Critical Patient Neuromuscular Rehabilitation with DINABANG-Controlled Exercises: An Entropy First

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Summary

Neuromuscular rehabilitation for intensive care patients can be performed by isometric increasing force, provided it is properly quantified as is the case with DINABANG [1]. Two patients performed 5 feedback exercises in dorsal decubitus with coefficient of variation (CoV) 65% to 6% and Approximate Entropy 0.08 to 0.70 Arbitrary Units (AU). Initial measurements of each five trials series have greater coefficient of variation & lower entropy as neuromotor control benefits of visual DINABANG feedback.

Introduction

Neuromuscular rehabilitation is seldom performed to critical care patients, with deleterious effects to be corrected after discharge. To better preserve limb function, isometric exercises are planned by physical therapists with no monitoring nor quantified record of neuromuscular performance. Approximate Entropy (ApEn) [2], as calculated from the instant limb-developed force time series, reflects motor control, with high values indicating strong fine control and low entropy an impaired control. ApEn is a statistical measure of time series regularity. It reflects the probability that a similar pattern is NOT repeated, putting numbers to the imprecision of fluctuations in time series.

Figure 1: DINABANG applied to an Intensive Care Patient ankle strap and a horizontal bed bar. Note the Approximate Entropy and Force displayed on the tablet.

To optimize post intensive care (IC) muscular rehabilitation, we introduce here the concept of DINABANG-monitored exercises during hospitalization. The objective is to present the first ApEn measurements taken during IC rehabilitation.

Methods

We have estimated ApEn during 60% of maximal isometric quadriceps force, for 10 seconds, repeated five times for both limbs [3]. The two patients (F 68y, 160cm, 98Kg, BMI 39 & M, 65y, 182cm, 76Kg, BMI 23) had Chronic Obstructive Pulmonary Disease (COPD) with no cognitive impairment.

Torque is displayed in real time on a tablet as biofeedback (Figure 1), where ApEn and CoV are calculated after each trial [2]. The required force is displayed as a trajectory which its needed to be followed as precise the subject can; increasing up to 60% max force, then 10s plateau & decrease (Fig 1, right).

Results and Discussion

Table 1 Coefficient of variation & Approximate Entropy

	Patient 1				Patient 2			
	Left		Right		Left		Right	
	CoV	**ApEn**	**CoV**	**ApEn**	**CoV**	**ApEn**	**CoV**	**ApEn**
1	35,10	0,09	21,80	0,10	8,50	0,47	64,90	0,08
2	24,30	0,10	4,60	0,48	6,60	0,51	14,40	0,54
3	18,70	0,25	10,70	0,46	4,50	0,53	10,00	0,56
4	6,20	0,59	5,70	0,56	7,00	0,54	6,60	0,51
5	4,50	0,70	11,70	0,59	6,60	0,52	8,70	0,61
x̄ SD	17.76 ± 12.78	0.34 ± 0.34	10.9 ± 6.82	0.43 ± 0.19	6,64 ± 1.42	0,51 ± 0.02	20.92± 24.75	0,46 ± 0.21

Note: Patient 1 started with left limb, patient 2 with right limb. Coefficient of variation; CoV in percentage and Approximate Entropy; ApEn in AU.

Table 1 shows the CoV and ApEn of five successive tries of both limbs of the two patients. The range of CoV is from 65% at familiarization time down to 6% when the exercise is well understood (trial 5): motor control appears to train. ApEn, being a probability, ranges from 0.08 up to 0.70 AU, to describe 60% maximum force variability during the 10 seconds voluntary isometric tension guided by visual feedback on the DINABANG tablet (Figure 1).

Conclusions

The first ApEn and CoV values have been recorded with a standard clinical instrument, DINABANG, which paves the way to systematic recording of IC patient populations in need of keeping as intact as possible their neuromuscular control.

Acknowledgments

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References

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