

Does the APACHE II score predict performance of activities of daily living in patients discharged from a weaning center?

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Abstract

Introduction: Data regarding the functional status of patients after prolonged mechanical ventilation are scarce, and little is known about its clinical predictors.

Aim: To investigate whether the Acute Physiology and Chronic Health Evaluation (APACHE) II score on admission may predict performance in activities of daily living on discharge from a weaning center.

Material and methods: All consecutive patients admitted between January 1, 2012 and December 31, 2013 were enrolled ($n = 130$). During this period, 15 subjects died, and 115 were successfully discharged (34 women; 81 men). APACHE II was calculated based on the worst values taken during the first 24 hours after admission. On discharge, the Barthel Index (BI) and its extended version, the Early Rehabilitation Barthel Index (ERBI), were assessed.

Results: Median BI was 20 points (IQR 5; 40), and ERBI was 20 points (-50; 40). There was no correlation between APACHE II and either BI ($R = -0.07$; $p = 0.47$) or ERBI ($R = -0.07$; $p = 0.44$). APACHE II predicted the need for assistance with bathing (AUROC = 0.833; $p < 0.001$), grooming (AUROC = 0.823; $p < 0.001$), toilet use (AUROC = 0.887; $p < 0.001$), and urination (AUROC = 0.658; $p = 0.04$). APACHE II had no impact on any ERBI items associated with ventilator weaning, including the need of further mechanical ventilation (AUROC = 0.534; $p = 0.65$) or tracheostomy (AUROC = 0.544; $p = 0.42$).

Conclusions: Although APACHE II cannot predict the overall functional status in patients discharged from a weaning center, it helps identify subjects who will need support with bathing, grooming, and toilet use. The APACHE II score is inadequate to predict performance in activities associated with further respiratory support.

Key words: prolonged mechanical ventilation, weaning, APACHE, functional status, Barthel Index.

Streszczenie

Wstęp: Istnieją ograniczone dane dotyczące stanu funkcjonalnego chorych przewlekle wentylowanych mechanicznie i predyktorów klinicznych tego stanu.

Cel: Ocena, czy punktacja w skali APACHE II przy przyjęciu na oddział, na którym chorzy są odzwyczajani od respiratora, przewiduje ich funkcjonowanie w zakresie czynności życia codziennego przy wypisie.

Materiał i metody: Do badania włączono chorych ($n = 130$) kolejno leczonych od 1 stycznia 2012 do 31 grudnia 2013 roku. W tym czasie zmarło 15 chorych, a 115 zostało wypisanych (34 kobiety, 81 mężczyzn). Punktację w skali APACHE II obliczono na podstawie najgorszych wartości uzyskanych podczas 24 godzin od przyjęcia. Przy wypisie z oddziału obliczono wartość punktacji w skali Barthel (BI) oraz jej rozszerzonej wersji: *Early Rehabilitation Barthel Index* (ERBI).

Wyniki: Mediana BI wynosiła 20 (IQR 5; 40) pkt, a ERBI 20 (-50; 40) pkt. Nie stwierdzono zależności pomiędzy punktacją w skali APACHE II a BI ($R = -0,07$; $p = 0,47$) oraz ERBI ($R = -0,07$; $p = 0,44$). Skala APACHE II pozwalała przewidzieć konieczność pomocy w utrzymaniu higieny osobistej (AUROC = 0,833; $p < 0,001$), ubieraniu (AUROC = 0,823; $p < 0,001$), korzystaniu z toalety (AUROC = 0,887; $p < 0,001$) oraz kontrolowaniu oddawania moczu (AUROC = 0,658; $p = 0,04$). Nie miała natomiast wpływu na parametry związane z odzwyczajaniem od respiratora, w tym konieczność dalszej wentylacji (AUROC = 0,534; $p = 0,65$) i utrzymanie tracheostomii (AUROC = 0,544; $p = 0,42$).

