Clinical characteristics and outcomes of mechanically ventilated patients in respiratory intensive care unit according to weaning classification

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Abstract

Background: The weaning classification based on the difficulty and duration of the weaning process has been evaluated

Purpose: To compare the clinical characteristics and outcomes of patients with three weaning groups (simple, difficult and prolonged weaning) in respiratory intensive care unit (RICU).
Design: Prospective observational clinical study
Patients and methods: the study included fifty three (53) patients who were admitted to the RICU and required invasive mechanical ventilation for more than 24 hours and they were ready to be weaned. Chest X-ray, arterial blood gases analysis, blood chemistry including renal function tests, liver function tests and serum electrolytes were done. Patients were weaned by using T-piece or PSV < 7cmH2O for two hours. Patients were classified as simple, difficult and prolonged weaning. Baseline characteristics were compared across weaning classifications.
Results: The study included 34 cases survived and 19 cases died, according to the weaning outcomes, the patients were divided into 3 groups; 20 cases experienced simple weaning, 20 cases experienced difficult weaning and 13 cases experienced prolonged weaning.Results showed the following factors that affect weaning outcome; pneumonia (P= 0.04), cardiovascular diseases (P= 0.047), low serum Mg++ level (P <0.0001), low serum Ca++ level (P= 0.0001), high serum urea level (P=0.001), ALT (P=0.0001), AST (P=0.0005)RSBI (P<0.0001), minute ventilation (VE) (P= 0.0001), SaO2% (P <0.0001), high respiratory rate (P <0.0001) and duration of MV and ICU stay (P= 0.0001& 0.0002 respectively).
Conclusion: Causes and duration of MV can affect weaning outcomes, factors as WBCs count, hemoglobin level, serum urea, albumin, Mg++ and Ca++ levels, respiratory rate, minute ventilation,RSBI, high respiratory rate and Sao2% can affect weaning outcome. Patients with prolonged weaning had longer duration of MV and ICU stay than those with simple and difficult weaning.

Key words:
Mechanical ventilation,Intensive care unit, Respiratory intensive care unit.

Introduction:

Weaning from MV is a major issue in ICUs [(1)].The weaning process comprises at least 40% of the total duration of MV [(2)]; approximately 15% of patients receiving MV require a prolonged process of weaning and experience higher mortality [(3)].Progress in the treatment of acute critical episodes has resulted in higher survival rates for patients admitted to ICU. However, these advances have also given rise to the appearance of a growing population characterized by prolonged dependence on MV, requiring a tracheostomy and other life sustaining therapies [(4)]. An international consensus conference (ICC) on weaning from MV in 2005 proposed that weaning be categorized into three groups (simple,

difficult, and prolonged weaning) based on the difficulty and duration of the weaning process [5].In the absence of a consensus for the definition of prolonged mechanical ventilation (PMV), a useful practical definition of PMV onset is the time of tracheostomy tube insertion for continued MV[6].Patients with PMV have high one year mortality, with recognized contributing factors including COPD, cardiac failure, renal failureand respiratory muscle weakness[7].Prolonged weaning is associated with increased mortality and morbidity. A large proportion of patients admitted to RICUs have chronic respiratory disorders, which are associated with a longer duration of weaning[8].

The aim of the study was to compare the clinical characteristics and outcomes of patients with three weaning groups (simple, difficult and prolonged weaning) in RICU.

Patients and methods:

This prospective nonrandomized clinical study included fifty three (53) patients who were admitted to the ICU and required invasive MV for more than 24 hours and they were ready to be weaned. The study was conducted in RICU of Chest Department, ELkasrALainy Hospital, in the period from July 2016 to June 2017 after the approval of the ethical committee and written consents where taken from the patients or relatives.

The patients with accidental extubation and patients with previous decision to limit life-sustaining treatments were excluded from the study.

