COMPLICATIONS OF CIRRHOSIS

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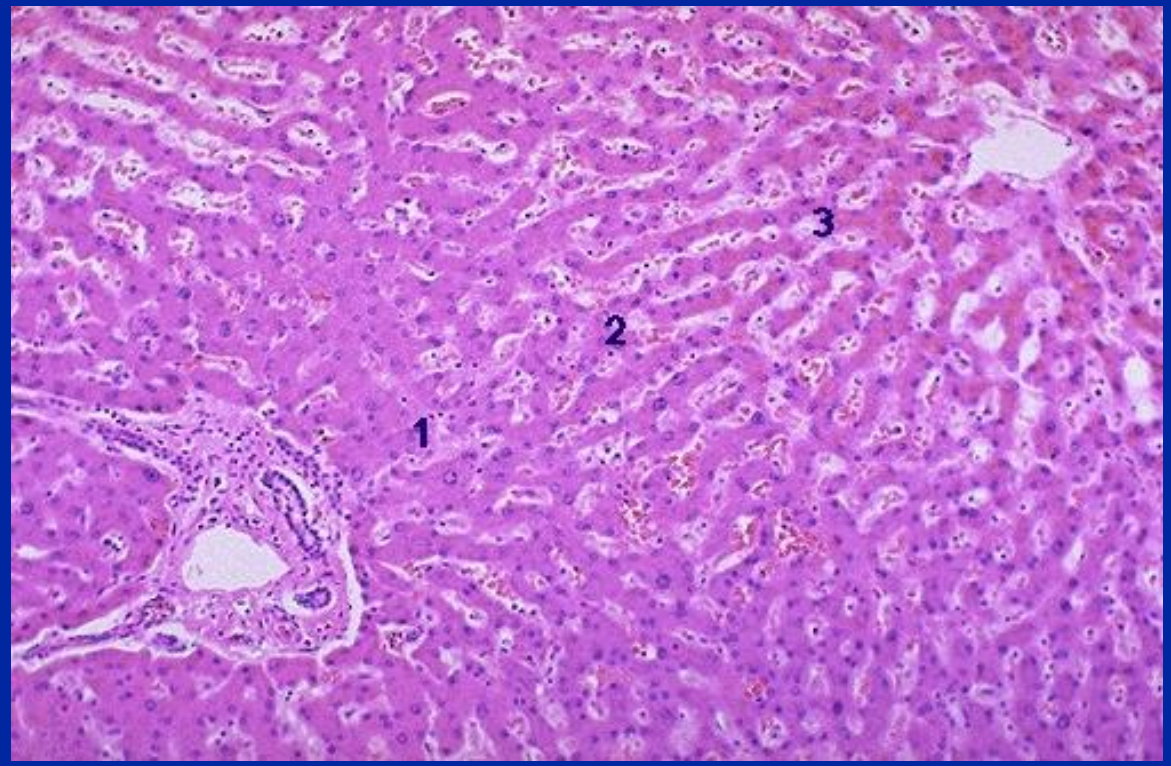
OBJECTIVES

Conceptual Framework

Pathophysiology, clinical features and therapies:

Varices
Ascites
Hepatic encephalopathy
Acute Kidney injury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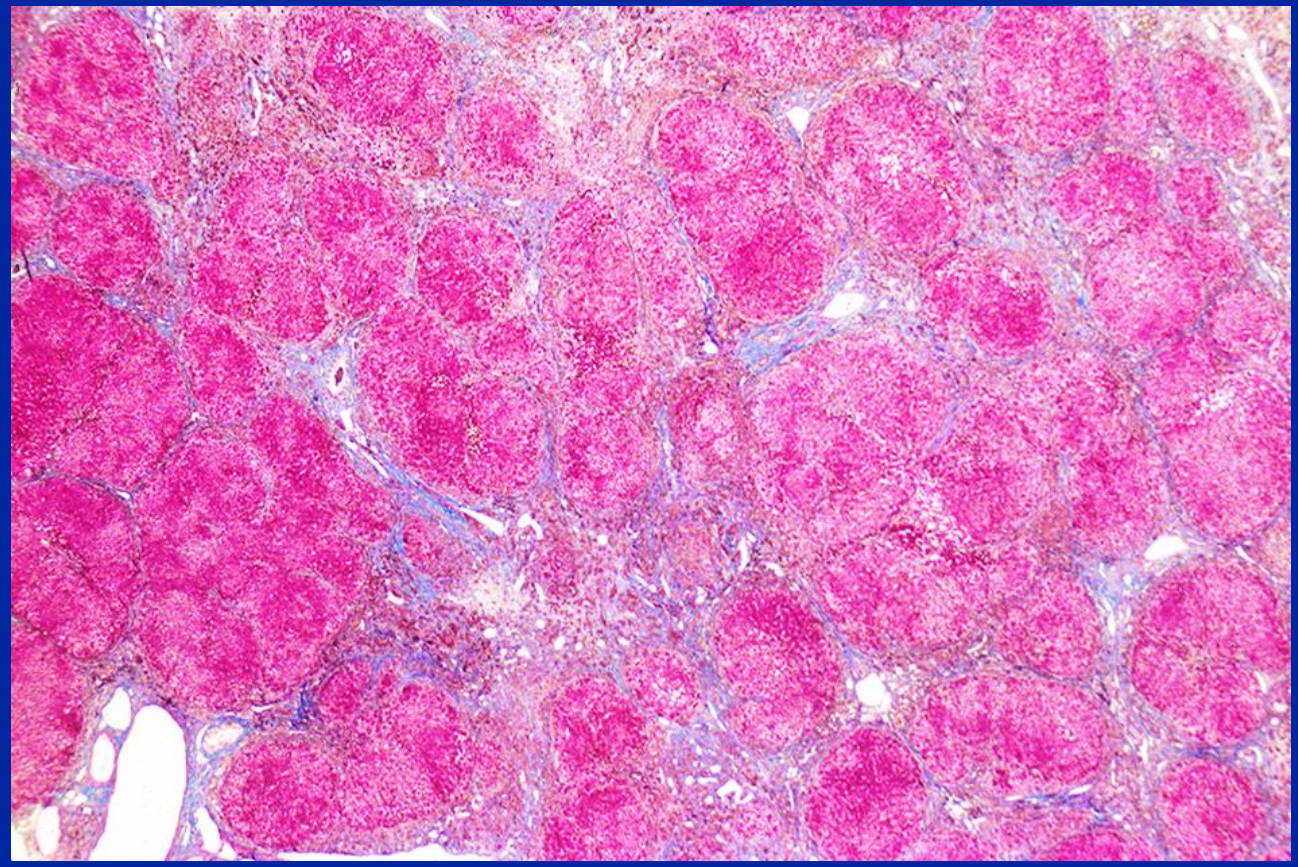


Complications of Cirrhosis

(1) Portal hypertension	“plumbing”
(2) hepatic dysfunction	“metabolism”
(3) altered vessel tone	“vasculature”

Complications of Cirrhosis

Portal Hypertension

↓

porto-systemic shunting
increased hepatic lymph

↓

varices
ascites
encephalopathy
splenomegaly

Hepatic dysfunction

↓

defective synthesis
and degradation

↓

low serum albumin
high prothrombin time
elevated total bilirubin
encephalopathy

Altered vessel tone

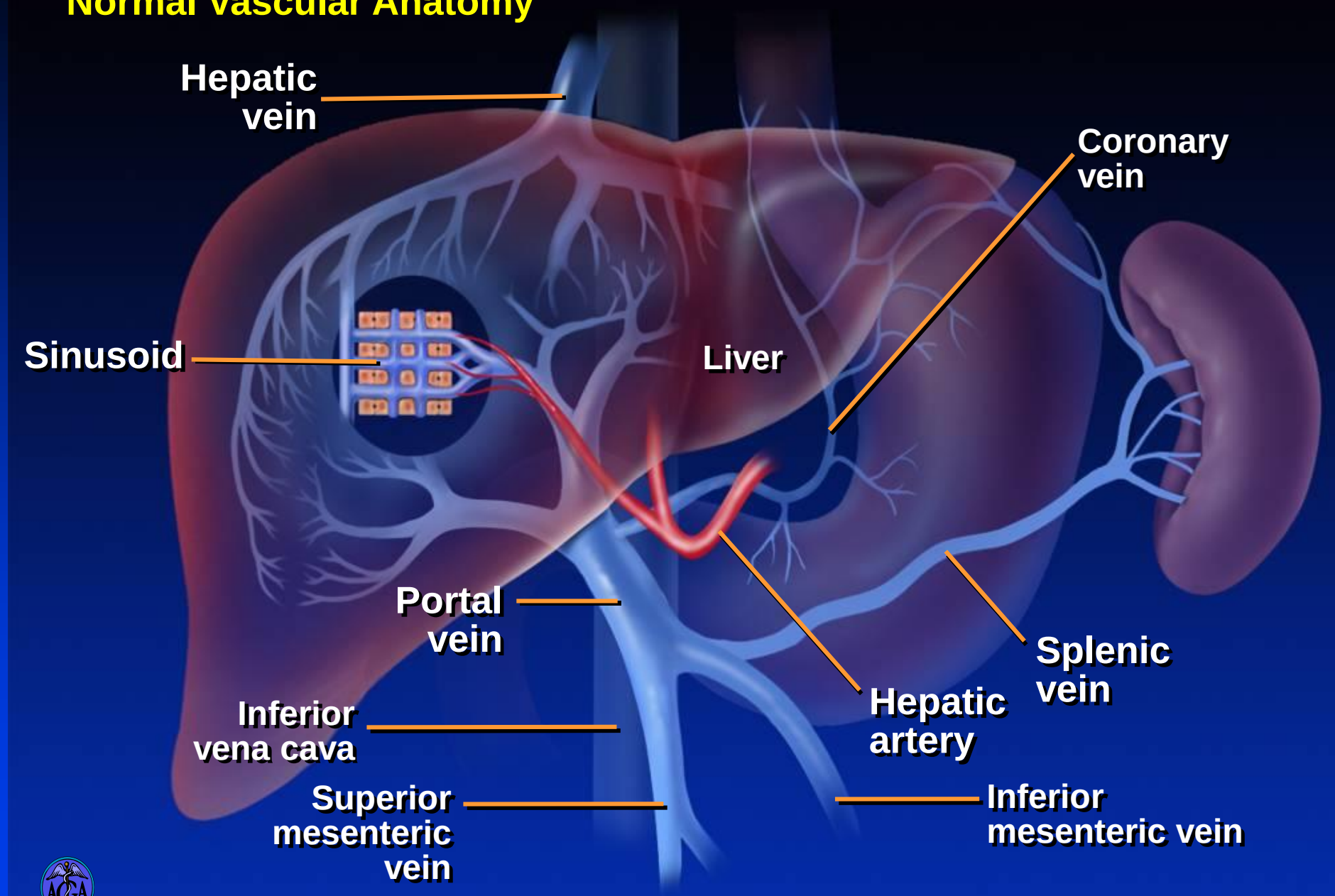
↓

vasoactive mediators

↓

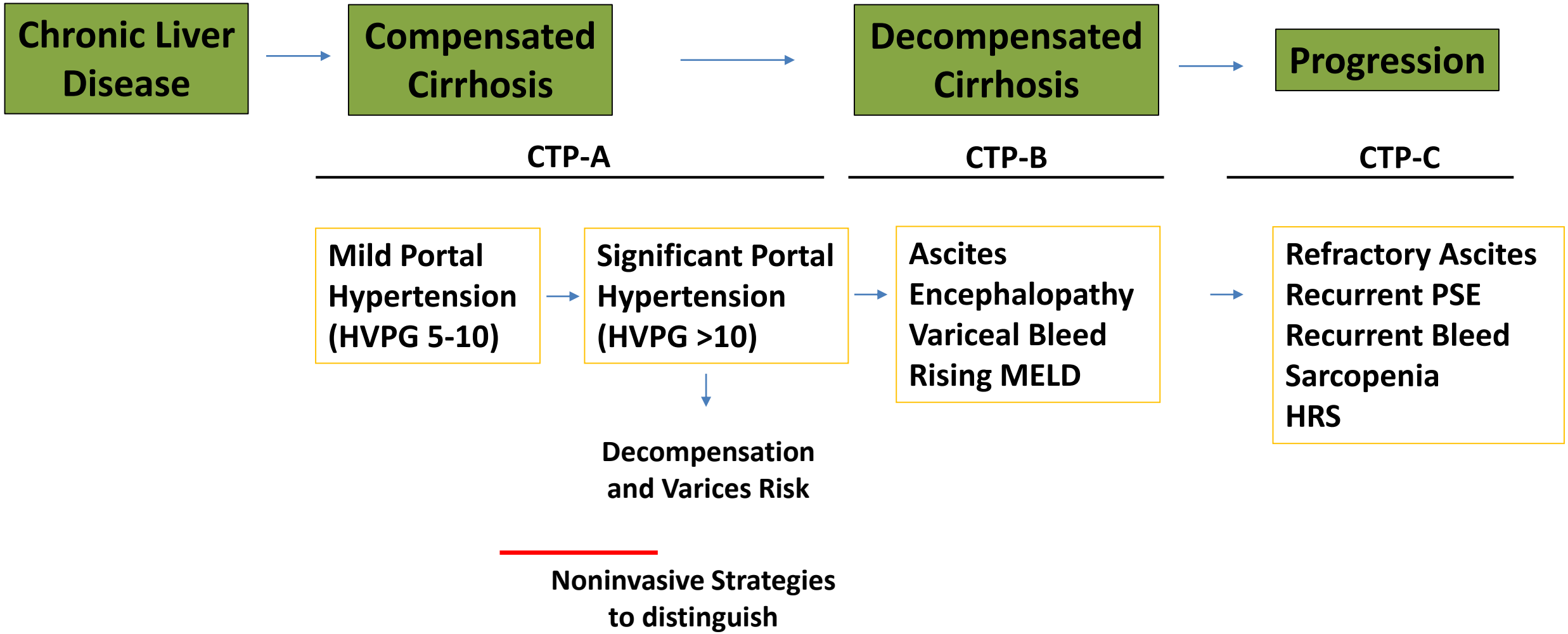
hyperdynamic circulation
hepatorenal syndrome
hepatopulmonary syndrome
portal hypertensive gastropathy

