Aspectos clínicos y pronósticos de las Neoplasias Mieloproliferativas

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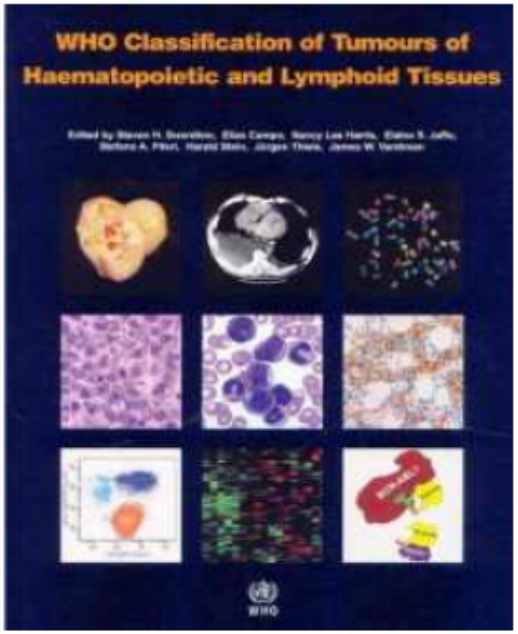
Trujillo 28 Agosto 2015

WHO Classification of the MPNs

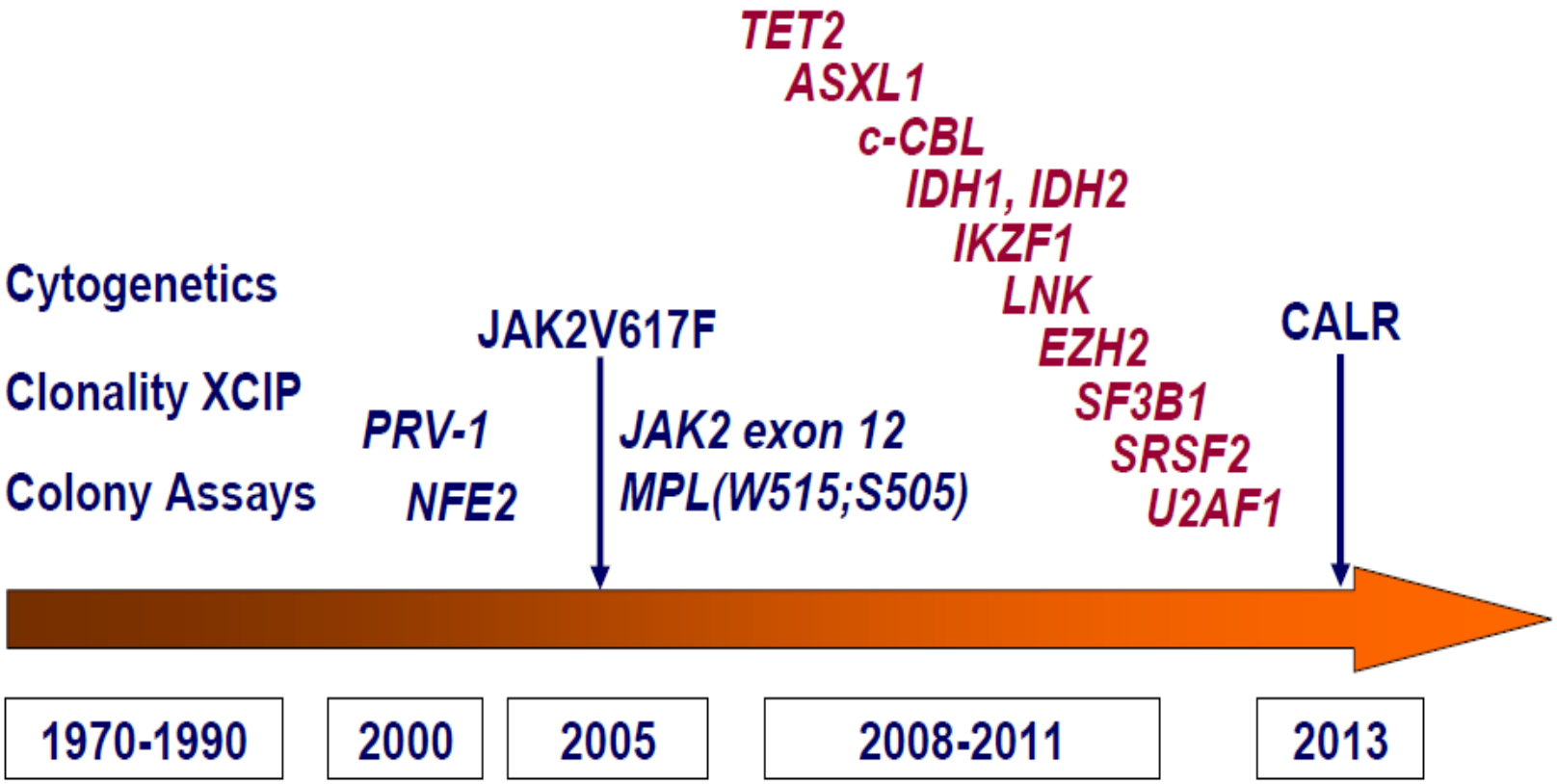
Myeloproliferative neoplasms (MPN)

- Chronic myelogenous leukemia, *BCR-ABL1*–positive
- Chronic neutrophilic leukemia
- Polycythemia vera
- Primary myelofibrosis
- Essential thrombocythemia
- Chronic eosinophilic leukemia, not otherwise specified
- Mastocytosis
- Myeloproliferative neoplasms, unclassifiable



Vardiman *et al.*, Blood 2009; 114:937-51

Biomarkers in Ph-negative MPNs



Proposal new WHO criteria

Leukemia (2014) **28**, 1407–1413

www.nature.com/leu

REVIEW

An overview on *CALR* and *CSF3R* mutations and a proposal for revision of WHO diagnostic criteria for myeloproliferative neoplasms

A Tefferi[1], J Thiele[2], AM Vannucchi[3] and T Barbui[4]

Table 4. 2014 proposed revision for World Health Organization (WHO) diagnostic criteria for *BCR-ABL1*-negative myeloproliferative neoplasms

	Polycythemia vera (PV)[a]	*Essential thrombocythemia (ET)*[b]	*Primary myelofibrosis (PMF)*[c]
Major criteria			
1	Hemoglobin >16.5 g/dl (men) >16 g/dl (women) or hematocrit >49% (men) >48% (women)	Platelet count $\geqslant 450 \times 10^9$/l	Megakaryocyte proliferation and atypia[d], accompanied by either reticulin and/or collagen fibrosis or[e]
2	BM trilineage myeloproliferation with pleomorphic megakaryocytes	Megakaryocyte proliferation with large and mature morphology	Not meeting WHO criteria for CML, PV, ET, MDS or other myeloid neoplasm
3	Presence of *JAK2* mutation	Not meeting WHO criteria for CML, PV, PMF, MDS or other myeloid neoplasm	Presence of *JAK2*, *CALR* or *MPL* mutation
4		Presence of *JAK2*, *CALR* or *MPL* mutation	
Minor criteria			
1	Subnormal serum erythropoietin level	Presence of a clonal marker (e.g. abnormal karyotype) or absence of evidence for reactive thrombocytosis	Presence of a clonal marker (e.g. abnormal karyotype) or absence of evidence for reactive bone marrow fibrosis
2			Presence of anemia or palpable splenomegaly
3			Presence of leukoerythroblastosis[f] or increased lactate dehydrogenase[f]

Assessing MPN Burden

WHO Diagnosis Does Not Tell Whole Story

Vascular Events
- PV/ET > MF
- Counts matter
- Can be unrecognized

Baseline Health
AGE/ Medicines
Comorbidities

Cytopenias
- MF > ET/PV
- Anemia
  - ✓ MF 75%
  - ✓ TX Dep 25%
- TPN 30%

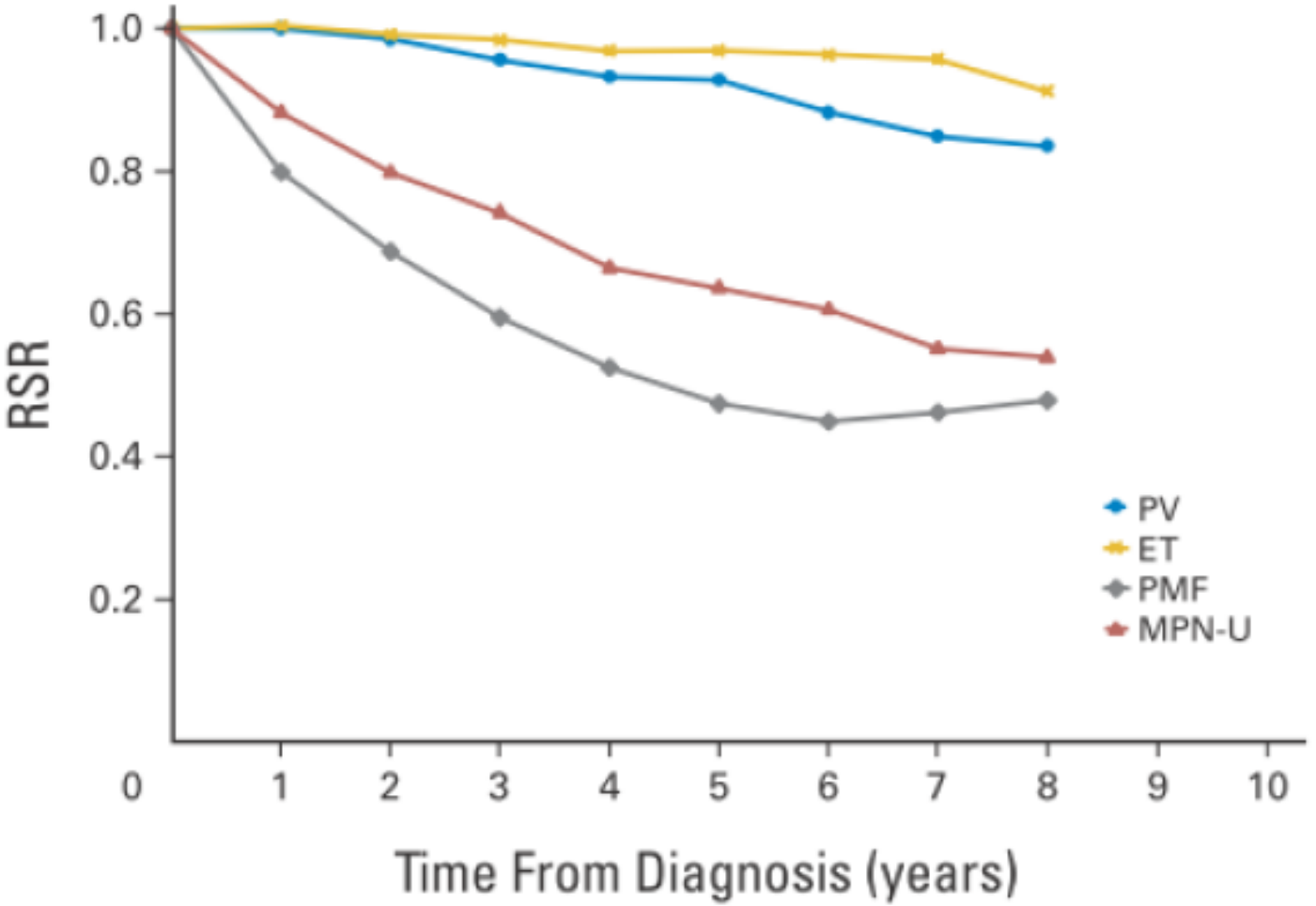
Progression
- PV/ET to MF
- PV/ET to AML
- MF to AML
- ? 2nd MDS

Splenomegaly
- MF > ET/PV
- Pain not always a function of size

MPN Symptoms
- MF > PV > ET
- Multifactorial
- Some ET/PV > MF
- Cytoreductive rx frequently not effective

MAYO CLINIC
Cancer Center

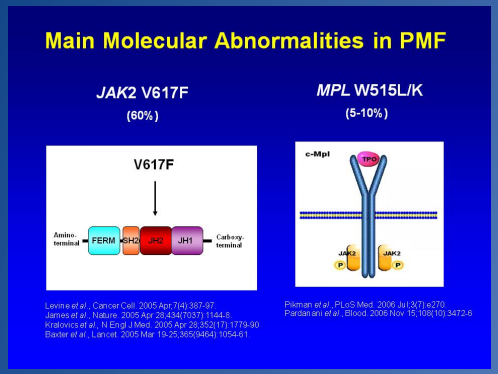
SURVIVAL of MPN

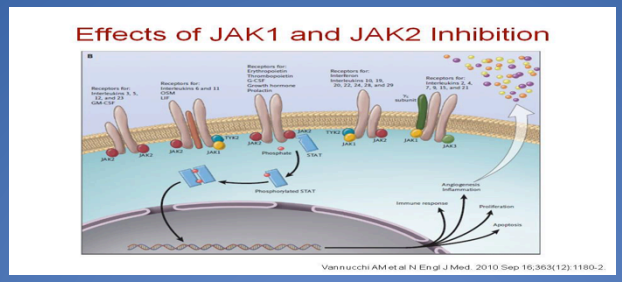


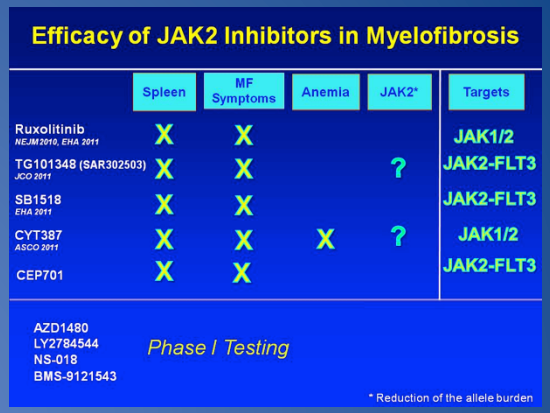
Hultcrantz, JCO 2012

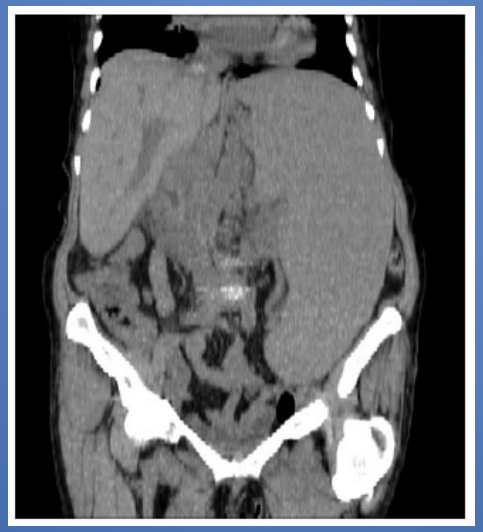
1) MIELOFIBROSIS

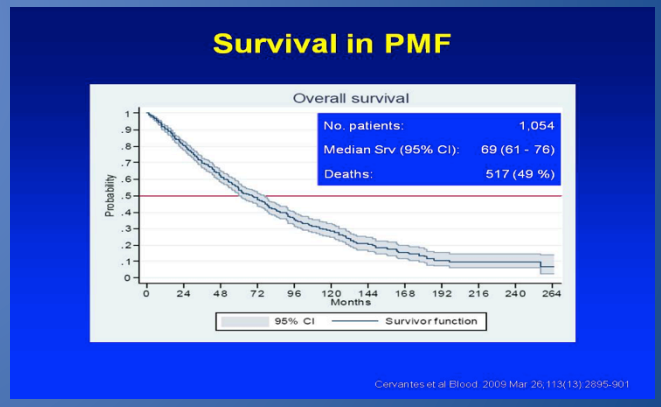
Mielofibrosis primaria.

