of weaning and elicit their individual as well as relative importance in trials of extubation.[28] The pulmonary markers that were chosen were P/F ratio, RSBI and Trigger.[10-16]. **P/F ratio** is the ratio of partial pressure of oxygen in the blood and the fraction of oxygen in the air air that is being breathed in by the patient. In this study we found that the value of P/F ratio around 240 and above is found to significantly influence the positive outcome of the patient being given a trial of weaning and it was an independent positive predictor in approximately 60% of the patients. **Rapid shallow breathing index** is a ratio of respiratory rate of the patient and the tidal volume (in liters) delivered/generated.We found that the value of RSBI between 100-110 favors weaning-off of a patient most significantly.

Trigger is a reflector of the strength or ability of the respiratory apparatus of the mechanically ventilated patient to generate a negative intrathoracic pressure that is enough to draw adequate tidal volume. A trigger of -3 cm H_2O or below was seen to relate to a successfully weaned-off patient most of the time and even this parameter was an independent positive predictor in more than 50% patients as was RSBI.

The number of patients in the pulmonary sub-groups that could be weaned off successfully was almost the same (as given in tables) in all the 3 sub-groups and there was no relative advantage of one parameter over the other within the pulmonary sub-group. When the outcome of the patients in the pulmonary group was compared with the outcome in the non-pulmonary sub-group, there was no significant difference among the 2 groups. Hence,there was no clear cut advantage of using non-pulmonary weaning index over pulmonary weaning index and vice-versa which could be attributed to the sample size we worked on.
In critically ill patients, malnutrition is associated with impaired immunity, impaired ventilatory drive, and weakened respiratory muscles, leading to prolonged ventilatory dependence and increased morbidity and mortality, reported as being as high as 40%.[41-48]. Recent review papers have documented that nutrition support ***does*** influence morbidity and mortality in critically ill patients.[63-64] Therefore, strategies to improve the delivery of nutrition support are relevant and may result in decreased morbidity and mortality.

Recently, A.S.P.E.N.(American Society of Parenteral and Enteral Nutrition) guidelines were updated to reflect a more current, evidence-based approach to the practice of nutrition support.[54,68-70]

Chul Ho Chang, et al(2007)[2] emphasized the importance of non-pulmonary (ASA class and Emergency status) factors while attempting to wean a patient from mechanical ventilation, **Safavi M, et al**(2009)[3] concluded that albumin and blood glucose are possible indices of the metabolic status of the trauma patient, essential in deciding the need of ventilator and weanable status of the patients and **Schlossmacher P, et al**(2002)[4] concluded that the PINI (prognostic inflammatory and nutritional index) scoring formula worked as an independent predictor of the weaning trial outcome.

Vieira JM Jr, **et al**(2007)[5] studied effect of acute kidney and concluded that serum creatinine is an important maker of weaning while **Sapijaszko MJ,et al**(1996)[7] concluded that albumin may be an index of the metabolic status of the patient, which could be important in determining the weanability of the patients. Also, **Clochesy JM, et al (1995)**[9] highlighted serum albumin as one of the factors that play a determining role in extubation of a patient from mechanical ventilation**.**

Based on these studies, we decided to evaluate the importance of hemoglobin, serum creatinine and serum albumin as non-pulmonary indices of weaning and also compared the non-pulmonary markers with the pulmonary indices of weaning. In the non-pulmonary group, the number of patients having successful weaning from mechanical ventilation was quite good (35/45).

CONCLUSION:

- In pulmonary group, there were non-significant differences between the sub-groups with respect to incidence of weaning.
- Overall incidence of weaning is higher in non-pulmonary group compared to pulmonary group, but the difference is non-significant (p=0.11)
- The **non-pulmonary variables (composite score) affect significantly the incidence of weaning in pulmonary group**.
- On whole model (pooled: n=90), regression analysis shows non-pulmonary variables (composite score) and PF ratio are significant contributors to the incidence of weaning while RSBI and Trigger are non-significant; further, the non-pulmonary variables (composite score) are more significant than PF ratio.