Normal Vascular Anatomy



Portal Hypertension Is Classified According to the Site of Increased Resistance

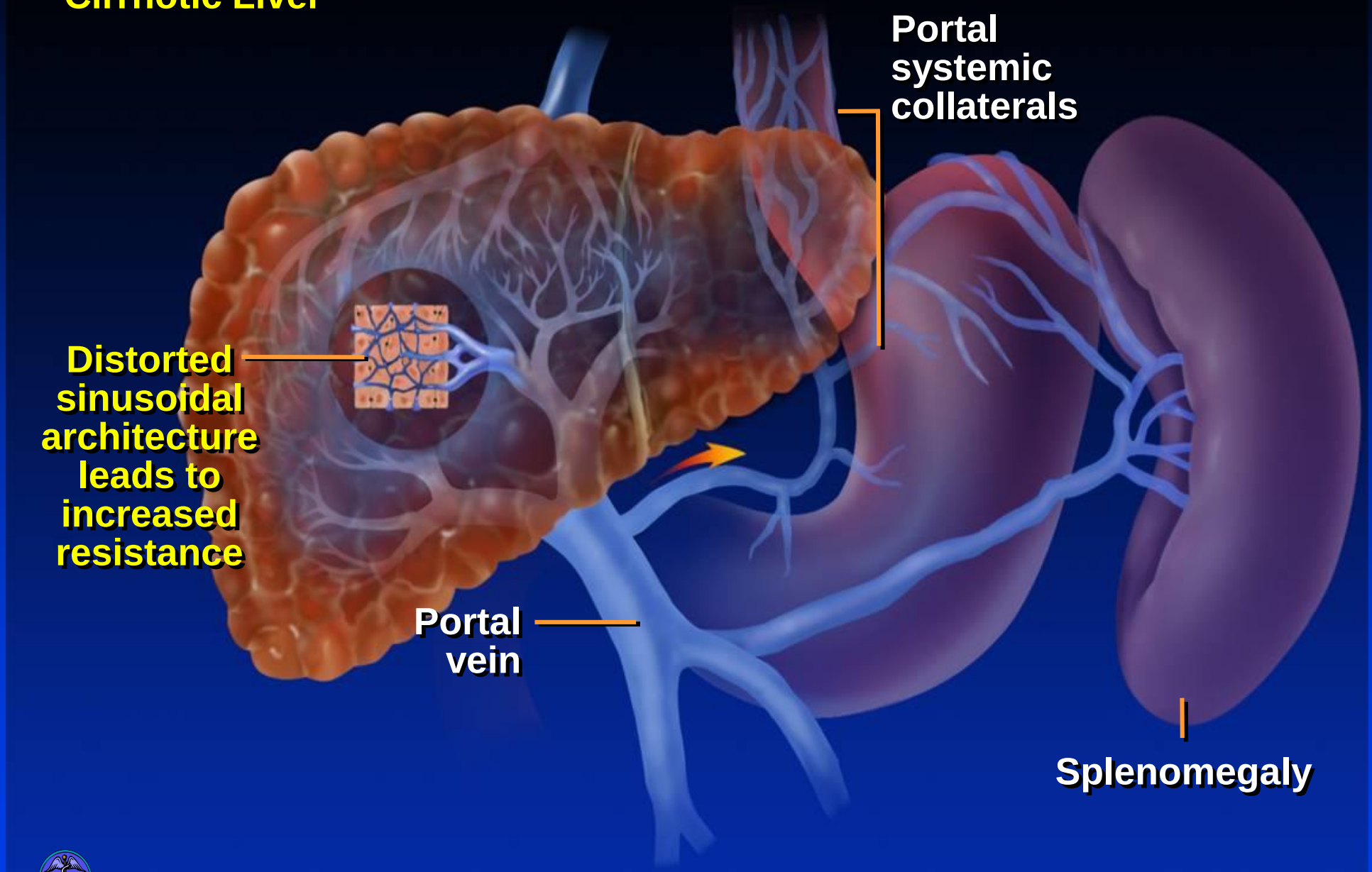
Type	Example
Pre-hepatic vein	Portal or splenic thrombosis
Pre-sinusoidal	Schistosomiasis
Sinusoidal	**Cirrhosis**
Post-sinusoidal disease	Veno-occlusive
Post-hepatic syndrome	Budd-Chiari



Adapted from: Garcia-Tsao et al. Hepatology 2017

Varices

Cirrhotic Liver

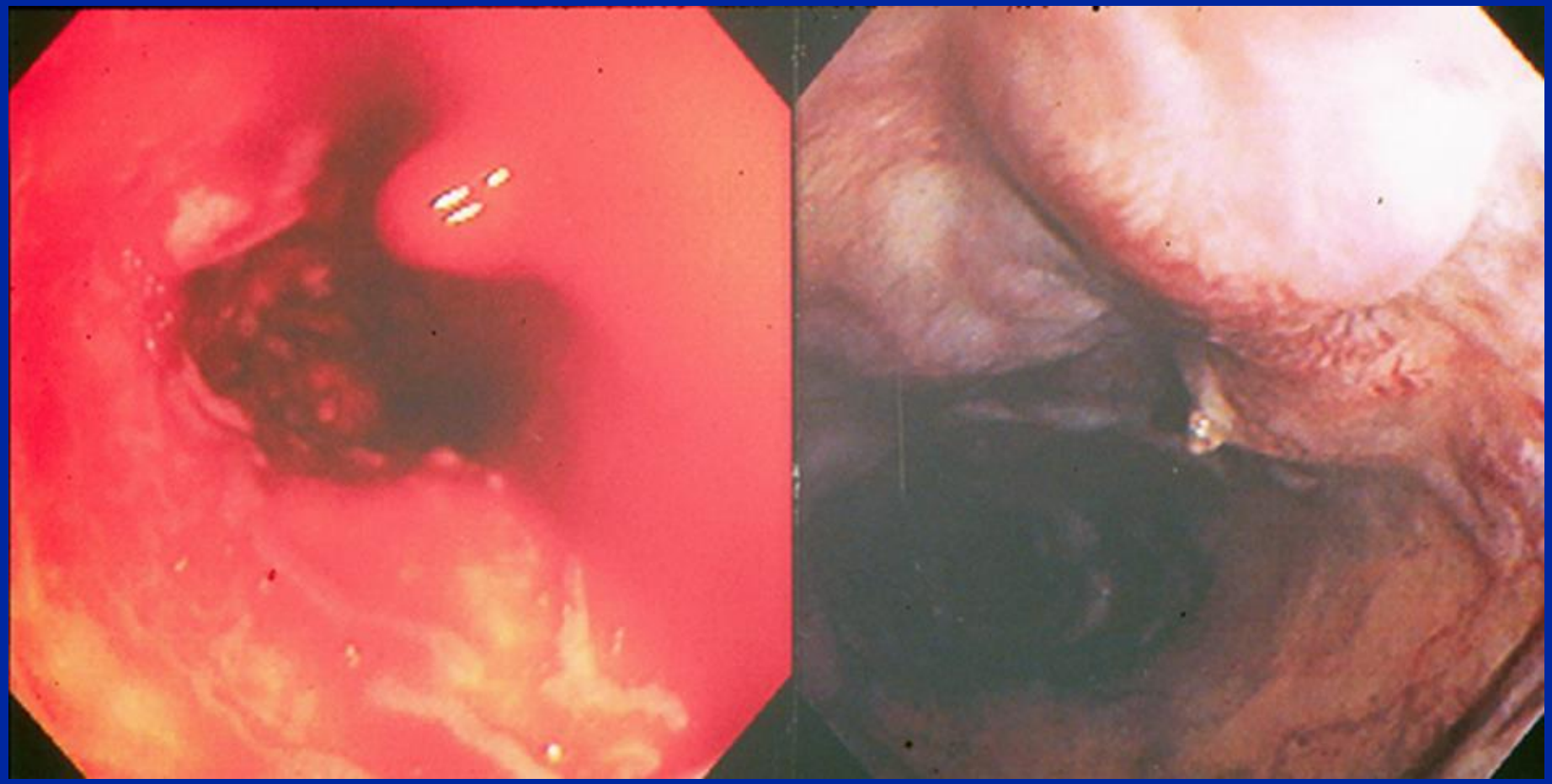


Varices Increase in Diameter Progressively

No varices | Small varices | Large varices

7-8%/year | 7-8%/year

Merli et al. J Hepatol 2003;38:266



Variceal hemorrhage

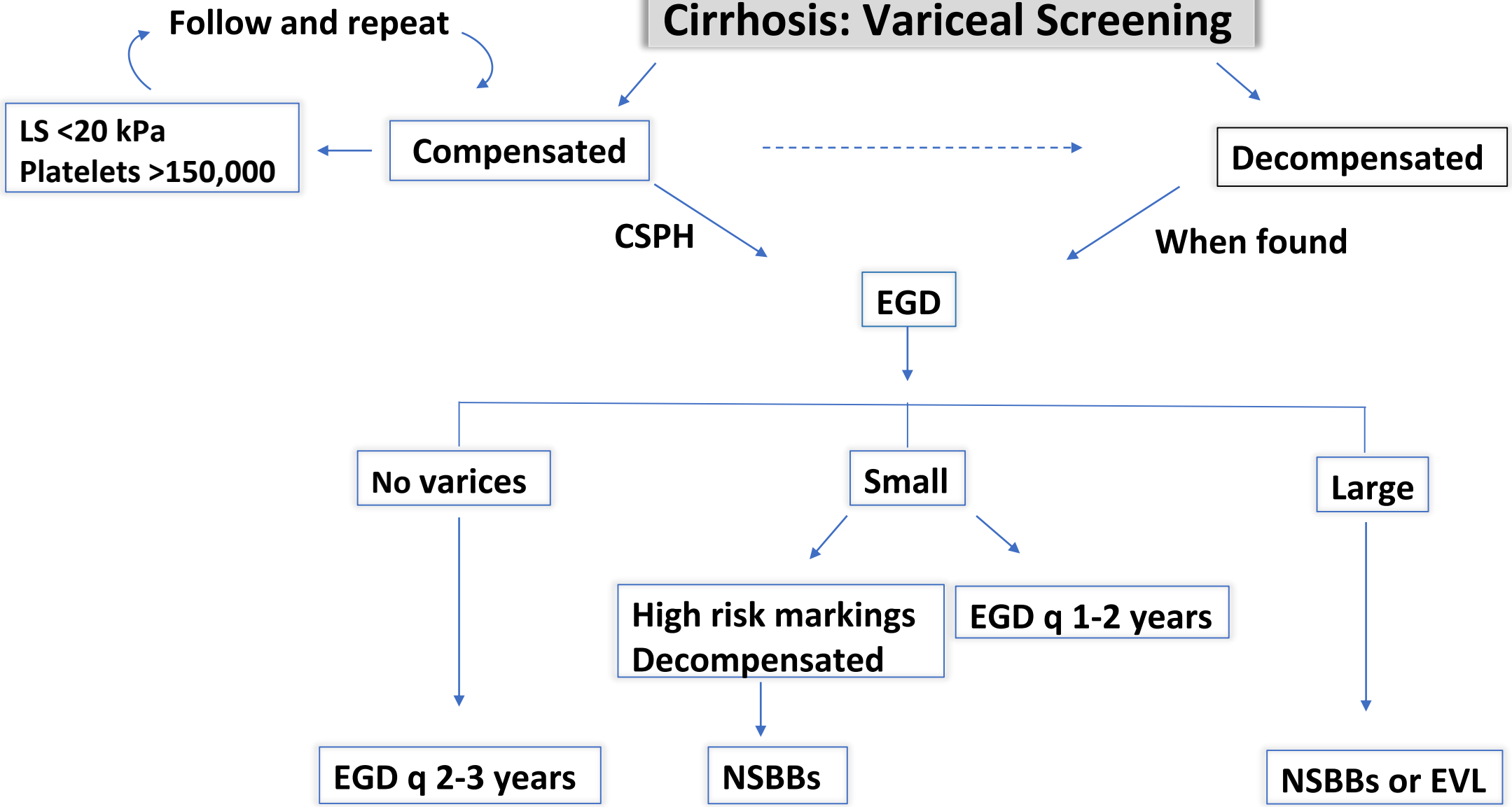
Varix with red signs

Predictors of hemorrhage:

- Variceal size
- Red signs
- Child B/C

NIEC. N Engl J Med 1988; 319:983

Cirrhosis: Variceal Screening



Garcia-Tsao et al. Hepatology 2017
de Franchis et al. J Hepatol 2015

Acute Variceal Bleeding

Resuscitate/risk stratify (US, Child Pugh score, cardiac echo)

Restrictive transfusion: threshold 7g/dl maintain 7-9 g/dl
Antibiotics: ceftriaxone 1gm q 24hrs (maximum 7 days)
Octreotide 50ug bolus then 50ug/hr
EGD within 6-12 hrs (band ligation)

Continue therapy for 3-5 days

controlled

Beta Blocker
Serial band ligation (q 2-4 weeks)

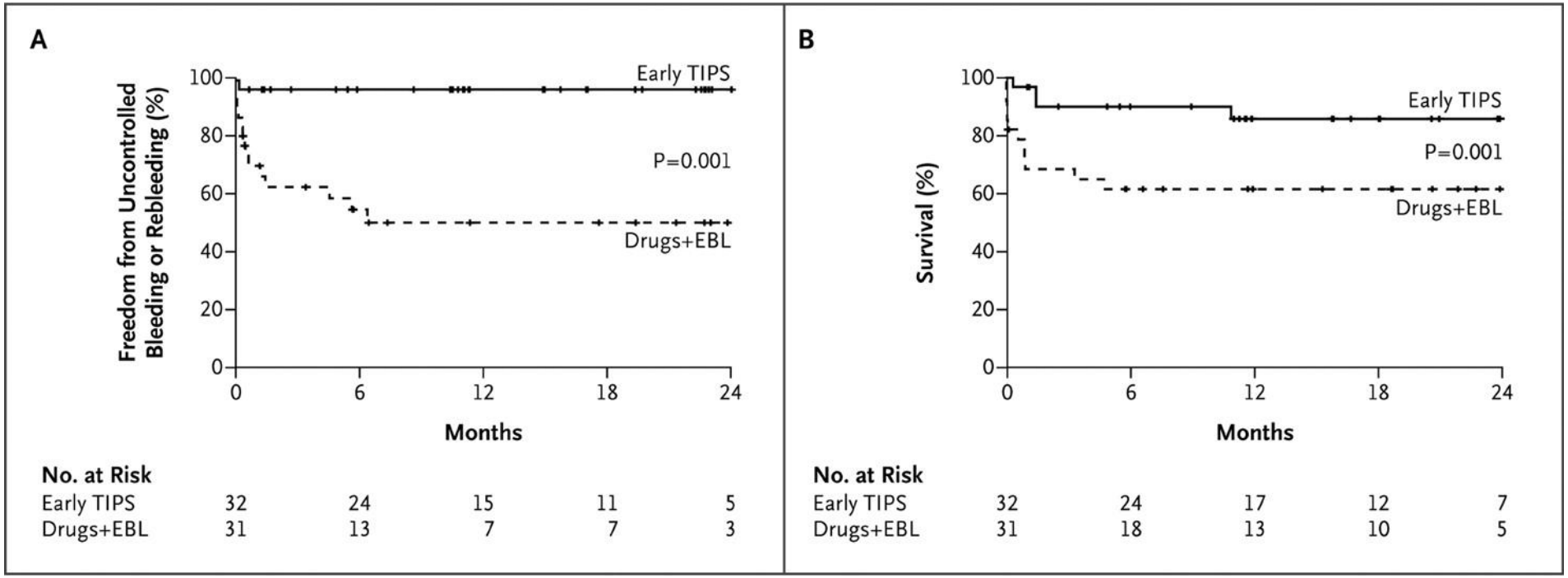
Rebleed or gastric varices
(TIPS, BRTO, glue, OLT)

Re-bleed

Salvage TIPS

Child Pugh C 10-14 (no contraindication)
Early TIPS (72hrs)