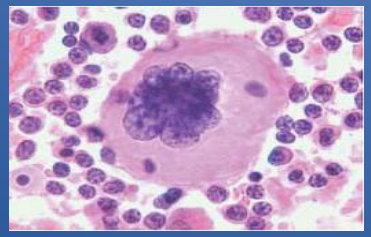


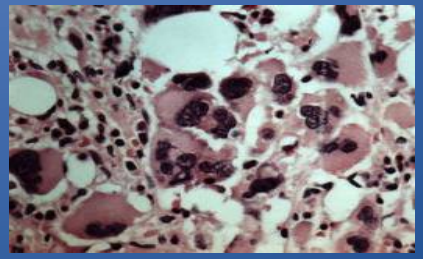


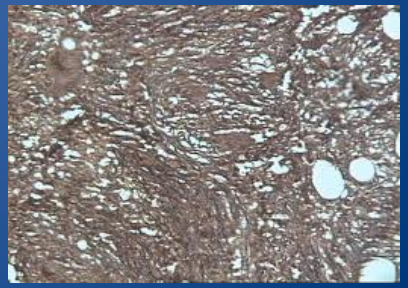




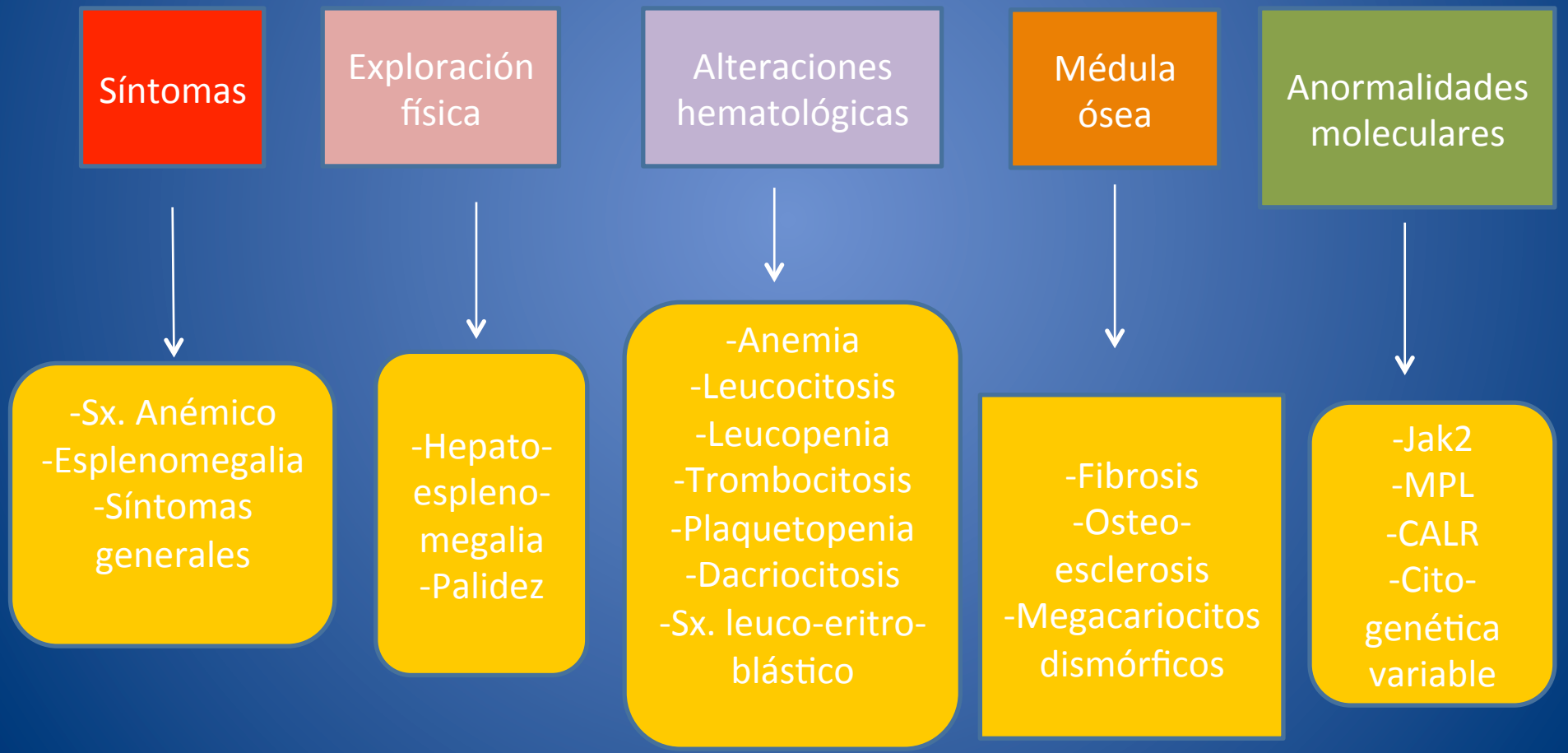




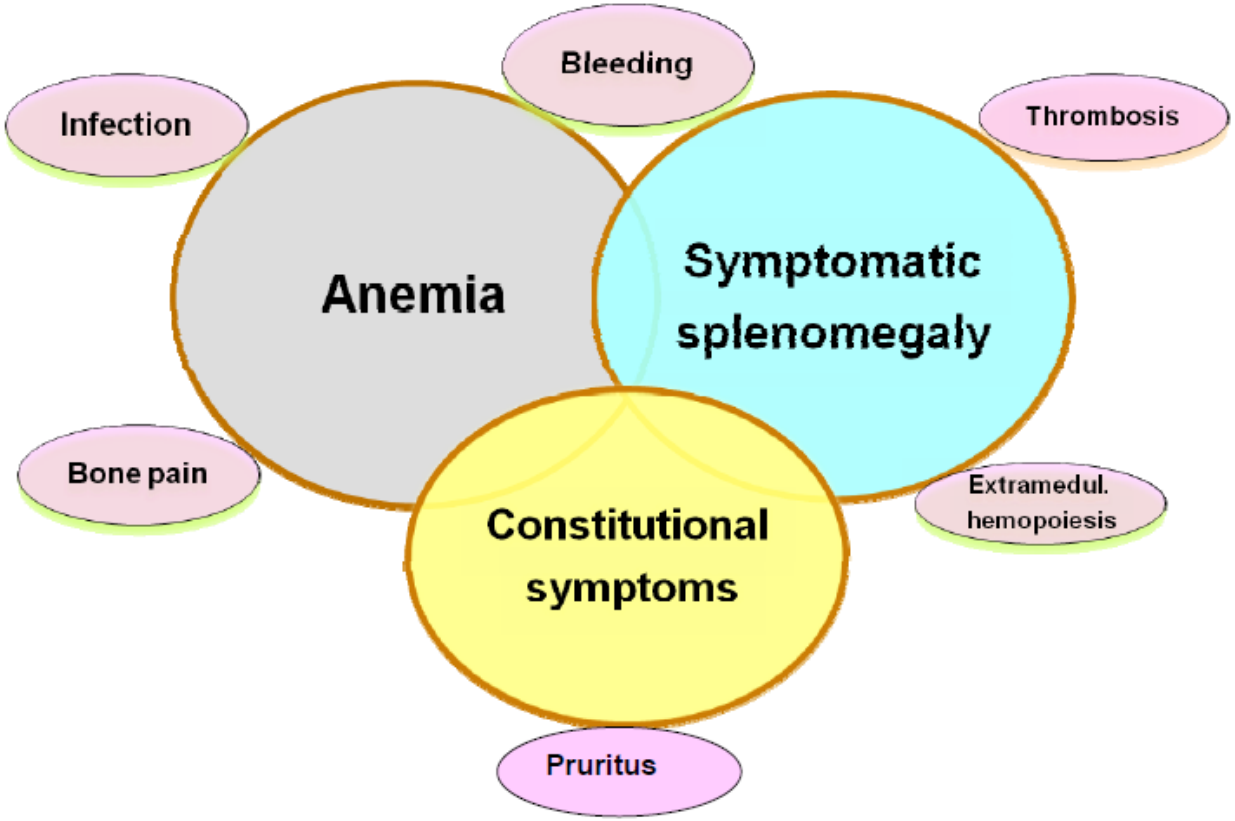




Mielofibrosis Primaria
Expresión de la enfermedad

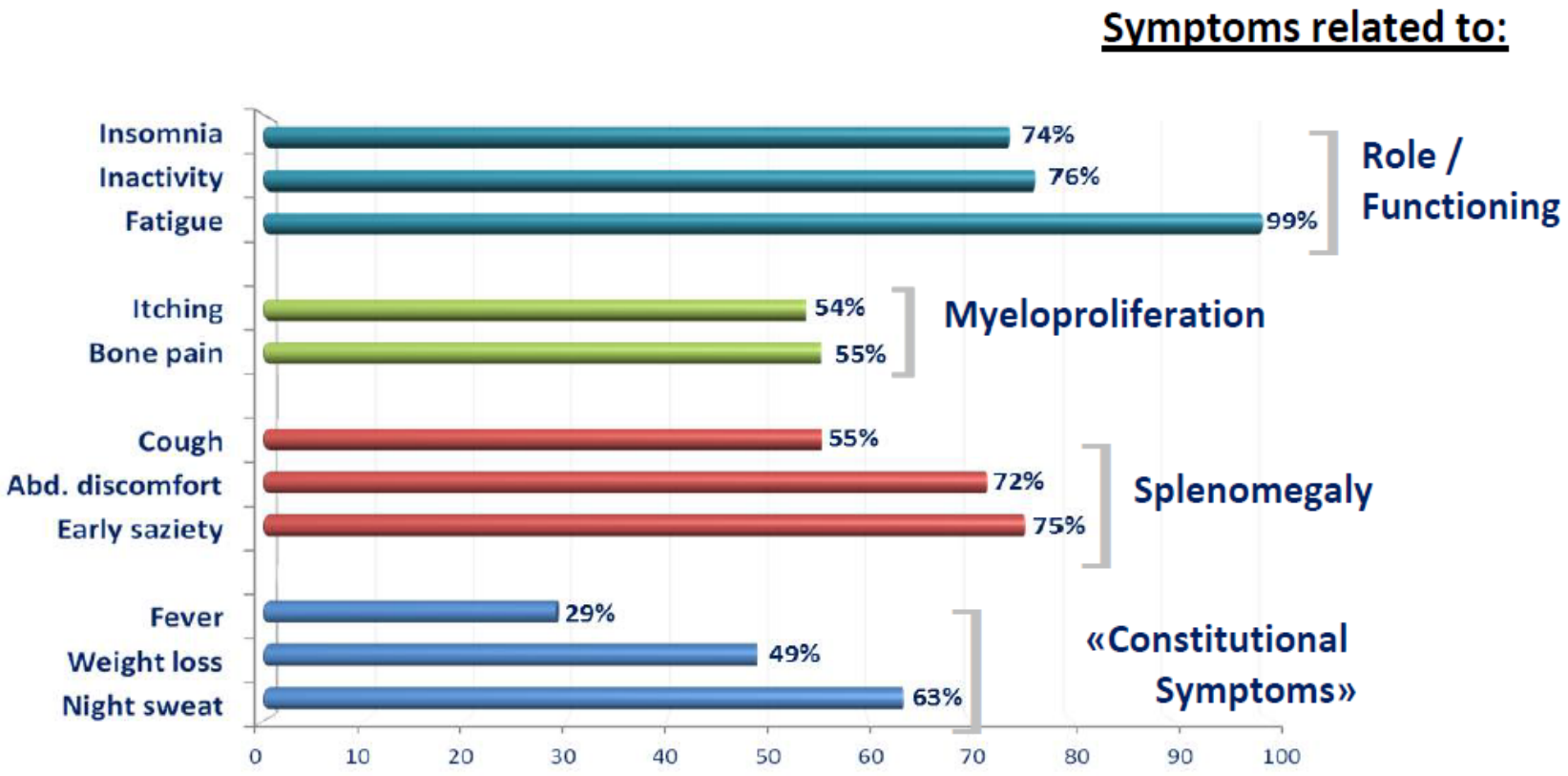


Clinical Manifestations of Myelofibrosis



Cervantes F, How I treat myelofibrosis, Blood 2014;124:2635-42

Symptomatic Burden in PMF



Scherber *et al.*, Blood 201;118:401-8

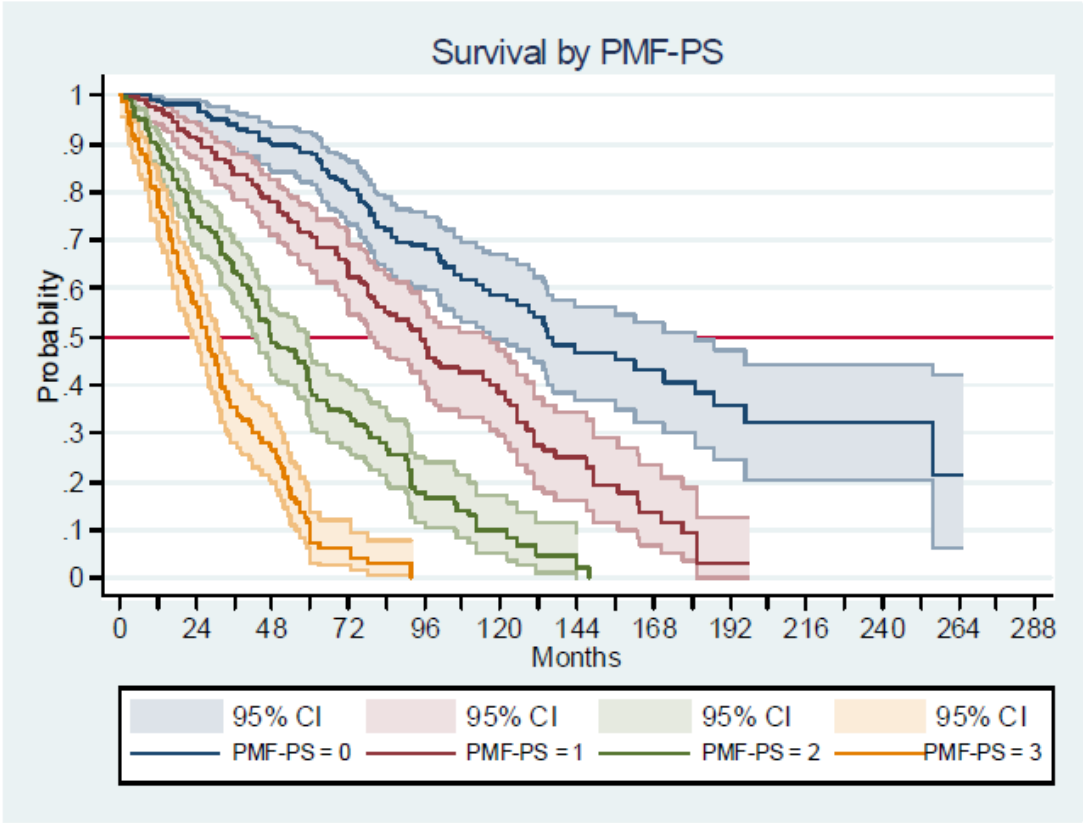
IPSS: Risk Classification of PMF at Presentation

