Interpretation of Troponin Values

John Coyle, M.D.

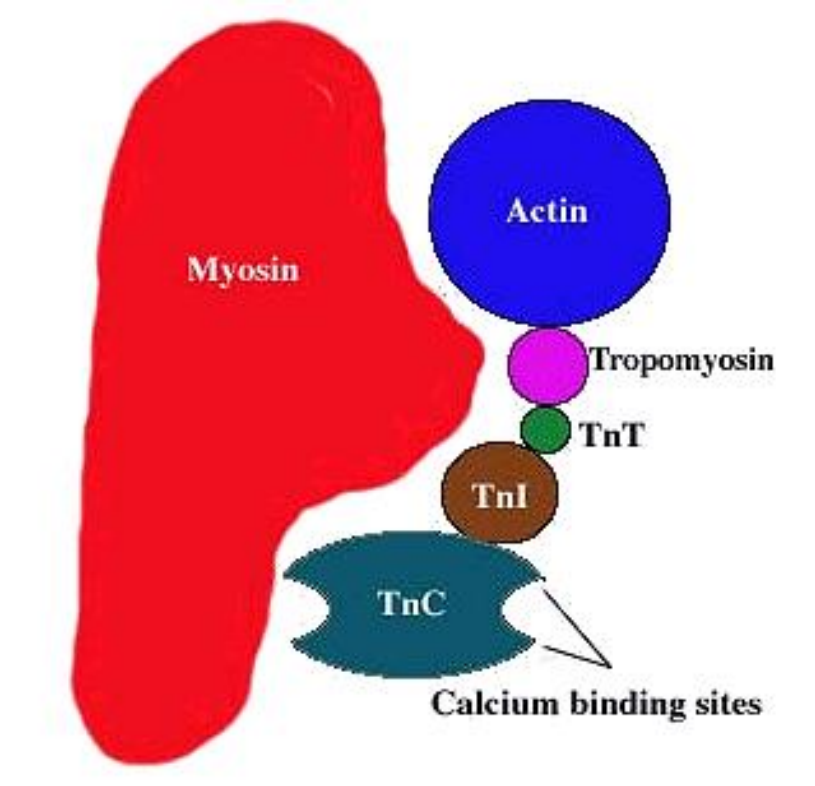
February 9, 2005

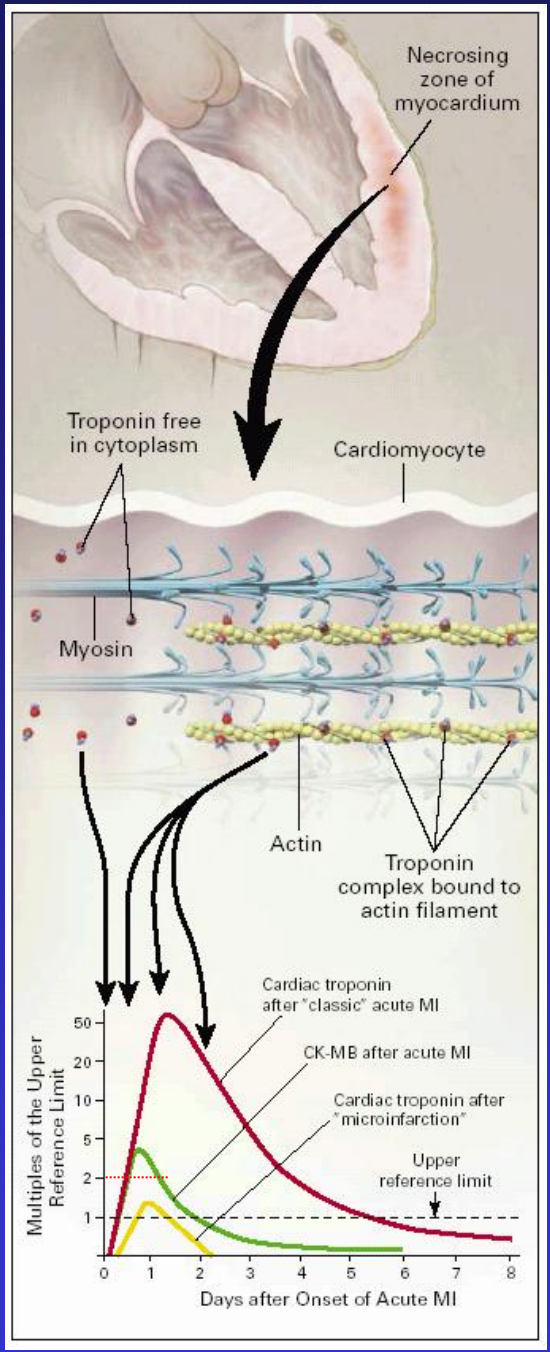
1.67 Years.

(Really)

Kuida, H. Fundamental Principles Of Circulation Physiology For Physicians. Elsevier, 1979. p.20.

Cardiomyocyte Troponin Overview





Antman EM, N Engl J Med 346: 2079 – 2082, 2002

RELATIVE SIZE OF MYOCARDIAL PROTEINS

Marker	Size (kd)	% Cytoplasmic
Myoglobin	18	100
Troponin I	24	2
Troponin T	33	6
CK/CK MB	86	100
AST	111	60
LDH	135	100

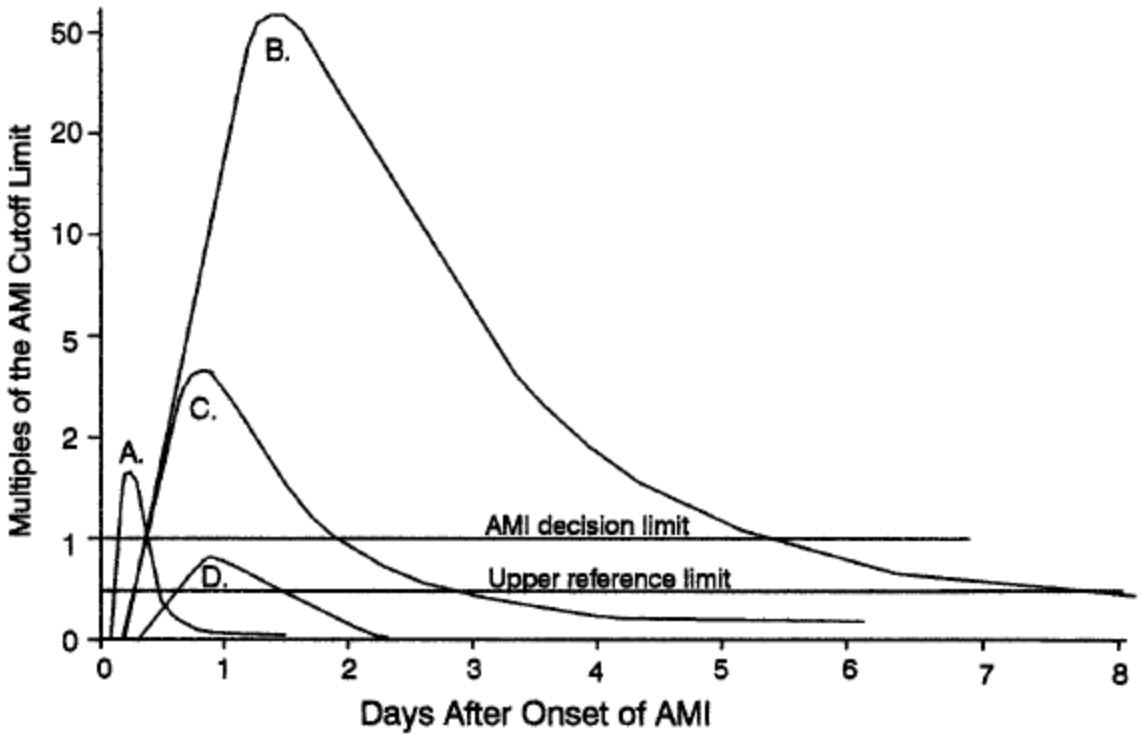
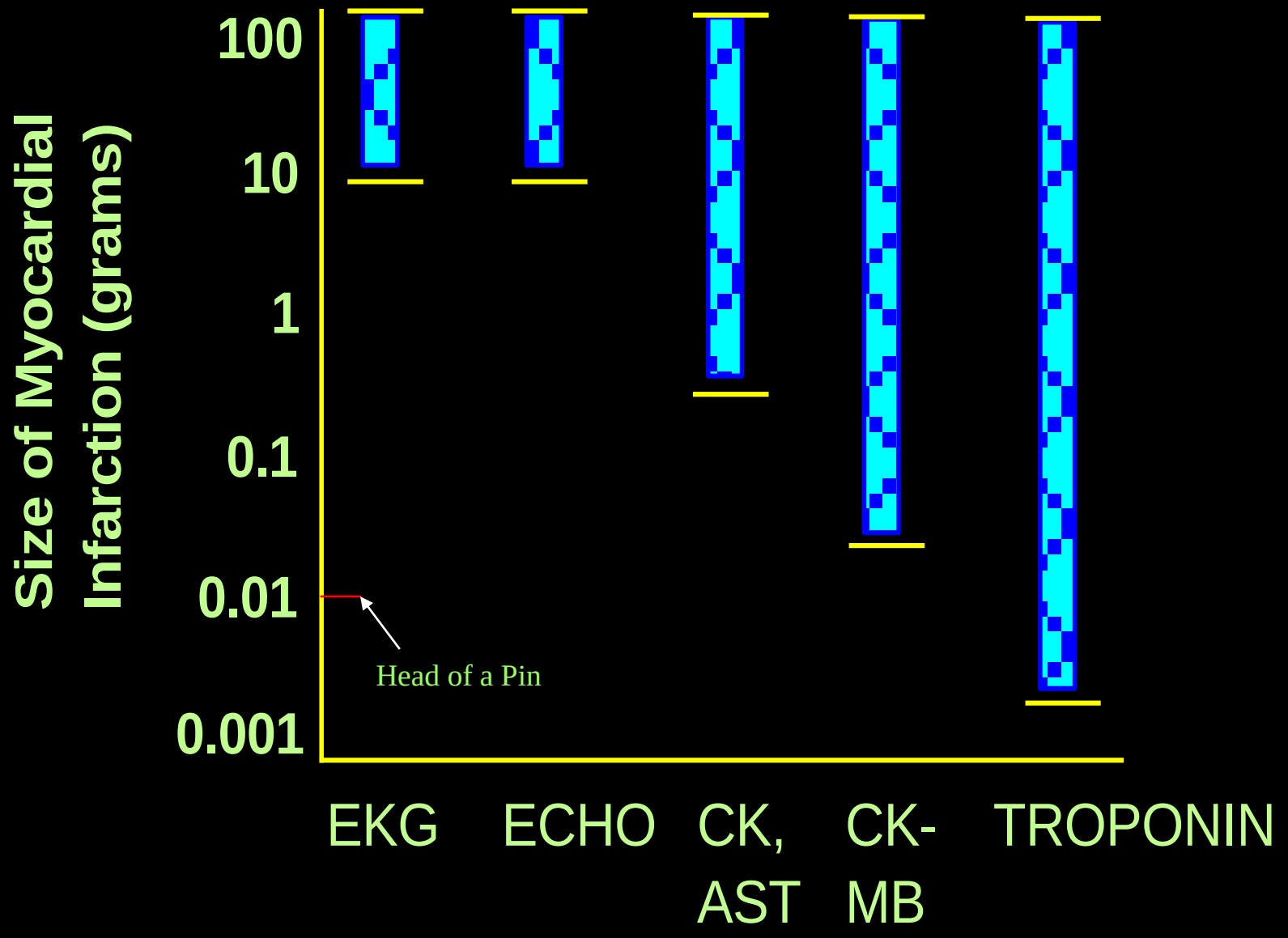