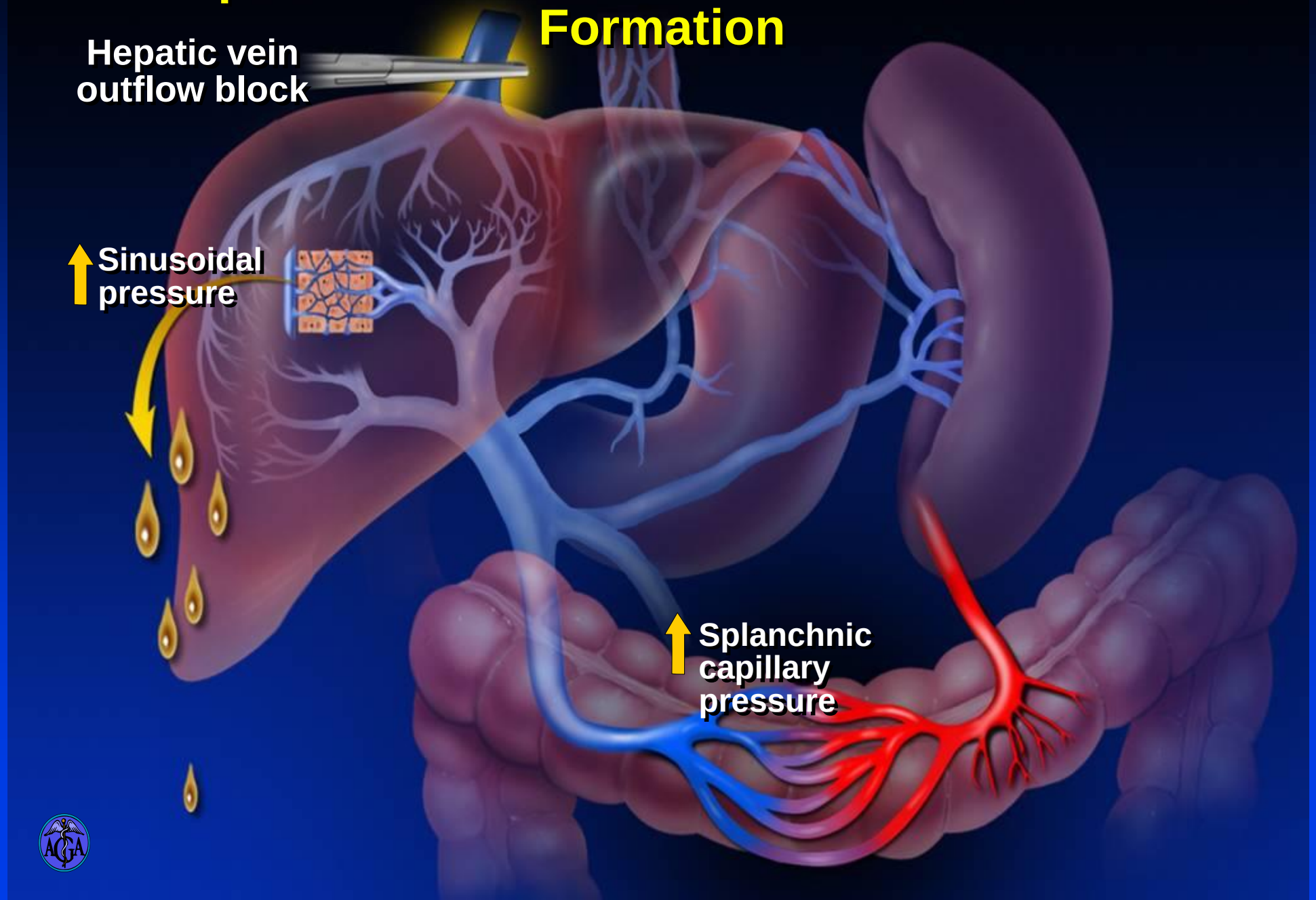
Bleeding/rebleeding and survival in TIPS vs Medical therapy



Garcia-Pagan et al NEJM 2010

Ascites

Hepatic Vein Obstruction Leads to Ascites Formation

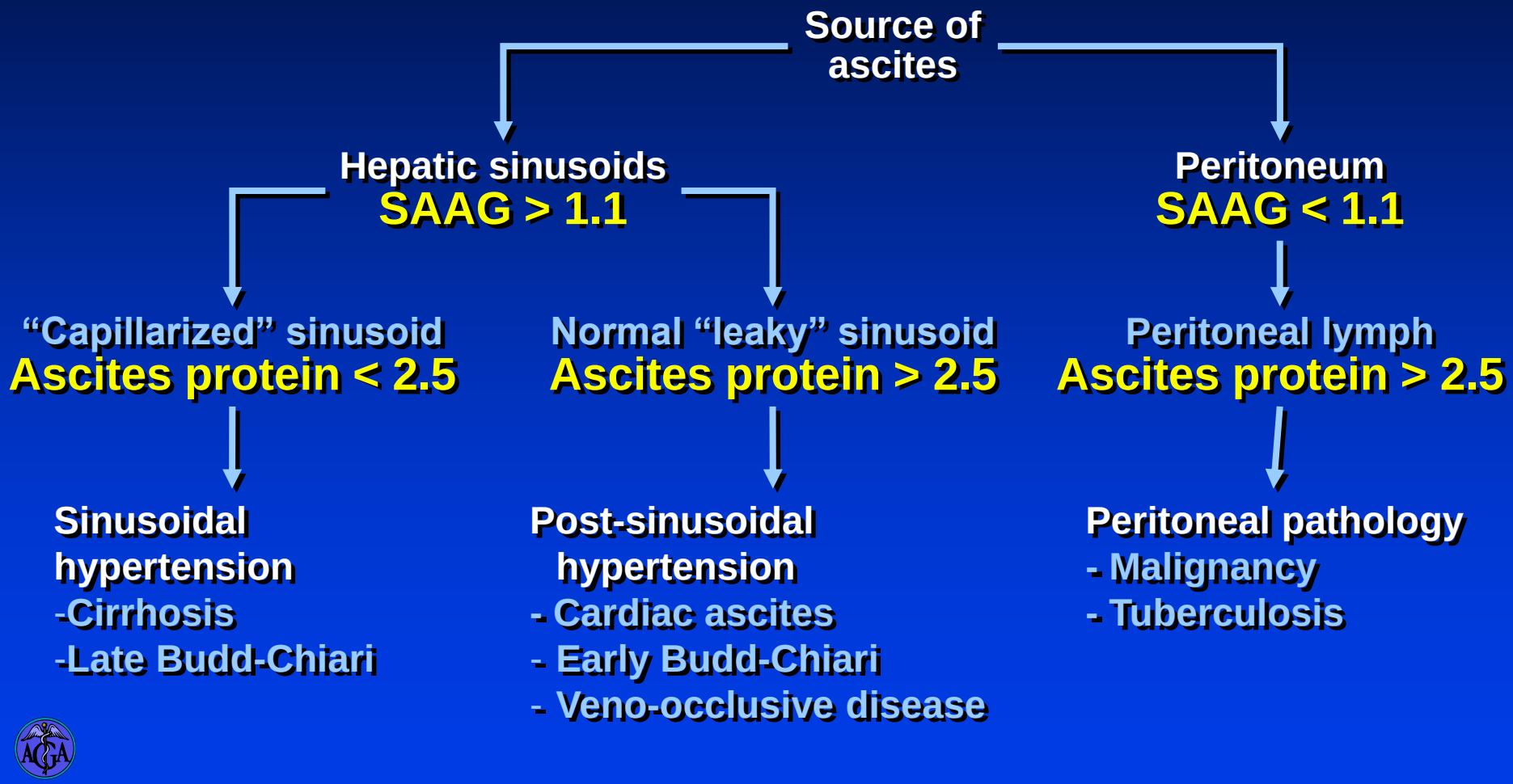


Serum-to-ascites albumin gradient (SAAG)

- SAAG = $[Albumin]_{serum} - [Albumin]_{ascites}$
  - portal hypertension ≥ 1.1
  - no portal hypertension < 1.1

- 97 % accuracy

Ascites Can Be Characterized by Serum-Ascites Albumin Gradient (SAAG) and Ascites Protein



Ascites (cell count)

- **Single most helpful test: defines infection**
- **PMNs ≥ 250 = SBP**
- **Traumatic tap (250 RBC = 1 PMN)**

Ascites

Diagnostic approach:

Diagnostic paracentesis (at diagnosis, ? Infection, change)
No data that FFP or plts decrease bleeding risk (spinal needle)
Inoculate blood cultures at bedside

Therapeutic approach:

Cardiac echo
Sodium restriction (pickles, pickle juice, canned soup)
No salt substitute
Avoid NSAIDs, ACEI, ARBs
Diuretics aldactone +/- furosemide (~2:1)
LVP vs TIPS

SBP

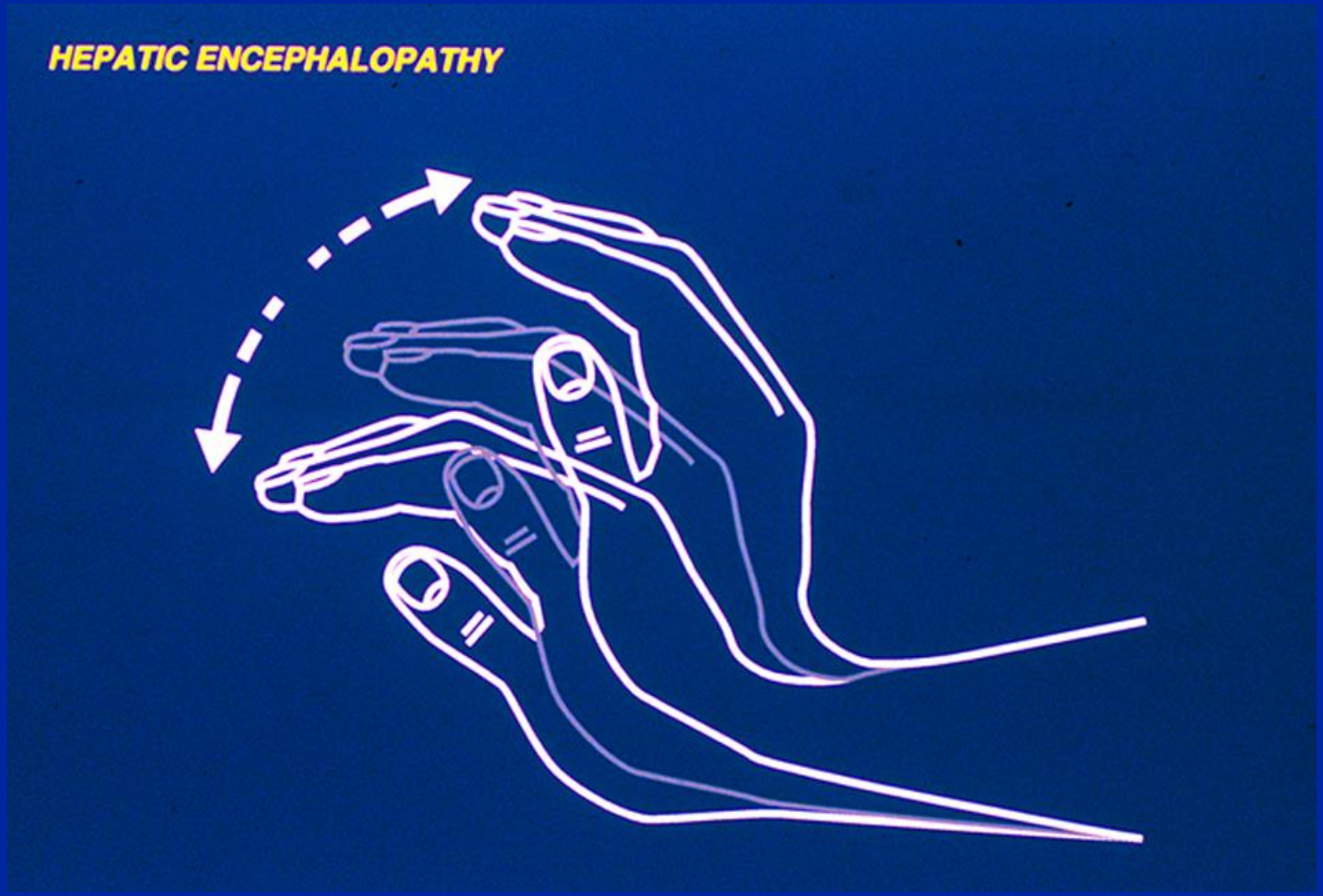
Diagnosis:

Early SBP does NOT present as peritonitis
Diagnostic paracentesis (? Infection, any change of concern)
Inoculate blood cultures at bedside

Treatment:

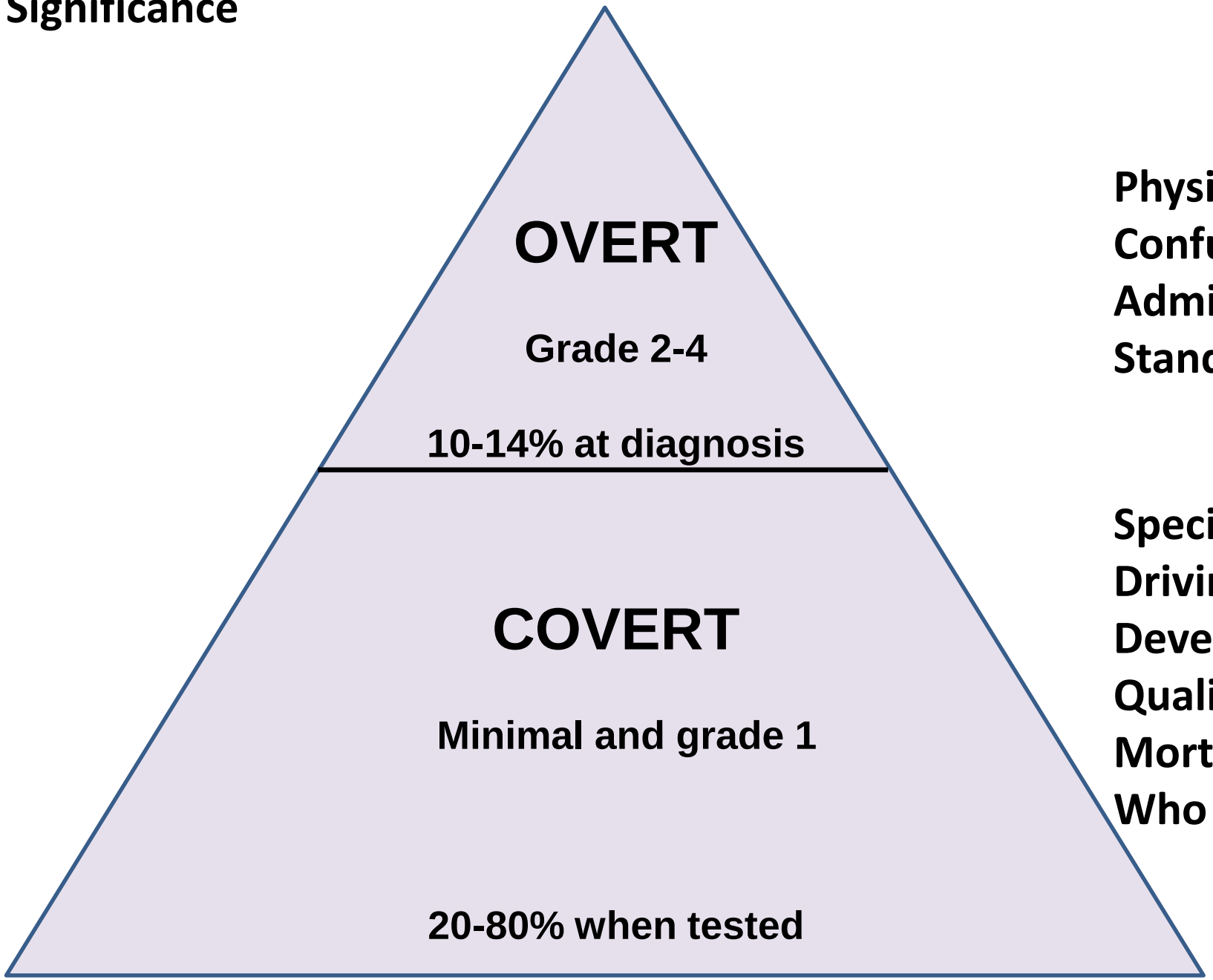
Third generation cephalosporin
Albumin 1.5g/Kg BW and 1.0g/Kg on day 3
Repeat paracentesis if atypical response or nosocomial situation