Prognostic factors

- Age > 65 years
- Constitutional symptoms
- Hb < 10 g/dL
- Leukocytes > 25 x 10^9/L
- Blood blasts ≥ 1%

Risk groups

• Low	0
• Intermediate-1	1
• Intermediate-2	2
• High	≥ 3



Cervantes *et al*., Blood 2009;113:2895-901

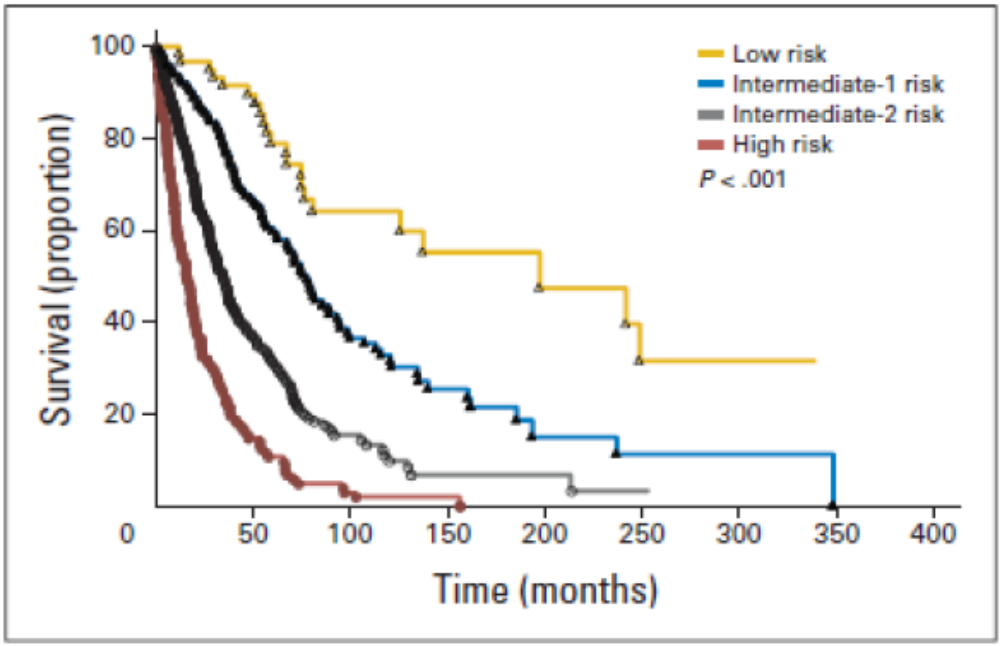
DIPSS-plus Risk Stratification of PMF

Factors	Score
DIPSS int-1:	1
int-2:	2
high:	3
Platelets < 100 x 10^9/L	1
RBC transfusion need	1
Unfavorable karyotype *	1

* +8, -7/7q-, -5/5q, i17q, 12p-, 11q23 rearr.

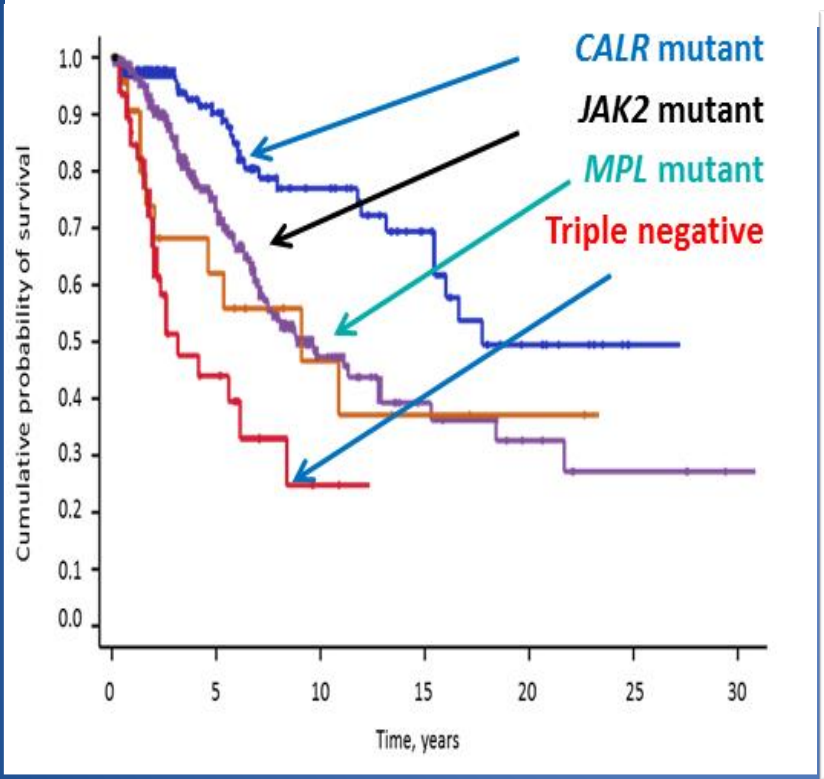
Risk groups

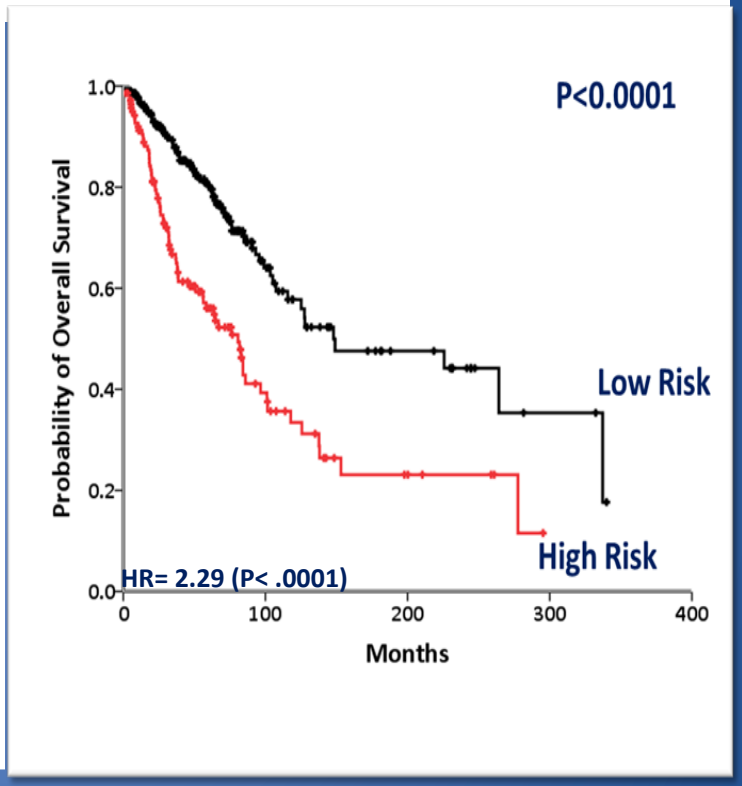
• Low	0
• Intermediate-1	1
• Intermediate-2	2-3
• High	4-6



Gangat N *et al.*, JCO 2011, 29:392-7

Mutations impact in PMF prognosis





HR: 2.3 for *JAK2*V617F (P<.001)
2.6 for *MPL (P=.009*)
6.2 for TN *(P<.001*)

High risk:

any mutation in *ASXL1, EZH2, SRSF2, IDH1/2*

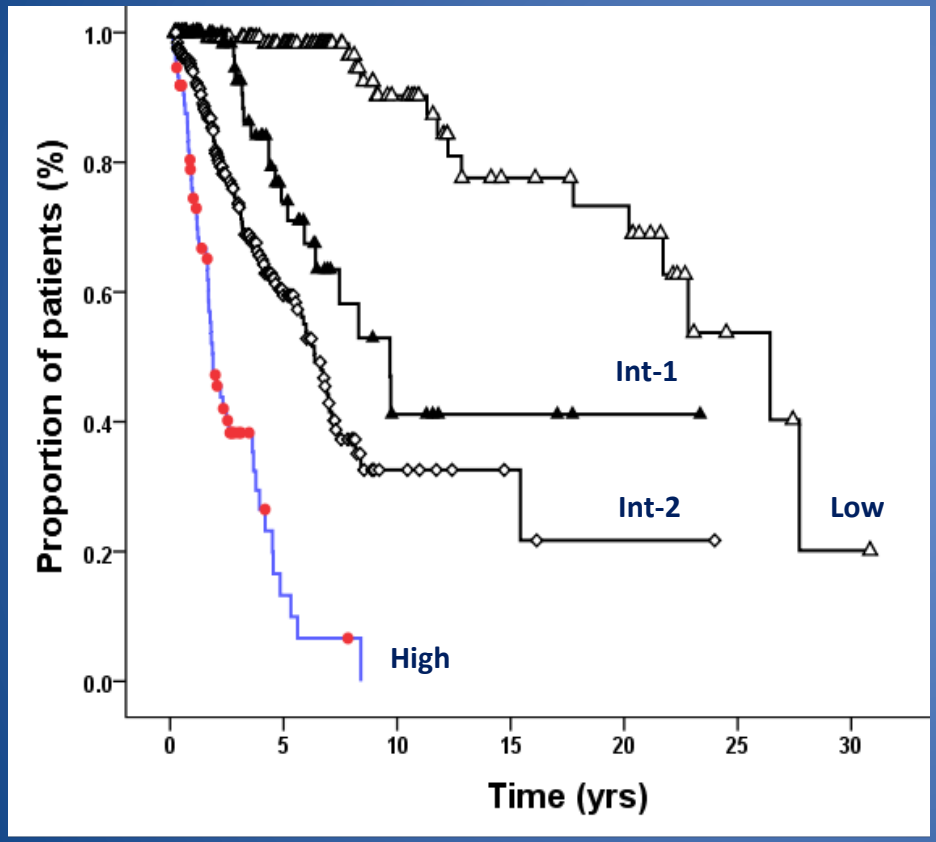
Rumi E et al, *Blood* 2014; 124:1062-9; Vannucchi AM et al, *Leukemia* 2013; 27:1861-9

MIPSS: Molecular International Prognostic Scoring System for PMF

MULTIVARIATE ANALYSIS			Weighted value
Variables	HR (95% CI)	P	
Age > 60 yrs	3.8 (2.60-5.51)	<0.0001	1.5
Hb < 100 g/L	1.4 (1.01-1.99)	0.04	0.5
Constitutional symptoms	1.5 .(1.13-2.16)	0.007	0.5
PLT < $200x10^9$/L	2.5 (1.77-3.42)	<0.0001	1.0
Triple negativity	3.9 (2.20-6.80)	<0.0001	1.5
JAK2/MPL mutation	1.8 (1.11-2.90)	0.016	0.5
ASXL1 mutation	1.4 (1.06-1.99)	0.02	0.5
SRSF2 mutation	1.7 (1.08-2.58)	0.02	0.5

Vannucchi A *et al.*, ASH 2014

MIPSS score

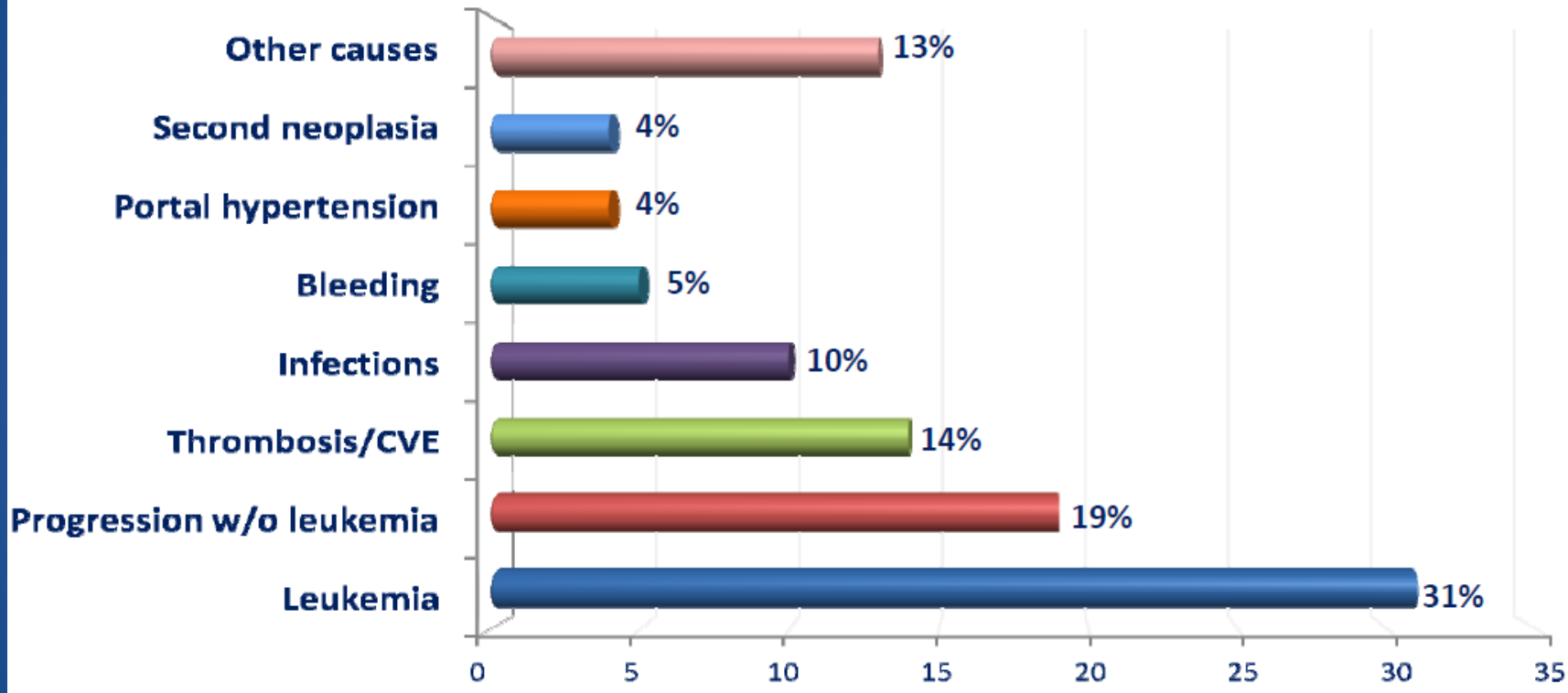


Risk category	Score	% of pts	OS (y)	HR
Low	0-0.5	27	12.4	1
Int-1	1-1.5	14	5.7	4.7
Int-2	2-3.5	46	3.4	9.9
High	≥4	13	1.5	36.5

Akaike information criterion indicated that MIPSS performed better than IPSS in predicting survival (1611.6 *vs* 1649.0).

