

Papel de las pruebas de función respiratoria en la valoración preoperatoria de la Cirugía Torácica.

VIII Curso de Fisiología Respiratoria SOCALPAR.

Dr. F. del Campo Matías

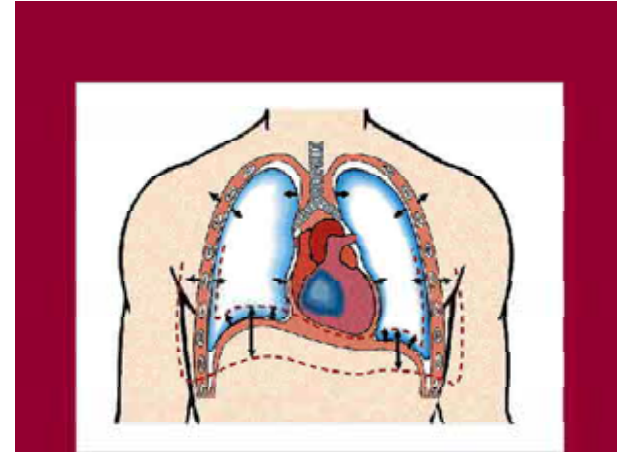
Servicio de Neumología

Hospital Universitario Río Hortega

Valladolid



EVALUACION PREOPERATORIA



Conceptos iniciales:

- ❖ Evaluación interdisciplinaria
- ❖ Riesgos asociados a la resección pulmonar

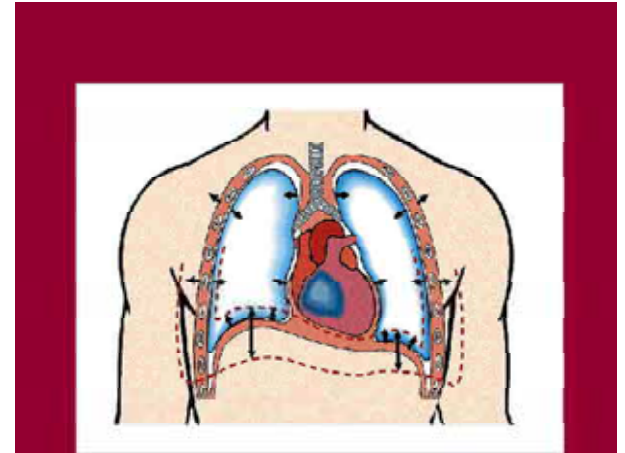
EVALUACION PREOPERATORIA

Conceptos iniciales:

- ❖ Importancia: . Mortalidad:1-9%
. Morbilidad:11-47%

Neumonectomia:	11.6%
Lobectomía	4,2%
Segmentectomía	3,7%

- ❖ Dificultades: -Definición imprecisa de complicaciones
-Cambios en las indicaciones
-Diversidad de técnicas



EVALUACION PREOPERATORIA

Complicaciones postoperatorias:

- ❖ Atelectasias pulmonares
- ❖ Broncoespasmo
- ❖ Insuficiencia respiratoria
- ❖ Necesidad de ventilación mecánica
- ❖ Exacerbación enfermedad de base
- ❖ Neumonías.
- ❖ Fístula broncopeural
- ❖ Neumotórax

EVALUACION PREOPERATORIA

TABLE 2. INFLUENCE OF SURGICAL SITE ON RATES OF POSTOPERATIVE PULMONARY COMPLICATIONS.

STUDY	YEAR	TYPE OF SURGERY				
		UPPER ABDOMINAL	LOWER ABDOMINAL	LAPAROSCOPIC CHOLECYSTECTOMY	THORACIC	ALL OTHER
% of cases with complications (total no. of cases)						
Pooler ³⁹	1949	19 (331)	11 (1334)			0.7 (4204)
Wightman ³	1968	19 (130)	6 (323)			0.6 (330)
Tarhan et al. ^{19*}	1973	13 (75)	7 (45)		10 (112)	3 (396)
Gracey et al. ^{6†}	1979	25 (57)	0 (7)		19 (21)	17 (72)
Garibaldi et al. ^{13‡}	1981	17 (201)	5 (208)		40 (102)	
Pedersen et al. ⁵	1990	33 (419)	16 (200)			3 (6687)
Southern Surgeons Club ⁴⁰	1991			0.3 (1518)		
Phillips et al. ²⁹	1994			0.4 (841)		
Brooks-Brunn ⁹	1997	28 (238)	15 (162)			

*Patients had moderate-to-severe chronic obstructive pulmonary disease. Complication was defined as postoperative death.

†Patients had chronic obstructive pulmonary disease.

‡Complication was defined as pneumonia.

EVALUACION PREOPERATORIA

TABLE 3. PROCEDURE-RELATED RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS.

RISK FACTOR	TYPE OF SURGERY	STUDY	INCIDENCE OF PULMONARY COMPLICATIONS		UNADJUSTED RELATIVE RISK ASSOCIATED WITH FACTOR
			WHEN FACTOR WAS PRESENT	WHEN FACTOR WAS ABSENT	
			percent		
Surgery lasting >3 hr	Unselected	Kroenke et al., ⁴ Pedersen et al., ⁵ Tarhan et al. ¹⁹	10–53	3–15	1.6–5.2
	Thoracic or abdominal	Garibaldi et al. ¹³	40	11	3.6
General anesthesia	Unselected	Gracey et al., ⁶ Tarhan et al. ¹⁹	8–19	0–17	1.2–∞
	Thoracic, abdominal, or vascular	Christopherson et al., ⁴¹ Yeager et al. ⁴²	28–32	11–12	2.2–3.0
Intraoperative pancuronium	Unselected	Berg et al. ⁴³	17*	5	3.2

*The value is the incidence among patients with residual neuromuscular blockade.

