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## Original Article

# APHACHE Score as a Predictive Indices for Weanability from Mechanical Ventilation

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**Abstract:**

***Objective:*** *To determine the significance of acute physiology and chronic health evaluation (APACHE) score as an important parameter of weaning outcome for mechanical ventilation.*

***Design:*** *prospective, observational.*

***Setting:*** *The medical ICU of a modernized private hospital, Dhaka.*

***Method:*** *The study was carried out during the period of 2008 to 2009 in a specialized private hospital Dhaka. Critical care physicians were asked to filled up the data sheets having detail problem of the patients including the APACHE II score. The APACHE II score is divided into three steps High score>25, Medium score 20-24 and Low score < 20. The clinicians were suggested to predict whether it would take < 3 days or 4to 7days or >8days to wean each patients from mechanical ventilation. The cause of respiratory failure and total duration of weaning were recorded. The significance was set at p<.05.*

***Result:*** *Total number of patients included in this study were 40. Male were 22 (55%) and female were 18 (45%), the mean age of the patients were 51.1±13.9. The most common cause of respiratory failure were COPD 11(24.5%) and next common were pneumonia and ARDS due to sepsis 8 (20%) each. Among the studied population 20 (50%) having low APACHE score (<20), 12 (30%) were medium score (20-24) and 8 (20%) patients were high score (>25). Total 25 (62.5%) of the patients were successfully weaned from mechanical ventilation, 10 (25%) of the patient died and 5 (12.5%) of the patent were shifted to other low cost hospital. The successfully weaned groups 17 (68%) had lower APACHE II score than the unsuccessfully (failure) group which were statistically significant ÷2 =.8546, df =2, p-value >.005.*

***Conclusions:*** *The overall severity of illness as assessed by APACHE II score correlates better with weaning outcome.*

***Key Word:*** *acute physiology and chronic health evaluation; ICU; mechanical ventilation; respiratory failure; weaning*

**Introduction:**

Although the concept of artificial respiration was recognized in the 16th century by Vasalius, it was not until the 20th century that mechanical ventilation became a widely used therapeutic modality. Over the last decade there has been an exploration of new ventilator techniques that present a bewildering array of the alternative for the treatment of respiratory failure[1]. Over the past few years our understanding of the detrimental as well as beneficial effects has increases many folds and now majority of the patients requiring mechanical ventilation in the ICU are safely weaned from ventilation within a short period of time. Less than 10% of these patients require mechanical support >7days.The cost of maintaining patients with prolong mechanical ventilation in the ICUs of acute care hospital is huge.[2]

In the last years, regional weaning centers, ventilator dependent units and skilled nursing facilities have emerged as alternatives to the ICU in providing care to patients requiring prolonged mechanical ventilation.[3]

Weaning has been defined as the process whereby mechanical ventilation is gradually withdrawn and the patient resumes spontaneous breathing. This process can be fast weaning and slow weaning. Some times weaning attempts may fail due to many reasons and patients may become ventilator dependent[1]

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Accurate prediction of total mechanical ventilation duration is important for patients and their family members. It is also an essential first step in the allocation of resources and appropriate use of weaning centers. Varieties of criteria have been used as predictors of weaning outcome[4]. More recently, the respiratory (f) to tidal volume (VT) ratio; CROP index (thoracic compliance, respiratory rate, oxygenation, pressure - PImax); relative inspiratory effort (RIE) have been proposed as predictors of the success or failure of weaning attempts. However, these entire weaning indexes have been used to predict only the immediate outcome of weaning. We undertook this study to determine whether the degree of physiologic derangement as measured by APHCHE II (acute physiology and chronic health evaluation) score correlates better with weaning outcome than others[5].

APACHE II (Acute Physiology and Chronic Health Evaluation II) is a severity-of-disease classification system (Knaus et al., 1985). One of several ICU scoring systems. It is applied within 24 hours of admission of a patient to an intensive care unit (ICU): an integer score from 0 to 71 is computed based on several measurements; higher scores correspond to more severe disease and a higher risk of death[6].