Fig. 1. Plot of the appearance of cardiac markers in blood vs time after onset of symptoms.

Peak A, early release of myoglobin or CK-MB isoforms after AMI; *peak B*, cardiac troponin after AMI; *peak C*, CK-MB after AMI; *peak D*, cardiac troponin after unstable angina. Data are plotted on a relative scale, where 1.0 is set at the AMI cutoff concentration.

Wu WHB et al. Clinical Chemistry 45: 1104–1121 (1999)



Dufour DR, AACC, Washington VA Medical Center

Normal heart weight = 230-340 grams, ~2x10^9 - 2x10^10 cells

The Original Data Portion of the Presentation

Head of a pin = 0.0148 gm

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Myocardial Infarction Redefined—A Consensus Document of The Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction

The Joint European Society of Cardiology/
American College of Cardiology Committee**

"Currently available analyses demonstrate **no threshold below which elevations of troponins are harmless and without negative implications for prognosis**. Thus, any other definition of MI would involve an arbitrary setting of limits for an abnormal troponin and would be open to criticism and considerable debate. It should be emphasized that there is continuity from 'minimal myocardial damage,' characterized by elevation of cardiac troponin without apparent elevation of other biomarkers (also termed 'infarctlet' or 'necrosette'), to the classic 'large myocardial infarction,' often complicated by heart failure, shock or life-threatening arrhythmia. In applying the proposed new diagnostic criteria to clinical practice, patients should not be labeled primarily as "myocardial infarction" but rather as patients with coronary artery disease with MI."

Pop Quiz:

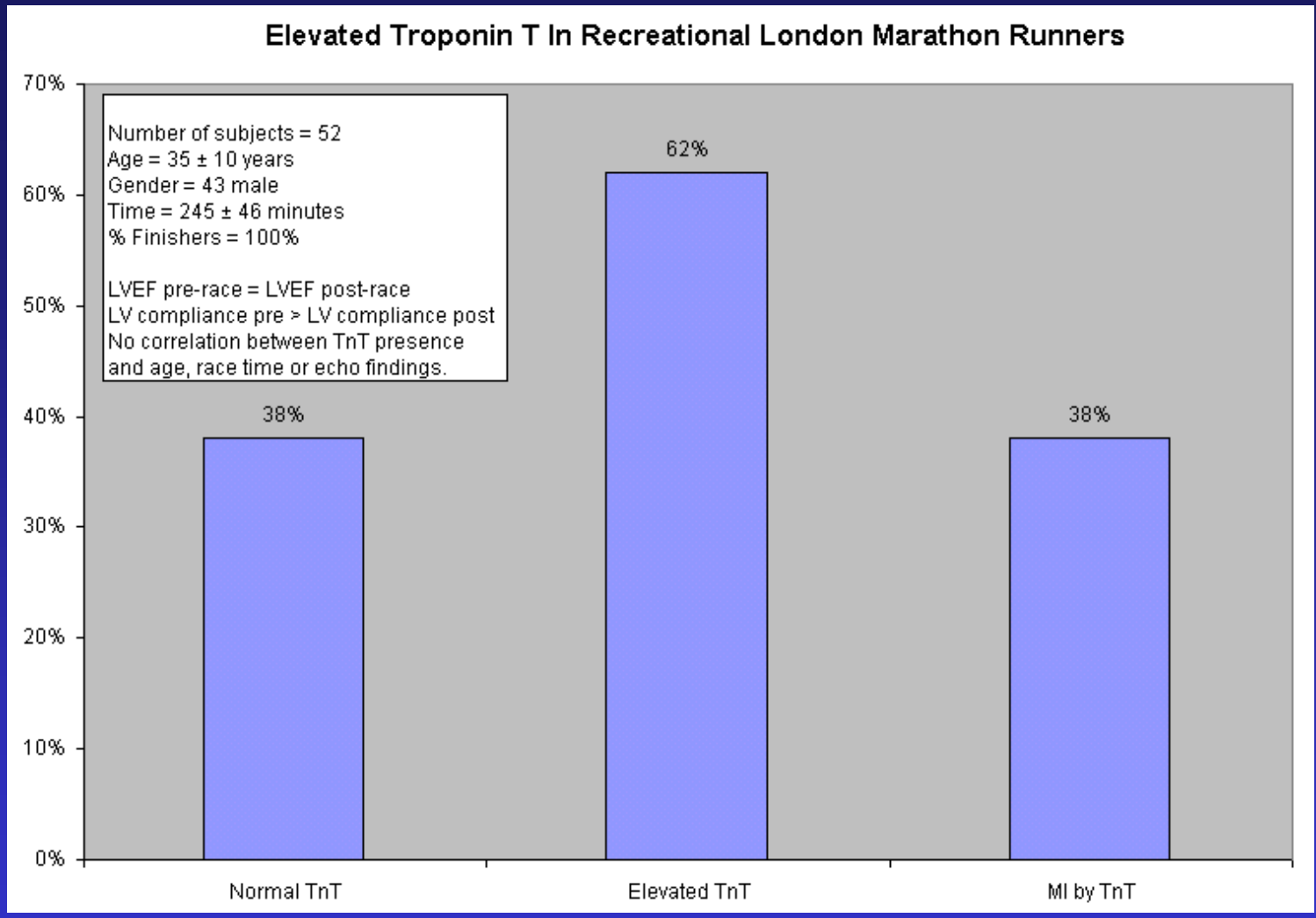
As the physician on call, you are contacted by the night Laboratory technician who relays a worrisome report. A collection of 52 blood samples has arrived, marked “Study Subjects”. Of these 52 samples, 32 show a troponin level above normal, and 20 values are in the laboratory’s “Myocardial Infarction” range.

At this point, you should probably

(a) Summon the EMSA Mega-Bus

(b) Expect a change in Homeland Security’s Color Level

(c) Call ESPN



Whyte G et al. Impact of marathon running on cardiac structure and function in recreational runners. Clinical Science (2005) 108: 73–80.

"Detectable increases in biomarkers of cardiac injury are indicative of injury to the myocardium, but elevations are not synonymous with an ischemic mechanism of injury. Therefore, increases do not now and did not in the past mandate a diagnosis of myocardial infarction." Jaffe AS et al. Circulation 102 (2000):1216-1220.

Pop Quiz:

Which of the following test findings always represents an emergency?

(a) Arterial Blood Gas showing pH = 6.91

(b) Venous blood sample showing Potassium = 9.1

(c) Arterial Blood Gas showing PO2 = 30

(d) EKG showing 5 mm of ST elevation in leads V1-V6, I and aVL in a patient with ongoing chest pain

(e) Troponin = 0.10 ng/ml (Normal <0.07 ng/ml) in an asymptomatic person

REVIEW

Elevation of cardiac troponin I indicates more than myocardial ischemia

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Clin Invest Med 2003;26(3):133-47.