HEPATIC ENCEPHALOPATHY



West Haven Criteria		SONIC			
GRADE	INTELLECTUAL	STAGE	MENTAL STATUS	SPECIAL TESTS	ASTERIXIS
0	Normal	Unimpaired	Not impaired	Normal	Absent
Minimal	Normal exam Work, driving problems	Covert HE	Not impaired	Abnormal	Absent
1	Personality changes attention Irritability				
2	Altered sleep-wake cycle lethargy behavior cognition	Overt HE	Impaired	Abnormal	Present (unless coma)
3	Altered consciousness confusion				
4	Stupor and coma				

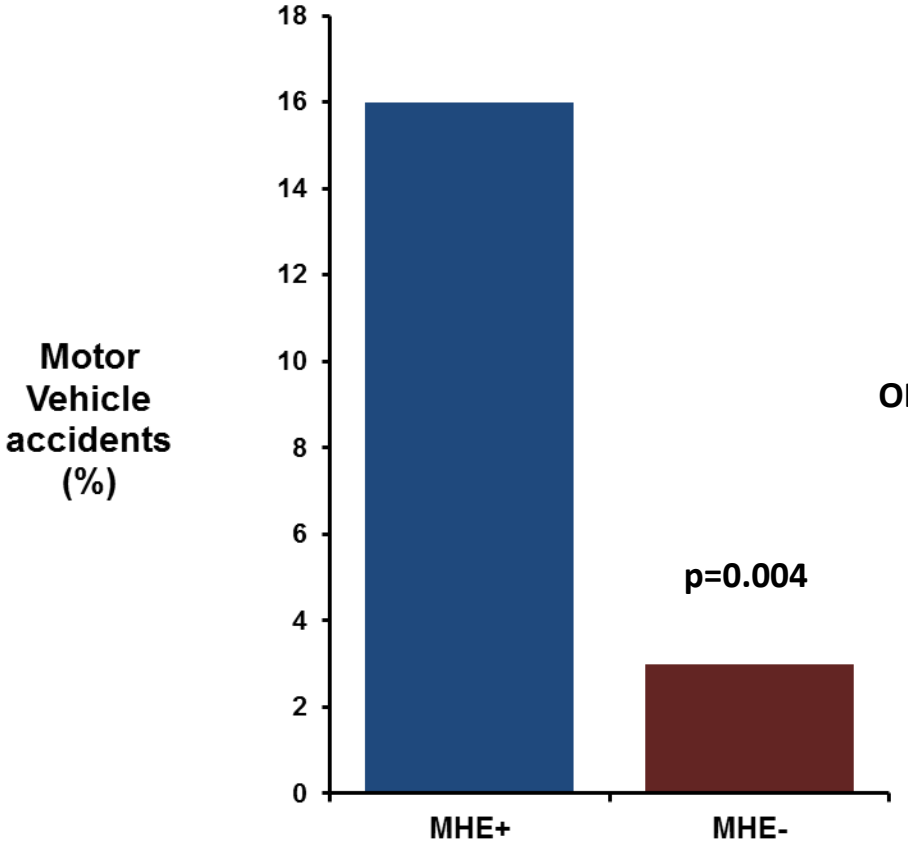
Clinical Significance



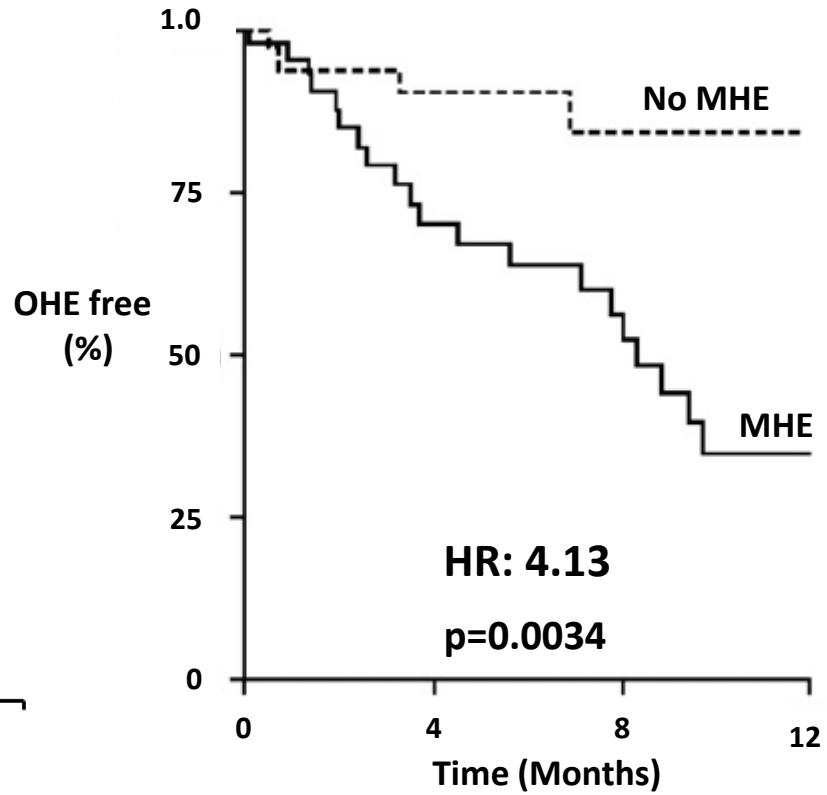
Physical Exam
Confusion
Admission
Standard treatments

Specialized tests
Driving
Development of overt
Quality of life
Mortality
Who to test and treat?

CHE: Risks

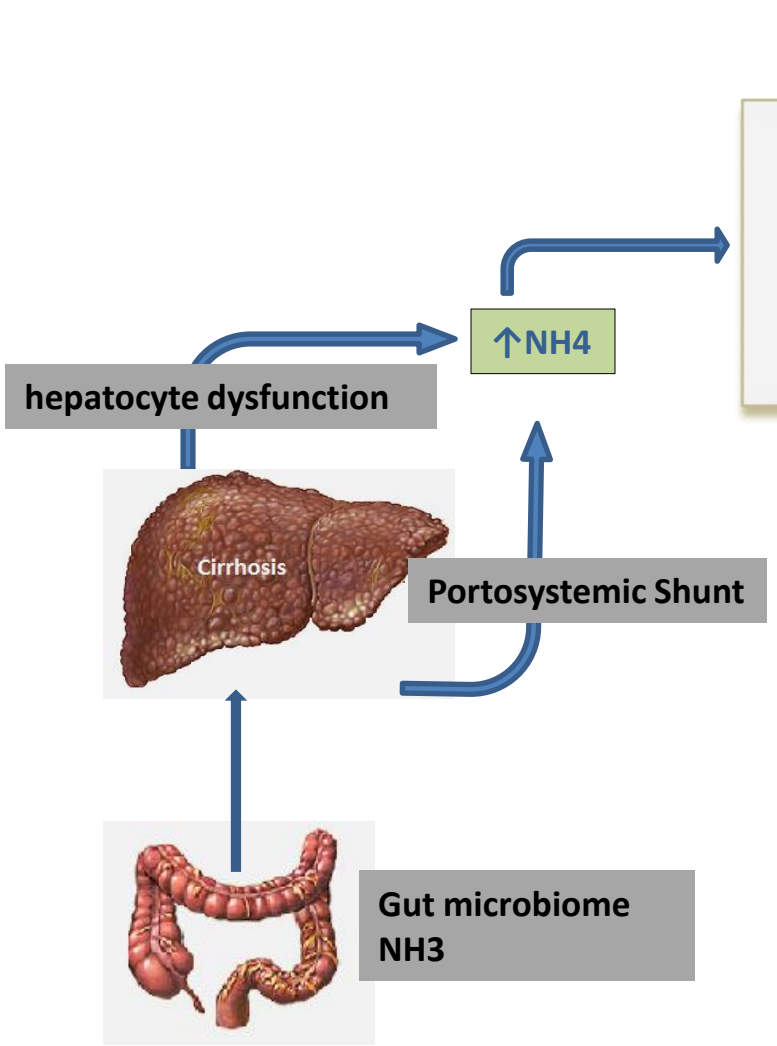


Bajaj et al, Hepatology 2009



Riggo et al, CGH 2011

Prevention of HE



Precipitating Factors

Sedatives - Benzodiazepines
Infection - Inflammatory cytokines
Electrolytes disturbances- Na, K
Diuretics
GI bleeding
Constipation
Renal dysfunction

HE: Diagnosis

- Clinical

- Neurocognitive tests for covert
- (PHES, STROOP others)

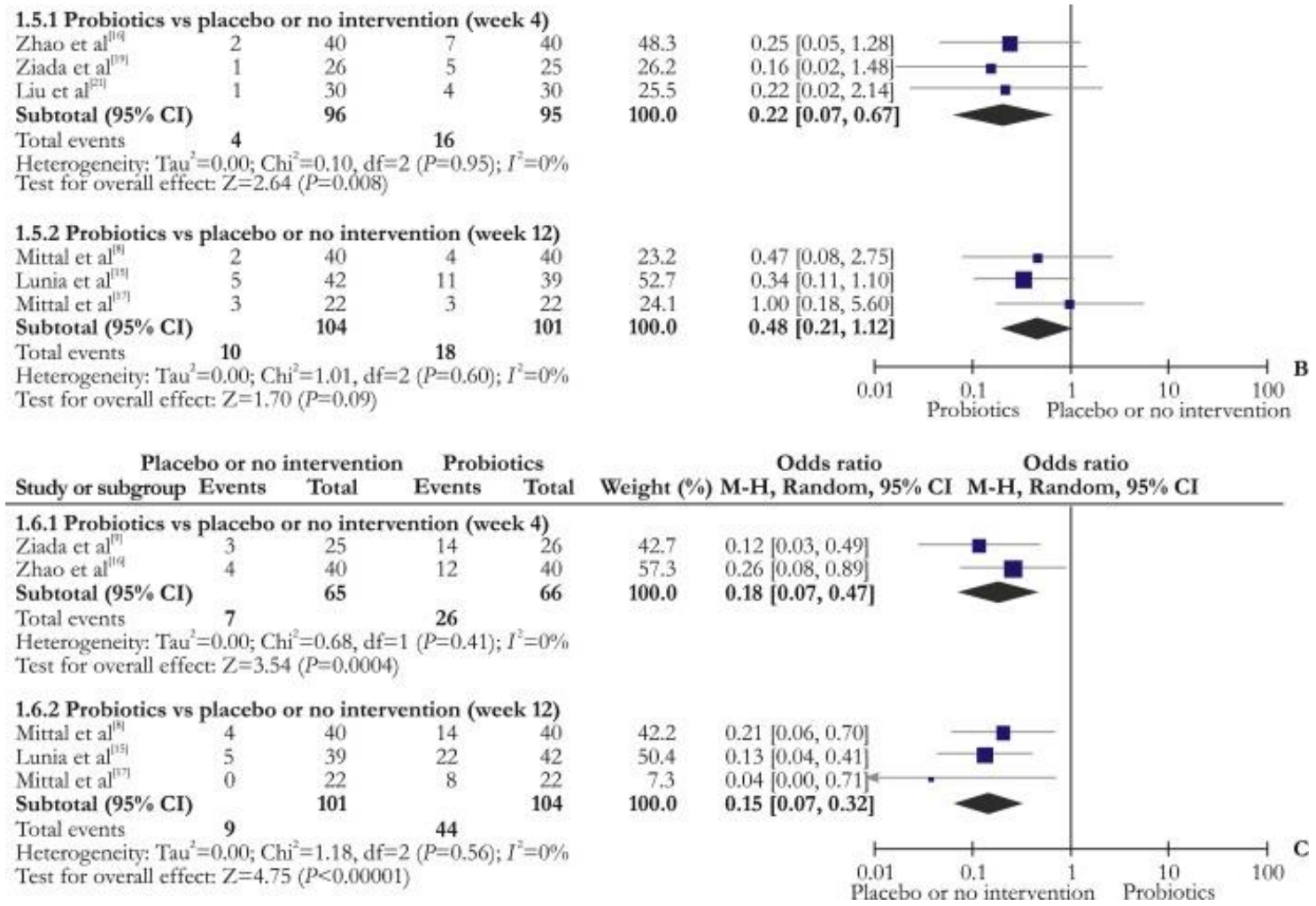
- Ammonia
- low sensitivity and specificity
- no diagnostic level

OTC deficiency

GI bleeding
Muscular exertion
Tourniquet use
Delayed processing/cooling of blood
Drugs: alcohol, barbiturates, diuretics, narcotics
Smoking

MHE: Treatment (lactulose/rifaximin effective)

Probiotics



Decreases OHE development

Improves MHE

Cao et al, Hepatobiliary Pancreat Dis Int 2018

Shukla et al, AJT 2011

HE

Diagnosis:

Alternate causes and contributors (infection, bleeding, medications)
? Head CT imaging
UDS

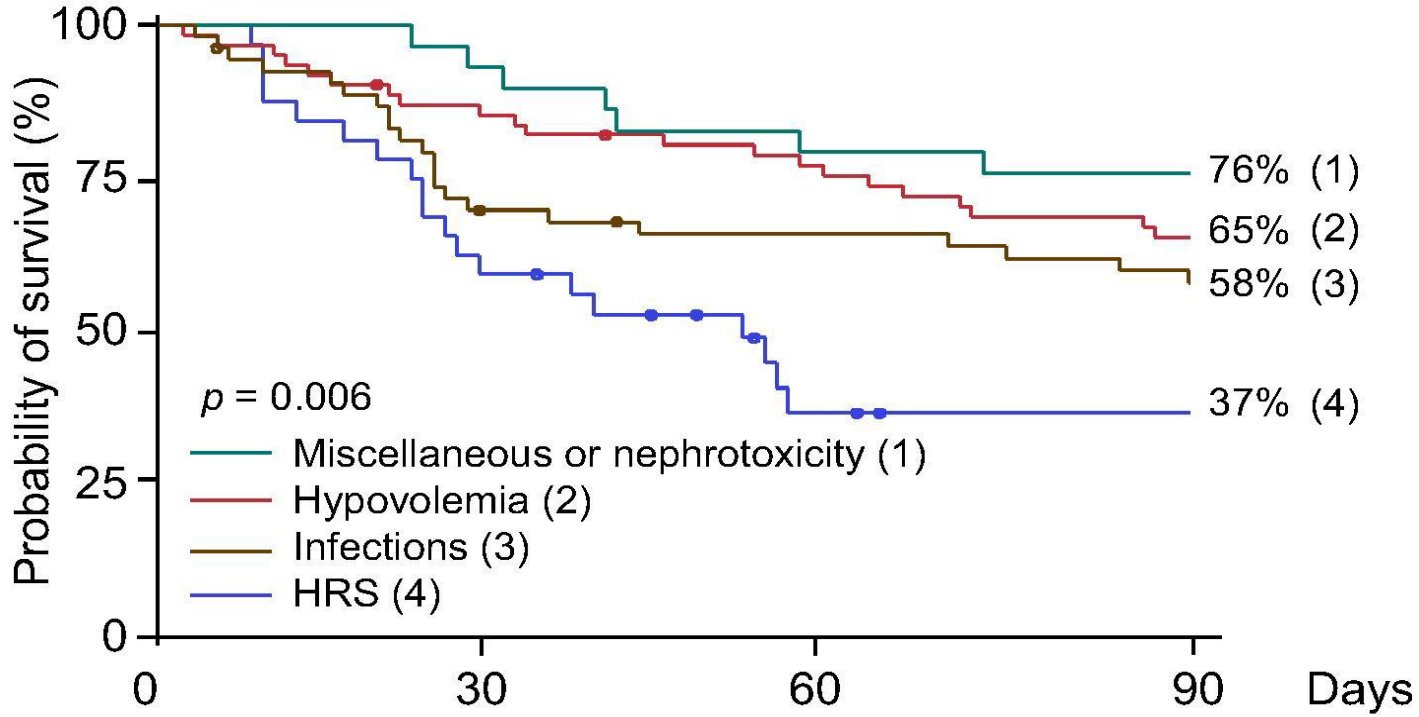
Treatment:

Probiotics
Lactulose 10grams/15mls (titrate to 2-3 BMS qd) route?
Rifaxamin 550mg PO BID
Zinc, neomycin, polyethylene glycol, BCAAs
No protein restriction

Acute Kidney Injury

HRS:*Classification*

- **Type 1 HRS**
  - **Rapid and progressive**
  - **Doubling of initial Cr > 2.5 or 50% reduction in GFR (<20ml/min) over 2 weeks**
- **Type 2 HRS**
  - **Diuretic resistant ascites, intense sodium retention, Cr > 1.5, prolonged survival**



1 (n = 29)	27	23	22
2 (n = 62)	52	45	39
3 (n = 54)	36	33	30
4 (n = 32)	19	9	7

Fagundes et al. J Hepatol. 59, 2013:477-481

Summary of the effects of baseline characteristics on HRS reversal (multivariate analysis, ITT population).