TABLE 1. POTENTIAL PATIENT-RELATED RISK FACTORS FOR POSTOPERATIVE PULMONARY COMPLICATIONS.

POTENTIAL RISK FACTOR*	TYPE OF SURGERY	STUDY	INCIDENCE OF PULMONARY COMPLICATIONS		UNADJUSTED RELATIVE RISK ASSOCIATED WITH FACTOR
			WHEN FACTOR WAS PRESENT	WHEN FACTOR WAS ABSENT	
			percent		
Smoking	Coronary bypass	Warner et al. ⁷	39	11	3.4
	Abdominal	Wightman, ³ Morton, ⁸ Brooks-Brunn ⁹	15-46	6-21	1.4-4.3
ASA class >II	Unselected	Wolters et al. ¹⁰	26	16	1.7
	Thoracic or abdominal	Brooks-Brunn, ⁹ Kroenke et al., ¹¹ Hall et al., ¹² Garibaldi et al. ¹³	26-44	13-18	1.5-3.2
Age >70 yr	Unselected	Wightman, ³ Pedersen ¹⁴	9-17	4-9	1.9-2.4
	Thoracic or abdominal	Garibaldi et al., ¹³ Thomas et al., ¹⁵ Calligaro et al. ¹⁶	17-22	12-21	0.9-1.9
Obesity	Unselected	Wightman ³	11	9	1.3
	Thoracic or abdominal	Brooks-Brunn, ⁹ Hall et al., ¹² Garibaldi et al., ¹³ Moulton et al., ¹⁷ Dales et al. ¹⁸	19-36	17-27	0.8-1.7
COPD	Unselected	Wightman, ³ Pedersen et al., ⁵ Tarhan et al. ¹⁹	6-26	2-8	2.7-3.6
	Thoracic or abdominal	Kroenke et al. ¹¹	18	4	4.7

*ASA denotes American Society of Anesthesiologists, and COPD chronic obstructive pulmonary disease.

Indice de riesgo cardiaco de Goldman

Factor	Puntos
• Edad > 70 años	5
• IM en los 6 meses previosnths	10
• S3 o distensión yugular	11
• Estenosis aórtica	3
• Alteraciones del ritmo o extrasistoles auric	7
• >5 PVC/min documentadas antes operación	7
• PO2 <60 or PCO2 >50 mmHg;	3
• Operación intratoráica o aórtica	3
• Intervención de urgencia	4

Indice de riesgo:

Clase I = 0-5 puntos (bajo), Class II = 6-12 puntos (intermedio),
Class III = 13-25 puntos (alta), Class IV => 25 puntos (muy alta)

Estudio caso control cirugía abdominal:

59% complicaciones pulmonares

15% complicaciones cardiacas

26% ambas complicaciones

Mayor estancia hospitalaria (22.5 vs 10.4 días)

Mayor mortalidad

Incidence and hospital stay for cardiac and pulmonary complications after abdominal surgery.

Lawrence VA - J Gen Intern Med 1995; 10(12): 671-8

Espirometría: Indicaciones en la evaluación preoperatoria

- ✓ Todos los pacientes que se les realice resección pulmonar
- ✓ Tabaco o disnea para cirugía coronaria o abdominal
- ✓ Disnea o síntomas pulmonares para cirugía abdominal, ortopédica o neuroquirúrgica

*Preoperative pulmonary function testing.
American College of Physicians.
Ann Intern Med 1990; 112:793-794*

Indicaciones en la evaluación preoperatoria Función pulmonar

- ✓ Indicado en todos los pacientes
- ✓ Finalidad:
 - Que pacientes son candidatos a cirugía?
 - Tolerancia de la extensión

Evaluación preoperatoria

Exploración funcional pulmonar

✓ Tests:

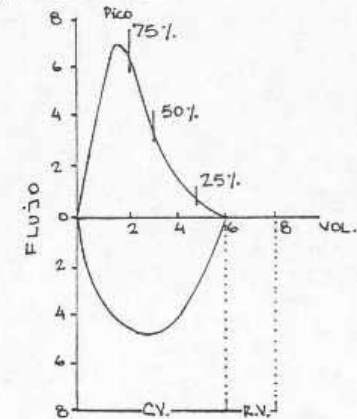
1. **Mecánica respiratoria:**-Espirometría
 - VVM
 - Volúmenes pulmonares
2. **Intercambio gaseoso:** -Difusión
 - Gasometría arterial/oximetría
3. **Reserva cardiopulm.:** -Test de la marcha
 - Test escalera
 - Prueba de esfuerzo

UTILIDAD DE LA ESPIROMETRIA EN LA EVALUACION PREOPERATORIA

- Sencillo, estandarizado, accesible, económico
- Múltiples parámetros:
 - FVC
 - FEV1
 - MMEF
 - VVM



Figura 3: Curva Flujo-Volumen Normal



EVALUACION FUNCIONAL PREOPERATORIA

ESPIROMETRIA

FEV1

	Neumonectomia	Lobectomia
Boushy	> 2L	
Wernly	> 2 L	> 1,5 L
Loddenkemper	>2,5 L	>1,75
Pate (1996)		> 1.6
Miller	> 2 L	> 1 L
Stephan (2000)	> 2 L	

EVALUACION FUNCIONAL PREOPERATORIA ESPIROMETRIA

FEV1 %

	Resección
Mittman	> 70%
Nagasaki/Pate	> 40%

BTS: FEV1 > 80%

Table 4 Univariate analysis of the perioperative variables contributing to the occurrence of pulmonary complications following a lobectomy

<i>Variable</i>	<i>Category</i>	<i>No of patients</i>	<i>No (%) of patients with pulmonary complications</i>	<i>p value</i>
Serum LDH (U/l)	<230	83	16 (19.3%)	0.007
	≥ 230	6	4 (66.7%)	
FVC (%)	<80	5	3 (60.0%)	0.04
	≥ 80	84	17 (20.2%)	
Pao ₂ (kPa)	<10.6	15	8 (53.3%)	0.002
	≥ 10.6	74	12 (16.2%)	

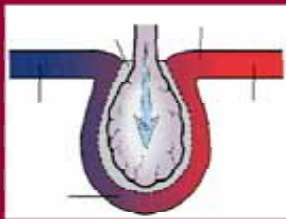
LDH = lactate dehydrogenase; FVC = forced vital capacity; Pao₂ = arterial oxygen tension.

