

# Weaning

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## Weaning

**Bendixén (1965)**  
 "Sacar al paciente del VM 3-4" cada media hora y si tolera, aumentar el periodo de desconexión rápidamente"  
*Respiratory Care, Mosby*

**Egan (1977)**  
 "Cuando el paciente puede respirar sin asistencia por un día, moviendo una cantidad razonable de aire sin esfuerzo indebido, y puede caminar distancias cortas, y cuando la ventilación es satisfactoria para los GSA, es tiempo de considerar la remoción del TET"  
*Fundamentals of RT, 3rd ed. Mosby*

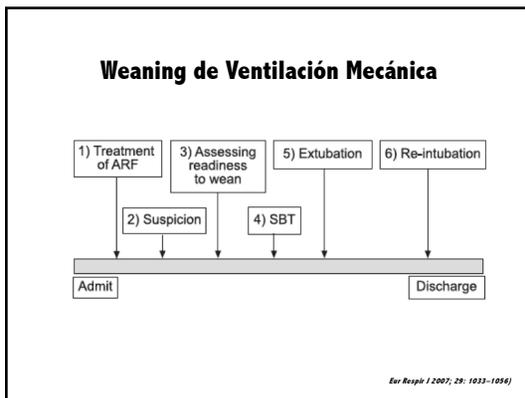
**80's**  
 IMV : lo más TOP (90% en USA)  
 CCM '8715:530-533

## Weaning de Ventilación Mecánica

- "Transferencia gradual del trabajo respiratorio desde el ventilador al paciente (> 48 hrs.)
- Puede corresponder hasta > 40% del tiempo de conexión a VM
- **DESCONEXION:**  
 RAPIDA (< 72 hrs. Post-op.)  
 PROGRESIVA



*Robbins, Chest 10th:1029-49 (1039)*  
 Mikiel Carbono writer: www.fppmthorax.com



## Weaning de Ventilación Mecánica

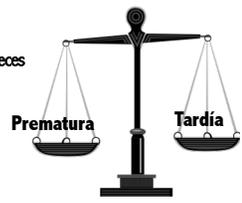
**TABLE 3** Classification of patients according to the weaning process

Group category	Definition
Simple weaning	Patients who proceed from initiation of weaning to successful extubation on the first attempt without difficulty
Difficult weaning	Patients who fail initial weaning and require up to three SBT or as long as 7 days from the first SBT to achieve successful weaning
Prolonged weaning	Patients who fail at least three weaning attempts or require >7 days of weaning after the first SBT

SBT, spontaneous breathing trial.

*Eur Respir J 2007; 29: 1033-1056*

## Momento de la Extubación



**Mortalidad 5 veces mayor**

- neumonía nosocomial
- Daño de mucosa
- Factores psicológicos.

**Criterios usados en estudios de Weaning:**

**Mediciones Objetivas:**

- Adecuada Oxigenación (PaO2 > 60 mmHg con FIO2 < 0,4; PEEP < 5-10 cmH2O; PaO2/FiO2 > 150-300)
- Estabilidad hemodinámica (FC < 140 lpm; PA estable; sin DVA o con uso mínimo)
- Afebril (T° < 38 °C)
- Sin acidosis respiratoria significativa
- Hemoglobina adecuada (> 8-10 gr/dL)
- Adecuado estado mental (consciente, GCS > 13, sin sedación continua)
- Estado metabólico estable (electrolitos adecuados)

**Evaluación clínica subjetiva:**

- Resolución de la patología de base; adecuado mecanismo de tos, que el médico crea posible la liberación de la VM

*Respir Care 2002;47(1):69 -90*

**TABLE 5** Considerations for assessing readiness to wean

<b>Clinical assessment</b>	Adequate cough Absence of excessive tracheobronchial secretion Resolution of disease acute phase for which the patient was intubated
<b>Objective measurements</b>	Clinical stability Stable cardiovascular status (i.e. FC <140 beats·min <sup>-1</sup> , systolic BP 90-160 mmHg, no or minimal vasopressors) Stable metabolic status Adequate oxygenation SpO <sub>2</sub> >90% on <FIO <sub>2</sub> 0.4 (or P <sub>a</sub> O <sub>2</sub> /FIO <sub>2</sub> >150 mmHg) PEEP <8 cmH <sub>2</sub> O Adequate pulmonary function R <sub>L</sub> <20 breaths·min <sup>-1</sup> MAP <20-25 cmHg V <sub>T</sub> >5 mL·kg <sup>-1</sup> VC >10 mL·kg <sup>-1</sup> RVV <100 breaths·min <sup>-1</sup> ·L <sup>-1</sup> No significant respiratory acidosis Adequate mentation No sedation or adequate mentation on sedation (or stable neurologic patient)