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REFERENCES:

1. Todorova L, Temelkov A. Weaning from long-term mechanical ventilation: a nonpulmonary weaning index. J Clin Monit Comput. 2004 Aug;18(4):275-81.
2. Chul Ho Chang, M.D., Yong Woo Hong, M.D., and Shin Ok Koh, M.D. Weaning Approach with Weaning Index for Postoperative Patients with Mechanical Ventilator Support in the ICU. Korean J Anesthesiol Vol. 53, No. 3, September, 2007
3. Mohammadreza SAFAVI, Azim HONARMAND. The impact of admission hyperglycemia or hypoalbuminemia on need ventilator, time ventilated, mortality, and morbidity in critically ill trauma patients. Turkish Journal of Trauma & Emergency Surgery. 2009;15(2):120-129
4. Schlossmacher P, Hasselmann M, Meyer N, Kara F, Delabranche X, Kummerlen C, Ingenbleek Y. The prognostic value of nutritional and inflammatory indices in critically ill patients with acute respiratory failure. Clin Chem Lab Med. 2002 Dec;40(12):1339-43.
5. Vieira JM Jr, Castro I, Curvello-Neto A, Demarzo S, Caruso P, Pastore L Jr, Imanishe MH, Abdulkader RC, Deheinzelin D. Effect of acute kidney injury on weaning from mechanical ventilation in critically ill patients. Crit Care Med. 2007 Jan;35(1):184-91.
6. Ko R, Ramos L, Chalela JA. Conventional weaning parameters do not predict extubation failure in neurocritical care patients. Neurocrit Care. 2009;10(3):269-73. Epub 2009 Jan 28.
7. Sapijaszko MJ, Brant R, Sandham D, Berthiaume Y. Nonrespiratory predictor of mechanical ventilation dependency in intensive care unit patients. Crit Care Med. 1996 Apr;24(4):601-7.
8. Khamiees M, Raju P, DeGirolamo A, Amoateng-Adjepong Y, Manthous CA. Predictors of extubation outcome in patients who have successfully completed a spontaneous breathing trial. Chest. 2001 Oct;120(4):1262-70.
9. Clochesy JM, Daly BJ, Montenegro HD. Weaning chronically critically ill adults from mechanical ventilatory support: a descriptive study. Am J Crit Care. 1995 Mar;4(2):93-9.
10. Thavanainen J, Salmenpera M, Nikki P. Extubation criteria after weaning from intermittent mandatory ventilation and continuous positive airway pressure. Crit Care Med 1983; 11: 702–707.
11. Hillman DR. Physiological aspects of intermittent positive pressur ventilation. Anaesth Intensive Care 1986; 14: 226–235.
12. Brochard L, Rauss A, Benito S, Conti G, Mancebo J, Rekik N, Gasparetto A, Lemaire F. Comparison of three methods of gradual withdrawal from ventilatory support during weaning from mechanical ventilation. Am J Respir Crit Care Med 1994; 150: 896–903.
13. Oh TE. Difficult weaning from mechanical ventilation. Annals Academy of Medicine Singapore 1994; 23: 503–509.
14. Chatila W, Jacob B, Guaglionone D, Manthous CA. The unassisted respiratory rate-tidal volume ratio accurately predicts weaning outcome. Am J Med 1996; 101: 61–67.
15. Vassilakopoulos T, Zakynthinos S, Roussos C. The conventional approach to weaning from mechanical ventilation. Eur Respir Mon 1998; 8: 266–298.
16. Burns SM, Clochesy JM, Goodnough Hanneman SK, Ingersoll GE, Knebel AR, Shekleton ME. Weaning from longterm mechanical ventilation. Am J Crit Care, 1995; 4(1): 4–22.
17. Clement J, Buck E. Weaning from mechanical ventilatory support. Dimensions Crit Care Nurs 1996; 15: 114–129
18. Gluck EH. Predicting eventual success or failure to wean in patients receiving long-term mechanical ventilation. Chest 1997; 111(3): 836.
19. Hurford W, Favorito F, Wilson D. Serum albumin concentrations during the weaning of mechanical ventilator-dependent patients. Am Rev Respir Dis 1991; 143: A685
20. Burns S, Burns J, Truwit J. Comparison of five clinical weaning indices. Am J Crit Care 1994; 3: 343–352.
21. Meade M, Guyatt G, Cook D, Griffith L, Sinuff T, Kergl C, et al: Predicting Success in weaning from mechanical ventilation. Chest 2001; 120: S400-4.
22. Vallverdu I, Calaf N, Subirana M, Net A, Benito S, Mancebo J: Clinical characteristics, respiratory functional parameters, and outcome of a two-hour T-piece trial in patients weaning from mechanical ventilation. Am J Respir Crit Care Med 1998; 158: 1855-62