Table 5 Multivariate analysis of the perioperative variables contributing to the occurrence of pulmonary complications following a lobectomy

<i>Variable</i>	<i>Category</i>	<i>Odds ratio</i>	<i>95% confidence interval</i>	<i>p value</i>
Serum LDH (U/l)	≥ 230	10.530	1.434 to 77.331	0.0207
	<230	1		
RV/TLC (%)	≥ 30	6.015	1.074 to 33.688	0.0412
	<30	1		
Pao ₂ (kPa)	<10.6	5.584	1.407 to 22.168	0.0145
	≥ 10.6	1		

LDH = lactate dehydrogenase; RV = residual volume; TLC = total lung capacity; Pao₂ = arterial oxygen tension.

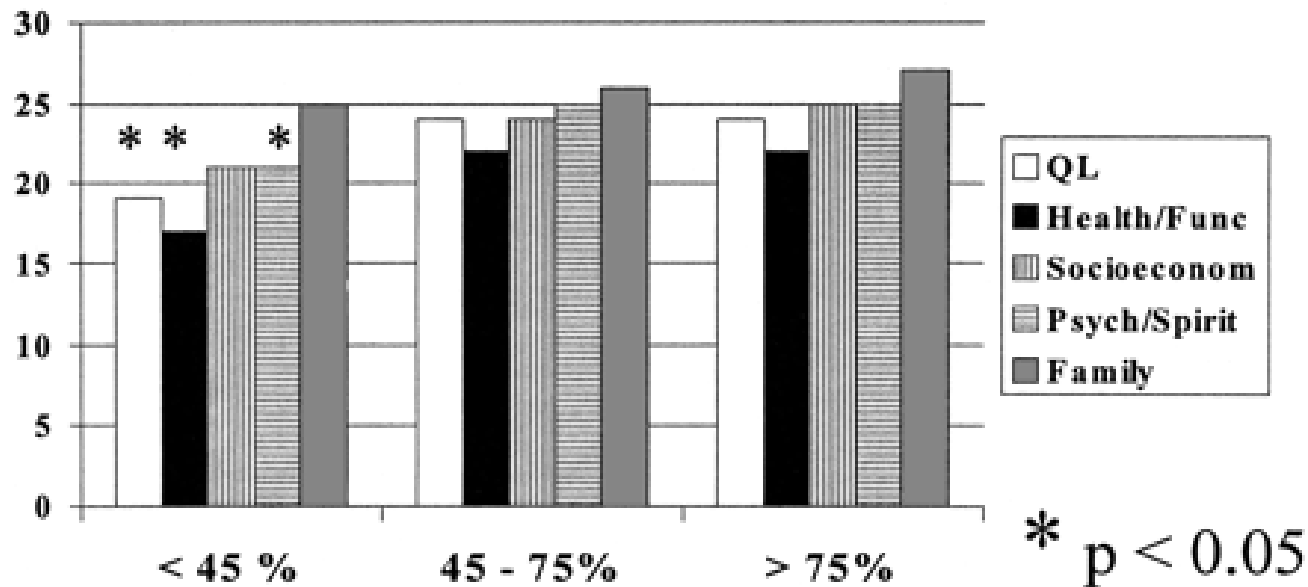
*Prediction of pulmonary complications after lobectomy in patients with NSCLC
Uramoto. Thorax 2001; 56:59-61*



EVALUACION FUNCION PULMONAR PREOPERATORIA DIFUSION PULMONAR

	Neumonectomia	Lobectomia
Cander (1963)	< 50%	
Nagasaki (1982)	< 50%	
Ferguson (1988)	< 60%	Doble complicaciones 80%

EVALUACION FUNCION PULMONAR PREOPERATORIA DIFUSION PULMONAR Y CALIDAD DE VIDA



What Happens to Patients Undergoing Lung Cancer Surgery? Outcomes and Quality of Life Before and After Surgery

John R. Handy. Chest 2002; 122:21-30

EVALUACION FUNCION PULMONAR PREOPERATORIA GASOMETRIA ARTERIAL

- **RIESGO QUIRURGICO**
- Hipercapnea ($PCO_2 > 45$): cuestionada como criterio de exclusión
- Hipoxemia y SaO_2 ($PaO_2 < 50$): Incremento de riesgo complicaciones

EVALUACION FUNCIONAL PREOPERATORIA

SUMARIO

	Neumonectomia	Lobectomia
FEV1	> 2L o > 60%	> 1L
VVM	> 55%	> 40%
DLCO	> 50%	> 50%
FEF25-75	> 1.6 L/s	> 0.6 L/s