Vannucchi AM et al, Oral, abst. 405

Causes of Death in PMF

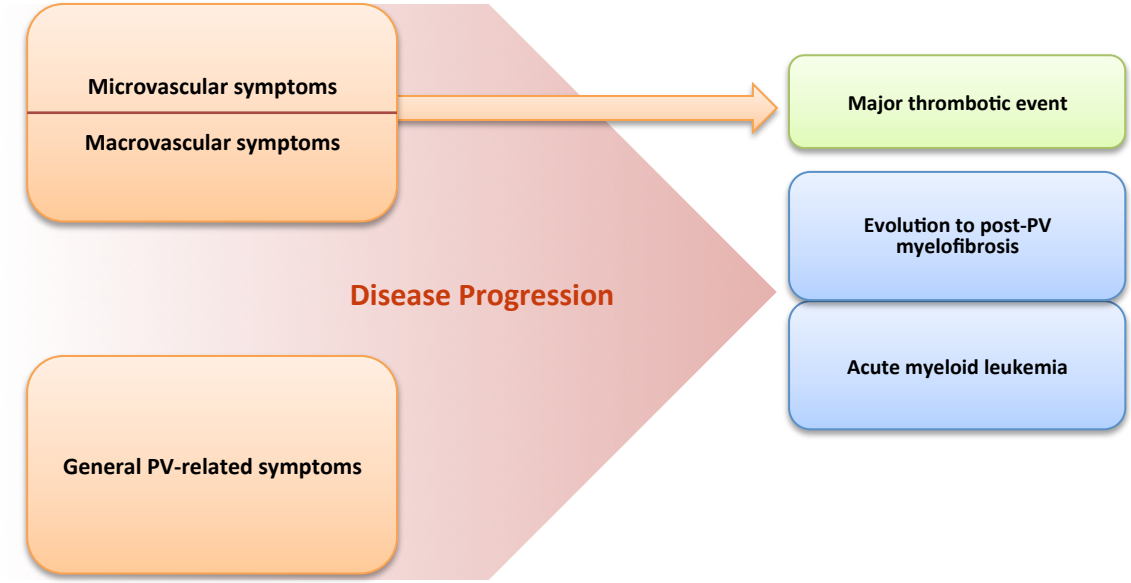


Cervantes *et al.*, Blood 2009;113:2895-901

2) POLICITEMIA VERA

Natural History of PV

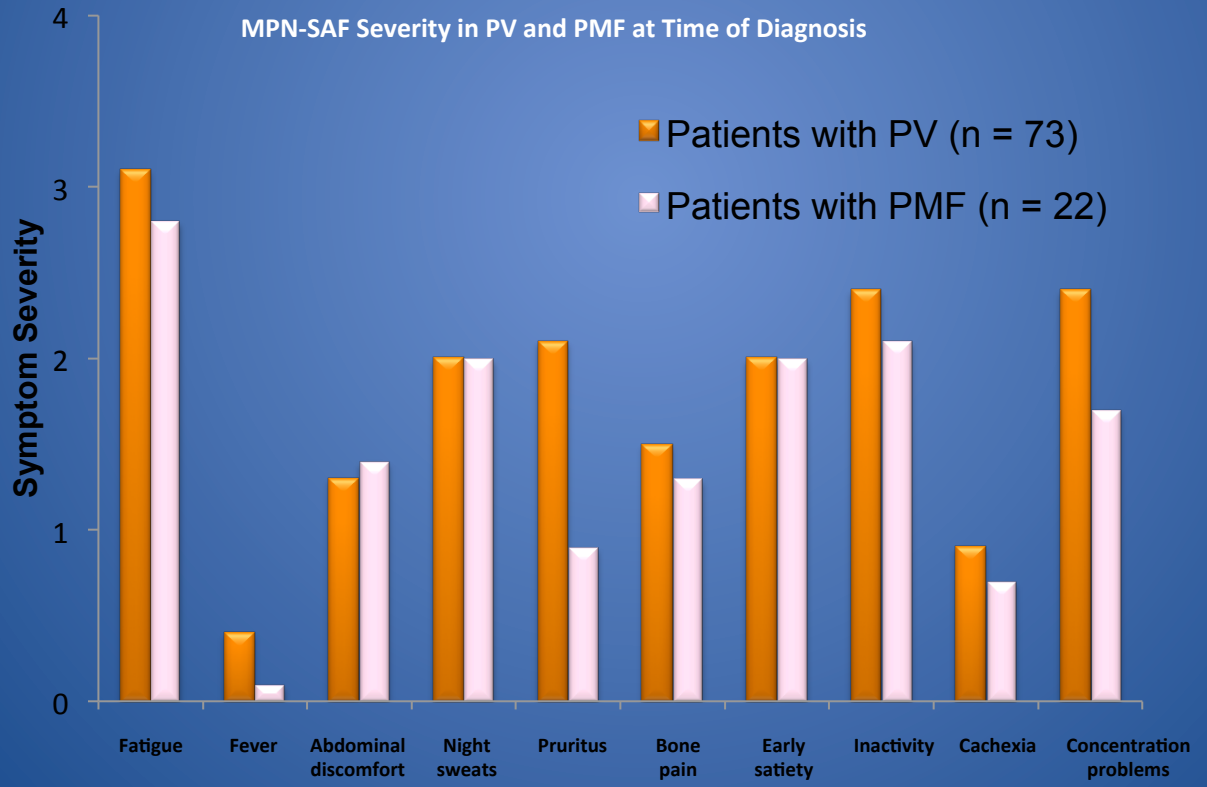
- PV can persist for many years without distinct stages or clear progression[1]
- Disease evolution occurs in patients with PV
  - Progression to post-PV MF occurs in up to 20% of patients per 10 years[2]
  - Transformation to acute myeloid leukemia (AML) occurs in up to 25% of patients per 10 years[3]



1. Swerdlow SH, et al. *WHO Classification of Tumours of Haematopoietic and Lymphoid Tissues*. Lyon, France: IARC; 2008.
2. Tefferi A. *Am J Hematol*. 2008;83:491-497.
3. Finazzi G, et al. *Blood*. 2005;105:2664-2670.

PV Symptom Burden

- The severity of symptoms at diagnosis in PV is as high as that in primary MF[1]
- PV symptoms are severe throughout the course of the disease[2]
- Symptoms may worsen in patients treated with conventional therapies, such as phlebotomy or hydroxyurea[3]



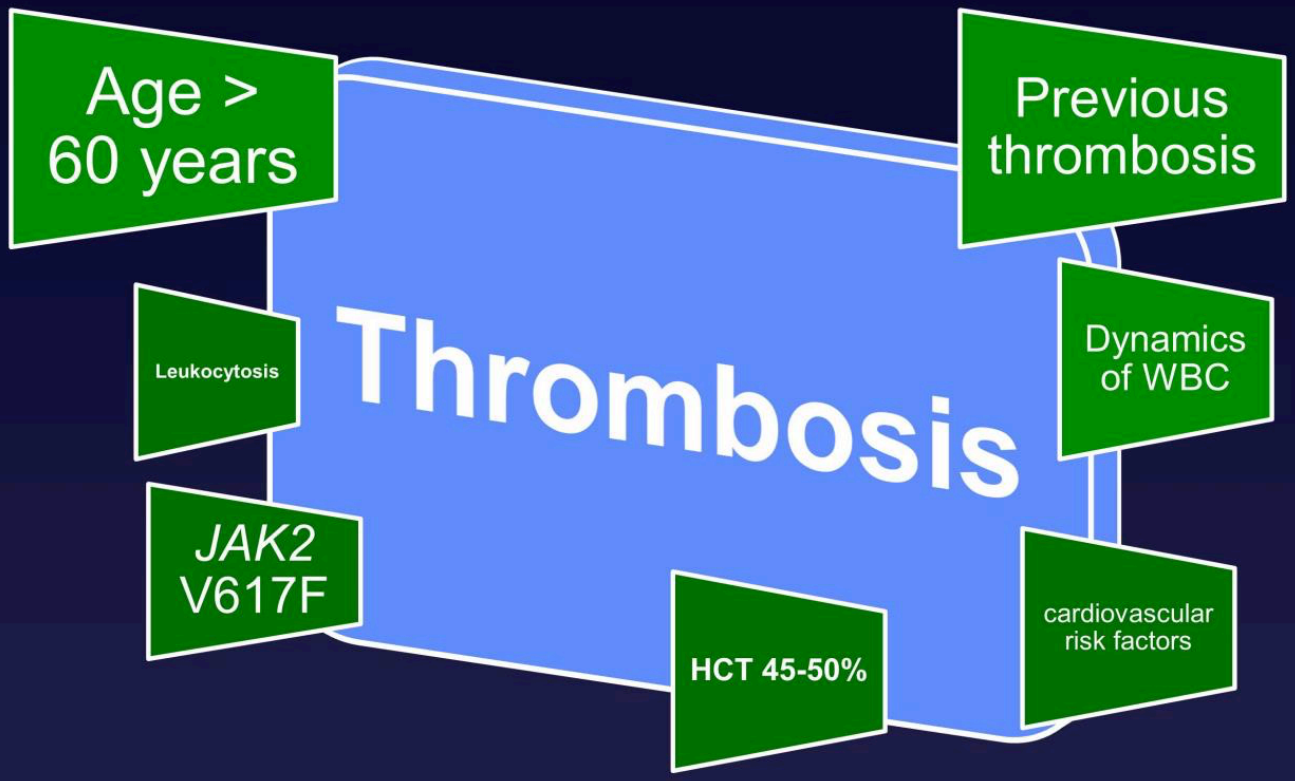
1. Abelsson J, et al. *Leuk Lymphoma.* 2013;54:2226-2230.
2. Scherber R, et al. *Blood.* 2011;118:401-408.
3. Emanuel R, et al. *Haematologica.* 2013;98:118-119.

PMF, primary myelofibrosis.

Events Determining the Prognosis of PV and ET

- **Vascular events:**
  - **Thrombosis**
  - Bleeding
- **Evolution to myelofibrosis**
- **Evolution to AML & MDS**

Risk factors for thrombosis in PV



Barbui et al. J Clin Oncol. 2011; Marchioli et al. J Clin Oncol. 2005;23(10):2224-32;
Carobbio et al. Blood. 2008 15;112(8):3135-7; Landolfi et al. N Engl J Med. 2004;350(2):114-124;
Carobbio et al. J Clin Oncol. 2008;1;26(16):2732-6; Passamonti et al, J Thromb Haemost. 2009;7(9):1587-9;
Barbui et al. Blood 2012;120(26):5128-33; Marchioli et. al. N Engl J Med 2013; 368:22-33.

RISK CLASSIFICATION OF PV

High risk

- Age > 60 years
- Previous thrombosis

Low risk

- Age ≤ 60 years
- No previous thrombosis

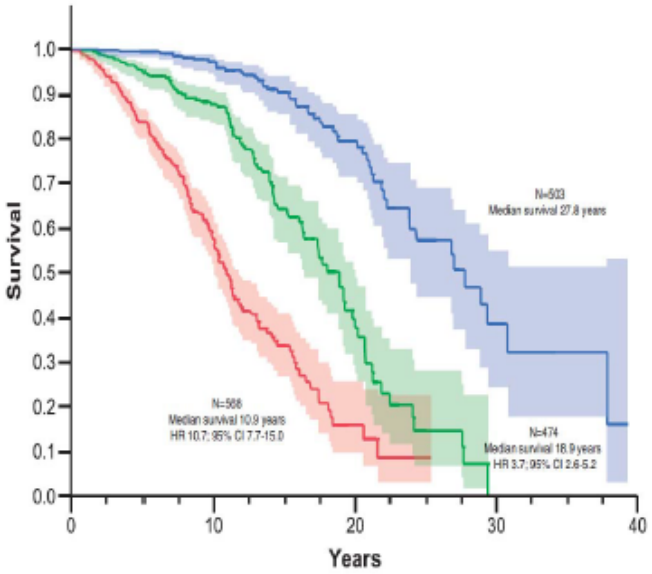
* Platelets > 1,500 x 10^9/L: high risk for bleeding

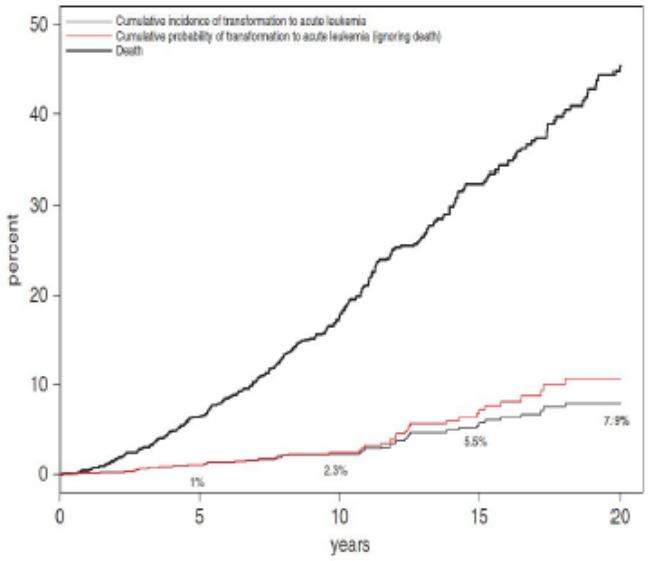
Intermediate risk ?