Wnioski: Choć skala APACHE II nie pozwala przewidzieć ogólnego funkcjonowania chorych przewlekle wentylowanych odzwyczajanych od respiratora, jest cennym narzędziem do predykcji konieczności pomocy w utrzymaniu higieny osobistej, ubieraniu i korzystaniu z toalety. APACHE II nie pozwala przewidzieć funkcjonowania w zakresie czynności związanych z koniecznością dalszego wsparcia oddechowego.

Słowa kluczowe: przewlekła wentylacja mechaniczna, odzwyczajanie od respiratora, APACHE, stan funkcjonalny, skala Barthel.

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Introduction

Patients requiring prolonged mechanical ventilation (PMV) pose a considerable medical, social, and economic burden for the healthcare system [1, 2]. The number of subjects being mechanically ventilated is predicted to increase, particularly among the elderly and patients with comorbidities [3]. Successful weaning from mechanical ventilation remains challenging from the clinical and organizational point of view [1, 2]. Therefore, the concept of specialized weaning centers has received increasing interest.

Being discharged from this type of unit is the first step of further rehabilitation [1, 2]. The discharge destination is influenced by a broad spectrum of health-related and social factors. Only subjects with adequate functional status and sufficient family support can safely return to a home environment. Those with impaired performance in activities of daily living or without satisfactory help of caregivers are usually transferred to rehabilitation centers or extended care facilities [1, 2]. The rehabilitation process is long-lasting, time-consuming, and multidisciplinary [4, 5]. Basically, it includes daily physical therapy and respiratory muscle strength training to overcome the sequelae of critical illness, malnutrition, and the side effects of artificial ventilation [4, 5].

Data regarding the functional status of patients after PMV are limited, and little is known about its clinical predictors [6–9]. Moreover, there is no widely accepted standard measure of functional independence and the need for assistance with mobility and self-care in this unique group of patients [10, 11]. Finally, no attempts have been made to assess the validity of the acknowledged intensive care unit (ICU) scoring systems in predicting functional status on discharge.

Aim

Therefore, we sought to investigate whether the Acute Physiology and Chronic Health Evaluation (APACHE) II score

Tab. I. Baseline characteristics of the study group

Variable	Median (IQR) or percent
Men/women	70.4/29.6
Age [years]	72 (62–77)
Postoperative respiratory failure	59.1
Chronic obstructive pulmonary disease	45.2
Acute respiratory distress syndrome	30.4
Pulmonary embolism	4.3
Pneumonia	98.3
Anemia	62.2
Any paresis or paralysis	32.2
Critical illness polyneuropathy	98.3
Phrenic nerve palsy	10.4
Neoplastic disease	13.0
Post-cardiac arrest syndrome	13.0
Dysphagia	100.0

on admission may predict performance in activities of daily living in patients discharged from weaning centers.

Material and methods

In this retrospective analysis, we enrolled 130 consecutive patients admitted to a weaning center (Weaning Station Neuerburg) between January 1, 2012 and December 31, 2013. During this period, 15 (11.5%) subjects died, while 115 (88.5%) patients were successfully discharged.

The indications for admission were based on the guidelines of the German Respiratory Society [12]. The treatment strategy and weaning procedures were implemented according to the nationwide recommendations [12], with adjustment to local standards. More details regarding this issue have been published previously [13].

Data covering demographics, comorbid conditions, and clinical variables were retrieved from medical records. Clinical and laboratory data were recorded on the first day of admission. The APACHE II score was calculated [14] based on the worst values taken during the first 24 h after admission. To eliminate the possible confounding effect of analgesic and sedative agents on the scoring, we excluded the Glasgow Coma Scale (GCS) (baseline median RASS = –1 points; IQR –2 to +1) [15]. Patient confidentiality was ensured as the dataset was fully anonymized. The Ethics Committee of the Medical University of Silesia approved the study with a waiver of consent because the project was non-interventional.

The outcome measures included performance in activities of daily living on discharge (the overall status and subsequent items). We calculated the Barthel Index (BI) and its extended version, the Early Rehabilitation Barthel Index (ERBI) [16].