*Eur Respir J 2007; 28: 1033-1056*

**WEANING**

**Prueba de Ventilación Espontánea:**

- Tubo "T"
- Soporte ventilatorio bajo
- DURACION: 30 - 120 min.
- Parámetros : FR, FC, Pº, Sat, W musc, (Fatiga muscular)

**Duración de PVE**

• **Esteban et al:**

- PVE 120 min. v/s 30 min.
- Sin mayor diferencias.

— Recomendaciones:

- Tolerancia OK 30' : extubar
- Dudas : 120'

*AIRCW 159(2):512-518 (1999)*

**Parámetros de Falla durante el Weaning**

Factores que aumentan la carga		
> Carga Resistiva	> Carga elástica tórxica	> Carga elástica pulmonar
Broncoespasmo	Derrame pleural	Hiperinflación (PEEPi)
Edema de la VA, secreciones	Neumotórax	Edema alveolar
Obstrucción de la VA superior	Contusión costal	Infección
Apnea obstructiva del sueño	Obesidad	Atelectasia
Acodamiento del tubo endotraqueal	Ascitis	Inflamación y/o edema intersticial
Impacción de secreciones	Distensión abdominal	
Factores que afectan la competencia neuromuscular		
Drive disminuido	Debilidad muscular	Transmisión neuromusc. alterada
Sobredosis	Alteración electrolítica	Poliuropatía paciente crítico
Lesión cerebral	Malnutrición	Bloqueo neuromuscular
Deprivación del sueño	Micopalía	Amiglotósidos
Hipotiroidismo	Hiperinflación	Síndrome de Guillain Barré
Hambre / malnutrición	Drogas, corticoides	Miastenia Gravis
Alcalosis metabólica	Sepsis	Injuria del nervio frénico
Distrofia miotónica		Lesión medular

*Respir Care 2002;47(1):88 -90*

**WEANING**

**TABLE 2** Incidence of weaning success and failure

First author [Ref.]	Yr	Subjects	Failed initial SBT	Passed initial SBT	Re-intubated	Total failed weaning	Successful weaning
FARNA [24]	2001	257	56 (22)	201	28 (14)	84 (32.7)	173
ESTEBAN [22]	1999	526	73 (14)	453	61 (13)	134 (25.5)	392
VALVERDU [17]	1998	217	69 (32)	148	23 (9)	92 (42.4)	125
ESTEBAN [25]	1997	484	87 (18)	397	74 (9)	161 (25.3)	323
ESTEBAN [16]	1995	546	130 (24)	416	58 (14)	188 (34.4)	358
BUONOMO [18]	1994	456	100 (24)	347	8 (2)	117 (25.6)	339
<b>Total</b>		2486	524(21%)	1962(79%)	253(10%)	776 (31.2%)	1710(68.8%)

Data are presented as n or n (%), unless otherwise stated. SBT: spontaneous breathing trial

### WEANING

#### Métodos de Desconexión:

- TUBO " T "
- PRESION DE SOPORTE.
- SIMV.