- **Not high risk** but
- **CV risk factors** or
- **Age 40-60 years**

Barbui *et al.*, J Clin Oncol 2011; 29:761-70

Survival and leukemic transformation in 1545 patients with contemporary PV





Risk factors for survival

- Age
- **Leukocyte count**
- Venous thrombosis

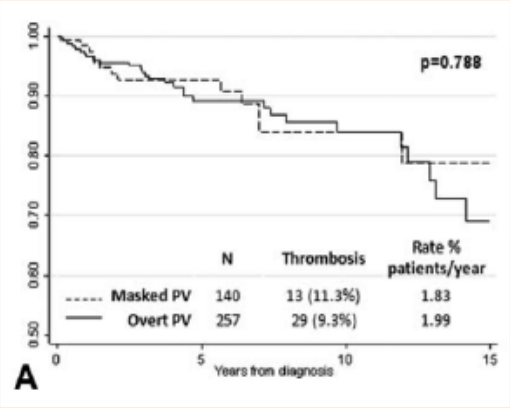
Risk factors for leukemia

- Age
- **Leukocyte count**
- Cytoreductive therapy

Tefferi et al, Leukemia 2013

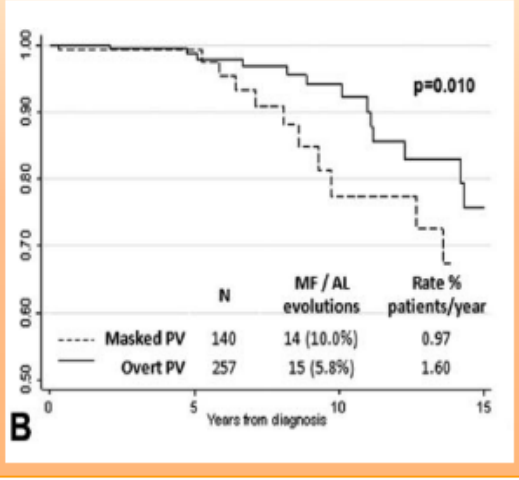
Masked PV: proposal of a new entity with different outcome

TROMBOSIS

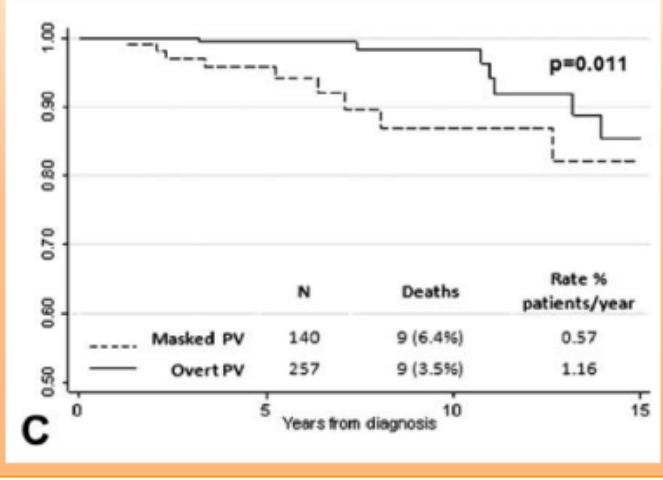


- Predominio masculino
- Hb y Hto por debajo de los criterios OMS2008
- Plaquetas más altas
- Historia de trombosis más frecuente
- Más Fibrosis medular
- Diagnóstico basado en la BMO

TRANSFORMACIÓN



SUPERVIVENCIA



3) TROMBOCITEMIA ESENCIAL

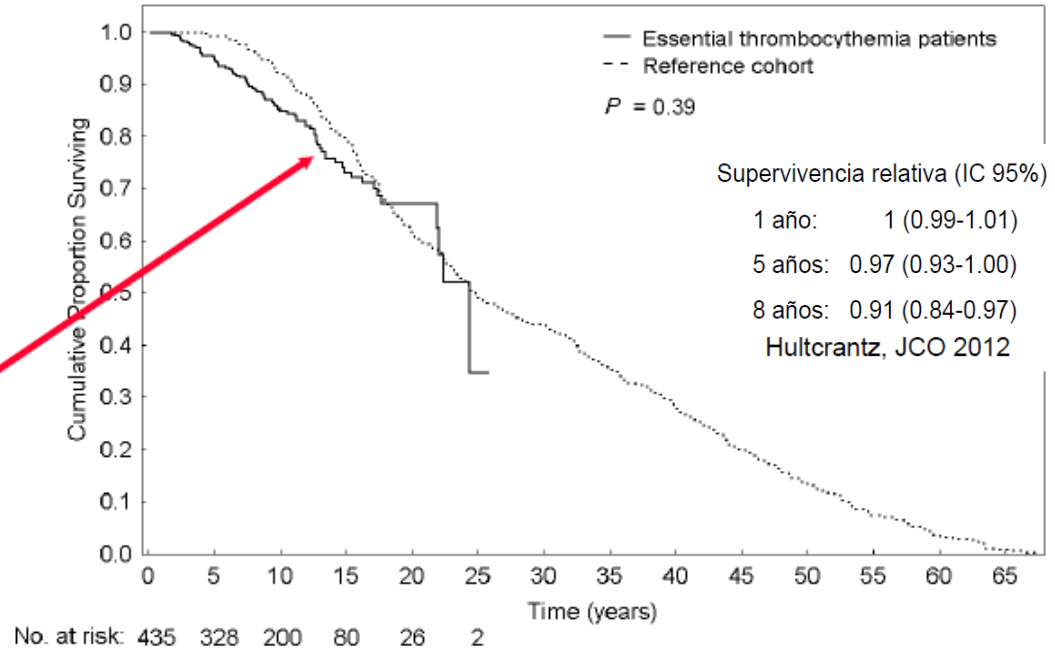
Life Expectancy of ET

N= 435 patients

Median f-u: 9.3 years

Median survival: 22.6 years

No difference compared to the general population



Passamonti *et al.*, Am J Med 2004; 117:755-61

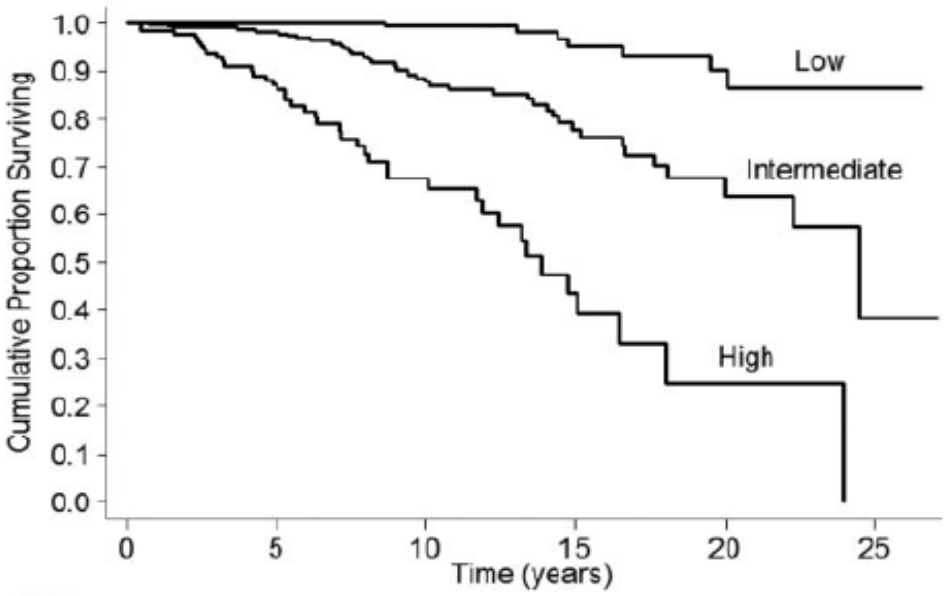
INTERNATIONAL PROGNOSTIC SCORE FOR ET (IPSET)

	Puntuación		
	0	1	2
Edad	< 60		≥ 60
Leucocitos, $x10^9/L$	< 11	≥ 11	
Historia de trombosis	No	Sí	

Bajo riesgo: 0 puntos

Riesgo intermedio: 1 – 2 puntos

Alto riesgo: 3 – 4 puntos



Passamonti *et al*; Blood 2012;120:1197

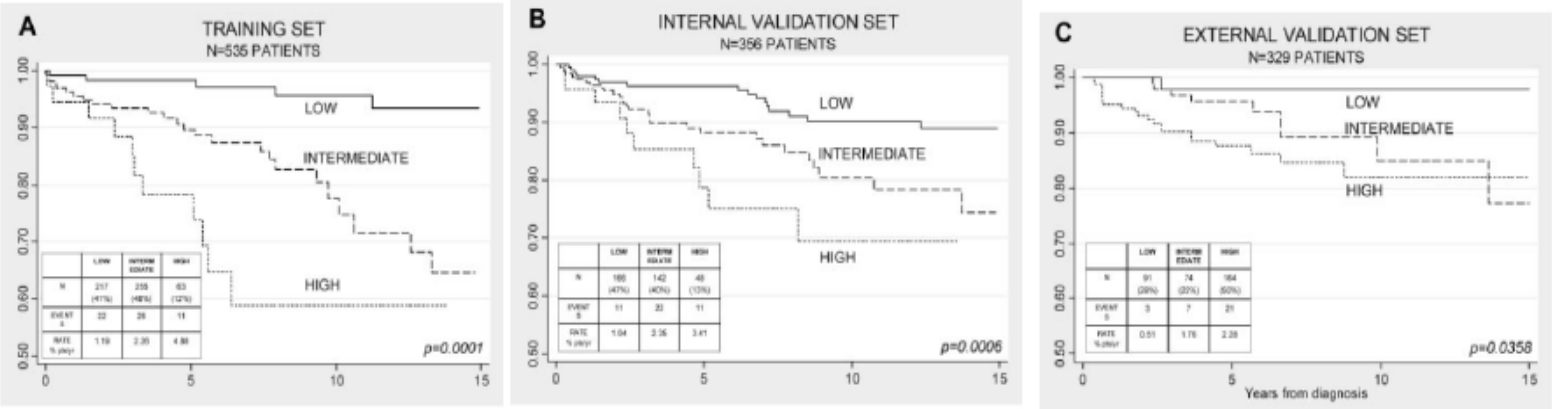
INTERNATIONAL PROGNOSTIC SCORE OF THROMBOSIS FOR ET (IPSET-THROMBOSIS)

	Puntuación		
	0	1	2
Edad	≤ 60	>60	
FRCV	No	Sí	
Historia de trombosis	No		Sí
*JAK2*V617F			Sí

Bajo riesgo: < 2 puntos

Riesgo intermedio: 2 puntos

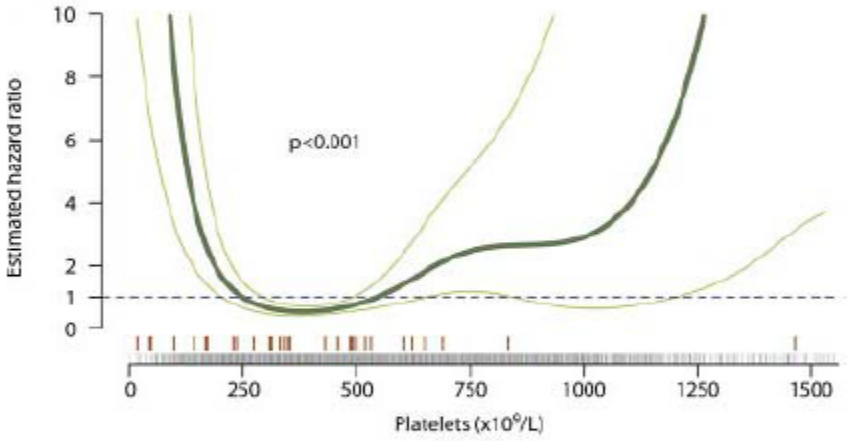
Alto riesgo: > 2 puntos



Barbui *et al*; Blood 2012;120:5128

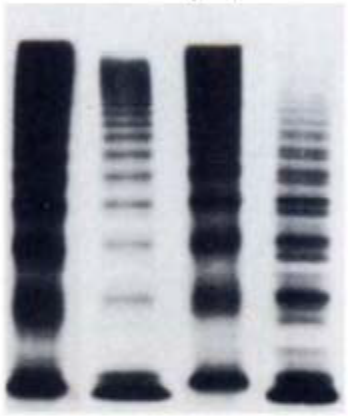
RISK OF BLEEDING IN ET

Risk of major bleeding in the PT-1 cohort according to platelet counts during follow-up