Statistical analysis

Statistical analysis was performed using MedCalc Statistical Software version 14.8.1 (MedCalc Software bvba, Ostend, Belgium). Continuous variables are expressed as medians and interquartile ranges (IQR, i.e. 25th; 75th percentile). Qualitative variables are expressed as percentages. Intergroup differences in quantitative variables were assessed using the Mann-Whitney *U*-test after the type of distribution was verified using the Shapiro-Wilk test. Correlation was determined using Spearman's rank coefficient. The area under the receiver operating characteristic curve (AUROC) was calculated to determine the ability of the APACHE II score to predict performance in activities of daily living as independent variables. A *p*-value < 0.05 was considered significant.

Results

This final analysis covered 115 survivors (34 women and 81 men) discharged from a weaning center. The subjects' baseline characteristics, including major health conditions with serious impact on functional status, are shown in Table I. The median APACHE II score (excluding the GCS) was 11 points (8.25; 14).

The median stay in a weaning unit was 27 days (20; 36). Regarding discharge disposition, the majority of the patients (53.9%) were transferred to a rehabilitation center (Tab. II). The median BI was 20 points (5; 40), and the ERBI was 20 points (-50; 40) (Fig. 1). Both the BI ($p = 0.6$) and the ERBI ($p = 0.4$) were comparable between men and women.

There was no correlation between the APACHE II score and either the BI ($R = -0.07$; $p = 0.47$) or the ERBI ($R = -0.07$; $p = 0.44$) (Fig. 2). However, we found statistically significant but weak correlations between the APACHE II score and the scoring of two BI items: bathing ($R = -0.21$; $p = 0.02$) and transferring from bed to chair ($R = -0.19$; $p = 0.04$) (Tab. III).

The patients requiring any assistance with bathing ($p = 0.02$), grooming ($p = 0.04$), urination ($p = 0.04$), and toilet use ($p = 0.02$) had statistically significantly higher APACHE II scores (Tab. IV). Moreover, the APACHE II score predicted with good diagnostic accuracy the need for assistance with bathing (AUROC = 0.833; $p < 0.001$; cut-off of 9 points), grooming (AUROC = 0.823; $p < 0.001$; cut-off of 9 points), and toilet use (AUROC = 0.887; $p < 0.001$; cut-off of 9 points); it also predicted with moderate accuracy the need for assistance with urination (AUROC = 0.658; $p = 0.04$; cut-off of 10 points). Interestingly, the APACHE II

Tab. II. Weaning center discharge destinations

Discharge destination	Percent
Rehabilitation unit	53.9
Geriatric unit	13.9
Home	11.3
Surgical unit	7.8
Internal medicine unit	7.0
Rest home	5.2
Neurological unit	0.9

score had no impact on any items added to the ERBI in comparison to the BI.

Discussion

Prolonged weaning requires a holistic approach [17]. The physical health of PMV subjects treated in respiratory intensive care units is markedly worsened in comparison to the general population [18], and discharge destinations are influenced by a variety of patient-related factors. Patients with acceptable functional status return home directly or after complex rehabilitation programs. Those with poor