UTILIDAD DE LA ESPIROMETRIA EN LA EVALUACION PREOPERATORIA

STUDY	YEAR	TYPE OF SURGERY	INCIDENCE OF PULMONARY COMPLICATIONS		RR ASSOCIATED WITH ABNORMAL FINDINGS (95% CI)*
			AMONG PATIENTS WITH ABNORMAL SPIROMETRIC FINDINGS	AMONG PATIENTS WITH NORMAL SPIROMETRIC FINDINGS	
			% (total no. of cases)		
Collins et al. ⁴⁹	1968	Upper abdominal	44 (25)	17 (95)	2.6 (1.4–4.9)
Stein and Cassara ⁵⁰	1970	Unselected	42 (48)	10 (29)	4.0 (1.3–12.4)
Appleberg et al. ⁵⁰	1974	Unselected	16 (76)	8 (24)	1.9 (0.5–7.9)
Fogh et al. ⁵¹	1987	Abdominal	27 (22)	16 (100)	1.7 (0.8–3.9)
Poe et al. ⁵²	1988	Cholecystectomy	34 (38)	11 (171)	3.3 (1.8–6.1)
Svensson et al. ^{53†‡}	1991	Aortic	49 (47)	32 (44)	1.5 (0.9–2.6)
Kispert et al. ⁵⁴	1992	Vascular	23 (62)	6 (85)	3.8 (1.5–10.1)
Kroenke et al. ^{11§}	1993	Abdominal and thoracic	52 (52)	39 (52)	1.4 (0.9–2.1)
Kocabas et al. ⁴⁵	1996	Upper abdominal	50 (16)	30 (44)	1.7 (0.9–3.3)
Bando et al. ^{55‡}	1997	Cardiac	11 (67)	10 (301)	1.0 (0.5–2.2)
Jacob et al. ⁵⁶	1997	Coronary bypass	45 (107)	50 (56)	0.9 (0.6–1.3)

UTILIDAD DE LA ESPIROMETRIA EN LA EVALUACION PREOPERATORIA

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Table 4—Preoperative Pulmonary Function Tests in 243 Patients*

Parameters	Patients With Pulmonary Complications (n = 63)	Patients Without Pulmonary Complications (n = 180)	p Value
FEV ₁ , L (range)	2.11 ± 0.71 (0.88–3.89)	2.51 ± 0.73(0.98–5.59)	0.0002
FEV ₁ , % predicted, (range)	0.76 ± 0.22 (0.31–1.27)	0.85 ± 0.20 (0.30–1.36)	0.006
FEV ₁ -ppo, L (range)	1.48 ± 0.57 (0.55–2.89)	1.74 ± 0.68 (0.70–4.70)	0.006
FEV ₁ -ppo, % predicted, (range)	0.53 ± 0.18 (0.17–1)	0.59 ± 0.21 (0.22–1.26)	0.04
FVC, L (range)	3.19 ± 0.96 (1.18–6.05)	3.51 ± 0.92 (1.44–7.20)	0.02
FVC, % predicted, (range)	0.86 ± 0.24 (0.36–1.47)	0.94 ± 0.19 (0.25–1.47)	0.01
FEV ₁ /FVC, (range)	0.69 ± 0.13 (0.38–0.98)	0.71 ± 0.1 (0.39–0.94)	NS
PaO ₂ at FIO ₂ 0.21, mm Hg	80.4 ± 12.9	83.0 ± 13.5	NS
Paco ₂ , mm Hg	40.0 ± 4.6	36.9 ± 4.7	<0.001
Paco ₂ > 45 mm Hg, No. (%)	7 (11)	8 (4)	0.08

*FIO₂ = fraction of inspired oxygen.

266 pacientes. Retrospectivo.
Lobectomia 53%, neumonectomia 33%
25% complicaciones

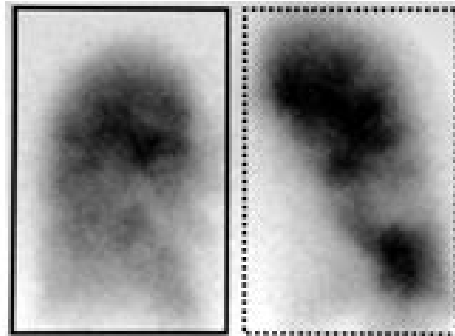
Puntuación ASA > 3
Duración intervención > 80 m
Ventilación asistida > 48 m

Pulmonary complications following lung resection
Stephan F. Chest 2000; 118:1263-1270

EVALUACION PULMONAR PREOPERATORIA PRUEBAS FUNCIONALES UNILATERALES

- Gammagrafia V/Q cuantitativa (Xe, Tecnecio)

```
BOX ROI STATISTICS
Display position = 1/2
Area of ROI = LEFT 3800
Total counts = 529983
Mean count = 139.469
Std. dev. = 127.878
Maximum count = 477
Max. count at (89 ,41 )
Minimum count = 0
Min. count at (102,17 )
Size - width = 50
      - height = 76
Resolution - width = 12
           - height = 12
```



```
Display position = 1/1
Area of ROI = RIGHT 3800
Total counts = 437937
Mean count = 115.247
Std. dev. = 104.772
Maximum count = 432
Max. count at (47 ,49 )
Minimum count = 0
Min. count at (15 ,17 )
Size - width = 50
      - height = 76
Resolution - width = 12
           - height = 12
```

$FEV1_{ppn}\% = (1 - \% \text{ flujo sanguineo}) \times FEV1_{\text{preoperatorio}} \text{ ml}$