Campbell et al Blood 2012

Electrophoresis of plasma and platelet vWF



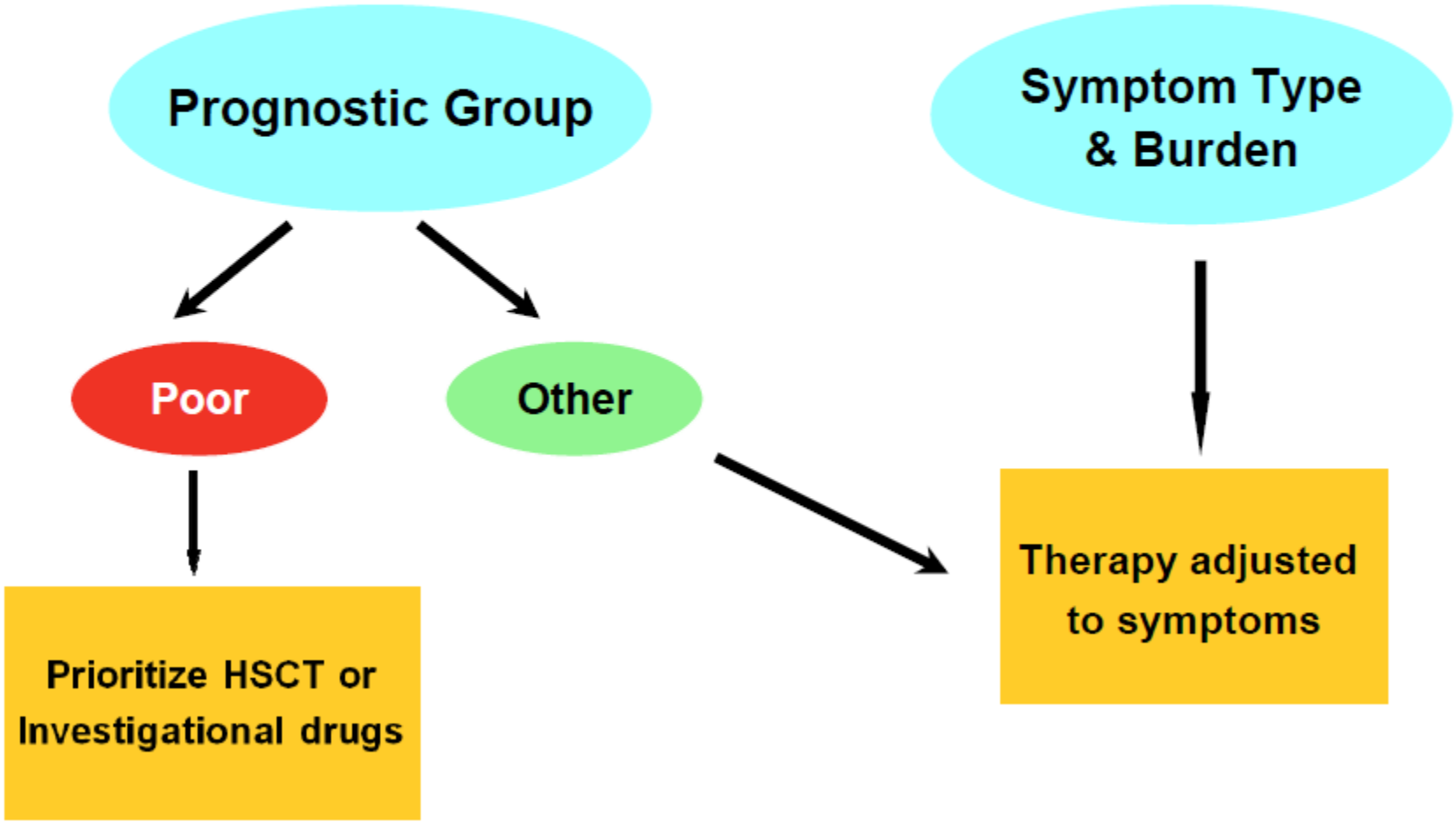
Budde et al Blood 1984

Extreme thrombocytosis has been associated with an increased risk of bleeding

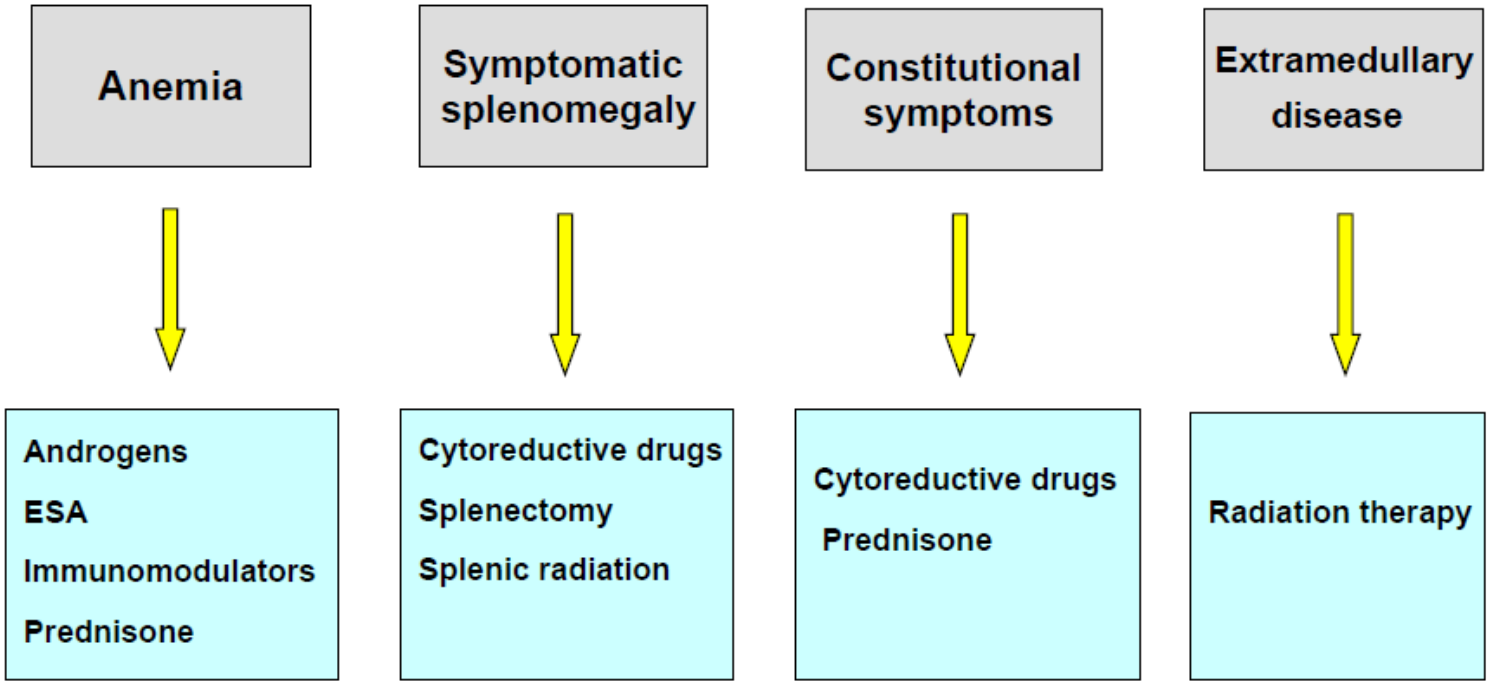
Tratamiento de la Mielofibrosis: Transición desde lo convencional a los inhibidores de Jak 1/2. Impacto de Ruxolitinib, eficacia y seguridad

Treatment Options for Myelofibrosis

Factors Driving Therapy Choice in Myelofibrosis



Clinically-adjusted Conventional Treatment of Myelofibrosis



Splenectomy in Myelofibrosis

Associated risks

- 40% morbidity
- 10% mortality
- Liver failure development
- Higher acute transformation rate?

Contraindication

Thrombocytosis

Main indications

- Symptomatic splenomegaly unresponsive to treatment
- Severe refractory anemia
- Unresponsive constitutional symptoms
- Uncontrollable hemolysis
- Portal hypertension

Splenic Radiation in Myelofibrosis

Indications

- **Symptomatic splenomegaly in poor candidates to surgery**
- Severe pain from splenic infarction

Dose & Results

- Dose: variable, median 2.8 Gy, fractioned
- **Effect duration: median 6 mos.**

Contraindication

As preparation for splenectomy

Associated Risk

Long-lasting cytopenias (43%)

Elliott *et al.*, Br J Haematol 1998; 103:505-11

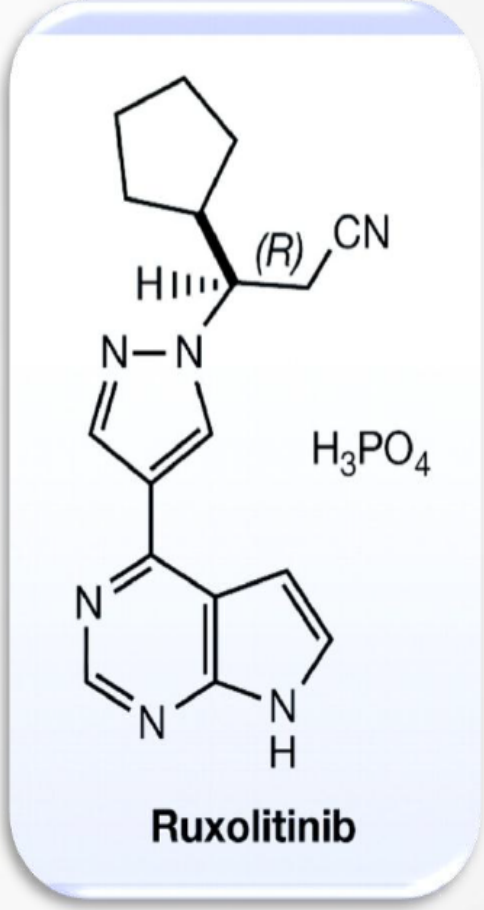
Allogeneic HSCT for Myelofibrosis

	Median ages	TRM (1 y)	OS (5 y)
Myeloablative (n= 504)	40-49	20-42%	31-61%
RIC (n= 263)	50-56	0-37%	50-67%

Adapted from Alchalby *et al.*, CHMR 2010; 5:53-61

RUXOLITINIB

- Primer inhibidor de JAK aprobado por FDA para MF y PV.
- Inhibidor potente de JAK1 y JAK2.
- Excelente biodisponibilidad oral, vida media de 3-5 horas.
- Información disponible de estudios fase III.



Ruxolitinib

Ganetsky A. Ruxolitinib: a new treatment option for myelofibrosis. Phamacotherapy 2013;33(1):84-92

RUXOLITINIB. PHASE III STUDIES




COMFORT I

- Sep 2009-Abril 2010
- N= 309
- Aleatorización: 1:1, Doble ciego
- Ruxolitinib vs Placebo
- IPSS Int-2/Alto
- 41.9% Reducción esplénica 24 sem
- Beneficio en la supervivencia

COMFORT II

- Cohorte hasta Abril 2011
- N= 219
- Aleatorización: 2:1
- Ruxolitinib vs Mejor tratamiento disponible
- IPSS Int-2/Alto
- 28.5% Reducción esplénica 48 sem
- Beneficio en la supervivencia

Ganetsky A. Ruxolitinib: a new treatment option for myelofibrosis. Phamacotherapy 2013;33(1):84-92

COMFORT-I

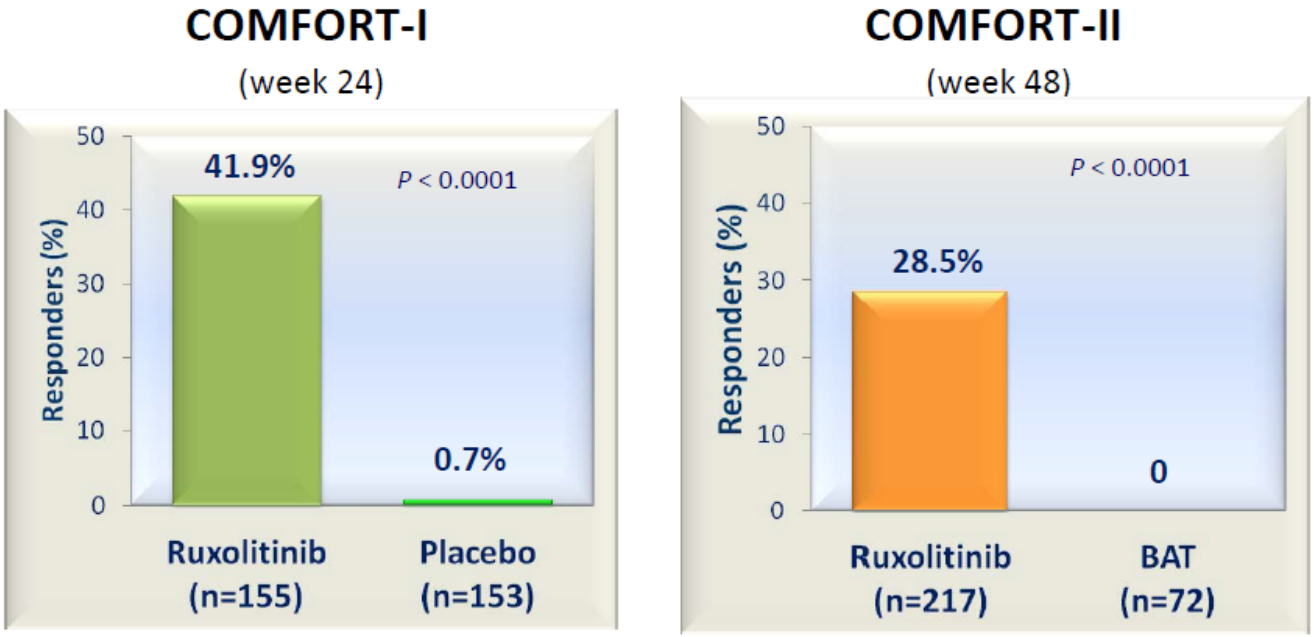
Parámetro	COMFORT-I	
Objetivo primario	Reducción en la esplenomegalia de ≥ 35% por IRM o TAC a las 24 semanas (41.9% vs 0.7%, p<0.001)	De estos, 67% mantuvieron la respuesta esplénica por al menos 48 semanas.

Parámetro	COMFORT-I
Control de síntomas (TSS)	Reducción de ≥ 50% en la TSS a la semana 24 (45.9% vs 5.3%, p<0.001)

COMFORT-II

Parámetro	COMFORT-II
Objetivo primario	Reducción en la esplenomegalia de ≥ 35% por IRM o TAC a las 48 semanas (28.5% vs 0%, p<0.001)

Ruxolitinib and Spleen Volume Reduction



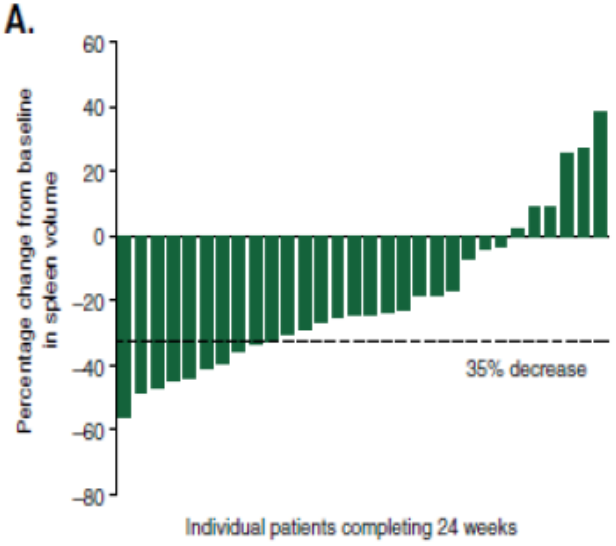
- **Response: ≥35% reduction of spleen volume by MRI/CT**
- It occurred at a median of 12 weeks and was maintained at 48 wks in 80% of responders
- A spleen volume reduction by MRI of 35%: ≅ **52% reduction in spleen length by palpation**

Verstovsek S *et al.*, NEJM 2012; 366:799-07

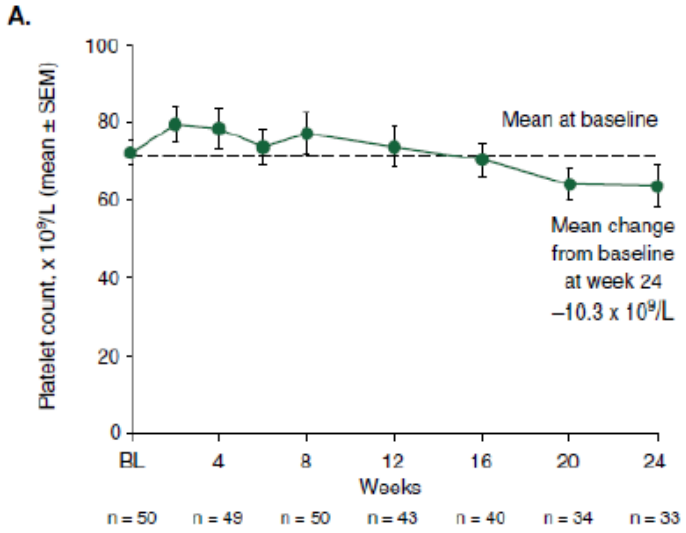
Harrison C *et al.*, NEJM 2012; 366:787-98