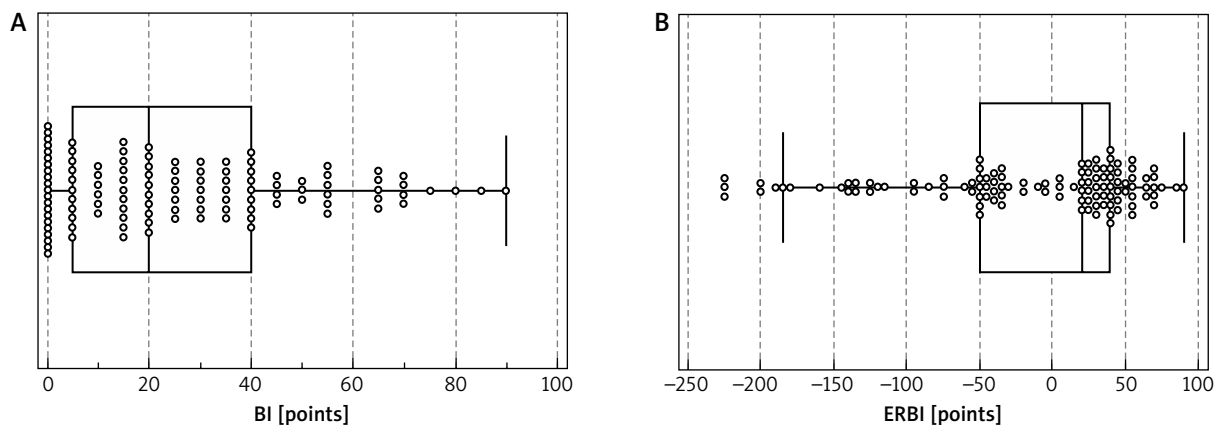


Fig. 1. Barthel Index (BI; A) and Early Rehabilitation Barthel Index (ERBI; B)

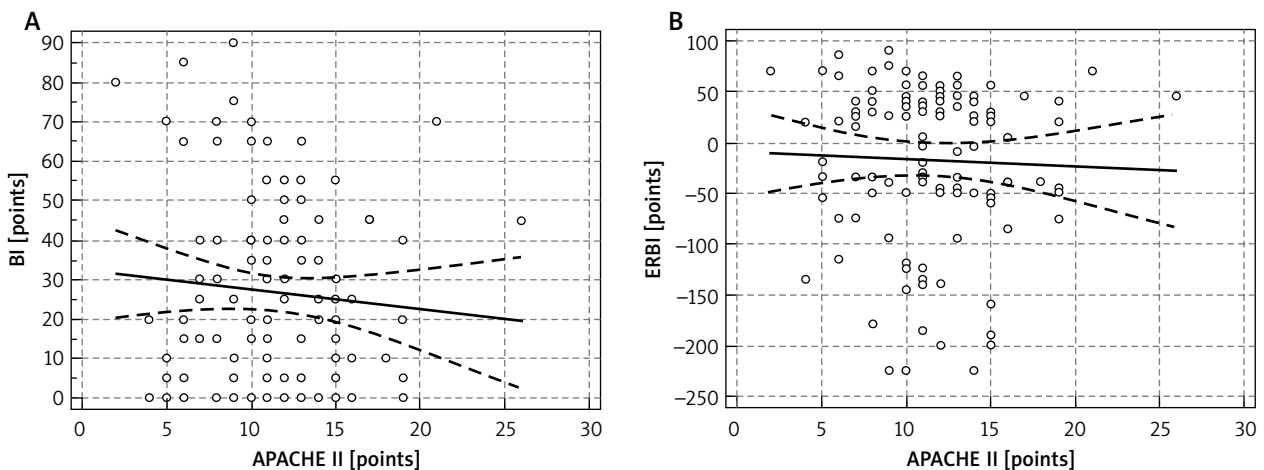


Fig. 2. Correlation between the APACHE II score on admission and the Barthel Index (BI; A) and Early Rehabilitation Barthel Index (ERBI; B) on discharge

Tab. III. Correlations between the APACHE II score and the items of the Barthel Index (BI)/Early Rehabilitation Barthel Index (ERBI)

BI/ERBI item	Spearman's rank correlation coefficient ('p')
Feeding	-0.09 ($p = 0.36$)
Bathing	-0.21 ($p = 0.02$)
Grooming	-0.05 ($p = 0.61$)
Dressing	-0.06 ($p = 0.52$)
Bowels	-0.02 ($p = 0.83$)
Bladder	-0.01 ($p = 0.88$)
Toilet use	-0.01 ($p = 0.88$)
Transfer (bed to chair and back)	-0.19 ($p = 0.04$)
Mobility (on level surfaces)	-0.03 ($p = 0.73$)
Stairs	-0.18 ($p = 0.06$)
Monitoring	-0.11 ($p = 0.25$)
Orientation	0.14 ($p = 0.13$)
Dysphagia	0.06 ($p = 0.56$)
Communication	0.17 ($p = 0.06$)
Behavior	0.06 ($p = 0.51$)
Tracheostomy	0.07 ($p = 0.43$)
Ventilation	-0.05 ($p = 0.62$)