### WEANING

#### Estudios con PVE fallida:

- BROCHARD → PSV ANZCCM 150 (4): 896-903 (1994)
- ESTEBAN → TUBO "T" NEJM 332 (6): 345-350 (1995)
- EN AMBOS IMV → FALLIDA

### La Mejor estrategia de Weaning....

**TENER UNA ESTRATEGIA**

### Weaning por Protocolos

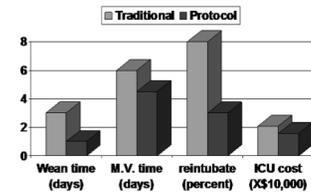
#### Guiados por Profesionales No Médicos

#### Ely et al.:

- 300 pacientes ventilados y evaluados bajo 4 criterios:
  - PaFi > 200
  - PEEP ≤ 5
  - Tos efectiva
  - Sin drogas vasoactivas o sedación.
- Randomizados:
  - weaning guiado por médico
  - Weaning guiado por protocolo

NEJM 335(21):1864-9 (1996)

#### Resultados (Ely et al)



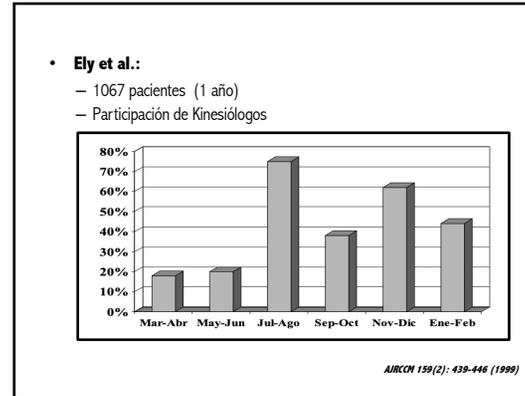
NEJM 335 (21):1864-9 (1996)

Ely et al. :

**COMPLICACIONES**

	Grupo Control	Grupo Protocolo
n	151	149
Reintubación < 48 hrs.	62 (41%)	30 (20%)
Traqueostomía	22 (15%)	13 (9%)
VM > 21 días	20 (13%)	9 (6%)

*NEJM 335(21):1864-9 (1996)*



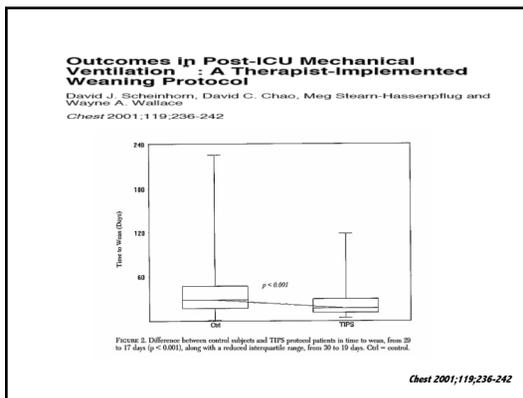
**Collaborative Practice: Development, Implementation, and Evaluation of a Weaning Protocol for Patients Receiving Mechanical Ventilation**  
 Mary Jo Grap, Dale Strickland, Laura Tormey, Kim Keane, Shannon Lubin, Joanne Emerson, Suzanne Winfield, Paul Dalby, Regina Townes and Curtis N. Sessler  
*Am J Crit Care 2003;12:454-460*

Table 3 Comparison of weaning outcomes before and after protocol implementation\*

Outcome	Before protocol (14 months of data, n=458)	After protocol (13 months of data, n=459)	pt	First 7 months of protocol (n=258)	Second 6 months of protocol (n=209)
Days of mechanical ventilation	7.00 (1-99, 10.4)	5.59 (1-58, 7.0)	.02	6.0 (1-158, 7.4)	5.09 (1-41, 6.43)
No. of ventilator shifts (8 hours)	20.95 (1-298, 31.2)	16.7 (1-175, 21)	.02	17.9 (1-175, 22.3)	15.3 (1-123, 19.3)
Days in intensive care unit	8.62 (1-117, 11.4)	7.93 (1-59, 8.2)	.29	7.98 (1-59, 8.1)	7.87 (1-149, 8.4)
Total charges for mechanical ventilation, \$	3372 (158-47,231, 5004)	2932 (174-30,456, 3673)	.13	3130 (174-30,456, 3879)	2695 (174-21,172, 3406)

\* All entries are means followed by range and SD in parentheses.  
 † Significance level of the comparison of values before and after implementation of the protocol.

*Am J Crit Care 2003; 12: 454-460.*



 **CHEST**

VOLUME 120 / NUMBER 6 / DECEMBER, 2001 Supplement

**Evidence-Based Guidelines for Weaning and Discontinuing Ventilatory Support\***

A Collective Task Force Facilitated by the American College of Chest Physicians; the American Association for Respiratory Care; and the American College of Critical Care Medicine

**Recommendation 8:** Weaning/discontinuation protocols that are designed for nonphysician health-care professionals (HCPs) should be developed and implemented by ICUs. Protocols aimed at optimizing sedation also should be developed and implemented.