23. Sahn SA, Lakshminarayan S: Bedside criteria discontinuation of mechanical ventilation. Chest 1973; 63: 1002-5.
24. Lee YJ, Kim KS, Moon BK, Kim JS: Clinical use of weaning indices from mechanical ventilation in surgical intensive care unit patients. Korean J Anesthesiol 2002; 43: 337-44.
25. Yang KL, Tobin MJ: A prospective study of indexes prediction the outcome of trials of weaning from mechanical ventilation. New Eng J Med 1991; 324: 1445-50.
26. Hess D: Ventilator modes used in weaning. Chest 2001; 120: S474-6.
27. Sporn PH, Morganroth ML. Discontinuation of mechanical ventilation. Clin Chest Med 1988;9:113-26.
28. Jabour ER, Rabil DM, Truwit JD, Rochester DF. Evaluation of a new weaning index based on ventilatory endurance and the efficiency of gas exchange. Am Rev Respir Dis 1991;144(3 Pt 1):531-7.
29. Benotti PN, Bistrian B. Metabolic and nutritional aspects of weaning from mechanical ventilation. Crit Care Med 1989;17:181-5.
30. Yukl RL, Bar-Or D, Harris L, Shapiro H, Winkler JV. Low albumin level in the emergency department: a potential independent predictor of delayed mortality in blunt trauma. J Emerg Med 2003;25:1-6.
31. Kudsk KA, Tolley EA, DeWitt RC, Janu PG, Blackwell AP, Yeary S, et al. Preoperative albumin and surgical site identify surgical risk for major postoperative complications. JPEN J Parenter Enteral Nutr 2003;27:1-9.
32. Menzies R, Gibbons W, Goldberg P. Determinants of weaning and survival among patients with COPD who require mechanical ventilation for acute respiratory failure. Chest 1989;95:398-405.
33. Finney SJ, Zekveld C, Elia A, Evans TW. Glucose control and mortality in critically ill patients. JAMA 2003;290:2041-7.
34. Laird AM, Miller PR, Kilgo PD, Meredith JW, Chang MC. Relationship of early hyperglycemia to mortality in trauma patients. J Trauma 2004;56:1058-62
35. Apelgren KN, Rombeau JL, Twomey PL, Miller RA. Comparison of nutritional indices and outcome in critically ill patients. Crit Care Med 1982;10:305-7.
36. Owen WF Jr, Lew NL, Liu Y, Lowrie EG, Lazarus JM. The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis. N Engl J Med 1993;329:1001-6.
37. Doweiko JP, Nompleggi DJ. The role of albumin in human physiology and pathophysiology, Part III: Albumin and disease states. JPEN J Parenter Enteral Nutr 1991;15:476-83.
38. Rodoman GV, Shalaeva TI, Dobretsov GE, Naumov EK, Obolenski VN. Serum albumin in systemic inflammatory reaction syndrome. Anesteziol Reanimatol 2006;(2):62-4. [Abstract]
39. Hurford WE, Favorito F, Wilson D: Serum albumin concentrations during the weaning of mechanical ventilatordependent patients. Am Rev Respir Dis 1991;143:A685. [Abstract]
40. Scheinhorn DJ: Increase in serum albumin and decrease in body weight correlate with weaning from prolonged mechanical ventilation. Am Rev Respir Dis 1992; 145:A522.
41. Daren K. Heyland; Rupinder Dhaliwal; John W. Drover; Leah Gramlich; Peter Dodek; and the Canadian Critical Care Clinical Practice Guidelines Committee : Canadian Clinical Practice Guidelines for Nutrition Support in Mechanically Ventilated, Critically Ill Adult Patients. JOURNAL OF PARENTERAL AND ENTERAL NUTRITIONVol. 27, No. 5
42. Dark DS, Pingleton SK: Nutrition and nutritional support in critically ill patients. J Int Care Med 8:16–33, 1993
43. Giner M, Laviano A, Meguid MM, et al: In 1995 a correlation between malnutrition and poor outcomes in critically ill patients still exists. Nutrition 12:23–29, 1996
44. Heyland DK: Nutritional support in the critically ill patient: A critical review of the evidence. Crit Care Clin 14:423–440, 1998
45. Mentec H, Dupont H, Bocchetti M, et al: Upper digestive intolerance during enteral nutrition in critically ill patients: Frequency, risk factors, and complications. Crit Care Med 29:1955–
46. 1961, 2001
47. Heyland DK, MacDonald S, Keefe L, et al: Total parenteral nutrition in the critically ill patient: A meta-analysis. JAMA 280:2013–2019, 1998