Related to myocardial damage

- Acute coronary syndromes — myocardial infarction and unstable angina
- Acute graft failure in cardiac transplant patients
- Cardiac amyloidosis
- Cardiac contusion
- Cardioversion
- Cerebrovascular accident
- Chemotherapy
- Coronary vasospasm
- Heart failure, acute
- Heart failure, chronic, ischemic,
- Heart failure, nonischemic*
- Human immunodeficiency virus disease
- Implantable cardioverter defibrillator shocks
- Interventional closure of atrial septal defects
- Left Ventricular Hypertrophy
- Myocarditis
- Pericardial effusion
- Pericarditis
- Percutaneous coronary intervention
- Pulmonary embolism
- Postoperative, cardiac and noncardiac surgery
- Radiofrequency ablation
- Scorpion envenomation, others
- Sepsis and septic shock
- Subarachnoid hemorrhage
- Tachycardia
- Ultraendurance exercise (marathon,triathlon)
- Endocarditis

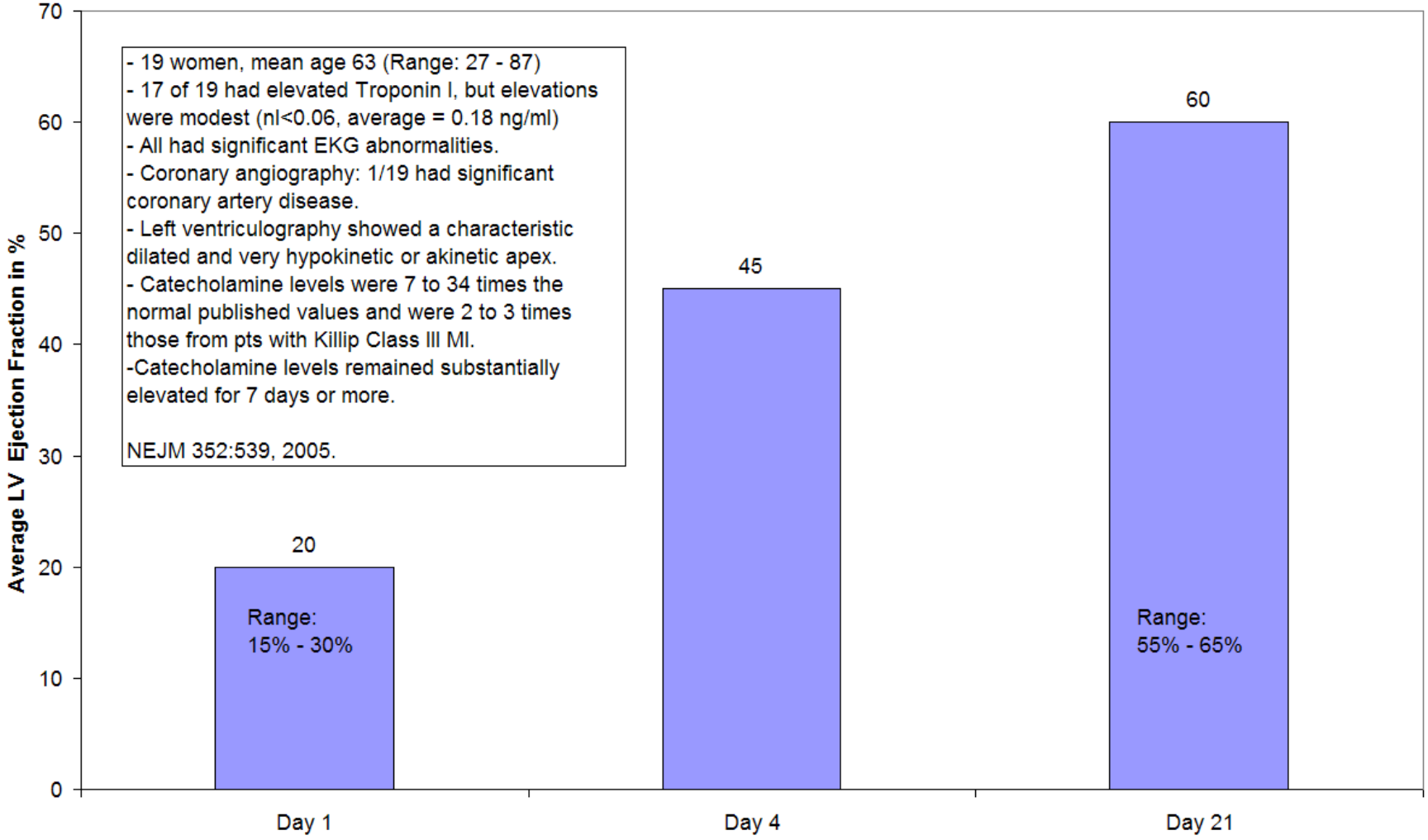
Potential analytical causes

- Assay cross-reactivity
- Alkaline phosphatase, elevated
- Antibody crossreactivity
- Bilirubin, elevated
- Cirrhosis of liver
- Hemolysis
- Heterophile antibody
- Rheumatoid arthritis, rheumatoid factor
- Decreased clearance
- Renal failure, acute and chronic

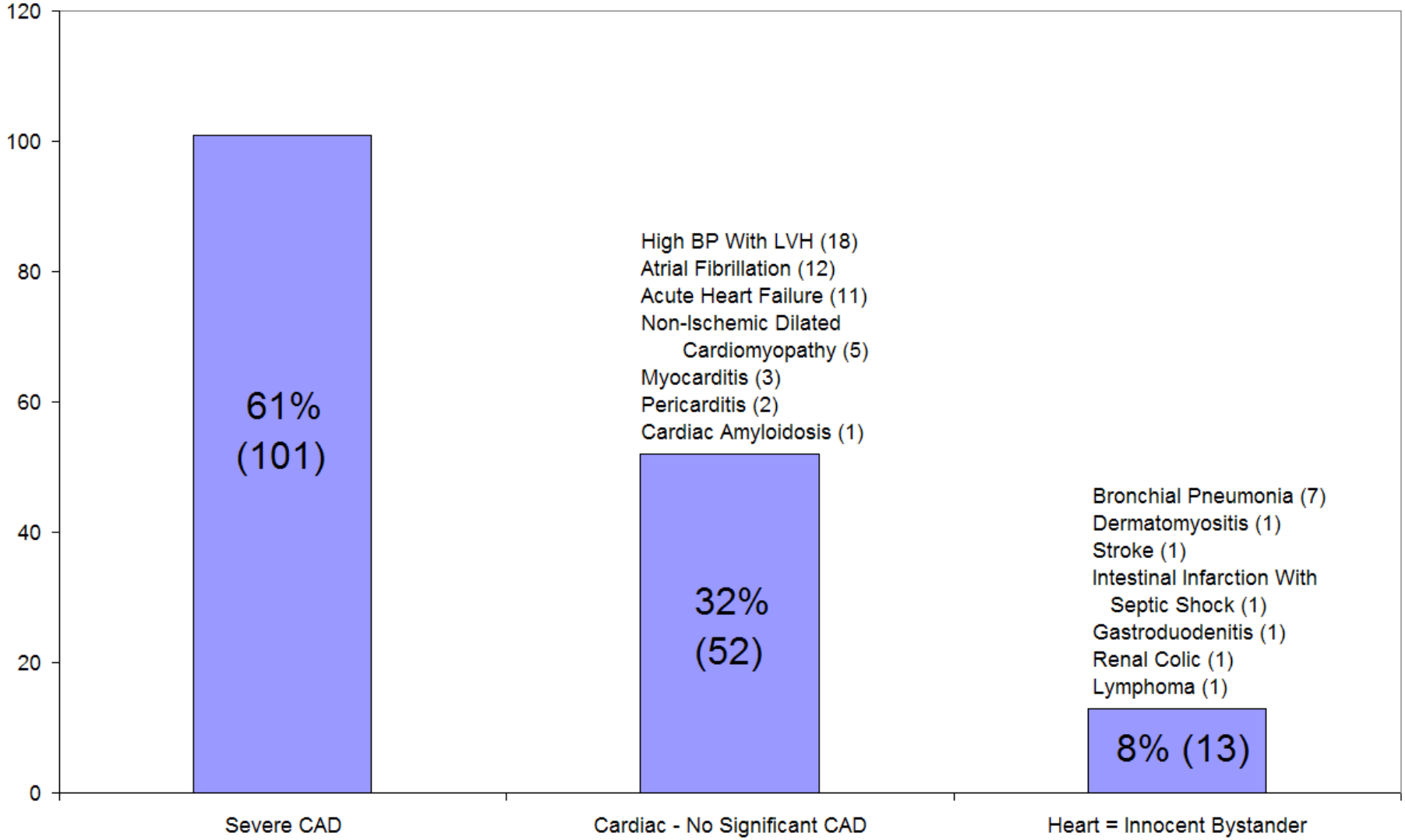
Miscellaneous

- Central nervous system disorders (including grand mal seizure)
- Hematologic malignant disease
- Labour and delivery
- Pre-eclampsia
- Perinatal hypoxia
- COPD exacerbation
- Pacemaker implantation
- Postpartum hemorrhage with shock
- Primary pulmonary hypertension
- Diabetic ketoacidosis
- Rhabdomyolysis
- Severe emotional stress