*Rationale and Evidence (Grade A)*



**TASK FORCE**

**Weaning from mechanical ventilation**

J.-M. Boles<sup>a</sup>, J. Blon<sup>a</sup>, A. Connors<sup>b</sup>, M. Herridge<sup>c</sup>, B. Marsh<sup>d</sup>, C. Meloni<sup>e</sup>, R. Pearl<sup>f,g</sup>, H. Silverman<sup>h</sup>, M. Stanchina<sup>i</sup>, A. Vieillard-Baron<sup>j</sup>, T. Welte<sup>k</sup>

Statement of the Sixth International Consensus Conference on Intensive Care Medicine Organised jointly by the European Respiratory Society (ERS), the American Thoracic Society (ATS), the European Society of Intensive Care Medicine (ESICM), the Society of Critical Care Medicine (SCCM) and the Société de Réanimation de Langue Française (SRLF), and approved by the ERS Executive Committee, February 2007

**Recommendations**  
 Weaning should be considered as early as possible in patients receiving mechanical ventilation; a majority of patients can be successfully weaned on the first attempt. SBT is the major diagnostic test to determine if patients can be successfully extubated. The initial SBT should last 30 min and consist of either T-tube breathing or low levels of PS (5-8 cmH<sub>2</sub>O in adults < 10 cmH<sub>2</sub>O in paediatric patients) with or without PEEP. SIMV should be avoided as a weaning modality. Weaning protocols are most valuable in hospitals in which physicians otherwise do not adhere to standardised weaning guidelines.

*Eur Respir J 2007; 20: 1033-1056*



## Índice f/Vt

Table 1

Accuracy of the f/V<sub>t</sub> ratio to predict weaning outcome in different studies

Reference	Patients	Pretest probability of weaning success (%)	Likelihood ratio (95% CI)		Post-test probability of weaning success (%)	
			Positive <sup>a</sup>	Negative <sup>b</sup>	Positive <sup>a</sup>	Negative <sup>b</sup>
[6]	64 Medical patients	56	2.72 (1.50-5.17)	0.04 (0.00-0.37)	77 (85-87)	5 (0-32)
[10]	100 Medical patients	63	1.49 (1.04-2.35)	0.27 (0.08-0.88)	72 (84-79)	31 (12-60)
[11]	185 Postoperative patients	92	1.45 (1.07-2.56)	0.09 (0.02-0.54)	94 (92-97)	51 (17-86)
[12]	49 Medical patients (aged >70 years)	77	2.70 (0.93-11.7)	0.38 (0.15-1.10)	90 (78-97)	55 (33-79)

Results are expressed as likelihood ratio. <sup>a</sup>Positive test result is a value of rapid shallow breathing index (f/V<sub>t</sub>) lower than 105 or 100; <sup>b</sup>negative test result is a value of f/V<sub>t</sub> higher than 105 or 100.

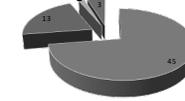
Crit Care 2000, 4:72-80

## RESULTADOS



Revista Chilena de Medicina Intensiva, Vol. 18(3): 196. 2003 (Abstract).

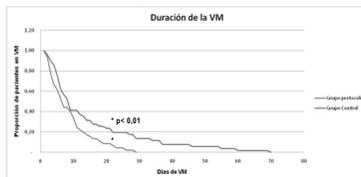
## Pacientes Ingresados a Protocolo: 62



	Control	Protocolo	n.s.
N	51	45	
Edad (años)	57 ± 17	58 ± 15	
Sexo Masc./Fem.	31 / 20	24 / 21	
Enfermedad pulmonar (%)	46.7	51.0	
Cirugía electiva (%)	35.3	31.1	
PaO <sub>2</sub> / FIO <sub>2</sub> en momento de PVE	322.2	312.1	
APACHE	19	17	

Revista Chilena de Medicina Intensiva, Vol. 18(3): 196. 2003 (Abstract).