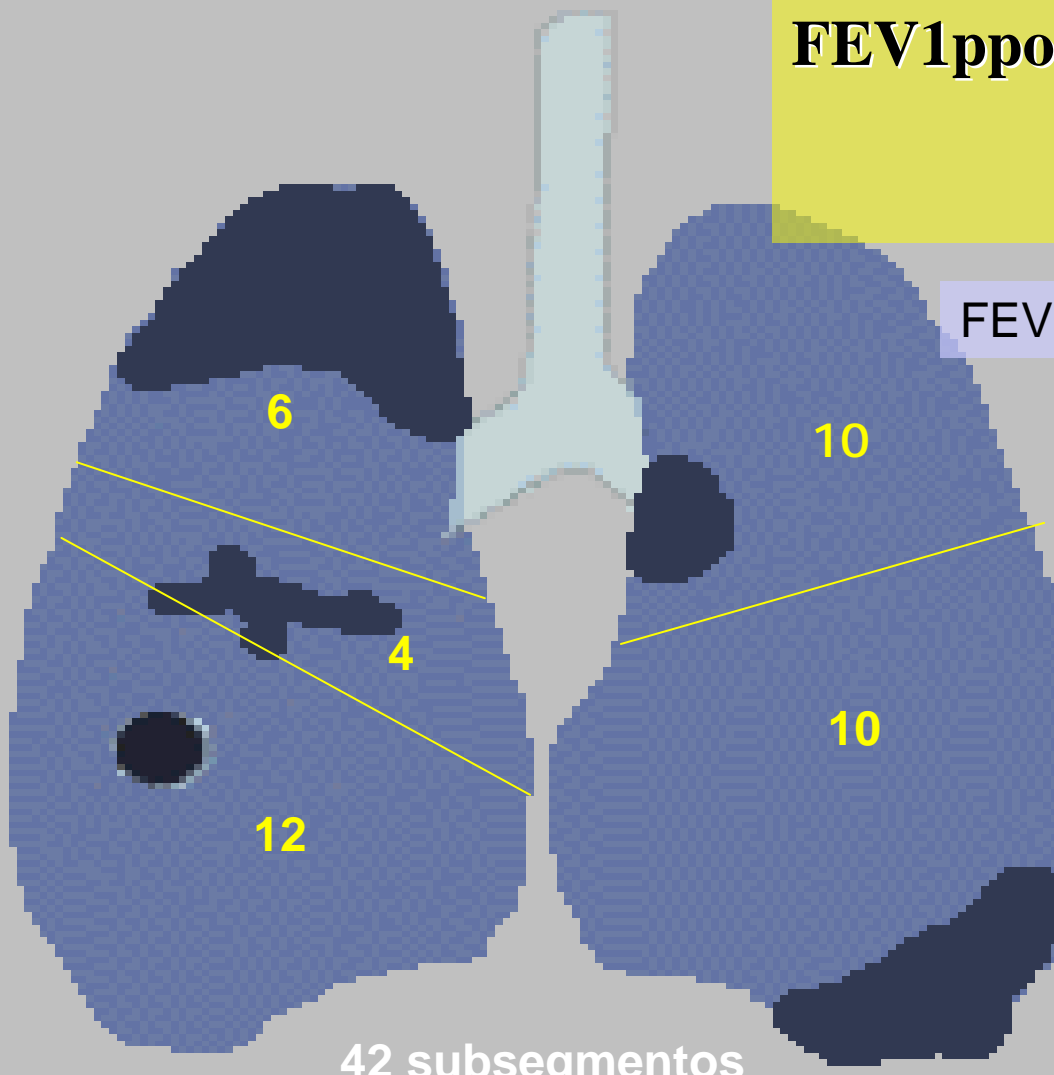
**FEV1 ppo: 1000 ml (Xenón)
FEV1 ppn: 800 ml (Tecnecio)**

**FEV1 ppo: < 40%
FEV1 ppn: < 35%**

EVALUACION PULMONAR PREOPERATORIA PRUEBAS FUNCIONALES UNILATERALES

$$\text{FEV1ppo\%} = \% \text{ segmentos resecar} \times \text{FEV1 predicho \%}$$