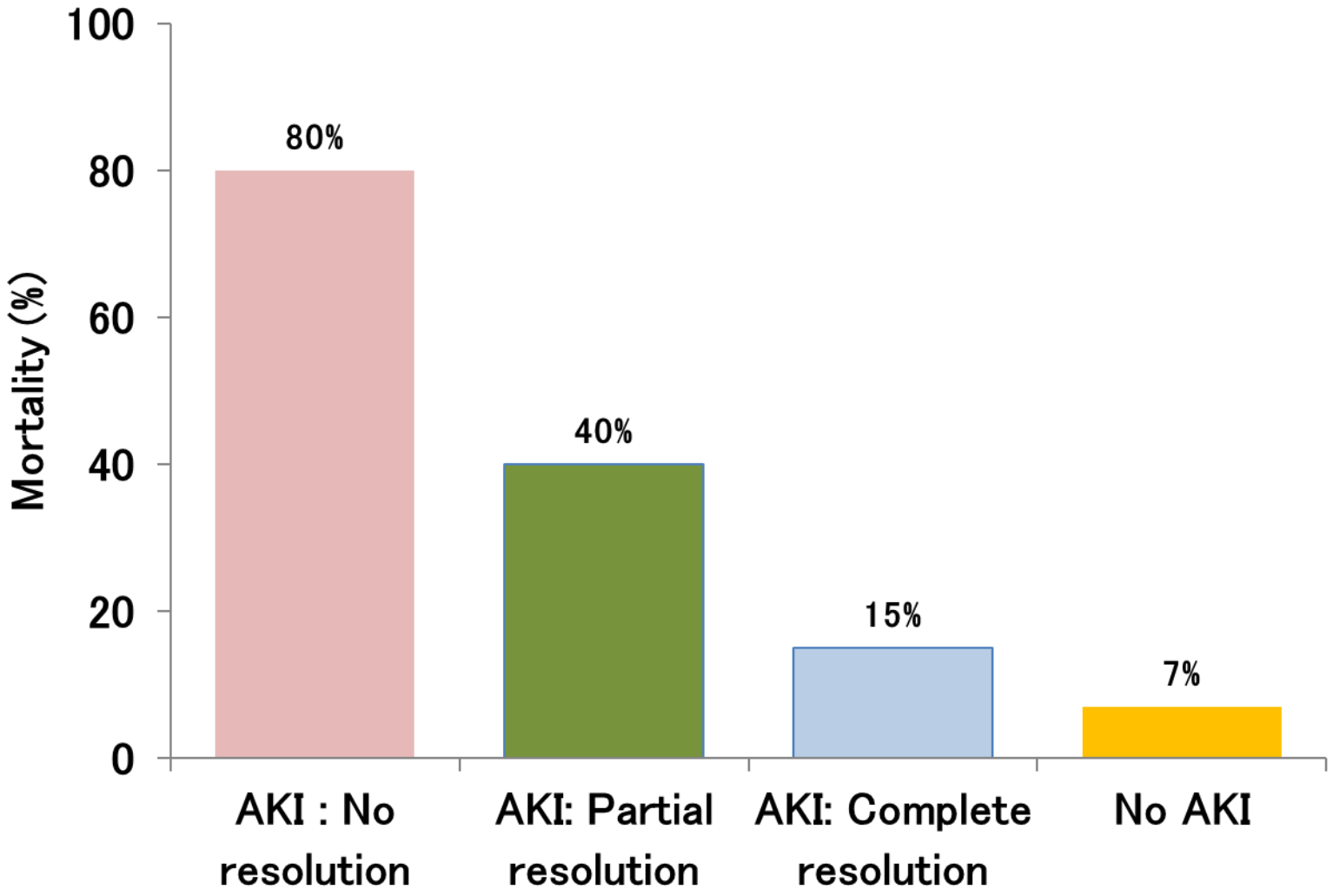
Baseline parameter	**RR**	**95% CI**	***p* value**
Alcoholic Hepatitis	0.98	0.32–2.94	0.965
Gender	0.68	0.23–1.96	0.472
MELD Score	0.92	0.80–1.05	0.223
Child-Pugh Score	0.89	0.62–1.27	0.513
Serum Creatinine	0.51	0.28–0.93	0.029
Bilirubin	1.02	0.97–1.08	0.374
Mean Arterial Pressure	0.98	0.94–1.02	0.348

RR: relative risk; 95% CI: 95% confidence intervals

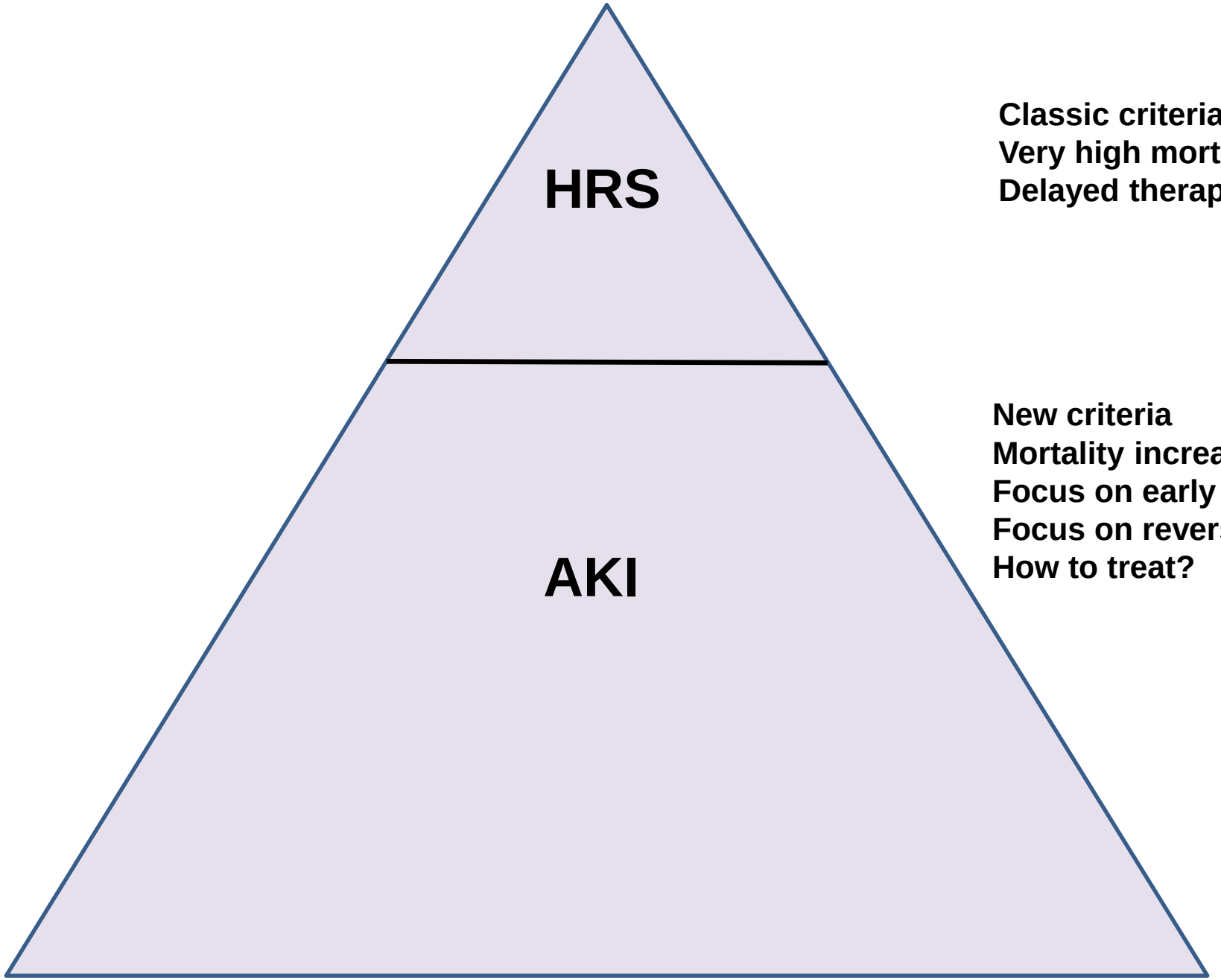
Boyer et al. J Hepatol 2011

Acute Kidney Injury in cirrhosis

- 20% of hospitalized cirrhotics
- Mortality 15 - 65% based on progression
- Often functional and linked to infection



Adapted from Wong *et al. Gatroentrology* 2013



Classic criteria
Very high mortality
Delayed therapy

New criteria
Mortality increased
Focus on early detection
Focus on reversible causes
How to treat?

Diagnosis and Prevention

Cr poor measure of renal function in cirrhosis

- **muscle mass**
- **creatine conversion to creatinine**
- **volume of distribution**

Consensus AKI criteria in cirrhosis

- **Increase in Cr >0.3 mg/dl in 48 hrs**
- **Increase in Cr 1.5 fold above baseline within 3 months**

Table 1.

The diagnostic criteria of acute kidney injury in cirrhosis

Parameter	Definition
Baseline SCr	Stable SCr ≤3 months
	If not available, a stable SCr closest to the current one
	If no previous SCr at all, use admission SCr
Definition of AKI	↑ in SCr ≥26.5 µmoL/L (0.3 mg/dL) ≤ 48 hours, or ↑ 50% from baseline
Staging	Stage 1 : ↑ SCr ≥26.4 µmoL/L (0.3 mg/dL) or ↑ SCr ≥1.5–2.0 × from baseline
	Stage 2 : ↑ SCr >2.0–3.0 × from baseline
	Stage 3 : ↑ SCr >3.0 × from baseline, or
	SCr ≥352 µmoL/L (4.0 mg/dL) with an acute ↑ of ≥26.4 µmoL/L (0.3 mg/dL), or
	Initiation of renal replacement therapy

With standard exclusions fulfills criteria for HRS

SCr, Serum creatinine; AKI, acute kidney injury.

IAC definition *Wong, F Clin Mol hepatol 2016*

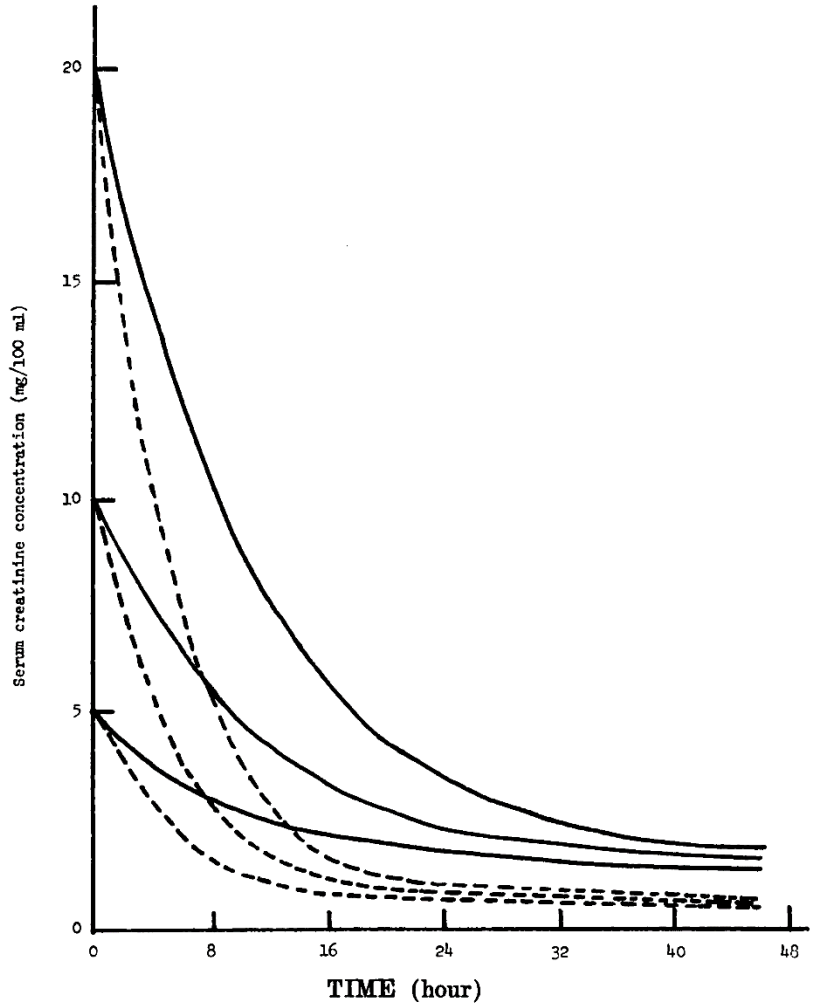
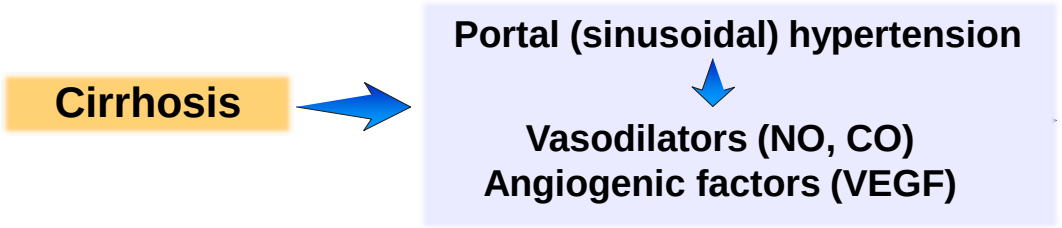
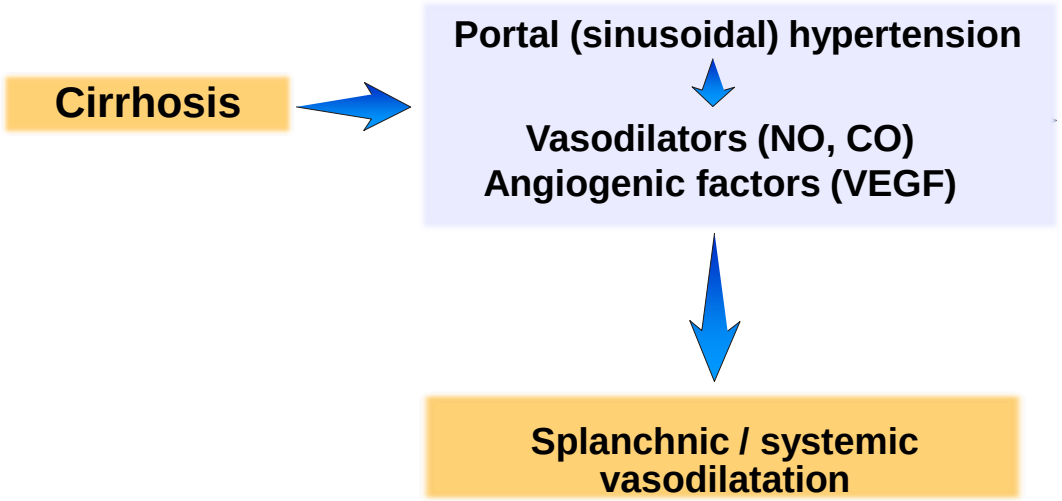


Fig. 2. Decay patterns of serum creatinine levels after improvement of renal function: solid lines, patients with 50 per cent of normal function; broken lines, patients with normal renal function.