Myocardial Stunning Due to Emotional Stress

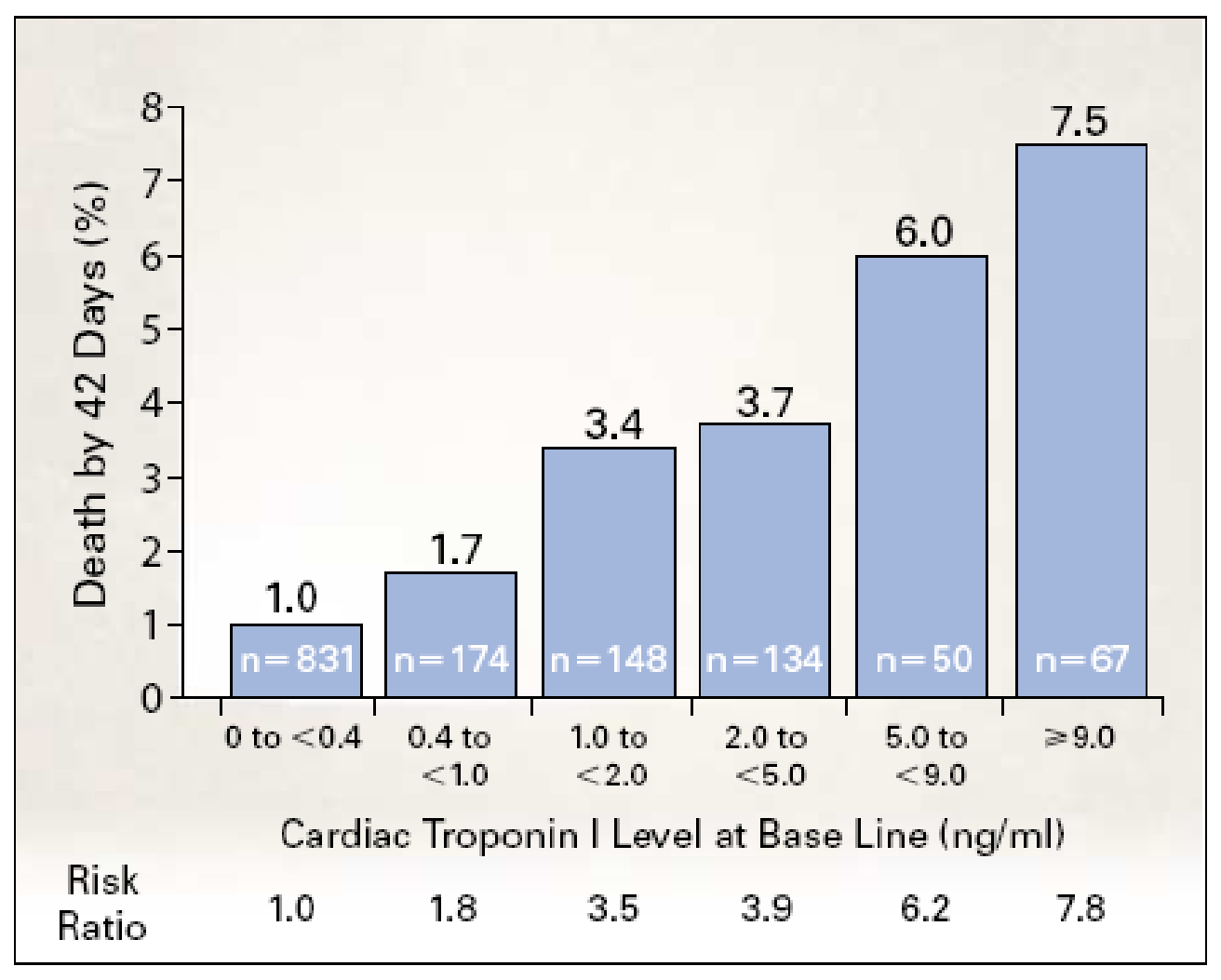


166 Consecutive Emergency Room Patients With Elevated Troponin I And Non-Specific ST-T Abnormality By EKG: Final Diagnoses After Heart Cath



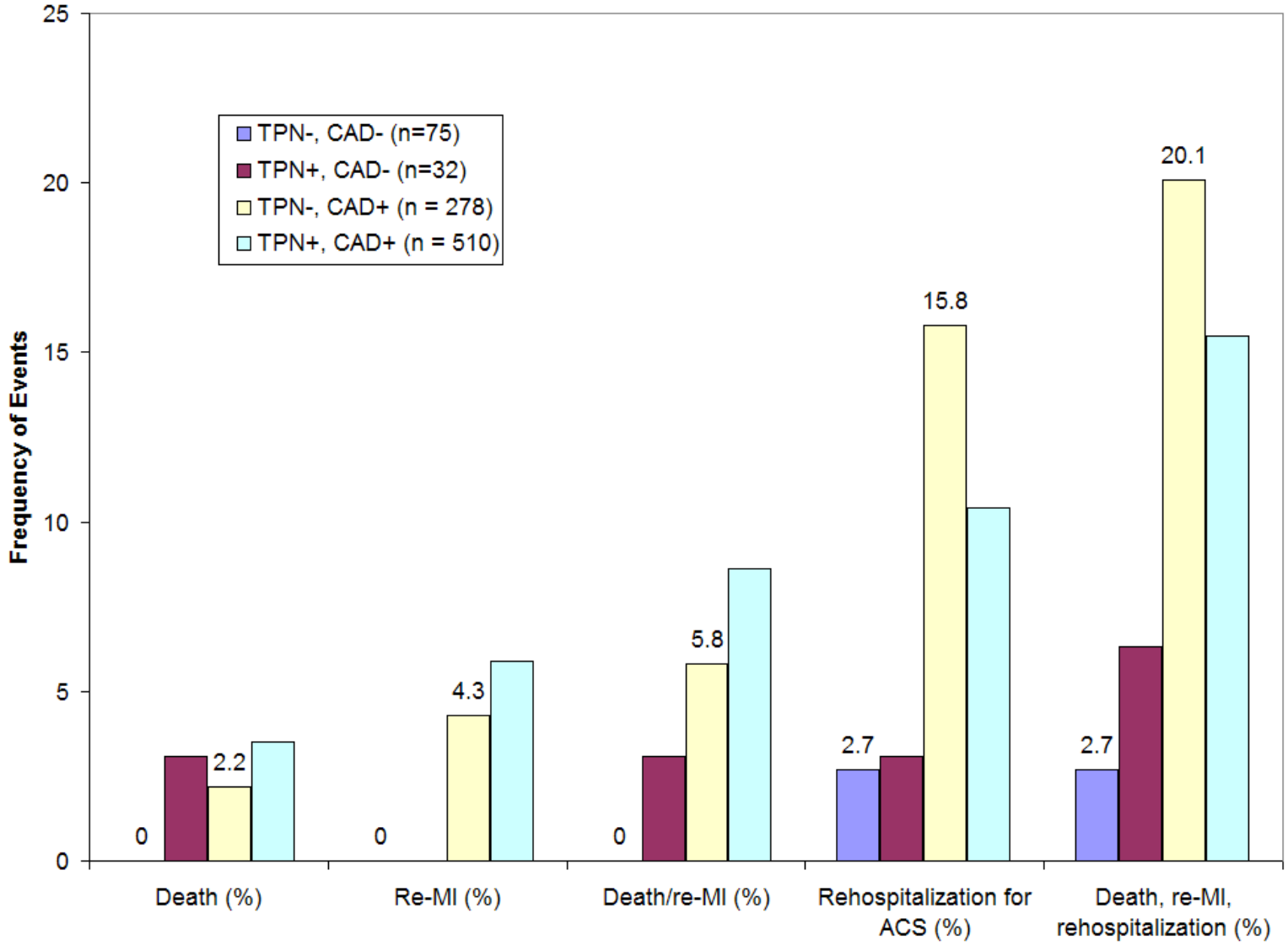
Bucciarelli-Ducci C et al. Coronary Artery Disease 15:499-504, 2004.