Ruxolitinib in MF Patients with Platelet Counts 50-100 x 10^9/L

Effect on Spleen



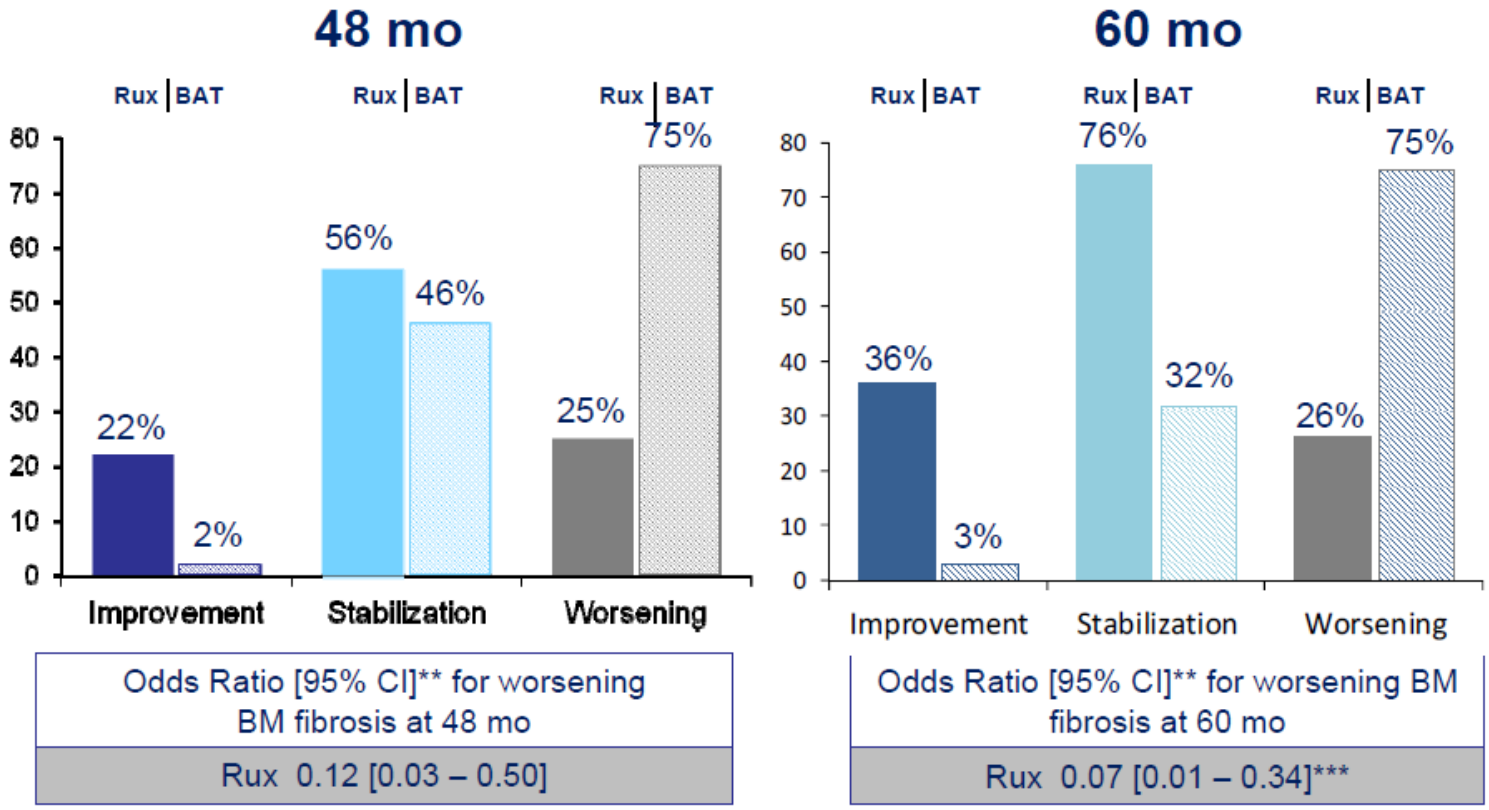
Effect on Platelet Counts



Talpaz M et al., *et al.*, J Hematol Oncol 2013; 6:81-90

Change in BM Fibrosis Over Time with Ruxolitinib and BAT*

SC2



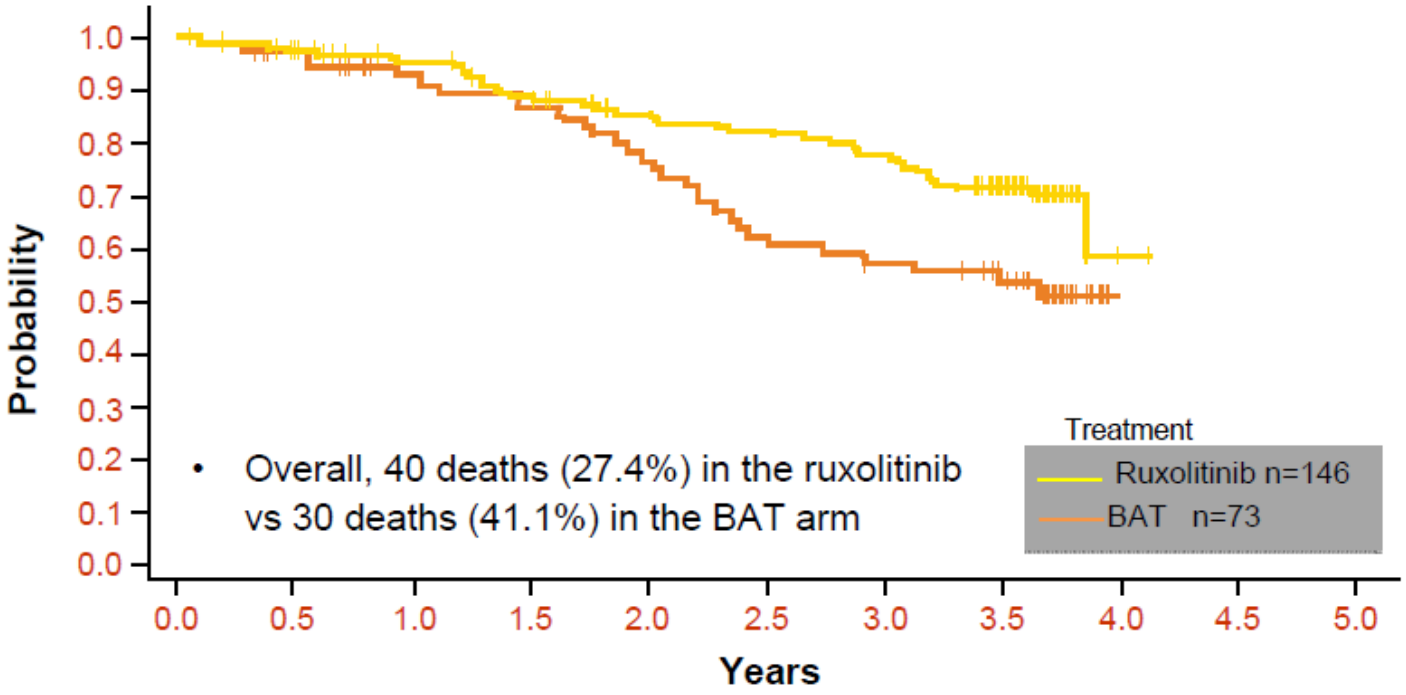
Odds Ratio [95% CI]** for worsening BM fibrosis at 48 mo
Rux 0.12 [0.03 – 0.50]

Odds Ratio [95% CI]** for worsening BM fibrosis at 60 mo
Rux 0.07 [0.01 – 0.34]***

* Compilation of data - not a formal comparison
** Logistic regression method
*** Last available grade from 54, 60, or 66 mo

Kvasnicka HM, *et al.*, 213 ASH abs 4055

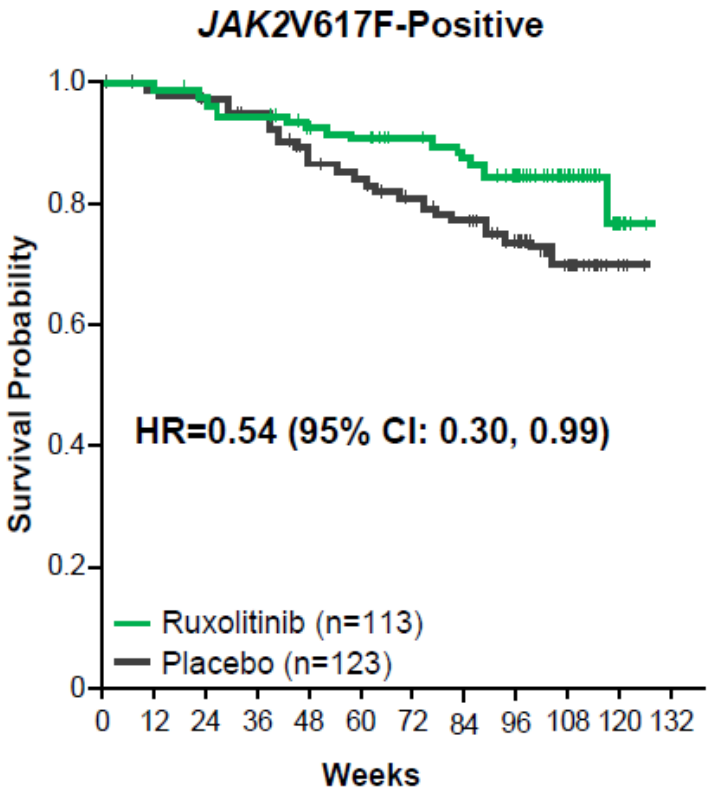
COMFORT-II (Ruxolitinib vs BAT): Overall Survival at 3.5 years

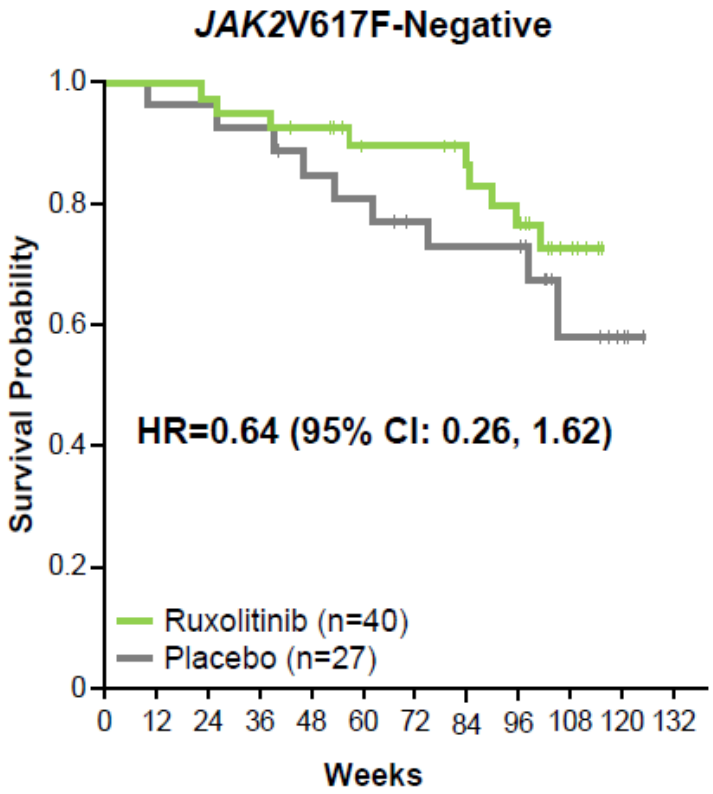


- The estimated survival probability at 3.5 years was 0.71 (95% CI, 0.63-0.78) in the ruxolitinib arm and 0.54 (95% CI, 0.41-0.65) in the BAT arm
- There was a significant overall reduction in risk of death of 42% with ruxolitinib treatment compared with BAT (HR = 0.58; 95% CI, 0.36-0.93; log-rank test *P* = .022)

Harrison C *et al.*, EHA 2014, Abstr. P403

COMFORT-I
Overall Survival by *JAK2*V617F Mutation Status





Verstovsek *et al.*, ASH 2012

Conclusión

COMFORT-I / COMFORT-II	
El tratamiento con ruxolitinib en pacientes con MF de riesgo intermedio o alto, produjo una mejoría significativa en la esplenomegalia y los síntomas asociados a MF con un perfil de toxicidad aceptable.	Beneficios independientes del subtipo de MF, el estado mutacional de JAK2, el tamaño inicial del bazo, nivel inicial de Hb.

Modificado de: Promise and Pitfalls of therapy with JAK2 inhibitor. International Journal of Clinical Reviews. 2012

Ruxolitinib Dose Optimization

Platelet Count	Starting Dose
Greater than 200,000/mm^3	20 mg orally twice daily (BID)
100,000/mm^3 to 200,000/mm^3	15 mg orally BID
50,000/mm^3 to 100,000/mm^3	Maximum: 5 mg orally BID*
With concomitant CYP3A4 inhibitors, severe renal impairment, or any hepatic impairment	Reduce BID starting dose by 50%

Dose reduction or interruption during therapy	
Platelet count below 100,000/mm^3	Consider dose reduction to avoid dose interruption due to thrombocytopenia
Platelet count below 50,000/mm^3 or absolute neutrophil count below 500/mm^3	Interrupt treatment. When blood cell counts rise above these levels, restart treatment at 5mg orally BID. Gradually increase dose as blood cell counts recover
Dose increase during therapy	
If efficacy is considered insufficient and platelet and neutrophil counts are adequate	Consider increasing dose by 5mg orally BID at 2-weeks intervals*

*Titrate cautiously.

JAKAVI, Summary of Product Characteristics.

Open questions on Ruxolitinib for MF Treatment

- Different dosing?
- Thrombocytopenic patients
- Role in SCT
- Treatment at earlier stages?
- Combinations

Manejo actual de la Policitemia Vera

Current Management of PV

- **Treatment objective**
  - Controlling symptoms
  - Preventing thrombotic and bleeding complications without increasing the risk of transformation
  - -- Reduce or eliminate *JAK*2 mutant clone
  - -- Cure the disease
- **General basis of treatment**
  - Reduction of red cell mass with phlebotomies
  - Low-dose aspirin
  - Strict correction of cardiovascular risk factors
  - Cytoreductive therapy with hydroxyurea for:
    - Age > 60 years
    - History of thrombosis
    - Poor tolerance of phlebotomy
    - Severe disease-related symptoms
    - Symptomatic or progressive splenomegaly
    - Progressive leukocytosis
    - Platelet count > 1500 $x10^9$/L

Barbui et al, J Clin Oncol. 2011 Feb 20;29(6):761-70.