All patients were subjected to full clinical evaluation including thorough history taking from patients or their relatives and clinical examination , chest radiograph , electrocardiogram, abdominal ultrasonography,echocardiography (if indicated), computed tomography (if indicated), complete blood count and arterial blood gases analysis: including (PH, PaO2, PaCO2, SaO2%, HCO3),the samples were analyzed using automated blood gases analyzer (GEM Premier 3000: Instrumentation Laboratory Inc. Lexington MA 02421, USA). , blood chemistrywas done, including renal function tests, liver function tests and serum electrolytes(Na+, K+, C a++, Mg++)(Roche/Hitachi cobas c 311systen, Germany).

Weaning from mechanical ventilation:

Weaning from MV was initiated when the patients presented with following criteria:

Clinical criteria; resolution or improvement of the cause of respiratory failure, suppressed sedation or neuromuscular blockade,satisfactory level of consciousness (Glasgow scale ≥ 8),absence of fever (T ≤ 37.5 °C), hemodynamic stability at minimal doses or in the absence of vasoactive drugs,absence of decompensated coronary insufficiency or arrhythmia with hemodynamic reperfusion.

Gasometric criteria:PaO2 ≥ 60 mm Hg with FIO2 ≤ 0.4; PaCO2 within normal (35-45mmHg) or increase ≤ 10 mmHg; PH within normal (7.33-7.44) or decrease ≤ 0.1.[9].

Ventilator parameters: peak airway pressure of < 45cmH2O,plateau pressure of < 30 cmH2O,static lung compliance of > 33 mL/cm H2O,dynamic lung compliance of > 22 mL/cm H2O,RSBI was less than 105 on CPAP of 5 cmH2O for 3 minutes, FiO2 <0.4, PEEP ≤ 5 - 8 cm H2O [10].

Weaning method:

When patients were ready for weaning in a semi-recumbent position, we started with spontaneous breathing trial using either T-piece or PSV < 7cmH2O for two hours. When failed we used gradual reduction of ventilatory support using either pressure support or NIV.

Statistical analysis

Data was analyzed using STATA intercooled version 12.1. Quantitative data was represented as mean, standard deviation, median and range. Data was analyzed using student t-test to compare means of two groups and ANOVA with post-hoc for comparison of the means of three groups or more. Qualitative data was presented as number and percentage and compared using either Chi square test or fisher exact test. P value was considered significant if it was less than 0.05.

Results:

MV outcome included 34 cases survived and 19 cases died, according to the weaning outcome the patients were divided into 3 groups; 20 cases were simple weaning, 20 cases were difficult weaning and 13 cases were prolonged weaning. All demographic data and the relationship between it and the weaning outcome were summarized in table 1.

Table (1): Demographic data of the studied population

Variable	Number (%)
Age (year)	
Mean ± SD	59.81±14.31
Median (range)	63 (17-88)
Gender	
Females	23 (43.4%)
Males	30 (56.6%)
Occupation	
House wife	23 (43.4%)
Farmer	10 (18.9%)
Worker	10 (18.9%)
other	10 (18.9%)
Smoking status	
Non-smoker	26 (49.1%)
Smoker	13 (24.5%)
Ex-smoker	14 (26.4%)
Smoking index	
Mild	1 (3.7%)
Moderate	4 (14.8%)
Heavy	22 (81.5%)
history of previous ICU admission	
Yes	11 (20.8%)
No	42 (79.2%)

ICU: Intensive care unit

Table (2): Relationship between weaning outcomes and demographic data

Variable	Simple weaning Number (%)	Difficult weaning Number (%)	Prolonged weaning Number (%)	P	P1	P2	P3
Age (year)	57.3±13.90	62.85±15.80	59±12.65	0.47	0.68	1.00	1.00
Gender							
Females	6 (30%)	11 (55%)	6 (46.15%)	0.27	0.11	0.35	0.62
Males	14 (70%)	9 (45%)	7 (53.85%)				
Smoking status							
Non-smoker	7 (35%)	12 (60%)	7 (53.85%)	0.61	0.28	0.56	0.94
Smoker	6 (30%)	4 (20%)	3 (23.85%)				
Ex-smoker	7 (35%)	4 (20%)	3 (23.08%)				
Smoking index							
Mild	1 (7.69%)	0	0	0.53	0.76	0.67	1.00
Moderate	3 (23.08%)	1 (12.5%)	0				
Heavy	9 (69.23%)	7 (87.50%)	6 (100%)				
History of previous ICU							
Yes							
No	2 (10%)	5 (25%)	4 (30.77%)				
	18 (90%)	15 (75%)	9 (69.23%)	0.3	0.41	0.18	1.00