## Protocolo de Weaning Hospital Clínico U. Chile



	Control	Protocolo	n.s.
N	51	45	
Duración de la VM (días)	15,3 ± 10,6	9,2 ± 6,7	p<0,01
Reintubación < 48 horas (%)	21,6	11,1	p<0,01
Pacientes con TQT (%)	21,6	8,9	p<0,001
VM > 21 días (%)	17,6	6,8	p<0,001

Revista Chilena de Medicina Intensiva, Vol. 18(3): 196. 2003 (Abstract).

## Protocolo de Weaning 60 Minutos



Grupo	PVE 120'	PVE 60'
N	45	53
Apache	17	15
Días VM	8,4	9,2

## Weaning from mechanical ventilation

J-M. Boles<sup>a</sup>, J. Bion<sup>a</sup>, A. Connors<sup>b</sup>, M. Herridge<sup>c</sup>, B. Marsh<sup>d</sup>, C. Melot<sup>e</sup>, R. Peari<sup>g</sup>, H. Silverman<sup>h</sup>, M. Stanchina<sup>h</sup>, A. Vieillard-Baron<sup>h</sup>, T. Welte<sup>h</sup>

Eur Respir J 2007; 29: 1033-1056

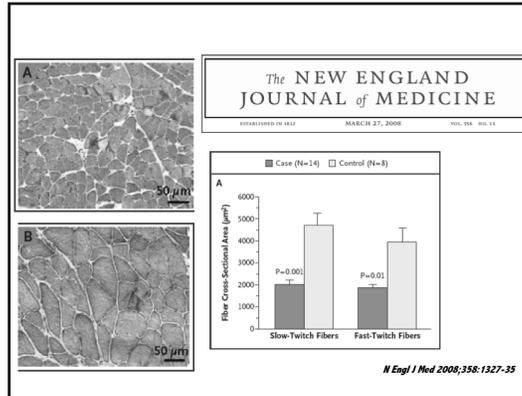
## Weaning Fallido

TABLE 2 Incidence of weaning success and failure

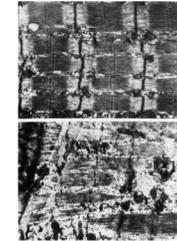
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Data are presented as n or n (%), unless otherwise stated. SBT: spontaneous breathing trial

## ¿ Fatiga o atrofia

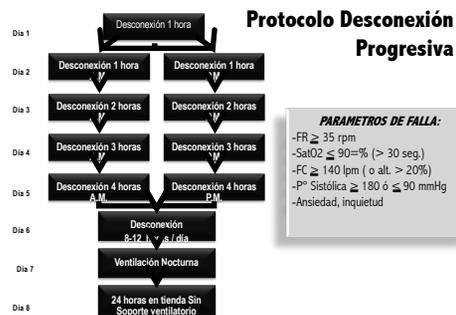


## Músculos Respiratorios



## ¿ Fatiga o atrofia ?

J Appl Physiol; 76(1):176-184 (1994)



## Uso PAV como método de weaning

Pacientes que no toleran PVE (< 10 min.)

PAV 80%



Parámetros de Tolerancia

- FR > 30 x (> 25%)
- Aleración > 25% FC
- Signos apremio
- Ansiedad, inquietud
- Hipertensión (>25%)



## Espacio Muerto



### TQT: Ventajas

Table 1. Possible Reasons Why Tracheostomy Might Facilitate Weaning

- Reduced dead space
- Less airway resistance
- Decreased work of breathing
- Better secretion removal with suctioning
- Less likelihood of tube obstruction
- Improved patient comfort
- Less need for sedation
- Better glottic function, with less risk of aspiration
- Ability to move patient out of the intensive care unit
- Changes in clinician behavior