48. Hill SA, Nielsen MS, Lennard-Jones JE: Nutrition support in intensive care units in England and Wales: A survey. Eur J Clin Nutr 49:371–378, 1995
49. De Jonghe B, Appere-De-Vechi C, Fournier M, et al: A prospective survey of nutritional support practices in intensive care units patients: What is prescribed? What is delivered? Crit Care Med 29:8–12, 2001
50. Heyland DK, Schroter-Noppe D, Drover JW, et al: Nutrition support in the critical care setting: Current practice in Canadian ICUs: Opportunities for improvement? JPEN 27:74–83, 2003
51. Heyland DK, Novak F, Drover J, et al: Should immunonutrition become routine in critically ill patients? A systematic review of the evidence. JAMA 286:944–953, 2001
52. Klein S, Kinney J, Jeejeebhoy K, et al: Nutrition support in clinical practice: Review of published data and recommendations for future research directions: National Institutes of Health, American Society for Parenteral and Enteral Nutrition, and American Society for Clinical Nutrition. JPEN 21:133–156, 1997
53. Cerra FB, Benitez MR, Blackburn GL, et al: Applied nutrition in ICU patients: A consensus statement of the American College of Chest Physicians. Chest 111:769–778, 1997
54. A.S.P.E.N. Board of Directors and the Clinical Guidelines Taskforce: Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. JPEN 26(Suppl):1–138, 2002
55. Adams S, Dellinger EP, Wertz MJ: Enteral versus parenteral nutritional support following laparotomy for trauma: A randomized prospective trial. J Trauma 26:882–891, 1986
56. Borzotta AP, Pennings J, Papasadero B, et al: Enteral versus parenteral nutrition after severe closed head injury. J Trauma 37:459–468, 1994
57. Hadfield RJ, Sinclair DG, Houldsworth PE, et al: Effects of enteral and parenteral nutrition on gut mucosal permeability in the critically ill. Am J Resp Crit Care Med 152:1545–1548, 1995
58. Hadley MN, Grahm TW, Harrington T: Nutritional support and neurotrauma: A critical review of early nutrition in forty-five acute head injury patients. Neurosurgery 19:367–373, 1986
59. Kalfarentzos F, Kehagias J, Mead N, et al: Enteral nutrition is superior to parenteral nutrition in severe acute pancreatitis: Results of a randomized prospective trial. Br J Surg 84:1665–1669, 1997
60. Kudsk KA, Croce MA, Fabian TC, et al: Enteral versus parenteral feeding: Effects on septic morbidity after blunt and penetrating abdominal trauma. Ann Surg 215:503–513, 1992
61. 28. Moore FA, Feliciano DV, Andrassy RJ, et al: Early enteral feeding, compared with parenteral, reduces postoperative septic complications: The results of a meta-analysis. Ann Surg 216: 172–183, 1992
62. Rapp RP, Young DB, Twyman D, et al: The favorable effect of early parenteral feeding on survival in head-injured patients. J Neurosurg 58:906–912, 1983
63. Young B, Ott L, Twyman D, et al: The effect of nutritional support on outcome from severe head injury. J Neurosurg 67:668–676, 1987
64. Woodcock NP, Zeigler D, Palmer MD, et al: Enteral versus parenteral nutrition: A pragmatic study. Nutrition 17:1–12, 2001
65. Moore EE, Jones TN: Benefits of immediate jejunostomy feeding after major abdominal trauma: A prospective, randomized study. J Trauma 26:874–881, 1986
66. Chiarelli A, Enzi G, Casadei A, et al: Very early nutrition supplementation in burns patients. Am J Clin Nutr 51:1035–1039, 1990
67. Eyer SD, Micon LT, Konstantinides FN, et al: Early enteral feeding does not attenuate metabolic response after blunt trauma. J Trauma 34:639–643, 1993
68. Chuntrasakul C, Chinswangwatanakul V, Chockvivatanavanit S, et al: Early nutrition support in severe trauma patients. J Med Assoc Thai 79:21–26, 1996
69. Singh G, Ram RP, Khanna SK: Early postoperative enteral feeding in patients with nontraumatic intestinal perforation and peritonitis. J Am Coll Surg 187:142–146, 1998
70. Kompan L, Kremzar B, Gadzijev E, et al: Effects of early enteral nutrition on intestinal permeability and the development of multiple organ failure after multiple injury. Int Care Med 25:157–161, 1999