| Physiologic Variable | High Abnormal Range | | | | Low Abnormal Range | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | +4 | +3 | +2 | +1 | 0 | +1 | +2 | +3 | +4 | Points |
| Temperature- rectal °C | > 41° | 39 to 40.9° | | 38.5 to 38.9° | 36 to 38.4° | 34 to 35.9° | 32 to 33.9° | 30 to 31.9° | <29;9° | |
| Mean Arterial Pressure - mm H | >160 | 130 to 159 | 110 to 129 | | 70 to 109 | | 50 to 69 | | <49 | |
| Heart Rate (ventricular response) | >180 | 140 to 179 | 110 to 139 | | 70 to .109 | | 55 to 69 | 40 to 54 | <39 | |
| Respiratory Rate (non-ventilated or ventilated | >50 | 35 to 49 | | 25 to 34 | 12 to 24 | 10 to 11 | 6 to 9 | | <5 | |
| Oxygenation: A-aD02 or PaO2 (mm Hg) | > 500 | 350 to 499 | 2 00 to 349 | | <200 | | | | | |
| a. F162 > 0.5 record A-aD02 | | | | | | | | | | |
| b. F102 <0.5 record Pa02 | | | | | P02>70 | P02 61 to 70 | | P02 55 to 60 | P02<55 | |
| Arterial PH (preferred) | >7.7 | 7.6 to 7.69 | | 7.5 to 7.59 | 7.33 to 7.49 | | 7.25 to 7.32 | 7.15 to 7.24 | <7.15 | |
| Serum HCO3(venous mEq/I) (not preferred, but. may. use if no ABGs | >52 | 41 to 51.9 | | 32 to 40.9 | 22 to 31.9 | | 18 to 21.9 | ;5 to 17..9 | <15 | |
| Serum Sodium (mEq/I) | >180 | 160 to 179 | 155 to 159 | SSA to .154 | 1.30 to .149 | | 120 to 129 | III to 119 | <110 | |
| Serum Potassium mEq/I | >7 | 6. to 6.9 | | 5.5 to 5.9 | 3.5 to 5.4 | 3. to 3.4 | 2.5 to 2.9 | | <2.5 | |
| Serum Creatinine (mg/dl) Double point score far acute renal failure | >3.5 | 2 to 3.4 | 1.5 to 1.9 | | 0.6 to 1.4. | | a0.6 | | | |
| Hematocrit (96) | >60 | | 50 to 59.9 | 46 to 49.9 | 30 to 45.9 | | 20 to. 29.9 | | < 20 | |
| White Blood Count (total/mm3) in 1000s | >40 | | 20. to 39.9 | 15 to 19.9 | 3 to 14.9 | | 1 to 2.9 | | < 1 | |
| Glasgow Coma Score (GCS) Score =15 minus actual GCS | | | | | | | | | | |
| A. Total Acute Physiology Score sum of 12 above points) | | | | | | | | | | |
| B. Age points (years < 44 = 0; 45 to 54=2; 55 to 64=3; 65 to 74=5; a75=6. | | | | | | | | | | |
| C. Chronic Health Points see below | | | | | | | | | | |
| Total APACHE 11 Score (add together the-points from A+B+C) 1 | | | | | | | | | | |

(adapted after Knaus et al.-1985)

Chronic Health Points: If the patient has a history of severe organ system insufficiency or is immuno-compromised as defined below, assign points as follows:

- 5 points for nonoperative or emergency postoperative patients
- 2 points for elective postoperative patients

**Definitions:** organ insufficiency or immuno-compromised state must have been evident prior to this hospital admission and conform to the following criteria:

- **Liver** – biopsy proven cirrhosis and documented portal hypertension; episodes of past upper GI bleeding attributed to portal hypertension; or prior episodes of hepatic failure/encephalopathy/coma.
- **Cardiovascular** – New York Heart Association Class IV.
- **Respiratory** – Chronic restrictive, obstructive, or vascular disease resulting in severe exercise restriction (i.e., unable to climb stairs or perform household duties; or documented chronic hypoxia, hypercapnia, secondary polycythemia, severe pulmonary hypertension (>40 mmHg), or respirator dependency.
- **Renal** – receiving chronic dialysis.
- **Immunocompromised** – the patient has received therapy that suppresses resistance to infection (e.g., immunosuppressant, chemotherapy, radiation, long term or recent high dose steroids, or has a disease that is sufficiently advanced to suppress resistance to infection, e.g., leukemia, lymphoma, AIDS).