Chiou, W and Hsu, F J Clin Pharm 1975


Cirrhosis
Portal (sinusoidal) hypertension
Vasodilators (NO, CO)
Angiogenic factors (VEGF)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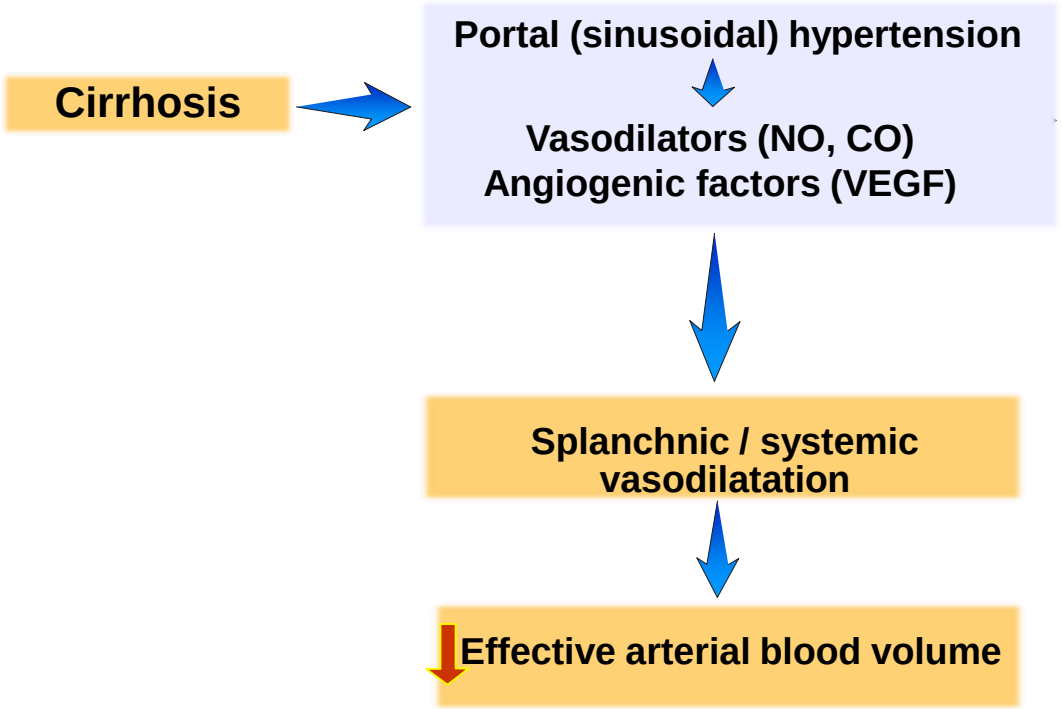
Splanchnic / systemic vasodilatation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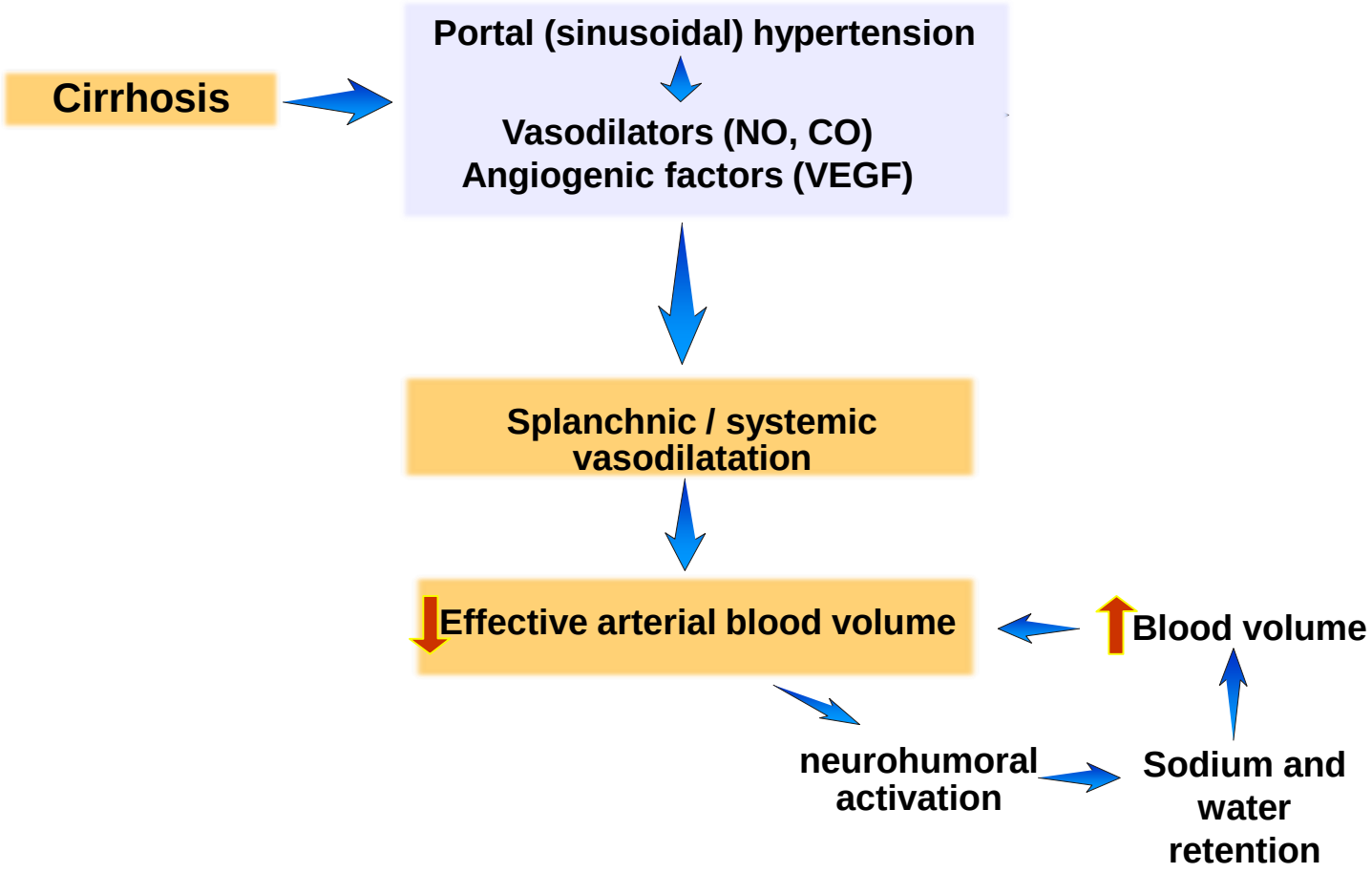
Effective arterial blood volume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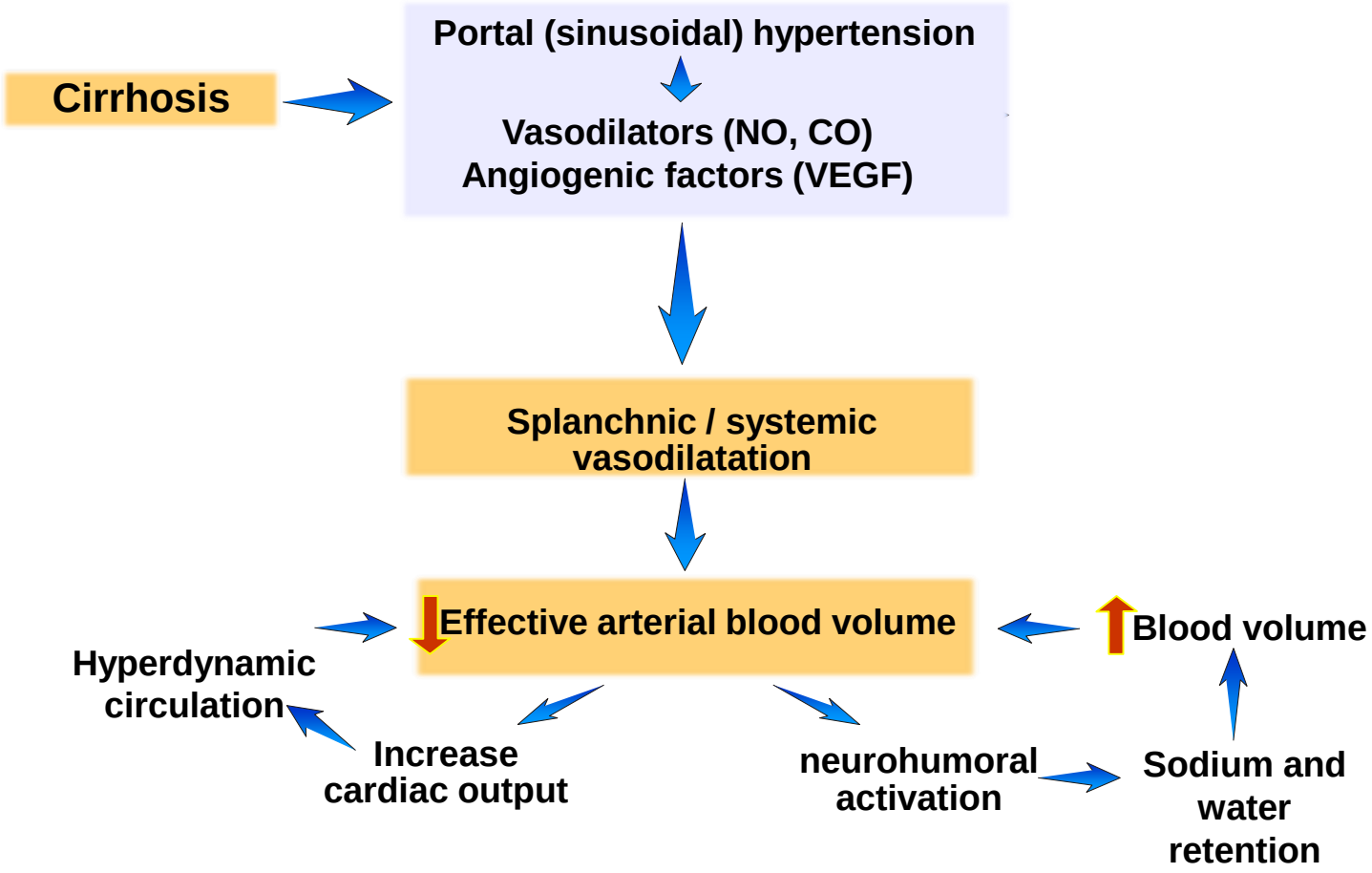
neurohumoral activation
Sodium and water retention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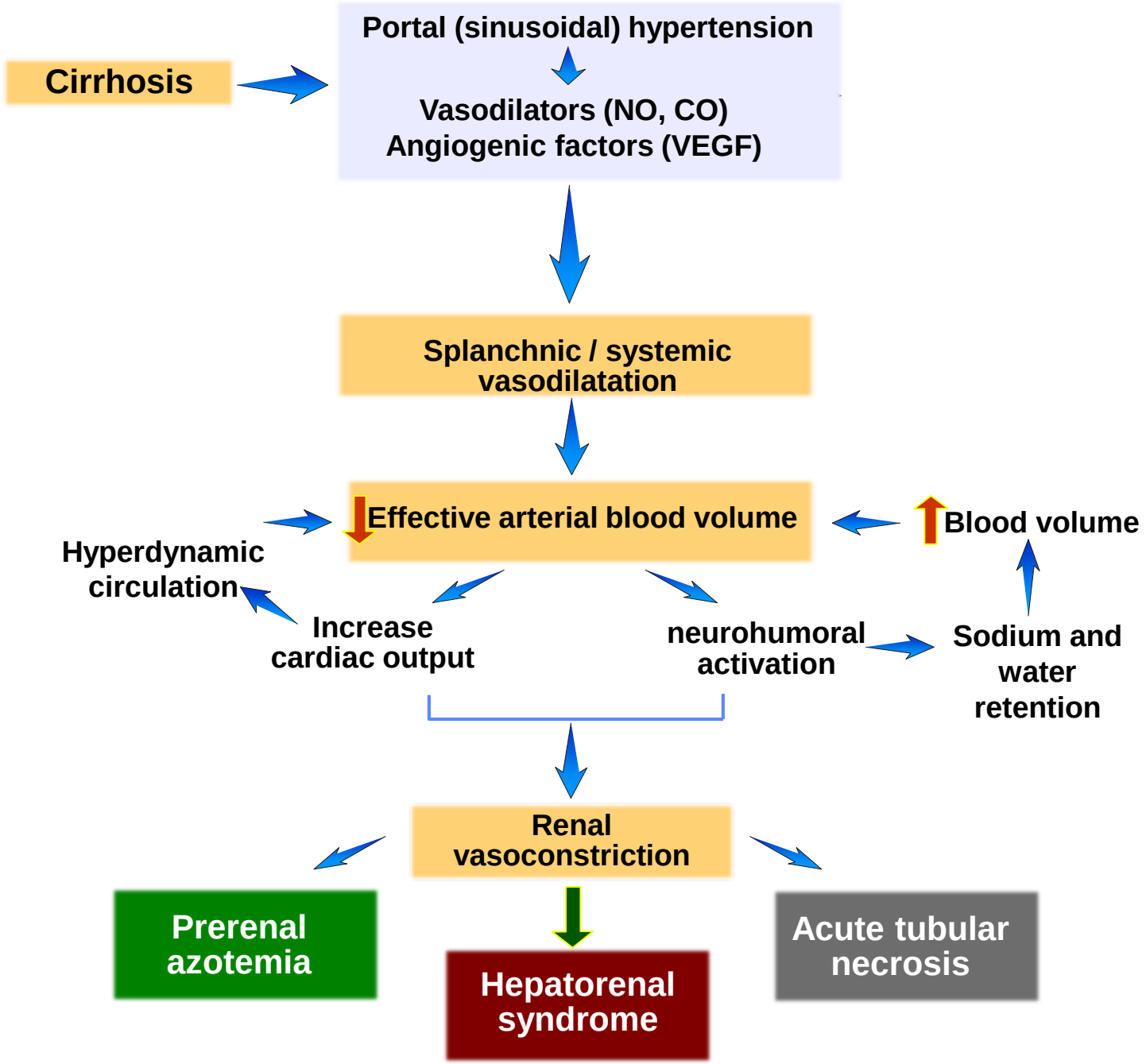
Increase cardiac output
neurohumoral activation
Sodium and water retention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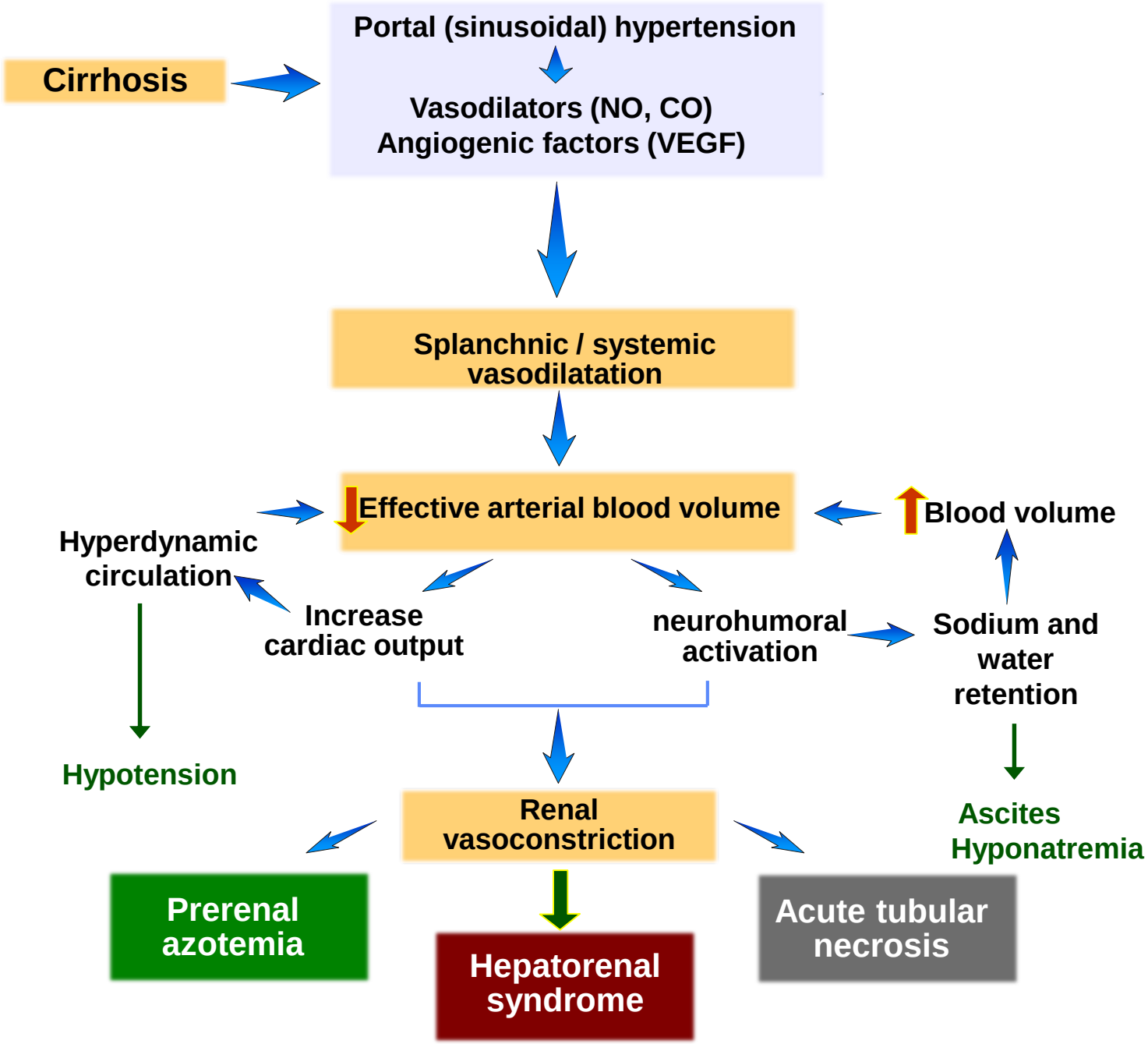
Renal vasoconstriction
Prerenal azotemia