Chest Pain Patients: Risk of Various Troponin I Levels



Antman EM, N Engl J Med 346: 2079 – 2082, 2002 (Ref TIMI IIIB)

6-Month Outcome: Patients With Suspected Acute Coronary Syndrome, Undergoing Coronary Angiography Within 4 To 48 Hours After Admission



Dokainish H et al. J Am Coll Cardiol 2005;45:19 –24. Prognostic Implications of Elevated Troponin in Patients With Suspected Acute Coronary Syndrome But No Critical Epicardial Coronary Disease (A TACTICS-TIMI 18 Sub-Study)

Atherosclerotic Plaques Are **Common**

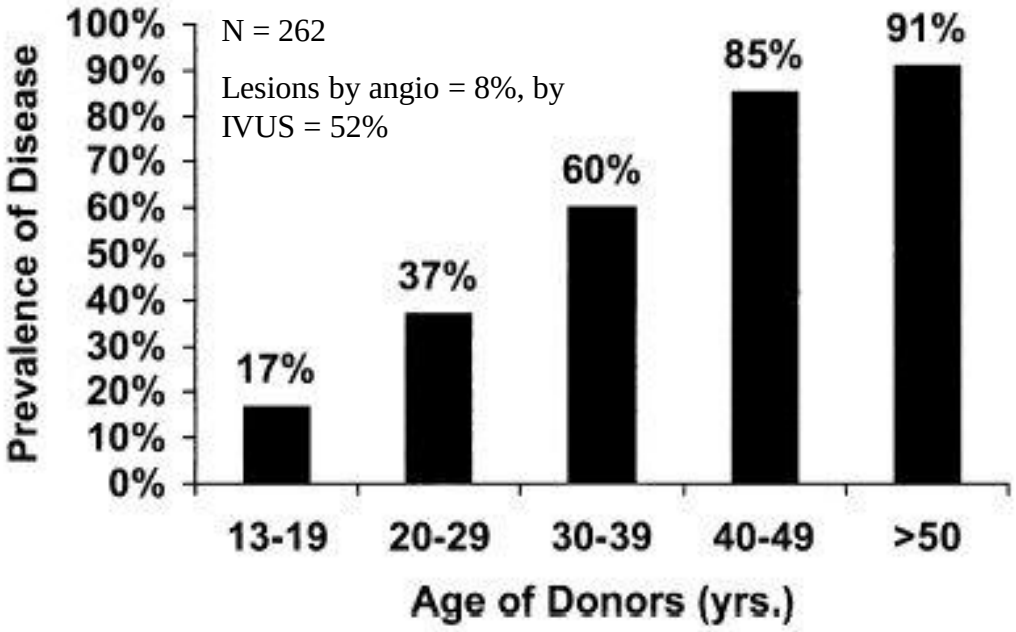
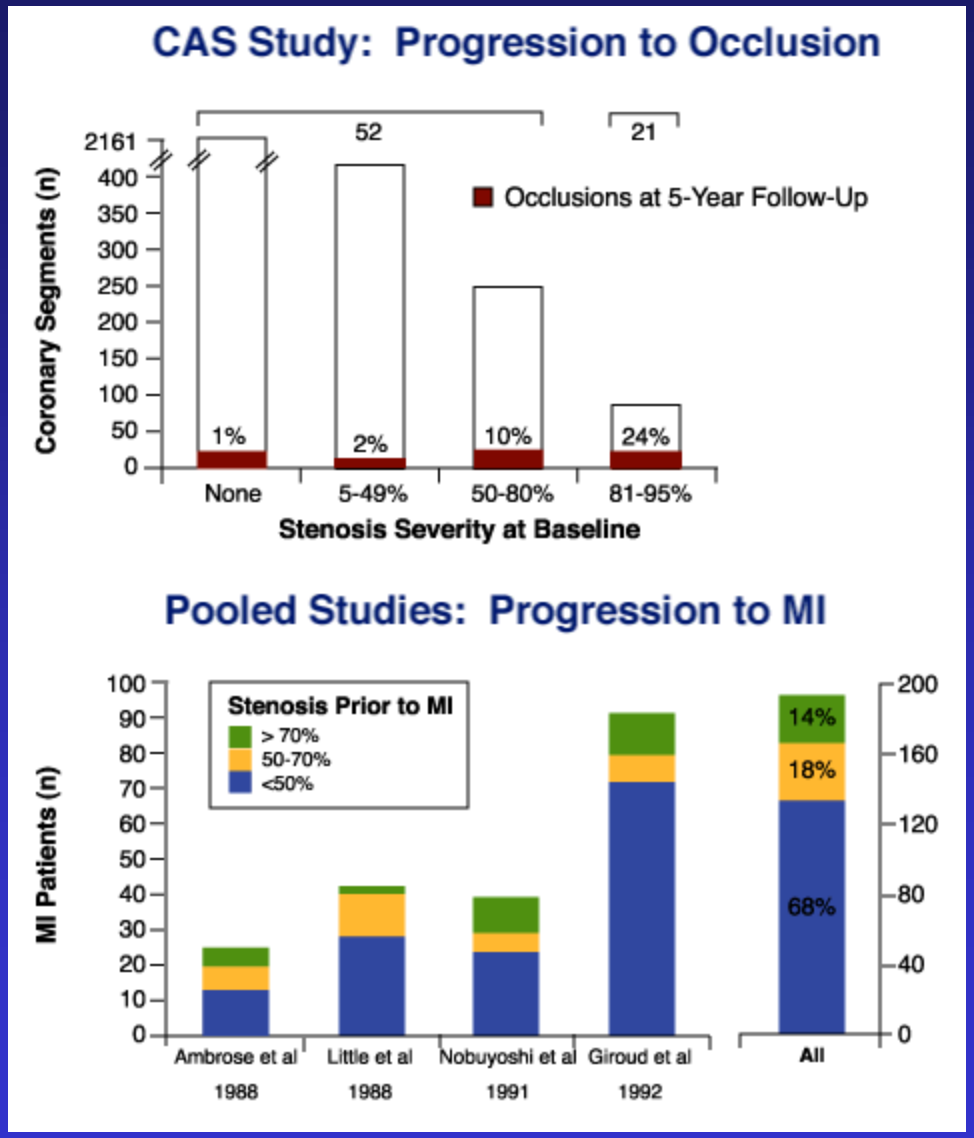
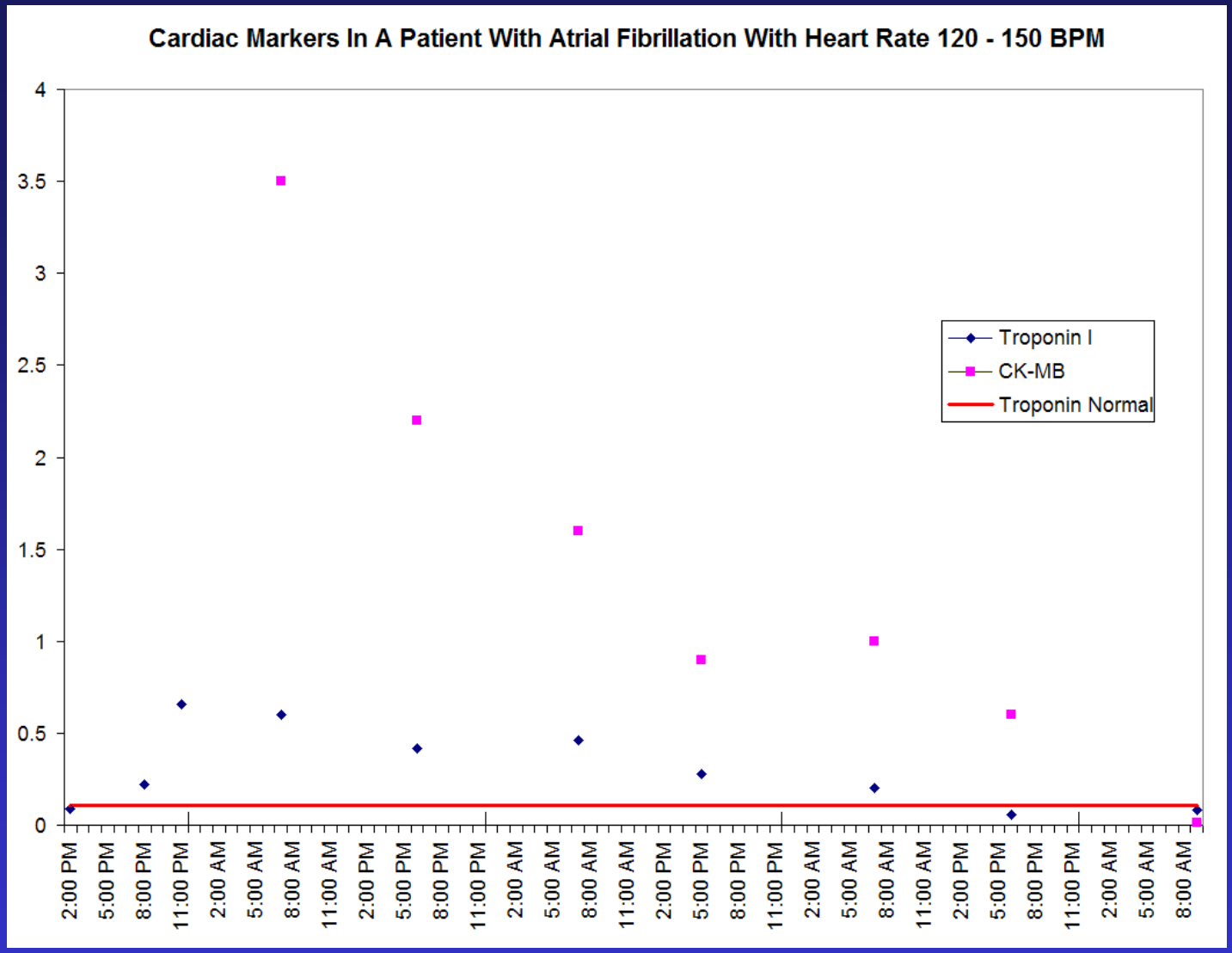


Figure 7. Prevalence of coronary disease in transplant donors. These data demonstrate an aggressive increase in the likelihood of an atheroma of at least 0.5 mm in thickness in individuals as young as 13 years of age. yrs. = years. Tuzcu EM, Kapadia SR, Tutar E, et al High prevalence of coronary atherosclerosis in asymptomatic teenagers and young adults: evidence from intravascular ultrasound. Circulation 2001;103:2705–10. Adapted with permission from Lippincott, Williams, and Wilkins.