Data are presented as mean ± SD (unless otherwise indicated)
P: compared the 3 groups P1: compared simple with difficult P2: compared simple with prolonged, P3: compared difficult with prolonged

Table (2) shows that there was no statistically significant relationship between 3 different groups of weaning outcomes (simple, difficult, prolonged weaning) and demographic data as regard of age (P= 0.47), gender (P= 0.27), smoking status and index (P= 0.61& 0.43 respectively) and history of previous admission of ICU (P= 0.3).

Table (3): Relationship between weaning outcomes and co-morbidities

Co-morbidities	Simple weaning Number (%)	Difficult weaning Number (%)	Prolonged weaning Number (%)	P	P1	P2	P3
Cardiac disease	4 (20%)	11 (55%)	7 (53.85%)	0.047	0.02	0.07	0.95
DM	6 (30%)	7 (35%)	7 (53.85%)	0.37	0.74	0.17	0.28
Hypertension	4 (20%)	9 (45%)	7 (53.85%)	0.1	0.09	0.07	0.62
Neurological disease	3 (15%)	5 (25%)	7 (53.85%)	0.19	0.18	0.28	1.00
Thyroid disease	2 (10%)	1 (5%)	0	0.47	1.00	0.51	1.00
Rheumatological disease	1 (5%)	1 (5%)	0	0.71	1.00	1.00	1.00
Renal disease	0	1 (5%)	0	0.43	1.00	1.00	1.00
No of co-morbidity None < 2co-morbidity ≥ 2co-morbidity	 5 (25%) 12 (60%) 3 (15%)	 3 (15%) 6 (30%) 11 (55%)	 0 3 (23.08%) 10 (76.92%)	0.007	0.03	0.001	0.26

P: compared the 3 groups P1: compared simple with difficult P2: compared simple with prolonged, P3: compared difficult with prolonged
DM: Diabetes mellitus

Table (3) shows that cardiac co-morbidities were significantly associated with difficult and prolonged weaning in comparison to patients with simple weaning (P= 0.047& 0.02 respectively).There was no statistically significant relationship between 3 different groups of weaning outcomes and other co-morbidities as regard DM (P= 0.37), hypertension (P= 0.1), neurological diseases (P= 0.19), thyroid diseases (P= 0.47), hepatic diseases (P= 0.18), rheumatological diseases (P= 0.71) and renal diseases (P= 0.43). Difficult and prolonged weaning was significantly higher in patients with≥ 2 co-morbidities weaning in comparison to patients with < 2co-morbidities or without co-morbidities (P= 0.007, 0.03 and 0.001 respectively).

Table (4): Relationship between weaning outcomes and the causes of respiratory failure

Variable	Simple weaning Number (%)	Difficult weaning Number (%)	Prolonged weaning Number (%)	P	P1	P2	P3
COPD	10 (65%)	9 (45%)	5 (38.5%)	0.26	0.20	0.14	0.71
Pneumonia	3 (15%)	10 (50%)	3 (23.1%)	0.04	0.02	0.56	0.12
IPF	1 (5%)	3 (15%)	2 (15.4%)	0.53	0.61	0.55	1.00
Overlap syndrome	1 (5%)	2 (10%)	2 (15.4%)	0.61	1.00	0.55	1.00
Bronchiectasis	2 (10%)	0	3 (23.1%)	0.09	0.45	0.36	0.052
OH syndrome	2 (10%)	0	0	0.61	1.00	1.00	0.55
Malignancy	2 (10%)	2 (10%)	1 (7.7%)	0.97	1.00	1.00	1.00
Kyphoscliosis	0	1 (5%)	0	0.43	1.00	1.00	1.00

P: compared the 3 groups P1: compared simple with difficult P2: compared simple with prolonged P3: compared difficult with prolongedCOPD:Chronic obstructive pulmonary diseaseIPF: Interstitial pulmonary fibrosisOH syndrome: Obesity hypoventilation syndrome

Table (4) shows the relationship between weaning outcomes and the cause of respiratory failure; Patients with pneumonia experienced difficult weaning in comparison to simple and prolonged weaning (P= 0.02). There was no statistically significant relationship between 3 different groups of weaning outcomes and other respiratory diseases as regard COPD (P= 0.26), IPF (P= 0.53), overlap syndrome (P= 0.61), bronchiectasis (P= 0.09), OH syndrome (P= 0.61), malignancy (P= 0.97) and kyphoscoliosis (P= 0.43).