Respir Care 2005;50(4):526-533

### Movilización Precoz y Weaning



### Weaning Dificultoso



### Independent Effects of Etiology of Failure and Time to Reintubation on Outcome for Patients Failing Extubation

SCOTT K. EPSTEIN and RONALD L. CIUBOTARU

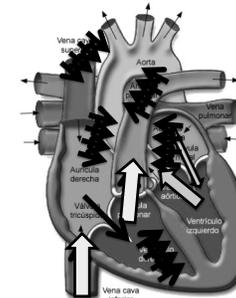
TABLE 3  
CAUSES OF EXTUBATION FAILURE

Cause of Extubation Failure	Patients*		Deaths <sup>†</sup>	
	(n)	(%)	(n)	(%)
Respiratory failure	21	28	12	57
Congestive heart failure	17	23	8	47
Aspiration/excess secretions	12	16	2	17
Upper airway obstruction	11	15	2	18
Encephalopathy	7	9	3	43
Other	6	8	4	67

\* Percentage of all patients (n = 74) requiring reintubation.  
<sup>†</sup> Percentage of patients dying compared with all patients reintubated secondary to that cause for extubation failure.

Am J Respir Crit Care Med 1998;158:489-493

### Weaning y Disfunción Cardíaca y P<sup>o</sup> Positiva



#### Disminuye el RV

- Disminuye la PreK VD
- Aumenta la PostK VD
- Disminuye el VS VD
- Disminuye preK VI
- Disminuye la postK VI
- Aumenta el VS VI
- Disminuye el VDF

### Weaning y Disfunción Cardíaca

**Presión Intratorácica (PIT):**

- Presión Negativa
- ↑ RV Sistémico ( $\Delta P^o$ )
- ↓ Gradiente eyección VI
- ↑ Volumen sanguíneo central
- EDEMA PULMONAR

*Pulmon 2007; 9(25): 47 - 50*

### Factors Associated With Failure of Weaning From Long-term Mechanical Ventilation After Cardiac Surgery

Emilia NOZAWA,<sup>1</sup> PT, Estela AZEKA,<sup>1</sup> MD, Maria Ignéz Z Zanetti FELTRIM,<sup>1</sup> PT, and José Otávio Costa AULER Júnior,<sup>1</sup> MD

Table IV. Comparison of Parameters of Cardiac, Renal, Pulmonary, and Neurological Function

Variable	Failure* (n = 27)	Success* (n = 25)	P Value <sup>b</sup>
LVEF (%)	48 ± 15.1	60 ± 13.6	0.0030
Use of vasoactive agents	23	11	0.0018
Need for dialysis	18	4	0.0003
Atelectasis	23	19	NS
Left pleural effusion	16	14	NS
Right pleural effusion	18	17	NS
Pneumonia	15	5	0.0086
Diaphragmatic paralysis	3	2	NS
Neurological changes	5	11	0.0467
GCS	5 ± 3	11 ± 4	0.0487

*Int Heart J 2005; 46: 819-831*

### Weaning y Disfunción Cardíaca

**EFFECTOS FISIOLÓGICOS DEL WEANING:**

- Paso a respiración espontánea.
- ↑ actividad de los MR.
- ↑ Consumo de O<sub>2</sub>.
- ↑ trabajo respiratorio
- ↓ Presión intratorácica
- ↑ tono simpático

↑ Demanda Cardíaca  
↑ Trabajo cardíaco

*Pulmon 2007; 9 : 2 : 47 - 50*

### Weaning y Disfunción Cardíaca

**Mecanismos Fracaso de Weaning**

- Isquemia Miocárdica
- Edema Pulmonar

*Chest 1996;109:1577-1583*

### Weaning de Ventilación Mecánica

**Tipos de Weaning**

- **Rápido o Simple** (< 8 – 10 horas, post-operatorio)
- **Programado:** Protocolos de Weaning  
Paciente con insuficiencia respiratoria ("Fatigado")
- **Progresivo :**
  - Paciente con atrofia muscular
  - Paciente con falla cardíaca

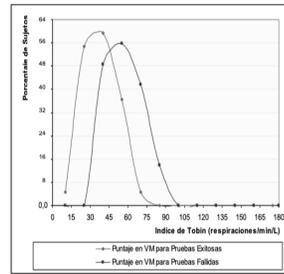
### Weaning de Ventilación Mecánica

**Tipos de Weaning**

¿Qué otras cosas hemos hecho?