"With the appearance of the first luminal irregularity, at least 80% of the coronary tree is already arteriosclerotic." Nissen, JACC 41:106S, 2003

What Category of Narrowing Produces the Greatest Hazard? Mild.





A 69 y.o. man, who had stroke at age 64 (left caudate nucleus), was admitted with prolonged chest pain (6 hours) and dyspnea. The EKG showed atrial fibrillation with ventricular rate = 120 – 150 bpm. BP = 94/61. What were the coronary angiographic findings?

Nunes JP et al. Acta Cardiol 59:346-6, 2004.

Normal.

Pop Quiz:

At your child's school's "back to school" night, you are approached by another parent who has received very troubling news about her niece. The child, who is 8 years old, was admitted to the hospital with fever. The next day, the child's physician unexpectedly told her parents that she had suffered a heart attack.

Your next move should be to

(a) Give sympathetic support

(b) Challenge the premise

(c) Give sympathetic support and silently challenge the premise.

Septic Shock in Children: Troponin Values

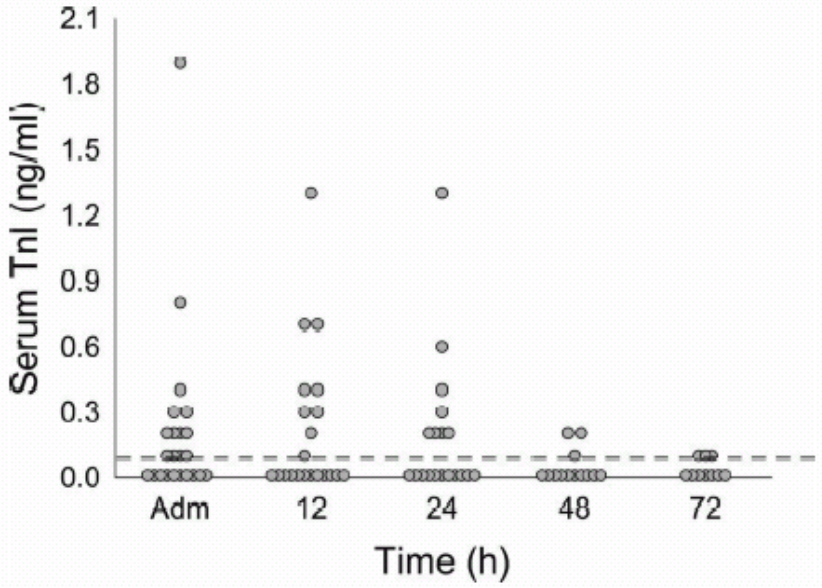
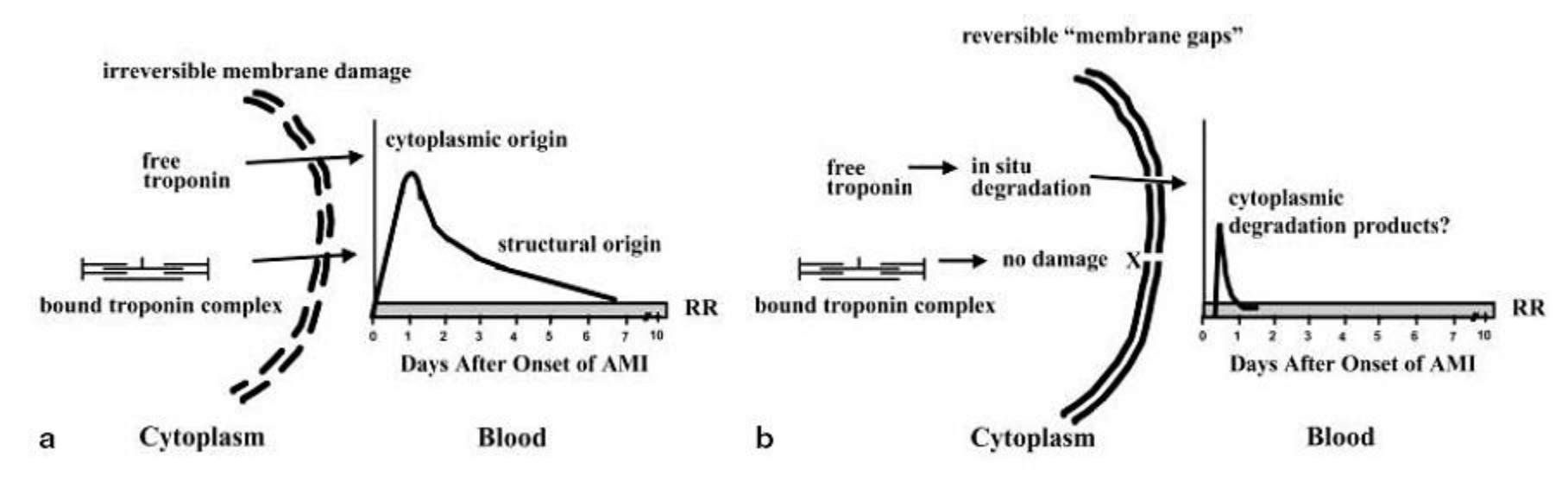


Figure 1. Serum troponin I (*TnI*) concentrations in children with septic shock over the first 72 hrs of critical illness. The *dashed line* demarcates the threshold of 0.1 ng/mL, determined to be abnormal using the Bayer I Immunoassay. Values <0.1 ng/mL are reported by our laboratory as "nondetectable levels" and are represented by the *circles* below the *threshold line*. *Adm*, at admission.

Fenton KE et al. Pediatr Crit Care Med. 2004 Nov;5(6):533-538 (Children's National Medical Center, Washington DC)

Troponin in Sepsis: Cell Death vs Cell Leak



Wu AH. Increased troponin in patients with sepsis and septic shock: myocardial necrosis or reversible myocardial depression? *Intensive Care Med* 2001;27:959-61.

Sepsis in Children: Troponin Values

Table 2. Echocardiographic variables and outcome measures in children with sepsis who had increased troponin I (TnI) at study admission (TnI positive) compared with those with normal TnI on study admission (TnI negative)

Variable	TnI Positive	TnI Negative	Significance, *p*
Age, yrs	8.5 ± 1.2	8.9 ± 1.5	.81
PRISM III	13.9 ± 1.4	10.3 ± 1.7	.73
Inotrope requirement	1.54 ± 0.22	1.10 ± 0.31	.42
OSF, n	2.4 ± 0.4	1.6 ± 0.2	.08
EF, %	62 ± 4	68 ± 2	.05
FS, %	32 ± 3	39 ± 2	.09
Vcf_c, circ/sec	1.25 ± 0.16	1.33 ± 0.06	.02
WS, g/cm^2	52 ± 13	33 ± 4	.0052

Heart rate corrected mean velocity of circumferential fiber shortening (Vcf_c) was decreased and wall stress (WS) was increased in TnI-positive children compared with TnI-negative children (data represented as mean ± SEM, Student's *t*-test). Other variables were not different, but trends were observed in ejection fraction (EF), fractional shortening (FS), and the number of organ system failures (OSF).

Table 1. Patient demographics of children with septic shock included in study: Organisms were isolated from blood cultures unless otherwise specified

Age, Yrs	Diagnosis	PRISM III Score	TnI Increased	OSF, No.	Inotrope Requirement
14	Acute lymphoblastic leukemia, sepsis of unknown etiology	10	Yes	1	Moderate
0.5	*Streptococcus pneumoniae* meningitis and sepsis	5	No	2	Low
5	Sepsis of unknown etiology	13	No	2	High
8	Relapsed acute lymphoblastic leukemia, bone marrow transplant, sepsis of unknown etiology	5	No	1	High
13	Influenza B pneumonia and sepsis	19	Yes	3	High
9	Pulmonary hypertension, sepsis of unknown etiology	18	Yes	4	High
9	Systemic lupus erythematosis, *Staphylococcus aureus* sepsis	10	Yes	5	High
5	Menke's syndrome, *Pseudomonas aeriginosa* urosepsis	13	Yes	1	High
14	Acute myelocytic leukemia, bone marrow transplant, sepsis of unknown etiology	7	No	1	Low
12	Spina bifida, chronic renal failure, Gram-negative pneumonia	19	Yes	3	High
10	Acute myelocytic leukemia, polymicrobial sepsis (*Enterococcus faecium*, pediococcus, *Staphylococcus epidermidis*)	14	Yes	2	Moderate
13	*S. aureus* toxic shock	8	No	1	Low
7	Sepsis of unknown etiology	11	Yes	2	High
11	Sepsis of unknown etiology	5	No	1	Low
4	Acute myelocytic leukemia, bone marrow transplant, polymicrobial sepsis (*Escherichia coli* and *Candida krusei*)	9	No	2	Moderate
7	Encephalitis, sepsis of unknown etiology	25	Yes	4	High
12	Systemic lupus erythematosis, *S. pneumoniae* sepsis	11	Yes	1	High
16	Medulloblastoma, *Klebsiella pneumoniae* sepsis	12	No	1	Low
10	Acute lymphoblastic leukemia, *Bacillus* species sepsis	16	Yes	2	High
2	Acute myelogenous leukemia, *Streptococcus viridans* sepsis	9	Yes	2	High
1	*Streptococcus pyogenes* pneumonia and sepsis	17	Yes	2	Low
7	Juvenile pyelocytic astrocytoma, sepsis of unknown etiology	6	No	2	High
13	Nasopharyngeal carcinoma, sepsis of unknown etiology	12	Yes	2	High

PRISM, Pediatric Risk of Mortality; TnI, troponin I; OSF, organ system failure.