Hepatorenal syndrome
Acute tubular necrosis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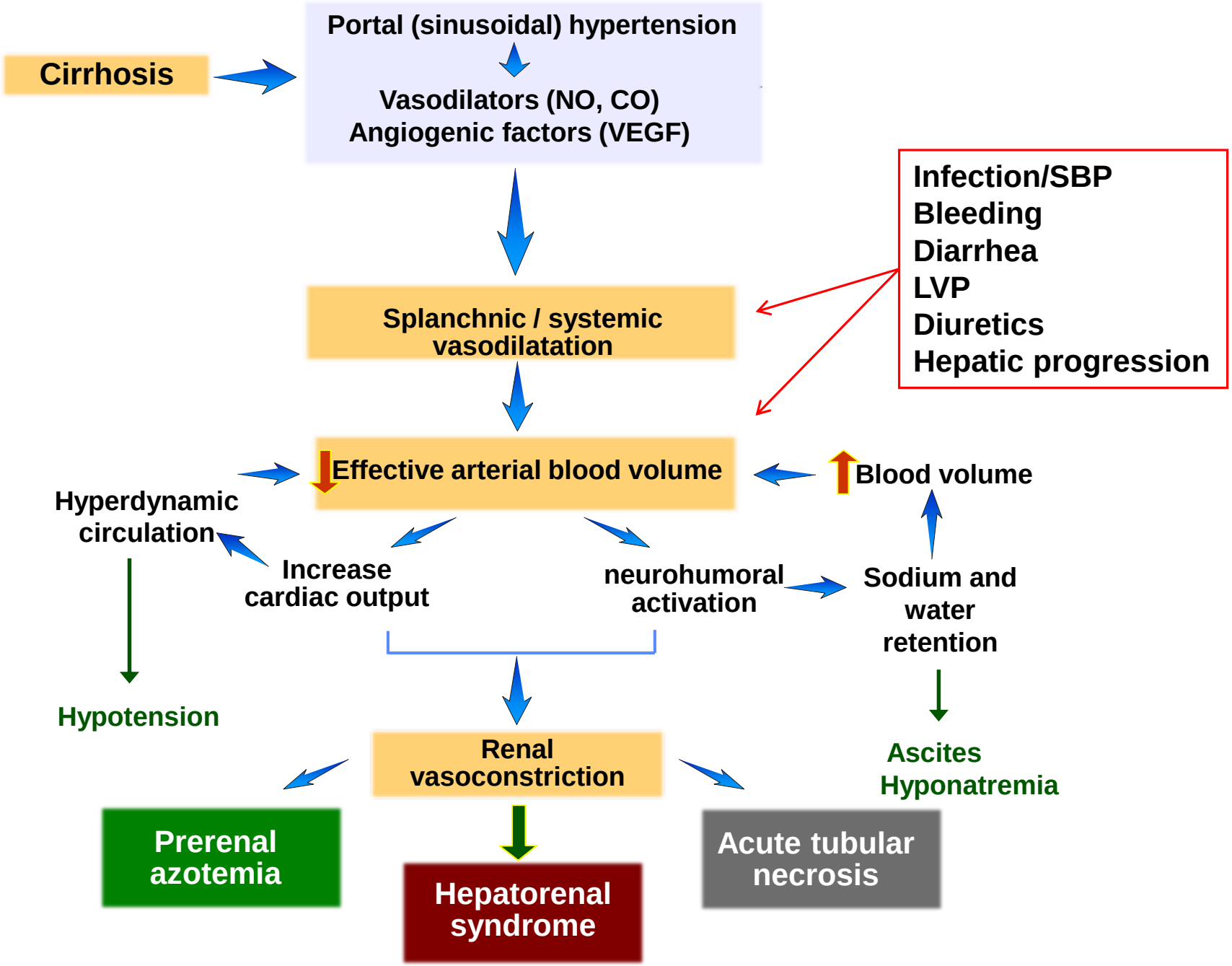
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Infection/SBP
Bleeding
Diarrhea
LVP
Diuretics
Hepatic progression
Splanchnic / systemic vasodilatation
Effective arterial blood volume
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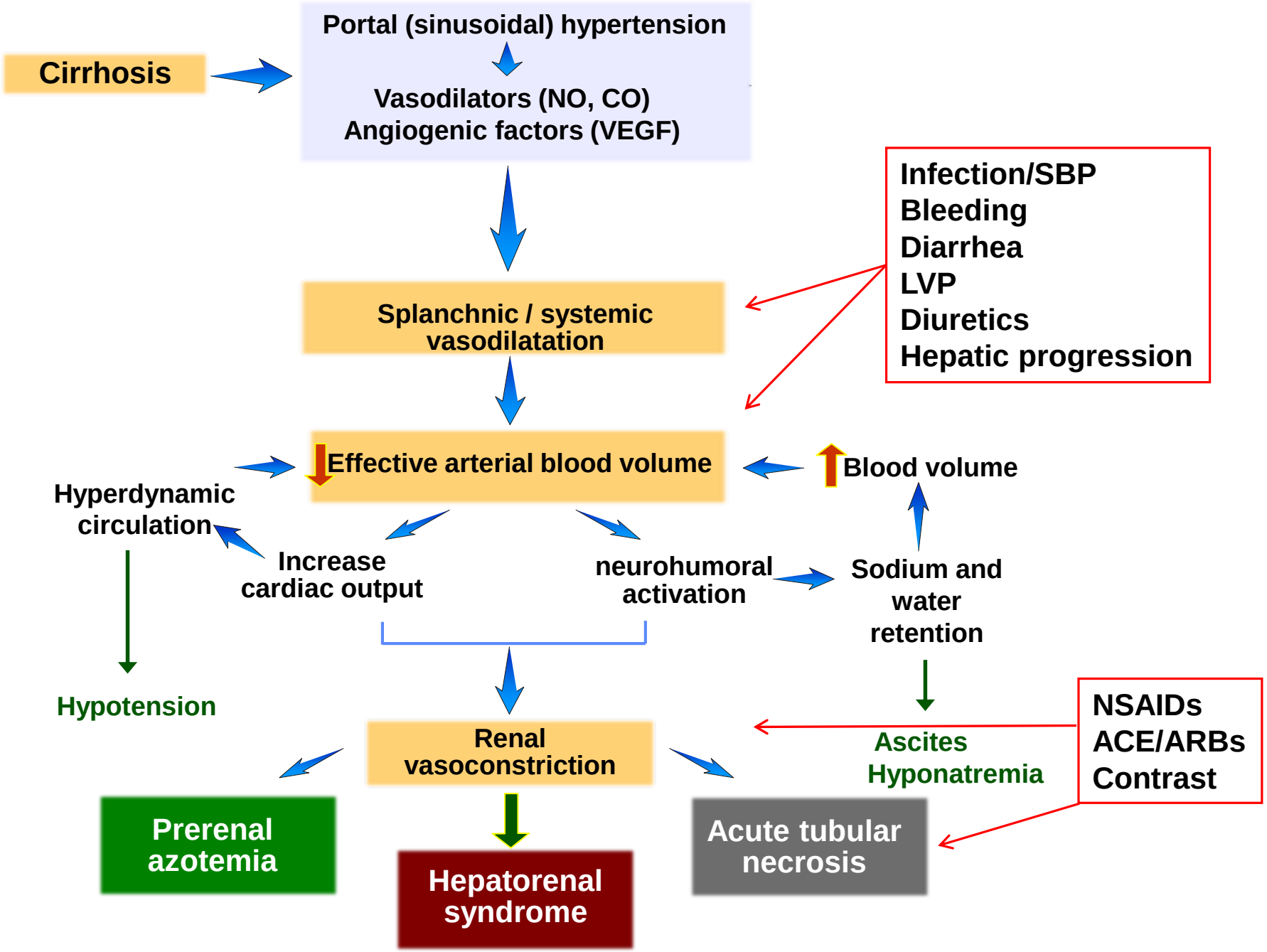
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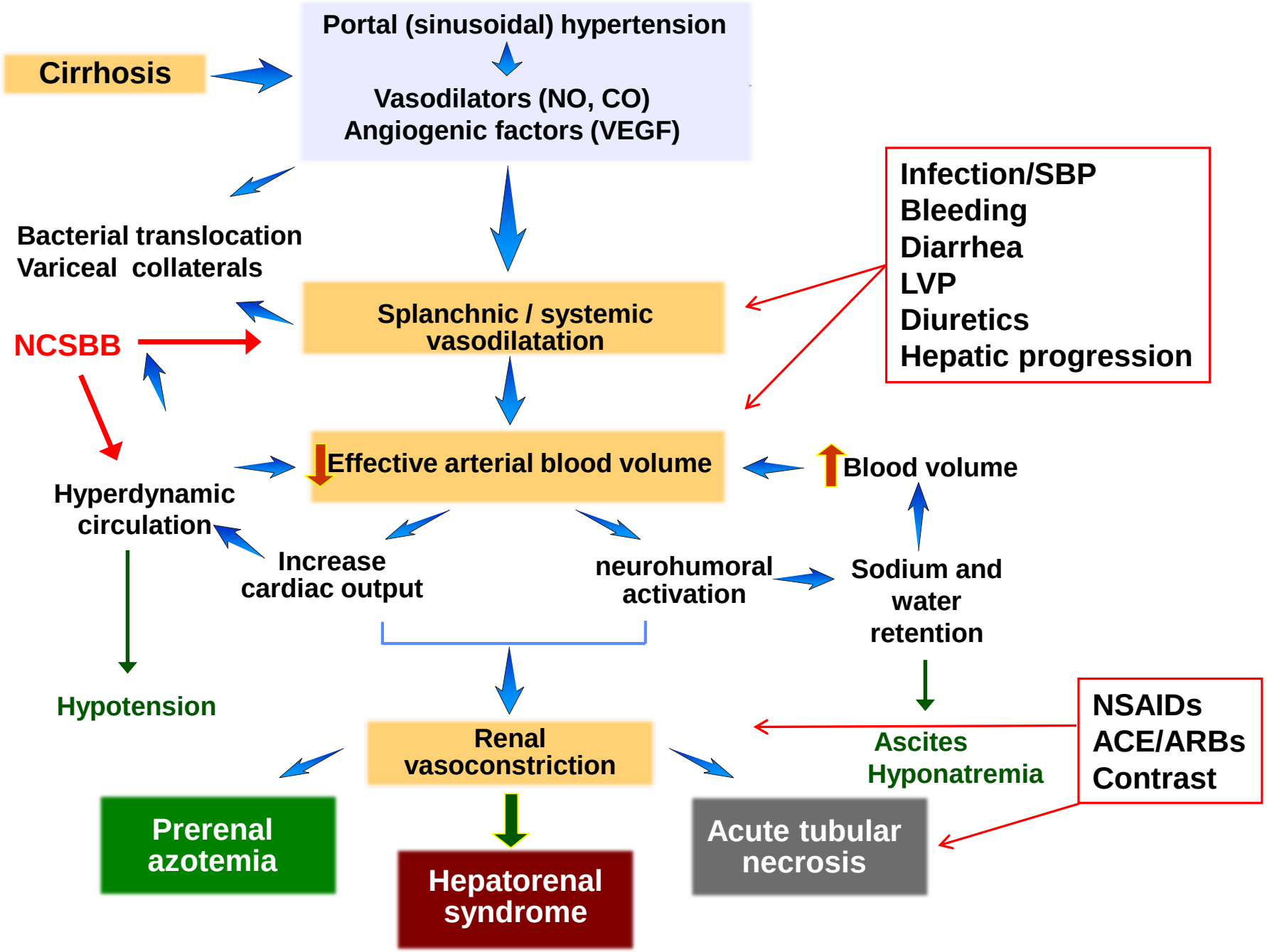
Renal vasoconstriction
Ascites
Hyponatremia
NSAIDs
ACE/ARBs
Contrast
Prerenal azotemia
Hepatorenal syndrome
Acute tubular necrosis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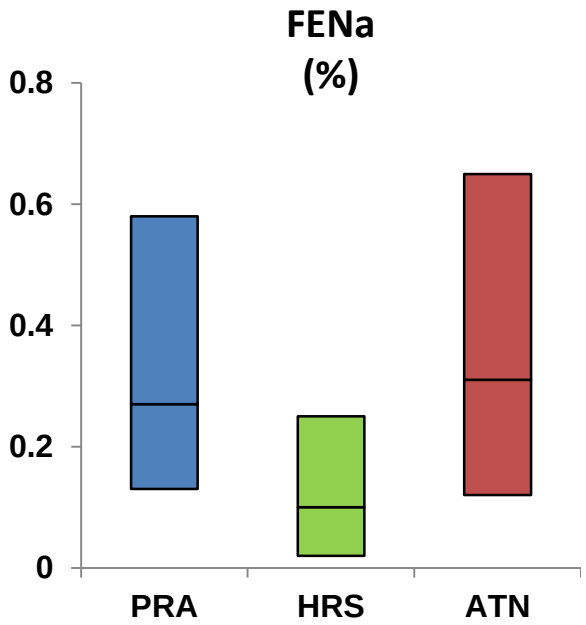
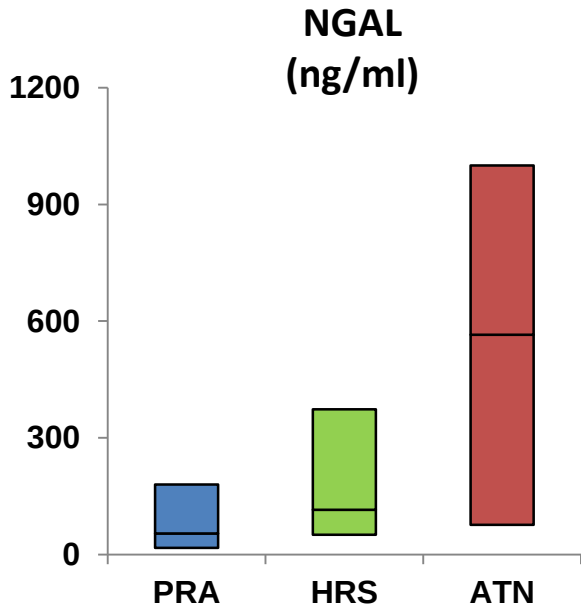
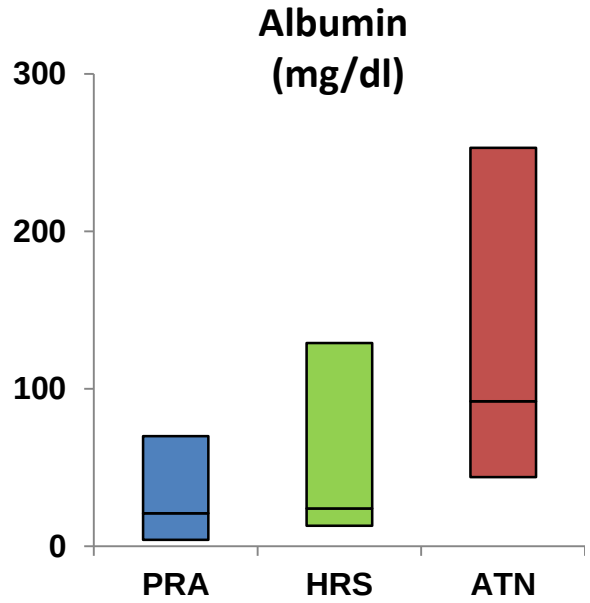
Urinary Biomarkers in AKI