$$\text{FEV1-ppo} : \text{FEV1} \times (1 - [S \times 5.26]/100)$$



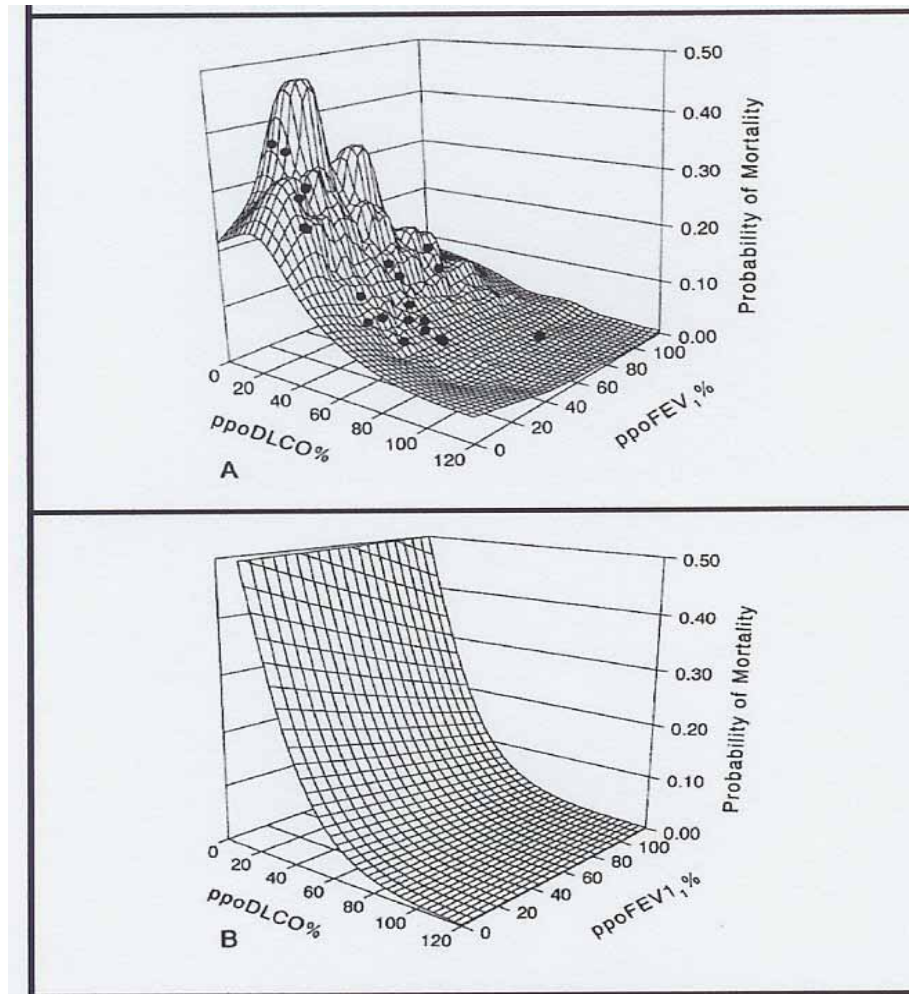
FEV1 = 1800

Neumonectomía izquierda

$$\text{FEV1 ppo} = 20/42 \times 1800 = 0.86$$

EVALUACION PULMONAR PREOPERATORIA PRUEBAS FUNCIONALES UNILATERALES

DLCO ppo



*Ferguson MK. Optimizing selection of patients for major lung resection.
The journal of thoracic and cardiovascular surgery 1995.*