Elevated Troponin in Children Treated with Doxorubricin for Acute Lymphocytic Leukemia

Lipshultz SE et al. The Effect of Dexrazoxane on Myocardial Injuryin Doxorubicin-Treated Children with Acute Lymphoblastic Leukemia.N Engl J Med 2004;351:145-53. (Univ.of Miami and collaborators)

Table 1. Characteristics of the Patients.*

Characteristic	Doxorubicin (N=101)	Dexrazoxane + Doxorubicin (N=105)
Sex — no.		
Male	56	64
Female	45	41
Median age at diagnosis — yr	7.3	7.5
Doxorubicin		
Median cumulative dose — mg/m²	300	300
Received less than the median of 300 mg/m² — no./total no. (%)	26/96 (27)	19/101 (19)
Troponin T samples		
Median no./patient	15.0	15.1
Total no. that could be evaluated	1139	1238
No. with doxorubicin- or dexrazoxane-associated dose-limiting adverse effects	0	0

* There were no significant differences between groups.

Table 2. Frequency of Elevations in Serum Cardiac Troponin T.*

Subgroup	Doxorubicin (N=76)		Dexrazoxane + Doxorubicin (N=82)		P Value
	No. with Finding/ Total No.	% (95% CI)	No. with Finding/ Total No.	% (95% CI)	
Any elevation in troponin T	38/76	50 (38–62)	17/82	21 (13–31)	<0.001
During doxorubicin therapy	35/76	46 (35–58)	12/80	15 (8–25)	<0.001
After doxorubicin therapy ended	11/29	38 (21–58)	5/29	17 (6–36)	0.14
Multiple elevations in troponin T	28/76	37 (26–49)	10/82	12 (6–21)	<0.001
Any extreme elevation in troponin T	24/76	32 (21–43)	8/82	10 (4–18)	<0.001
Multiple extreme elevations in troponin T	15/76	20 (11–30)	6/82	7 (3–15)	0.03
No pretreatment elevations in troponin T	71/76		75/82		
Any subsequent elevation	33/71	46 (34–58)	10/75	13 (7–23)	<0.001
Any elevation during doxorubicin therapy	32/71	45 (33–57)	9/74	12 (6–22)	<0.001
Any elevation after doxorubicin therapy ended	10/27	37 (19–58)	4/26	15 (4–35)	0.12
Multiple elevations	24/71	34 (23–46)	5/75	7 (2–15)	<0.001
Any extreme elevation	21/71	30 (19–42)	4/75	5 (1–13)	<0.001
Multiple extreme elevations	15/71	21 (12–32)	4/75	5 (1–13)	0.006

* An elevated troponin T level was one that exceeded 0.01 ng per milliliter, and an extremely elevated level was one that exceeded 0.025 ng per milliliter. CI denotes confidence interval.

Pop Quiz:

As the physician on call, you are contacted by the Surgery Service to evaluate a patient in SICU. This 27 y.o. man was involved in an automobile accident after his vehicle left the road at an estimated speed of 105 mph. He was trapped in the car for nearly 2 hours before being pried out by the Jaws of Life. Reason for the consultation is troponin elevation.

After reviewing the chart, you should probably order

(a) An EKG

(b) An Echocardiogram

(c) A copy of the Guinness Book of World Records' section on blood alcohol levels

Troponin and Trauma

Table 2. Characteristics of the 17 Patients with Significant and Sustained Troponin Release

	Sex	Age, yr	Mechanism of Trauma	ISS	SAPS	Shock	Peak Troponin I, μg/l	Norepinephrine Infusion	Emergency Surgery	Coronary Angiography Results (Delay, days)	ICU LOS, days
1	M	24	Motorcycle	29	83	Yes	74.8	Yes	No	Major (6)	23
2	M	44	Pedestrian	16	35	Yes	41.4	Yes	Yes (L + O)	Major (3)	19
3	M	35	Motor vehicle	25	25	No	2.2	Yes	No	Normal (15)	18
4	M	37	Fall	27	15	No	10.4	No	Yes (L)	Minor (4)	7
5	F	23	Motor vehicle	43	41	Yes	3.7	Yes	Yes (L)	Normal (4)	58
6	F	21	Motorcycle	50	37	Yes	11.4	Yes	Yes (L)	Normal (17)	22
7	F	24	Fall	43	21	No	2.2	No	No	Normal (18)	17
8	F	20	Pedestrian	9	8	No	2.4	No	No	Normal (2)	8
9	M	66	Motor vehicle	16	22	No	5.0	No	No	Normal (3)	3
10	M	47	Motorcycle	41	42	Yes	8.2	Yes	Yes (L + O)	NA	40
11	M	27	Motorcycle	34	24	Yes	34.5	Yes	Yes (L)	Minor (15)	10
12	M	18	Motor vehicle	48	26	Yes	9.7	Yes	Yes (O)	NA	8
13	F	19	Motor vehicle	24	20	No	3.8	Yes	Yes (O)	Normal (4)	24
14	M	22	Motor vehicle	34	28	Yes	13.2	Yes	Yes (O)	Minor (8)	13
15	M	23	Fall	34	20	Yes	4.6	Yes	Yes (O)	Normal (16)	27
16	M	26	Motor vehicle	29	20	Yes	7.3	Yes	Yes (L)	Minor (8)	16
17	M	38	Motor vehicle	29	35	Yes	8.7	No	No	Minor (8)	9

Major and *minor* refer to the vascular injury.

ICU = intensive care unit; ISS = Injury Severity Score; L = laparotomy; LOS = length of stay; NA = not available; O = orthopedic surgery; SAPS II = Simplified Acute Physiological Score.

Edouard AE et al. Anesthesiology 101:1262-68, 2004.

Troponin I assay: Limit of detection = 0.04ug/L, x>0.4ug/L = significant myocardial injury, x>1.5ugm/L = threshold for diagnosis of myocardial necrosis. In 5% of 86 pts. with elevated troponin, CAD was felt to be at cause.

Pop Quiz:

As the physician on call, you are asked to see a 23 y.o. man who arrived in the E.R. after being dumped on the sidewalk from a car that promptly sped away. The patient was comatose, hypotensive and tested positive for heroin, cocaine and methamphetamine. His elbows, sacrum and heels were reddened. CPK was 9,000. Troponin I was elevated, prompting consultation.

At this point, you should probably

(a) Intubate the patient and admit to the MICU

(b) Take steps to avoid renal damage

(c) Practice the “Just Say No” speech

Elevated Serum Cardiac Troponin I In Rhabdomyolysis

Table 2
Characteristics of cTnI-positive patients

Number	Age/sex	Cause	CK (IU/l)	CK-MB (ng/ml)	cTnI (ng/ml)	Echo findings	Outcome
1	87/F	Fall	1115	30	3.5	EF 55%	Alive
2	81/F	Fall	9042	55	1.4	EF 65%, LVH, DD	Alive
3	33/M	Sepsis	10,341	9	5.7	EF 40%, GH	Fatal
4	36/M	Cocaine overdose	48,691	120	12	EF 50%, GH	Alive
5	41/M	Sepsis	46,335	109	25.3	EF 60%, LVH, DD	Alive
6	39/M	Cocaine overdose	72,946	237	1.4	Not performed	Alive
7	68/M	Sepsis	93,597	432	2.6	EF 48%, LVH, GH, Dilated LV	Alive
8	78/M	Statin use	43,079	229	14.9	EF 60%, LVH, DD	Alive
9	76/F	Sepsis	2820	17	3	EF 46%, LVH, GH	Alive
10	92/F	Heat stroke	3090	56	11.9	Not performed	Alive
11	72/M	Sepsis	25,480	14	1	EF 47%, GH	Alive
12	75/F	Sepsis	12,330	19	13.3	EF 39%, LVH, GH	Fatal
13	32/M	Heroin overdose	15,081	42	6.5	EF 50%, GH	Alive
14	76/M	Leg injury	1680	5	1.1	EF 46%, GH, Dilated LV	Alive
15	49/M	Cocaine overdose	18,819	182	22.1	EF 60%	Alive
16	25/M	Heroin overdose	141,423	214	20.8	EF 35%, GH	Alive
17	71/M	Myositis	18,253	12	11.3	EF 69%, AS	Alive
18	62/F	Fall	14,440	54	0.9	Not performed	Alive
19	37/M	Cocaine + heroin overdose	82,753	403	24.2	EF 42%, LVH, GH	Fatal

AS, aortic stenosis; cTnI, cardiac troponin I; CK, creatine kinase; DD, diastolic dysfunction; GH, global hypokinesis; EF, left ventricular ejection fraction; F, female; LV, left ventricle; LVH, left ventricular hypertrophy; M, male; CK-MB, MB isoenzyme of CK.