**Materials and Methods:**

This prospective, observational study involved 40 patients who were admitted to ICU and required mechanical ventilation. Along with all baseline investigations APACHE score was assessed and a prepared proforma was filled up by the critical care physician. The (APACHE) score is divided into three steps- High score>25, Medium score 20-24 and Low score < 20. The APACHE score were calculated on the basis of the worst vital signs, Glasgow coma scale and laboratory values during mechanical ventilation period. On completion of the weaning assessment, when the primary insult has been mitigated and the support of the mechanical ventilation comes down to the level of baseline with SIMV mode the process of weaning started. The initial assessment was based on the results of a physical examination, review of pertinent clinical data, arterial blood gas analysis, required tidal volume, PEEP, Plateau and peak pressure etc. Our weaning process involved daily spontaneous breathing trials with a T-piece and outcome were classified into success or failure categories.

The demographic characteristics of the patients, the cause of the respiratory failure, duration of mechanical ventilation and in-hospital mortality were noted.

The sensitivity, specificity, positive and negative predictive values and total correct prediction for weaning outcome were calculated according to the relationships shown in table-I. All the results were statistically analyzed and p values<0.05 were considered significant.

**Table I**

*The outcome of weaning from Mechanical ventilation*

| Predicted | Observed | Outcome |
|---|---|---|
| Success | Success | a |
| Success | Failure | b |
| Failure | Success | c |
| Failure | Failure | d |

**Results:**

**Table II**

*Age and sex distribution of the patients*

| Age | No | Percentage | Male | Female |
|---|---|---|---|---|
| 30-40 | 7 | 17.5% | 22(55%) | 18(45%) |
| 40-50 | 10 | 25% | | |
| 50-60 | 8 | 20% | | |
| >60 | 15 | 37.5% | | |

The age range was 30years to 60 years and above. Majority of the patients (37.5%) were above 60 years the mean age of the patients was 52.1±13.9 years. 55% of the patients were male and 45% of the patients were female.

**Table III**

*Distribution of patients according to the causes of respiratory failure leading to mechanical ventilation*

| Cause | No | Percentage |
|---|---|---|
| Pneumonia | 8 | 20% |
| COAD | 11 | 24.5% |
| Pulmonary edema | 3 | 7.5% |
| ARDS due to sepsis | 8 | 20% |
| Aspiration with CVD | 3 | 7.5% |
| Asthma | 5 | 12.5% |
| Bronchogenic Carcinoma | 1 | 2.5% |
| Pulmonary embolism | 1 | 2.5% |

This table shows that the maximum number of patients 11(24.5%) requiring mechanical ventilation was COPD. This is more likely that COPD patients in out country comes lately for treatment so Co2 retention is the frequent cause of ventilator support and also due to environmental pollution , increase rate of smoking the prevalence of the disease is also high. Next highest number of patients are combine- pneumonia 8(20%) and ARDS 8(20%), which are related to infection or related to sequale of severe infection, which are also common in our country. Other causes of lower number of patients requiring ventilation are asthma, aspiration pneumonia in CVD patients and pulmonary edema.

**Table IV**

*Distribution of patients according to the APACHE score*

| | Low- <20 score | Medium (20-24) score | High - >24 score |
|---|---|---|---|
| No. patients | 20 (50%) | 12 (30%) | 8 (20%) |

This is the graded classification of APACHE II score according to the severity of physiological derangement in a patient. According to this table 20 (50%) of the patients were having low score and (20%) were having high APACHE score

**Table V**

*Distribution of patients according to the success of weaning*

| No-40 | Total | Low score | Medium score | High score |
|---|---|---|---|---|
| Improved | 25 (62.5%) | 17(68%) | 7(28%) | 1(4%) |
| Death | 10 (25%) | 1(10%) | 2(20%) | 7(70%) |
| DORB | 5 (12.5%) | 2(40%) | 3(60%) | |

This table shows that out of 40 patients 25(62.5%) was successfully weaned, among them 17(68%) having low APACHE score and 1(4%) having high score and rest were medium score. Among all 40 patients 10(25%) died and 5(12.5%) patients were released with risk bond as they were unable to bear the cost of ventilation management in this hospital.

**Table VI**

*Accuracy of predicting weaning outcome*

| Variables | | % |
|---|---|---|
| Sensitivity | a/a+c | 88% |
| Specificity | d/b+d | 60% |
| Positive predictive value | a/a+b | 78% |
| Negative predictive value | d/c+d | 75% |

The prediction sensitivity, specificity, positive and negative predictive values for short term weaning outcome by the critical care practitioners are listed in the table-VI.