Table (5): Relationship between weaning outcomes and laboratory investigation of the studied population

Variable	Simple weaning	Difficult weaning	Prolonged weaning	P	P1	P2	P3
WBCs (×103cells/mcL)	12.33±5.18	15.09±5.64	16.51±4.37	0.07	0.12	0.03	0.36
Hemoglobin(gm/dL)	13.09±2.51	10.61±2.47	11.02±1.53	0.003	0.004	0.04	1.00
ALT (IU/L)	39.35±30.41	58.75±87.74	20.77±10.03	0.003	0.38	0.007	0.001
AST (IU/L)	43.3±30.85	91.55±182.27	22.23±8.77	0.002	0.27	0.004	0.0009
Albumin (gm/lL)	2.87±0.67	2.64±0.61	2.37±0.75	0.25	0.56	0.1	0.25
Urea (mg/dL)	26.41±22.61	27.54±21.55	46.55±21.69	0.005	0.47	0.005	0.003
Serum Na+ (mmol/L)	138±4.91	139.15±6.07	140.46±6.70	0.5	1.00	0.72	1.00
Serum Mg++ (mg/dL)	2.15±0.36	2±0.4	1.43±0.47	<0.0001	0.99	<0.0001	0.001
Serum K+(mmol/L)	4.41±0.64	3.94±0.83	3.93±0.78	0.10	0.16	0.25	1.00
Serum Ca ++ (mg/dL)	8.62±0.57	8.34±0.99	6.93±1.49	0.0001	1.00	<0.0001	0.001

Data are presented as mean ± SD (unless otherwise indicated)

P: compared the 3 groups P1: compared simple with difficult P2: compared simple with prolonged P3: compared difficult with prolonged

WBCs: White blood cells PLTs: Platelets ALT: Alanine transaminase AST: Aspartate transaminaseNa+: Sodium Mg++: Magnesium K+: PotassiumCa++: Calcium

Table (5) shows that WBCs significantly higher in patients with prolonged weaning in comparison to patients with simple weaning (P= 0.03). Patients with low hemoglobin level were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning

(P= 0.004 & 0.04 respectively). There was statistically significant relationship between 3 different groups of weaning outcomes and high ALT and AST levels (P= 0.003) and also in comparison simple weaning with prolonged weaning (P= 0.007) and difficult weaning with prolonged weaning (P= 0.001). Patients with low albumin level were experienced difficult and prolonged weaning but statistically not significant (P= 0.25). Patients with elevated urea level were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning (P= 0.005& 0.004 respectively).

Patients with low serum Mg++ and serum Ca++ levels were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning.

Table (6): Relationship between weaning outcomes and baseline arterial blood gases parameters

Arterial blood gases	Simple weaning	Difficult weaning	Prolonged weaning	P	P1	P2	P3
PH	7.31±0.11	7.26±0.13	7.25±0.16	0.34	0.81	0.68	1.00
PaCo2 (mmHg)	68.25±18.99	70.25±25.40	63.92±34.80	0.74	0.87	0.47	0.52
PaO2 (mmHg)	54.±11.73	59.45±21.29	52.54±18.06	0.59	0.65	0.51	0.33
Sao2%	81.35±11.95	83.85±9.86	82.54±9.97	0.76	1.00	1.00	1.00
HCO3 (mEq/L)	33.33±6.61	28.12±9.53	27.28±6.44	0.05	0.12	0.11	1.00

Data are presented as mean ± SD (unless otherwise indicated)
P: compared the 3 groups P1: compared simple with difficultP2: compared simple with prolonged P3: compared difficult with prolonged
PaCO2: Partial arterial tension of carbon dioxide PaO2: Partial arterial tension of oxygen SaO2%: Oxygen saturation

Table (6) shows that there was no statistically significant relations between 3 different groups of weaning outcomes and baseline arterial blood gases as regard (PH, PaCO2, PaO2, SaO2%&HCO3).