EVALUACION PULMONAR PREOPERATORIA

FEV1 ppo < 800
FEV1 ppo < 35-40%



VALORACION RESERVA CARDIOPULMONAR

- Test de esfuerzo
- Test de la marcha
- Test de la escalera

Guidelines on the selection of patients with lung cancer for surgery BTS/SCTS

Función pulmonar

Lobectomía: FEV1 > 1.5 l
Neumonectomía: FEV1 > 2 l

si

No más estudios

no

- DLCO
- SaO₂
- Gammagrafía Q

FEV1 post >40%
DLCO post >40%
SaO₂>90%

Riesgo medio

FEV1 post <40%
DLCO post <40%

Riesgo alto

ALGORITMO EVALUACION PREOPERATORIA CANDIDATO A RESECCION PULMONAR

Función pulmonar

FEV1 > 60%; DLCO > 60%

SI

CIRUGIA

NO

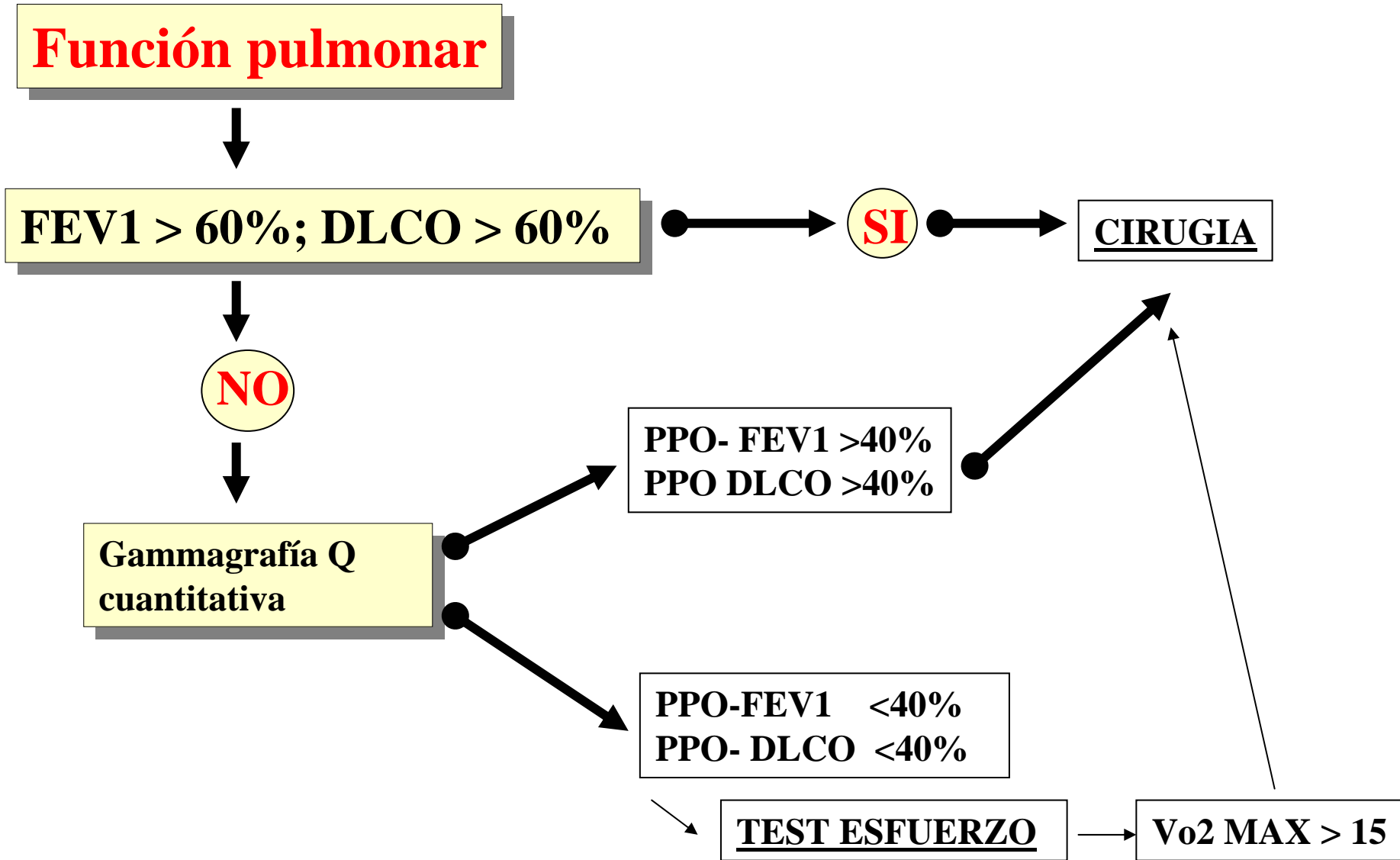
**Gammagrafía Q
cuantitativa**

**PPO- FEV1 >40%
PPO DLCO >40%**

**PPO-FEV1 <40%
PPO- DLCO <40%**

TEST ESFUERZO

Vo2 MAX > 15



EVALUACION FUNCION PULMONAR PREOPERATORIA RECOMENDACIONES

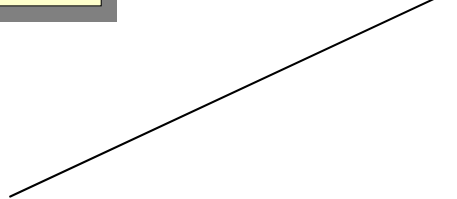
ESPIROMETRIA

FEV1 > 60% o > 2 L/1,5 L

CIRUGIA

DLCO > 60%

**ESTUDIOS FUNCIONALES
ADICIONALES**



EVALUACION FUNCION PULMONAR PREOPERATORIA RECOMENDACIONES

ESTUDIOS FUNCIONALES ADICIONALES

Gammagrafia

SI

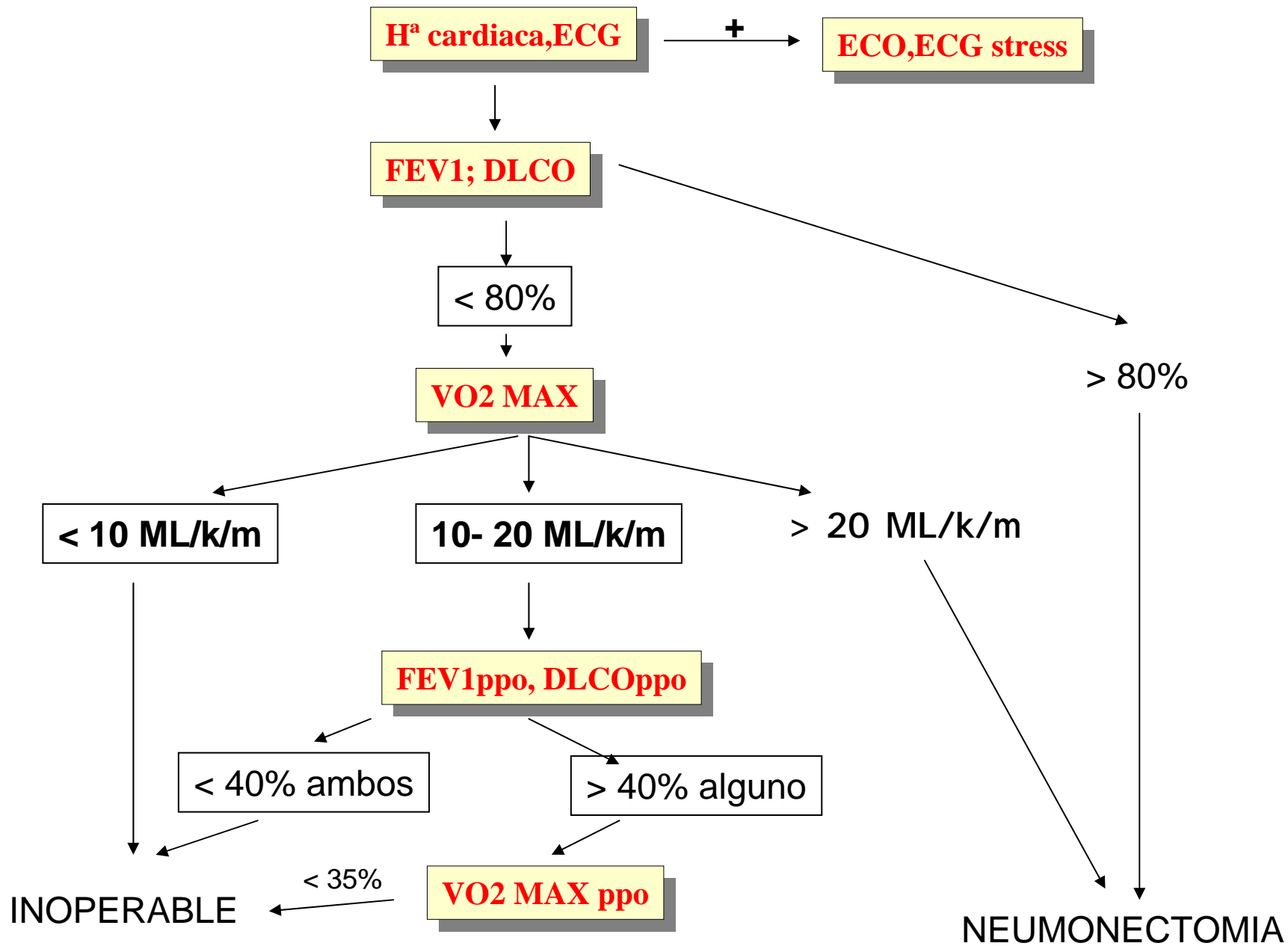
FEV1 ppo > 40%
DLCO ppo > 40%

NO

TEST ESFUERZO

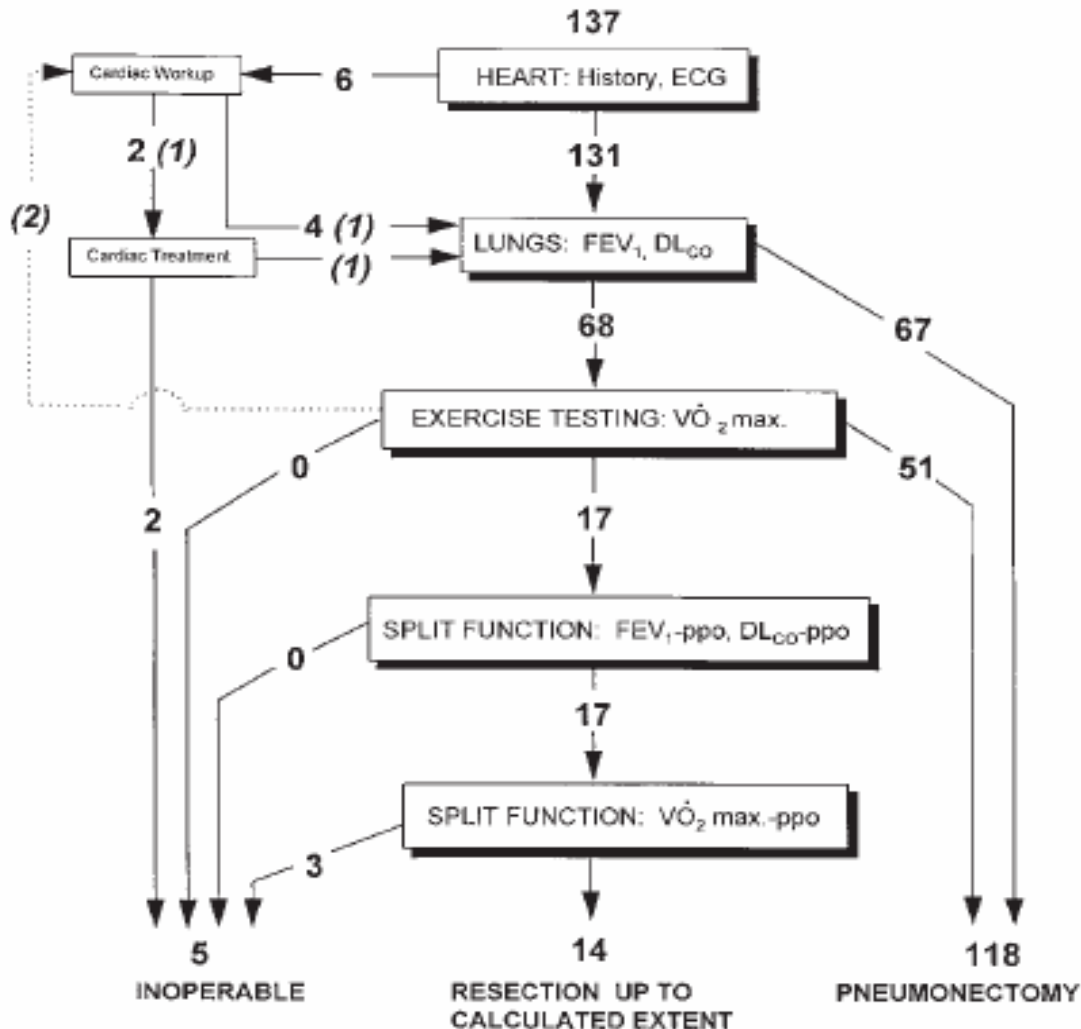
VO₂max > 15 ml/kg/m

CIRUGIA



Wyser C et als.

Prospective evaluation of an algorithm for the functional assesment of lung resection
Am J Respir Crit Care Med 1999; 159:1450-1456



Mortalidad: 1.5%
Morbilidad: 11%