functioning usually require additional care in long-term nursing facilities. Functional status is often recognized as the best predictor of outcome in patients liberated from mechanical ventilation [15, 19]. Therefore, we explored this interesting issue in terms of the association between baseline disease severity according to the APACHE II and performance in activities of daily living on discharge according to the BI/ERBI. To our knowledge, this is the first study to investigate this problem. Hence, it is difficult to compare our findings with others. Only Montagnani *et al.* [7] found that the Functional Independence Measure in ventilator-dependent patients in a weaning unit correlated negatively with the APACHE II score ($R = -0.286$).

No more than half of patients in weaning centers receive adequate physical therapy with regard to its frequency and intensity [20–22]. Nevertheless, it was confirmed that appropriate rehabilitation during hospital stay increases the BI approximately twofold and the weaning success by about 50% [21], while early mobilization is a positive independent factor contributing to being discharged home [23]. Ceriana *et al.* [24] also demonstrated that, after rehabilitation during respiratory ICU stay, the mean Dependence Nursing Scale score improved, decreasing from 23 to 12 points.

Using the Zubrod score, Scheinhorn *et al.* [25] revealed that 37.8% of the weaned subjects were bedridden for at least 50% of the time (with limited self-care), while 31.2% were fully bedridden. Overall poor functional status (i.e., Zubrod 3–4) was observed in 69% of patients on discharge, but it improved significantly by about 40% in survivors during a 1-year follow-up [25]. This is in line with the results of Bigatello *et al.* [26], who revealed that, in a cohort of

mechanically ventilated patients, the level of physical activity of daily living increased progressively from 24 ± 6 points (on a 100-point scale) at hospital discharge, through 54 ± 12 points at 3 months, to 64 ± 22 points at 6 months. Combes *et al.* [27] also showed that, in a 3-year follow-up, 99% of PMV survivors were functionally independent and living at home. However, one should bear in mind that post-discharge 3-year mortality often exceeds 50% [28].

In a group of patients requiring PMV after cardiac surgery, Engoren *et al.* [29] found that 16% of the patients were limited in their activities of daily living (eating, dressing, bathing), while 60% had limitations of moderate activity. Only 36% could climb stairs or walk uphill without limitations, and 54% could walk the length of one block [29]. It seems interesting that bathing has been recognized as a central care activity for PMV patients in a weaning unit, because it involves the overall patient's health condition and activity tolerance [30]. Other activities related to personal care and hygiene have also been highly valued by patients and caregivers [30]. Thus, our findings related to the association between the APACHE II score and bathing, grooming, and toilet use deserve special attention. There are also some data indicating that women have a better functional response when admitted to the ICU, spending less time ventilated and performing active exercises earlier [31], but we did not find any intergender differences in our study group.

Neuropsychiatric complications and abnormalities also compromise the outcome and reduce progress in rehabilitation. Weaning from PMV is associated with mental discomfort, with the development of post-traumatic disorders in 12% of patients 3 months after liberation from mechanical ventilation [32]. In a study by Rose *et al.*, thirst, lack of control, and noise were the most frequently recalled stressful situations from interdisciplinary ICUs, while medical procedures, night awakening, and inability to sleep were the most frequently recalled experiences from weaning centers [33]. Moreover, about 30% of the weaned patients experience neurological deficits, and 40% of the remaining group are diagnosed with depressive disorders [34].

To overcome the abovementioned drawbacks, several rehabilitation protocols for critical care nurses, nursing assistants, physical therapists, language pathologists, and psychologists have been suggested so far [35, 36]. When implemented early, they are feasible and safe; they do not increase costs and are associated with improved outcomes in survivors [36].