Treatment options and targets

- Phlebotomy
- Hydroxyurea
- Busulfan
- Interferon
- JAK2 inhibitors
- Histone deacetylases Inhibitors

ELN definition of clinicohematologic response in PV

Response criteria (2009)

1. Hct < 45% without phlebotomy
2. Platelet count < 400 $x10^9$/L
3. WBC count < $10x10^9$/L
4. Normal spleen size on imaging
5. No disease-related symptoms

COMPLETE RESPONSE

All criteria are achieved

PARTIAL RESPONSE

Hct < 0.45 L/L without phlebotomy or
Response in ≥ 3 criteria

Response criteria (2013)

A. No disease-related symptoms and normal spleen
B. Hct < 45% without phlebotomy, platelet count < 400 $x10^9$/L and WBC count < $10x10^9$/L
C. No disease progression, no vascular complications
D. Normal bone marrow

COMPLETE RESPONSE

All criteria are achieved

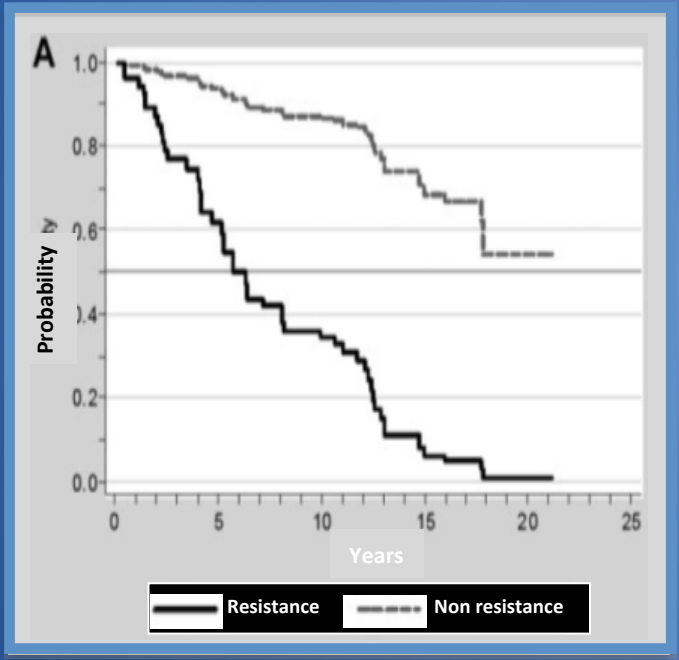
PARTIAL RESPONSE

A + B + C criteria

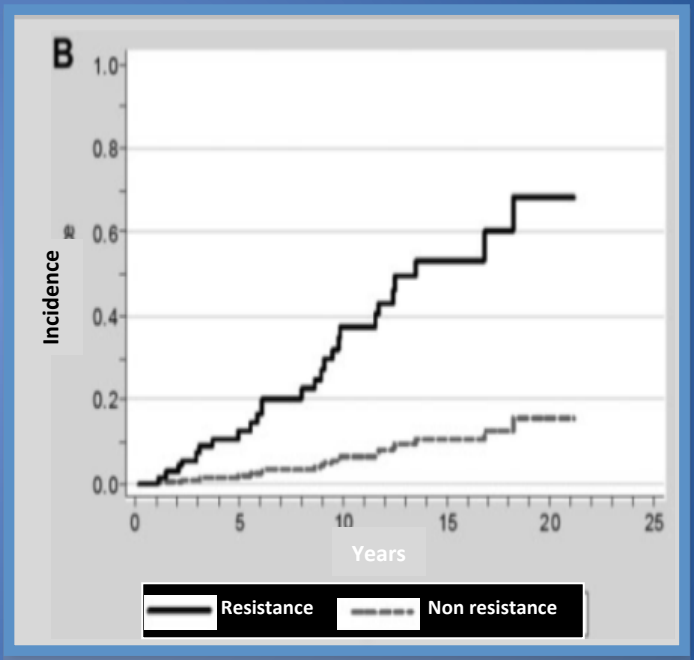
Barosi et al, Blood 2009, Barosi et al, Blood 2013

The Implication of resistance to Hydroxyurea in PV

Survival



Risk of disease evolution (MF & AML)



Resistance to HU was associated with a 5.6 fold increase in the risk of death

Alvarez-Larran A, et al. *Blood*, 2012; 119: 1363-1369.

ELN CRITERIA FOR RESISTANCE/INTOLERANCE TO HYDROXIUREA IN PV

1. Need for phlebotomy to keep hematocrit < 0.45 L/L after 3 months of at least 2 g/day of HU, OR
2. Uncontrolled myeloproliferation (platelet count > 400 $x10^9$/L and WBC count > 10 $x10^9$/L after 3 months of at least 2 g/day of HU), OR
3. Failure to reduce massive* splenomegaly by more than 50% or as measured by palpation after 3 months of at least 2 g/day of HU, OR
4. **Absolute neutrophil count < 1 $x10^9$/L or Hb level < 100 g/L or platelet count < 100 x 109/L at the lowest dose of HU required to achieve a CR or a PR, OR**
5. Leg ulcers or other unacceptable HU-related non-hematological toxicities at any HU dose.

* Extending > 10 cm from costal margin

Barosi et al, BJH 2009

Advantages of IFN-α in PV

- **Marked reduction of the PV clone**
- **Clinical remissions without cytoreductive therapy**
- **Reduction of vascular events**
- **Change in the disease natural history** (evolution to MF, AML, MDS)**?**
  - Clinicohematological CR
  - Molecular CR
  - Histopathological CR

Ruxolitinib en PV

ORIGINAL ARTICLE

Ruxolitinib versus Standard Therapy for the Treatment of Polycythemia Vera

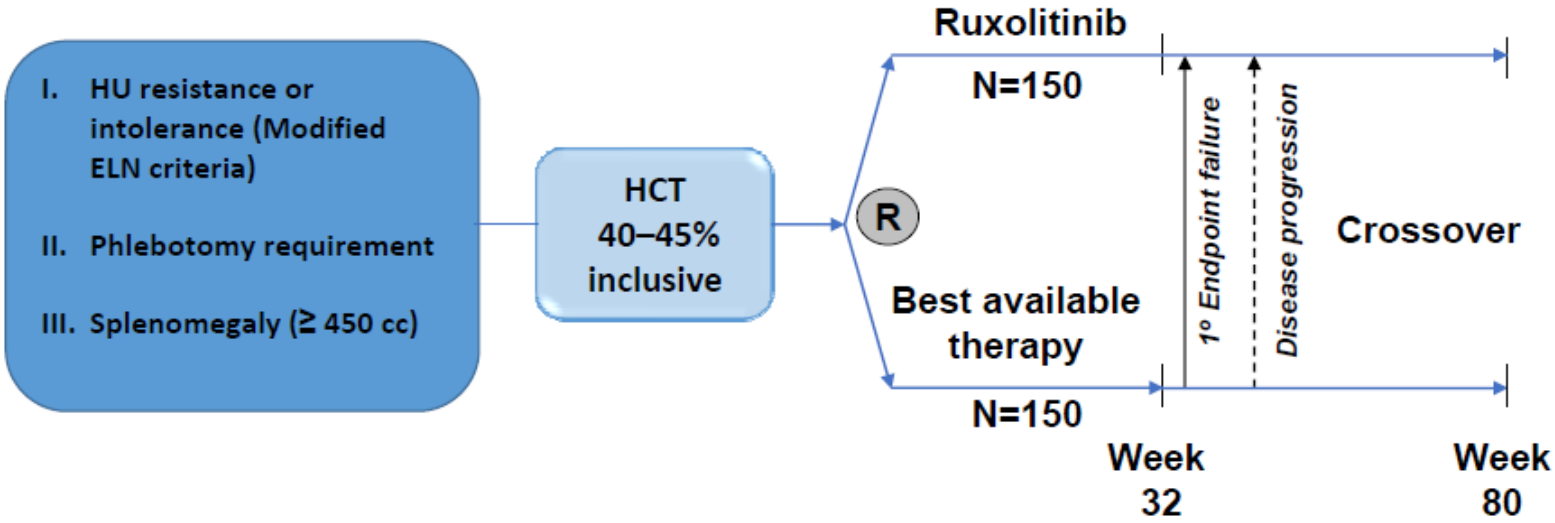
Alessandro M. Vannucchi, M.D., Jean Jacques Kiladjian, M.D., Ph.D., Martin Griesshammer, M.D., Tamas Masszi, M.D., Ph.D., Simon Durrant, M.D., Francesco Passamonti, M.D., Claire N. Harrison, D.M., Fabrizio Pane, M.D., Pierre Zachee, M.D., Ph.D., Ruben Mesa, M.D., Shui He, Ph.D., Mark M. Jones, M.D., William Garrett, M.B.A., Jingjin Li, Ph.D., Ulrich Pirron, Ph.D., Dany Habr, M.D., and Srdan Verstovsek, M.D., Ph.D.

- OBJETIVO: Evaluar la eficacia y seguridad de Ruxolitinib vs tratamiento estándar en pacientes intolerantes o resistentes a HU.

- MÉTODOS: Estudio Fase 3, aleatorizado 1:1, de etiqueta abierta, N= 22. Desenlace: control de Hto y reducción de al menos 35% del tamaño del bazo a la semana 32.

N Engl J Med 2015; 372: 426-35

Phase III trial of Ruxolitinib in PV: The RESPONSE study



- Special protocol assessment agreement reached with FDA
- Primary composite endpoint: hematocrit control in the absence of phlebotomy and ≥35% reduction in spleen volume at Week 32
- Secondary endpoints: Complete hematologic remission at Week 32; % of subjects who maintain primary endpoint response for ≥48 weeks
- NCT01243944; www.responsetrial.com

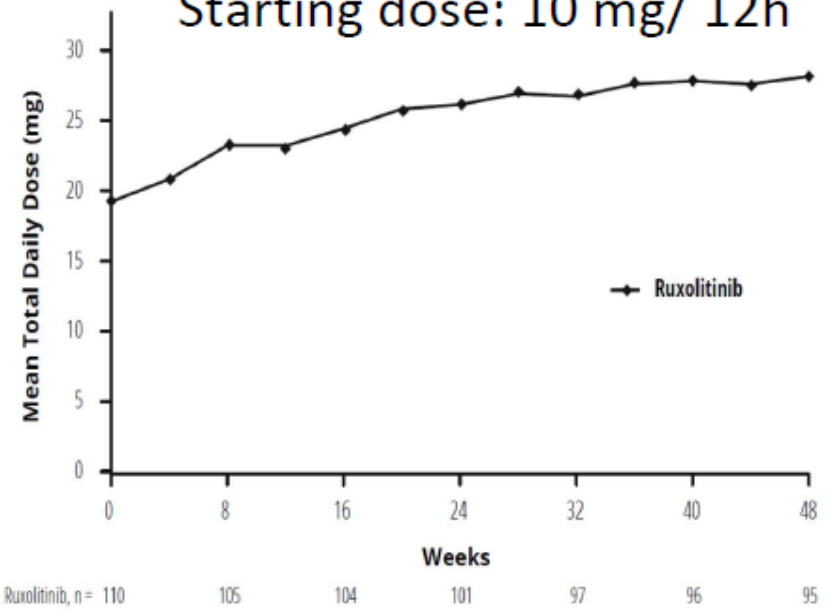
Treatment modalities in Response Trial

Standard therapy n=112

- Hydroxyurea: 59%
- Interferon: 12%
- Anagrelide: 7%
- Immunomodulators: 4.5%
- Pipobroman: 2%
- No medication: 15%

Ruxolitinib n=110

Starting dose: 10 mg/ 12h

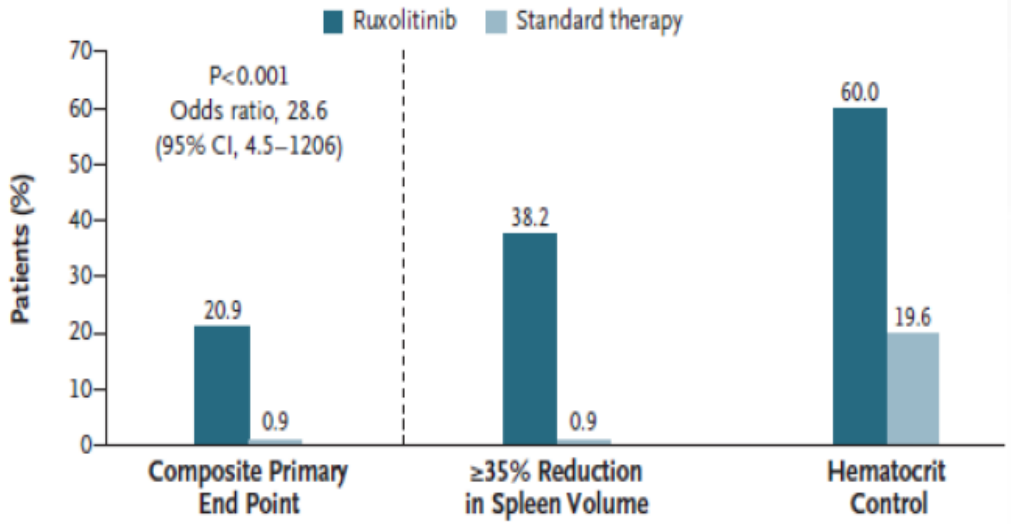


Discontinuation

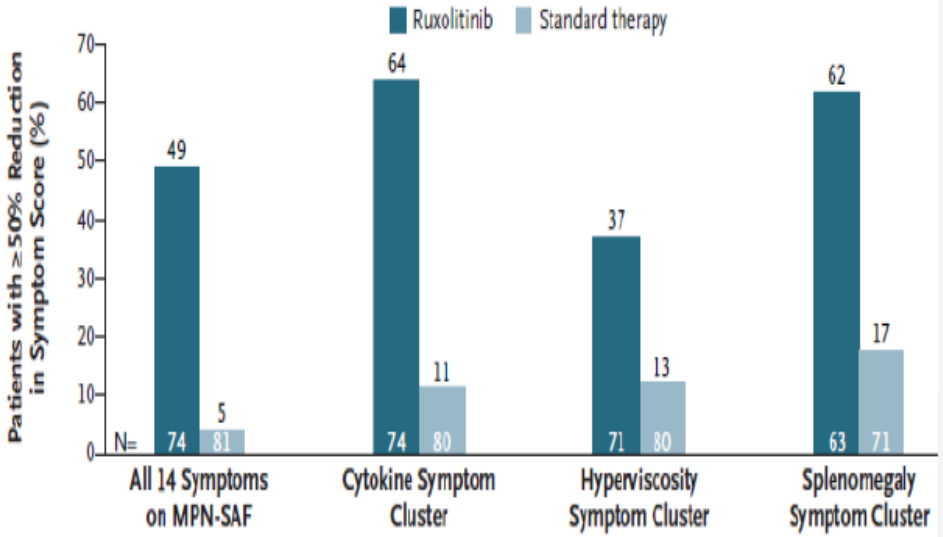
- Standard therapy: 96%
- Ruxolitinib: 15%

Vannucchi et al, NEJM 2015

Ruxolitinib en PV



CONCLUSIÓN: En pacientes intolerantes o resistentes a HU, ruxolitinib fue superior a la terapia convencional en controlar el Hto, reducir el bazo, y mejorar los síntomas asociados a PV.



- GRACIAS