INDICE DE RIESGO MULTIFACTORIAL



INDICE DE RIESGO CARDIOPULMONAR DE EPSTEIN (1993)

IRC	Nº	IRP	Nº
ICC	11	Obesidad > 27	1
Inf miocardio	10	Tabaquismo	1
>5 CVP	7	Tos productiva	1
Trastornos ritmo	7	Sibilancias	1
Edad > 70	5	FEV1/FVC < 70%	1
Estenosis aortica	3	PaCO2 > 45	1
Pobre condición	3		

IRC= 0-5= 1 punto, 6-12= 2 puntos, 13-25= 3 puntos, > 25= 4 puntos

IRP= 0-6 puntos

*Epstein SK. Predicting complications after pulmonary resection. Preoperative exercise testin vs mcri
Chest 1993; 104:694-700*

INDICES DE RIESGO MULTIFACTORIAL



Autor	Pacientes	Indice usado	Conclusiones
Epstein	42	CPRI: Pulmonar +Goldman	CPRI>4 OR > 19
Prause	845	Goldman,ASA	ASA>3 Alto riesgo. No CRI
Ferguson	400	EVAD	
Brunelli	250	Physiological and operative severity score for the enumeration of mortality and	
Arozullah	181.000	morbidity (POSSUM)	

EVALUACION FUNCION PULMONAR PREOPERATORIA RECOMENDACIONES

1. Los test de función pulmonar están indicados en todo paciente que sea sometido a cirugía de resección pulmonar
2. Un FEV1 y/o DLCO > 60% indican bajo riesgo
3. Los test de función pulmonar unilaterales están indicados en pacientes con FEV1 y/o DLCO < 60%
4. Un %FEV1ppo y %DLCOppo < 40% indica alto riesgo operatorio
5. Las pruebas de esfuerzo pueden aportar información importante en la evaluación de estos pacientes. Un VO2 max < 10 mL/kgr/min indican alto riesgo pulmonar
6. No existe un Índice de riesgo quirúrgico pulmonar validado