Study limitations

Firstly, each center has its own specific patient characteristics, admission and discharge criteria, weaning protocols, as well as diagnostic and therapeutic procedures. This limits the application of our findings in a broader context. On the one hand, direct comparisons of the results between units must, therefore, be limited and cautious. On the other hand, weakness, skeletal and inspiratory muscle dysfunction, swallowing problems, and the urgent need for total body (and mental) rehabilitation are nearly universal

Tab. IV. APACHE II score by items of Barthel Index/Early Rehabilitation Barthel Index

Item	Any assistance required (no. of patients)		APACHE II score	
			Median points (IQR)	AUROC; 95% CI ('p')
Feeding	Yes	74	11 (9; 14)	0.501; 0.406–0.596 (<i>p</i> = 0.98)
	No	41	12 (8; 13)	
Bathing	Yes	4	11 (9; 14)*	0.833; 0.752–0.896 (<i>p</i> < 0.001)
	No	111	8 (4.5; 9)	
Grooming	Yes	113	11 (8.75; 14)*	0.823; 0.741–0.888 (<i>p</i> < 0.001)
	No	2	7.5 (6; 9)	
Dressing	Yes	112	11 (8.5; 14)	0.552; 0.457–0.645 (<i>p</i> = 0.79)
	No	3	9 (8.25; 13.5)	
Bowels	Yes	94	11 (9; 14)	0.577; 0.482–0.669 (<i>p</i> = 0.28)
	No	21	10 (7.75; 13)	
Bladder	Yes	100	11 (9; 14)*	0.658; 0.563–0.744 (<i>p</i> = 0.04)
	No	15	9 (6.5; 11.75)	
Toilet use	Yes	112	11 (9; 14)*	0.887; 0.814–0.938 (<i>p</i> < 0.001)
	No	3	6 (3; 8.25)	
Transfer (bed to chair and back)	Yes	114	11 (8; 14)	NA
	No	1	9 (9; 9)	
Mobility (on level surfaces)	Yes	110	11 (9; 14)	0.620; 0.525–0.709 (<i>p</i> = 0.45)
	No	5	9 (7.5; 12.75)	
Stairs	Yes	115	11 (8.25; 14)	NA
	No	0	–	
Intensive care supervision	Yes	16	12 (10; 15)	0.586; 0.490–0.677 (<i>p</i> = 0.31)
	No	99	11 (8; 13)	
Confused patient in need of supervision	Yes	11	10 (6.75; 11.75)	0.639; 0.544–0.726 (<i>p</i> = 0.11)
	No	104	11 (8.5; 14)	
Dysphagia	Yes	33	11 (8.75; 14)	0.535; 0.440–0.628 (<i>p</i> = 0.56)
	No	82	11 (8; 14)	
Severe impairment of communication	Yes	18	10 (6; 11)	0.630; 0.535–0.718 (<i>p</i> = 0.06)
	No	97	11 (8.75; 14)	
Behavioral disturbances	Yes	10	10 (9; 12)	0.557; 0.461–0.649 (<i>p</i> = 0.53)
	No	105	11 (8; 14)	
Tracheostomy tube management	Yes	45	11 (9.5; 14)	0.544; 0.448–0.637 (<i>p</i> = 0.42)
	No	70	11 (8; 13.75)	
Mechanical ventilation	Yes	13	11 (10; 14.25)	0.534; 0.439–0.628 (<i>p</i> = 0.65)
	No	102	11 (8; 14)	

NA – not applicable; **p* < 0.05.

in all weaned patients, regardless of the abovementioned differences. Secondly, the retrospective nature of our study means that some data, particularly those related to baseline functional status, were unobtainable. Thirdly, we lack data concerning long-term survival and post-discharge performance in activities of daily living. However, we believe that these shortcomings have only a minor impact on the overall value of the study.

Conclusions

Although the APACHE II score cannot predict the overall functional status in patients on discharge from a weaning center, it helps identify subjects with the need for support with bathing, grooming, and toilet use. Unfortunately, the APACHE II score is inadequate in predicting performance in items particularly associated with further respiratory support.

Disclosure

Authors report no conflict of interest.

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