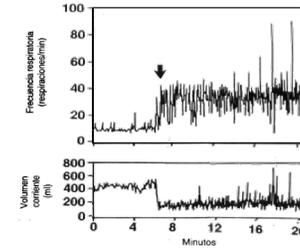
Puntajes en Ventilación Mecánica del índice de Tobin para pruebas exitosas y fallidas



PS 10 + CPAP 5  
PS 7 + CPAP 5

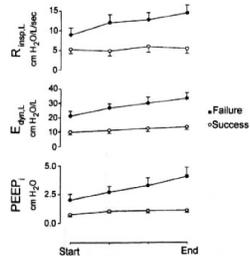
www.cybertesis.uchile.cl

IRRS



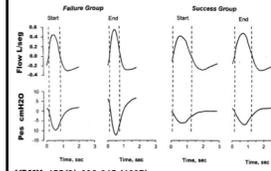
AIRCCH 134(6): 1111-1118 (1986)

Trabajo Respiratorio en pacientes que fallan el weaning



AIRCCH, 155(3):906-915 (1997)

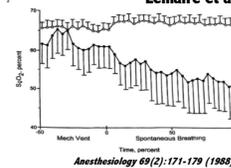
Jubran et al.



AIRCCH, 155(3):906-915 (1997)

"Hay "algo" en el acto de la respiración espontánea causaría el weaning fallido por empeoramiento de la mecánica pulmonar durante la PVE"

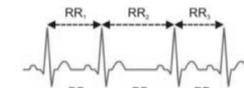
Lemaire et al.

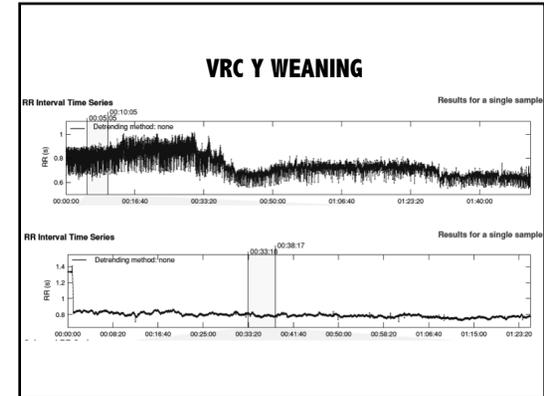
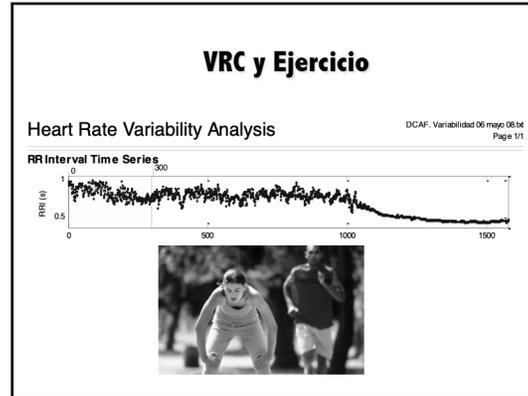
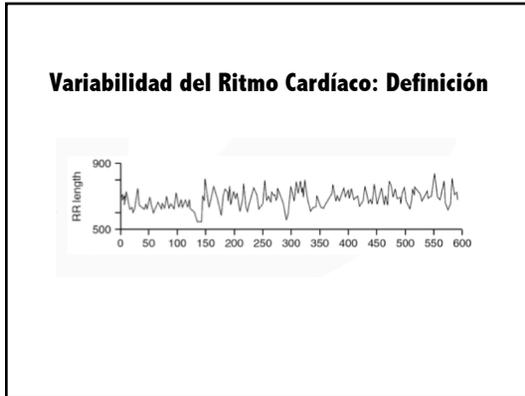


Anesthesiology 69(2):171-179 (1988)

Variabilidad del Ritmo Cardíaco: Definición

Medición estadístico-matemática de los cambios ocurridos en el ritmo instantáneo cardíaco por influencias del sistema nervioso autónomo (simpático-parasimpático).





- ### Datos Weaning (n=308)
- Promedio días VM general: 8,2 días (n=268)
  - Días VM (PDP): 25,3 días (n=40)
  - % VM prolongada: 13,0 %
  - Reintubación: 10,7 %
  - Días VM sin VM prolongada: 5,5 días (n=46)
  - Días VM < 48 h: 1,3 días
  - VMNI post-extubación: 10,7%