**Discussion:**

The study was carried out during the period of 2008 to 2009 in a specialized private hospital Dhaka to determine the significance of Acute Physiology and Chronic Health Evaluation (APHACHE) score as an important parameter of weaning outcome for mechanical ventilation

The results of this study show that the overall severity of illness of patients as assessed by APHACHE II score correlates better short term weaning outcome than any other weaning index.

The traditionally used weaning indices are measurement of vital capacity, minute ventilation, blood gas parameter, test of muscle function. However, part of the poor predictive accuracy of most weaning indices can be explained by an inherent limitation of assessing only the respiratory status of the patients. They are thus physiologically and temporally unable to predict weaning failure caused by non-respiratory process. Researchers have recently shown that the need for prolonged mechanical ventilation is determined by the degree of physiological derangement as measured by APHACHE II score. Vitacca et al[7] have shown that underlying general conditions as assessed by malnutrition and APHACHE II score are predictors of need for mechanical ventilation in patients with acute exacerbation of COPD.

In this study 22 (55%) of the patients were male and 18 (45%) of the patients were female, the dominance of the male patients may be due the driving member of most family is male and given more attention regarding treatment. Regarding age distribution most patients 15 (37.5%) were above 60 years which is the age a person may get serious illness more frequently and also having multiple co-morbidity

As per disease distribution, Maximum patients 11(24.5%) out of 40 were ventilated due to respiratory failure due to chronic obstructive airway disease. Most of the COPD patients of our country are noncompliant about their treatment, or they are not getting the standard guideline based treatment. So exacerbation and requiring mechanical ventilation is more frequent. Next important number of patient requiring ventilation in this study were 8 (20%) in two groups of patients that were pneumonia and ARDS due to sepsis. Both pneumonia and sepsis is common in our country and the disease process become complicated whenever they attended to the physician and needs to mechanical ventilation. The result of this observation correlates with the study of Bekele Afessa, Lamont Hogans and Ronald Murphy[8] which also showed the highest incidence of ventilation patients for COPD and pneumonia patients.

In regards to distribution of patients according to the severity of APACHE II score It has been seen that 20(50%) of the patients were low score (<20),12(30%) were medium score(20-24), and 8(20%) patients were high score(>24), Knaus WA, Draper EA,Wagner DP et al. 1985. It has been observed in our study that out of 40 patients 25 (62.5%) of total patients were weaned from mechanical ventilation, among them 17(68.5%) patients were having low APACHE score, 7(28%) of the medium score and 1(4%) of the patients from high APACHE score. The result were statistically significant and P-value were <.005. The result of our study were almost similar to the result of the study conducted by Bekele A, Lamont H and Ronald M which also showed lower the APACHE score higher the chance of weaning.

The focus of the study was not to assess the role of different weaning indexes in predicting immediate weaning outcome, but to determine whether these indexes and APACHE II score correlate with outcome of weaning from mechanical ventilation. With this focus, patients likely to be weaned from mechanical ventilation immediately were not included in the study. In an attempts to decrease the cost of caring for the critically ill patients, many ventilator –dependent patients are transferred to less expansive sub-acute care facilities as soon as their acute unstable condition are stabilized and prolonged mechanical ventilation dependence is anticipated. We chose 3-5 days weaning outcome to determine variables that will help us to evaluate patients who will require prolonged mechanical ventilation and thus need transferred to sub-acute care facilities.

We need easily measurable weaning indexes which will help us to make clinical decision. We choose APACHE II scoring system in this study because it is a better way of assessing the overall conditions of patients However, the APACHE score system requires13 variables, a task that may be time consuming.

The rising cost of caring for ventilator patients is a real concern for every one involve in health care delivery. The ability to accurately predict the duration of prolonged mechanical ventilation is beneficial to patients, their families, healthcare provider, and health care system. It will help in the allocation of health care resources and reduce health care cost by promoting the early transfer of patients requiring prolong mechanical ventilation from acute care center to the low cost chronic care centre.

**Conclusion:**

These finding suggest that we need a better weaning index, one that incorporates the overall physiological condition of the patient in order to improve the accuracy of predicting prolonged mechanical ventilation. From this study it can be concluded that APACHE II scoring system is better way to predict the early weanibilty and predict mortality. The cost of caring for ventilated patients can be mitigated by taking early decision for further treatment. But further large sale study is needed to make this result in effect.

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