Table (7): Relationship between weaning outcome and arterial blood gases parameters at the beginning of the first weaning trial

Arterial blood gases	Simple weaning	Difficult weaning	Prolonged weaning	P	P1	P2	P3
PH	7.44±0.05	7.42±0.06	7.42±0.11	0.66	1.00	1.00	1.00
PaCo2 (mmHg)	45.23±11.33	54.4±9.41	53.45±16.32	0.11	1.00	0.15	0.24
PaO2 (mmHg)	74.8±19.10	77.75±21.57	70.38±14.13	0.66	0.72	0.59	0.35
Sao2%	94.4±3.19	89.95±6.71	81.31±8.75	<0.0001	0.09	<0.0001	0.001
HCO3(mEq/L)	35.36±6.21	33.66±8.41	33.82±6.75	0.73	1.00	1.00	1.00
P/F	182.17±52.6	200.25±51.7	172.15±37.1	0.25	0.74	1.00	0.34
Shunt	12.36±3.54	10.99±2.36	11.78±1.67	0.3	0.37	1.00	1.00
(A-a) gradient	169.04±54.6	147.66±34.1	150.66±22.7	0.23	0.32	0.65	1.00

Data are presented as mean ± SD (unless otherwise indicated)
P: compared the 3 groups P1: compared simple with difficult
P2: compared simple with prolonged P3: compared difficult with prolonged
P/F: Partial arterial tension of oxygen/ friction inspiratory oxygen (A-a) gradient: Alveolar- arterial oxygen gradient

Table (7) shows the relationship between weaning outcome and arterial blood gases parameters at the beginning of the first weaning trial: the mean level of SaO2% was low in patients with prolonged and difficult weaning in comparison to patients with simple weaning (P= 0.0001& 0.001respectively). There was no statically significant relationship between 3 different groups of weaning outcomes and other arterial blood gases parameters as regard PH (P= 0.66), PaO2 (P= 0.66), PaCO2 (P= 0.11), HCO3 (P= 0.73), P/F (P= 0.25), shunt (P= 0.3) and [A-a] gradient (P= 0.23).

Table (8): Relationship between weaning outcome and ventilator parameters during first weaning trial

Ventilator parameters	Simple weaning	Difficult weaning	Prolonged weaning	P	P1	P2	P3
Tidal volume (mL)	465.5±39.93	448.5±55.18	448.46±39.13	0.44	0.75	0.92	1.00
Respiratory rate (cycle/min)	19.55±3.28	30.3±3.38	28.16±6.53	<0.0001	<0.0001	<0.0001	0.94
Mean blood pressure (mmHg)	85.8±9.42	88.48±17.38	87.17±5.86	0.79	1.0	1.00	1.00
SaO2%	94.3±2.89	94.9±4.24	93.3±3.63	0.47	1.00	1.00	0.67
Minute ventilation (mL/min)	9.12±1.57	13.35±3.62	11.84±2.73	<0.0001	<0.0001	0.03	0.40
RSBI	42.46±9.15	68.66±19.80	58.48±12.22	<0.0001	<0.0001	0.01	0.17

Data are presented as mean ± SD (unless otherwise indicated)
P: compared the 3 groups P1: compared simple with difficult
P2: compared simple with prolonged P3: compared difficult with prolonged
RSBI: Rapid shallow breathing index

Table (8) shows the relationship between weaning outcomes and ventilator parameters during first weaning trial: the mean value of respiratory rate, minute ventilation and RSBI were higher in patients with difficult and prolonged weaning in comparison to patients with simple weaning.