n=79 progressive AKI

PRA=19 + 36 non-progressive
ATN=39
HRS=16

Belcher et al, Hepatology 2014

AKI: Prevention

Prophylaxis of complications (Varices, SBP, PSE)

Avoid NSAIDs, ACE, COX2, ARBs, contrast

Consider and prepare for LT

AKI: Hospital

Stop diuretics

Stratify by likely mechanism

Albumin (25%) ~1gm/Kg (12-24hrs)

If ?, treatment for infection

SBP – IV albumin (1.5g/kg) at diagnosis (1gm/kg) at 48 hrs

(Sort NEJM 1999;5:403)

AKI: Progressive

Midodrine, octreotide and albumin

Retrospective studies (n=154)

7.5mg-12.5 PO TID

100ug SQ Octreotide or IV 25ug/hr

albumin 20 – 50gm daily

MAP ↑15mm Hg or >90mmHg*

Results: 35-60% Cr< 1.5 mg/dL

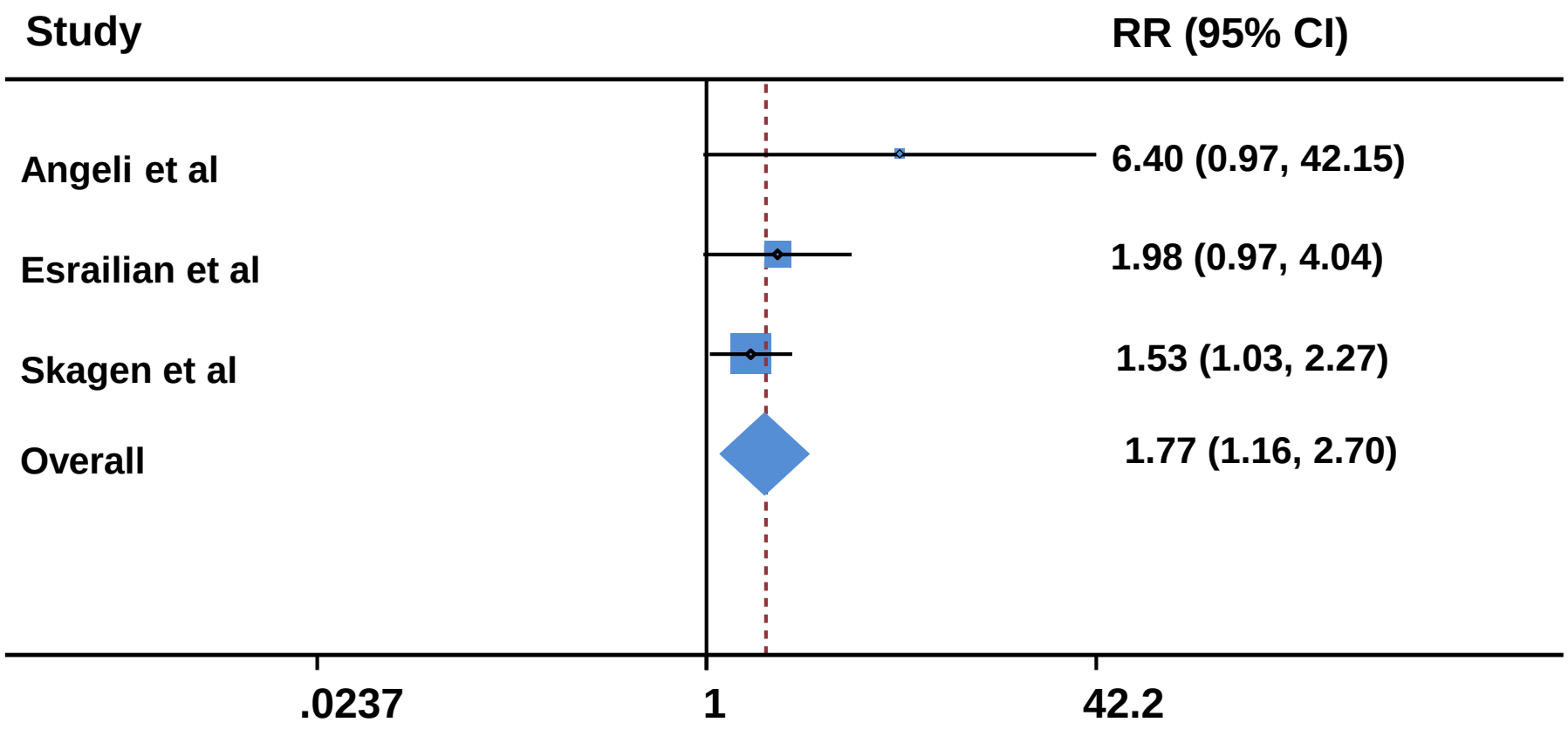
Survival improved (LT included)

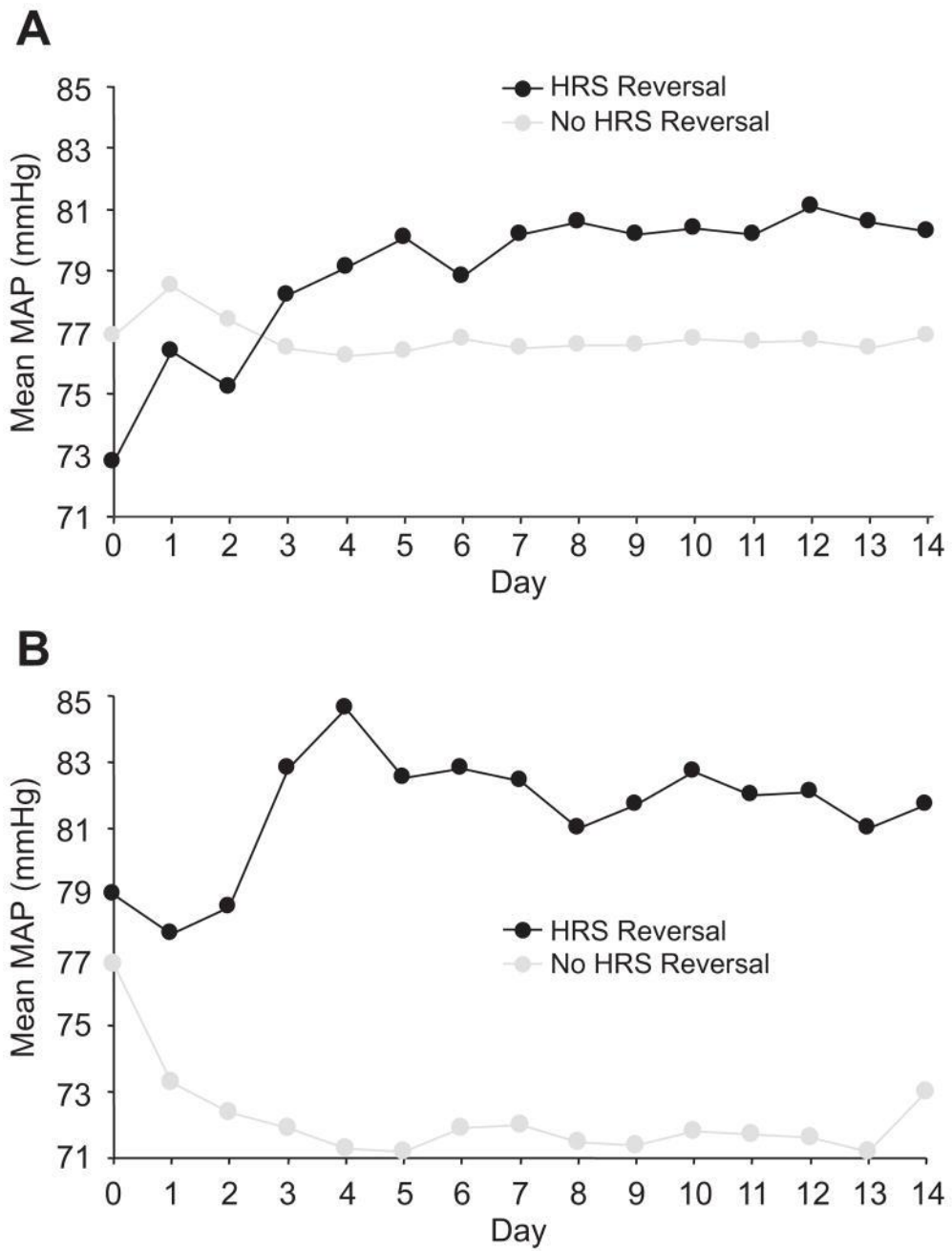
AKI: Progressive

Norepinephrine and albumin

- 0.5 – 3 mg/hr infusion ICU
- albumin 20 - 50 gm/day
- ↑ MAP 10mmHg or increased urine output

Midodrine and Octreotide: 30 day Survival





Boyer et al. J Hepatol 2011

Summary

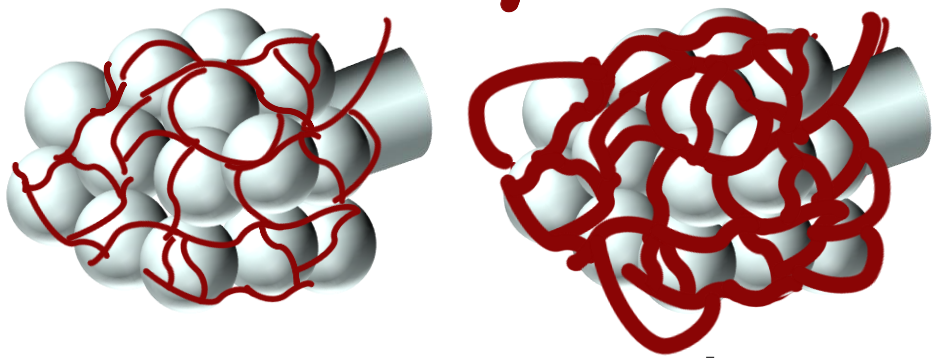
Varices:	**Prophylaxis works (risk groups, tx choice)**
	Early TIPS (subgroup 5-15%)*
Ascites:	**Early intervention, prevention**
	Diagnostic paracentesis
	Beta blockers
HE:	**Focus on covert and precipitants (QOL, driving, probiotics, apps)**
	Consider standardized inpatient protocols*
AKI:	**New definitions**
	Prevention
	Early recognition and treatment (“cause” deemphasized)*

- Portal Hypertension
- Cirrhosis
- Portosystemic shunting

40-50%

40-60%

Normal Pulmonary Microvasculature



Pulmonary vasodilatation

? Angiogenesis

50%

Abnormal ABGs

HPS

Rodriguez-Roisin et al , Thorax 1992, Eur Respir J 2004