Table (9): Relationship between weaning outcome and duration of MV and ICU stay, complications and outcome of MV

Variable	Simple weaning	Difficult weaning	Prolonged weaning	P	P1	P2	P3
Duration of MV(day)	6.25±4.24	10.3±5.42	18.38±4.38	0.0001	0.005	0.0001	0.0003
Duration in ICU (day)	11.8±6.37	15.35±6.93	22.69±3.17	0.0002	0.09	0.0001	0.002
Death Yes No	 0 20 (100%)	 12(60%) 8 (40%)	 7 (53.85%) 6 (46.15%)	 <0.0001	 <0.0001	 <0.0001	 0.73

Data are presented as mean ± SD (unless otherwise indicated)
P: compared the 3 groups P1: compared simple with difficult P2: compared simple with prolonged P3: compared difficult with prolonged
MV: Mechanical ventilation ICU: Intensive care unit
Table (9) shows the duration of MV and ICU stay were significantly longer in patients with difficult and prolonged weaning in comparison to patients with simple weaning.Patients with difficult and prolonged weaning associated with poor outcome (death) in comparison to patients with simple weaning

Discussion:

This study evaluated the clinical characteristics and outcomes of patients with three weaning groups (simple, difficult and prolonged weaning) in RICU.

Approximately 20 patients(37.7%) experienced simple weaning, 20 patients (37.7%) experienced difficult weaning and 13 patients (24.5%) experienced prolonged weaning. We found in our study that there was no significant relationship between 3 different groups of weaning outcomes and demographic data as regard age (P= 0.47), gender (P= 0.27), smoking status and index (P= 0.61&0.43) and previous admission of ICU (P= 0.3), this result was agreed with the results of Alaa, et al,[11] who found that there was no significant relation between

weaning outcomes and age (P= 0.641), sex distribution and smoking pattern (P= 0.793 for both).

we found that there was significant relationship between 3 different groups of weaning outcomes and pneumonia (P= 0.04) and in compared simple with difficult (P= 0.02), this result matched with the study of Jeong et al, [12] who found that across weaning classification from simple to prolonged weaning groups, pneumonia was increased (P= 0.029).

We found that patients with cardiac co-morbidities were significantly experinced difficult and prolonged weaning in comparison to patients with simple weaning (P= 0.047& 0.02 respectively) this result was agreed with the study of De Meirelles, et al,[13]who found that left ventricular diastolic dysfunction affects weaning outcomes. This can be explained as switching a patient from positive pressure ventilation to spontaneous breathing re-establishes negative inspiratory intra-thoracic pressures thus increasing venous return (left ventricular preload), central blood volume and left ventricular afterload and increased myocardial oxygen consumption, [14]

Our study found that leukocytosis was more noted in patients with prolonged weaning, this can be explained by the higher liability to respiratory infection in this group of patients which necessitate prolonged weaning in comparison to simple weaning.

Our results showed that patients with low hemoglobin level were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning these results was agreed with the result of Yi-Chun, et al, [15]who reported that hemoglobin level are associated with difficult weaning and suggested that lower hemoglobin level decrease arterial oxygen content, compromise oxygen delivery and increase respiratory muscle load during the weaning process. [16, 17]

The serum albumin level was low in difficult and prolonged weaning patients but statistically was not significant (P = 0.25). This resultwas in agreement with the result of Xiao and Duan[18]who signified the importance of albumin level in predicting in weaning outcome and they found that albumin was associated with re-intubation for several reasons. **First**, albumin reflects a patient's nutritional status, and malnutrition is associated with weaning failure from a ventilator. **Second**, albumin is responsible for 75%-80% of plasma colloid osmotic pressure.[19]Low albumin increases the pulmonary vascular permeability and then results in extravascular lung water increasing. Increased extravascular lung water is a reason for weaning failure. [20]**Third**, decreased albumin is also associated with systematic inflammation. And systematic inflammation is a risk factor for weaning failure. **Fourth**, low albumin can be resulted from hem dilution when fluid overload occurs.[21]

However, in spite of all these previous causes of the importance of albumin level in weaning outcome, our results did not show any statistically difference between our three groups of weaning which can be explained by the low level of serum albumin in most of

the studied patients of our three groups from the start.

As regard liver function test (ALT, AST) was significantly high patients with simple weaning and difficult weaning this can be explained as result of inadequate oxygen uptake by the centrilobular hepatocytes resulting in necrosis. The most common cause is insufficient hepatic perfusion (ischemia) in the setting of passive liver congestion. However, other factors can contribute as hypoxemia, poor oxygen delivery by the blood hypoxemia[22] and the decline in hepatic arterial flow appears to strongly correlate with use of PEEP. Hepatic vascular resistance is also elevated in mechanically ventilated patients.[23]

As regard serum urea level, Patients with elevated urea level were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning (P= 0.005& 0.004 respectively),these results was in agreement with the result of the study of Yao-Kuang, et al [24] who reported that high blood urea nitrogen (BUN) levels were associated with weaning failure, this can be explained as elevated BUN levels may be indicative of impaired renal function, reduced kidney blood flow and/or excessive protein catabolism resulting in muscle wasting and a negative nitrogen balance.

Patients with low serum Mg++level and low serum Ca++ level were significantly experienced difficult and prolonged weaning in comparison to patients with simple weaning (P<0.0001& 0.001 respectively), this result was in agreement with the results of Johnson et al [25] who concluded that hypomagnesaemia and hypocalcaemia is a recognized causes of both skeletal muscle weakness and of respiratory muscle weakness leading to difficult weaning, and also this result was in agreement with the result of Yehiaet al[26]who concluded that there was relation between hypomagnesaemia, hypocalcaemiaand neuromuscular dysfunctions which lead to difficult weaning so the early diagnosis of electrolytes disturbances may be of help in management of neuromuscular disorders acquired during ICU stay.

The mean level of respiratory rate during weaning was higher in patients with difficult and prolonged weaning in comparison to patents with simple weaning (P<0.0001 for both) this result was in agreement with the result ofJeong et al [12]who found that respiratory rate was worst in the prolonged weaning group (P < 0.001).

This study showed that the mean level of minute ventilation was significantly higher in patients with difficult and prolonged weaning than patients with simple weaning this result was not agreed with the result of Ali et al [27]who found that there was no significant relation between minute ventilation and weaning outcome. Minute ventilation can be increased by increasing either the tidal volume (Vt) or the respiratory frequency (f). Similarly, it can be decreased by decreasing either the tidal volume or the respiratory frequency.

The mean level of RSBI was significantly higher in patients

experienced difficult and prolonged weaning than patients with simple weaning this result was not agreed with the result of Jeong et al [12] who found that RSBI did not vary between weaning groups (P= 0.1). RSBI is an indicator of load/capacity balance and high index indicate imbalance between excess patients breathing load and diminished respiratory muscle capacity.[28]

This study showed that there was no significant relationship between 3 different groups of weaning outcomes and P/F ratio this result was not agreed with resultof Jeong et al [12]that found PaO2/FiO2 ratio (P < 0.001) was worst in the prolonged weaning group. There was no significant relationship between 3 different groups of weaning outcomes and other arterial blood gasesparameters at the beginning of first weaning trial as regard PH this result was in agreement with the result of Jeong et al [13]who found that PH and PaO2 results at the beginning of first SBT were not different between weaning groups.In the study of Ali et al [27]showed there is a significant difference between the succeeded and the failed groups as regards RSBI and ABG (PH, PaO2, PaCO2) (P < 0.001, 0.01, 0.02 respectively).

As regard duration of MV and ICU stay were significantly longer in patients with prolonged weaning than other weaning outcomes this result agreed with the result of Jacoboet al [29]whofoundthat patients with prolonged weaning had longer duration of MV and ICU stay. Patients with difficult and prolonged weaning associated with poor outcome (death) in comparison to patients with simple weaning (P <0.0001) this result agreed with the result of Jeong et al [12]who found that increased ICU and hospital mortality were observed in patients with prolonged weaning in comparison to those with simple weaning (P < 0.001).

Conclusions: Causes and duration of MV can affect weaning outcomes, factors as WBCs count, hemoglobin level, serum urea, albumin, Mg++ and Ca++ levels, respiratory rate, minute ventilation, RSBI, high respiratory rate and Sao2% can affect weaning outcome. Patients with prolonged weaning had longer duration of MV and ICU stay than those with simple and difficult weaning.

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