Punukollu G et al. International J of Cardiol 96 (2004): 35-40

Elevated troponin >0.6 ng/ml

Pop Quiz:

As a physician working in a heart failure clinic, you are caring for a 30 y.o. man who has severe dilated cardiomyopathy. He had coronary angiography (normal) at the time of diagnosis 3 months ago. Due to a clerical mix-up, a blood sample that was supposed to have been sent for electrolyte determination instead was used for a troponin measurement. Troponin I was slightly elevated.

Your next move should be to

(a) Contact the patient and admit to ICU

(b) Schedule another coronary angiogram

(c) Contact the patient, explain the test result, urge full compliance and push for maximum medical therapy

Troponin Elevation In Chronic Congestive Heart Failure

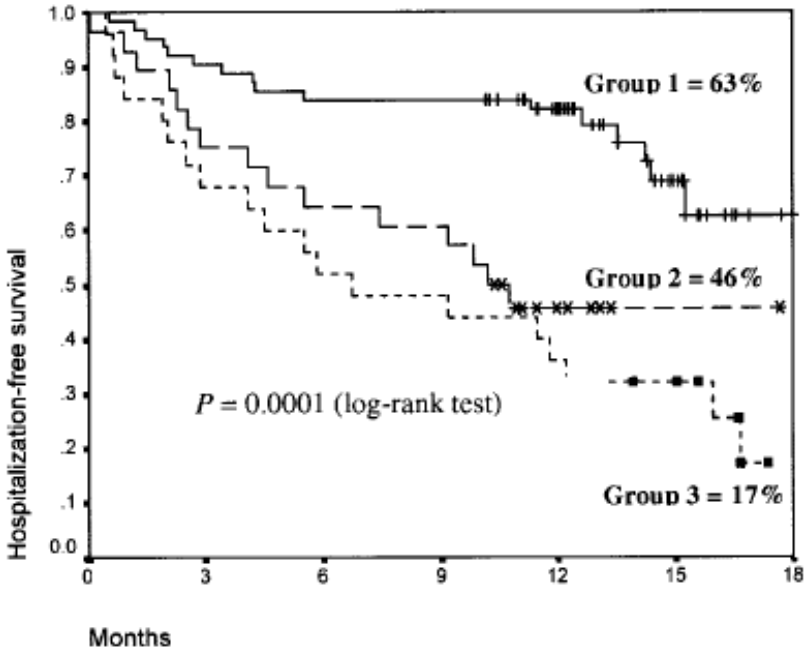


Figure 1. Hospitalization (for CHF)–free survival according to degree of myocardial injury. Group 1: all cTnT samples within normal limits; group 2: a single cTnT sample abnormal: group 3: ≥2 abnormal cTnT measurements.

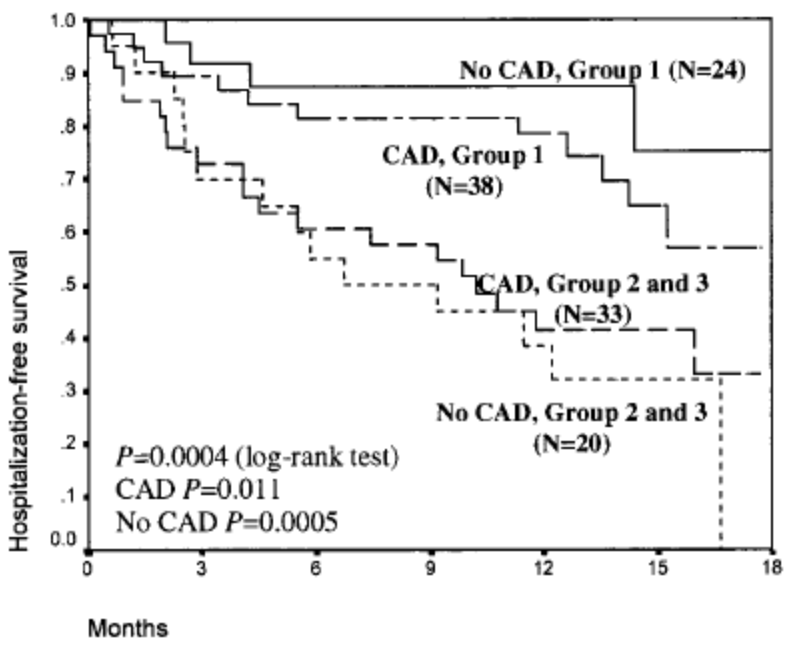


Figure 2. Stratified analysis of hospitalization (for CHF)–free survival according to degree of myocardial injury (group 1 vs groups 2 and 3) in patients with ischemic (CAD) vs nonischemic (No CAD) underlying heart disease.

Perna ER et al. Circulation. 2004;110:2376-2382.

Troponin in CHF – ADHERE Registry

Adverse Outcomes Tied to Elevated Troponin in Heart Failure

Adverse event	Troponin-positive group	Troponin-negative group
In-hospital mortality	8%	3%
CABG	4%	1%
Intraaortic balloon counterpulsation	3%	1%
Cardiac catheterization	24%	10%
Mechanical ventilation	11%	4%
Cardioversion	3%	2%
Time in ICU/CCU	2.9 days	2.3 days
Length of hospitalization	5.1 days	4.1 days

Note: Based on ADHERE data on 4,240 troponin-positive and 63,684 troponin-negative patients with decompensated heart failure.

Peacock WF, Abstract 2004 Am. Coll Emergency Physicians

Troponin Elevation In Acute Congestive Heart Failure

TABLE I Serum Level of cTnT and Clinical Backgrounds in Patients With Congestive Heart Failure

	cTnT ≥0.02 ng/ml (n = 30)	cTnT <0.02 ng/ml (n = 28)
Age (yrs)	68 ± 14	65 ± 12
Men/women	16/14	12/16
Cause of heart failure		
Valvular disease	9	7
Previous myocardial infarction	8	6
Hypertensive heart disease	7	9
Dilated cardiomyopathy	4	3
Congenital heart disease	1	1
Tachycardiac atrial fibrillation	1	1
Atrial standstill	0	1
Medication after hospitalization		
Furosemide	30	25
ACE inhibitors	14	12
Digitalis	16	14
Vasodilators	15	13

ACE = angiotensin-converting enzymes inhibitors.

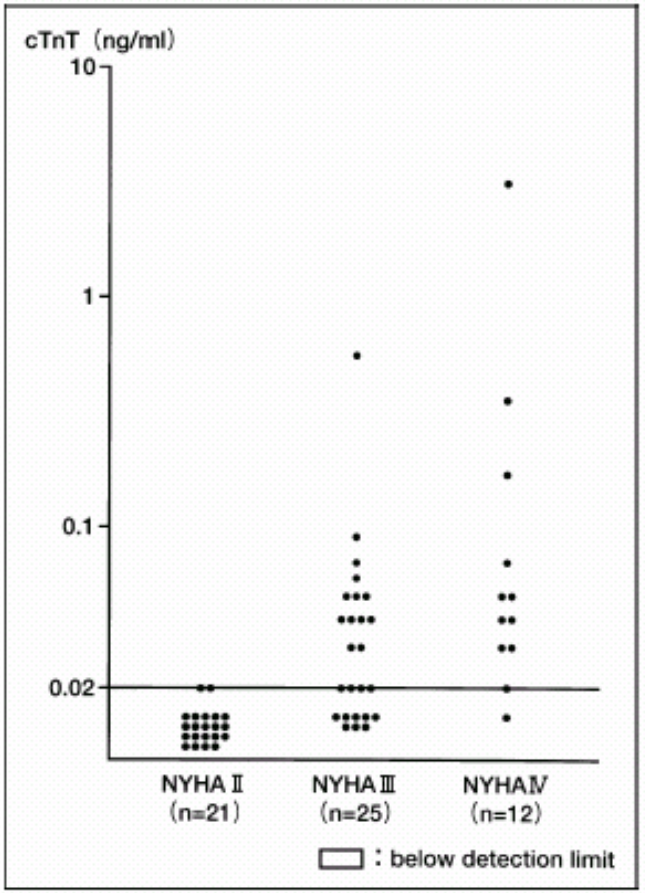


FIGURE 1. Serum levels of cTnT in patients with congestive heart failure.

Setsuta K, et al. Am J Cardiol 84:608-611, 1999.

Pathophysiology of Troponin-I Elevation In CHF Patients

Severe congestive heart failure is associated with noncontiguous areas of myocardial cell death, structural abnormalities in viable myocytes, and progressive interstitial fibrosis, which lead to worsening heart failure through cardiac remodeling. We theorize that the levels of cardiac troponin I in heart failure patients reflect cellular injury and ongoing degradative processes of the contractile apparatus. These levels are most likely part of the remodeling of the myocardium, and they sensitively monitor the cell death that accompanies the spontaneous progression of heart failure. The progressive impairment of cardiac structure and function occurs through a number of putative processes that include *neurohormonal factors, oxidative stress, and a number of cytokines.* Each of these factors can promote cardiac cell death by producing either myocyte necrosis or myocyte apoptosis through activation of specific genetic pathways. Both processes may be more common forms of myocardial cell death than initially believed, because focal and diffuse loss of contractile units constitutes the major structural characteristic of advanced heart failure and conditions the progression of the disease.

Missove E, et al Circulation. 1997;96:2953-2958. (University Hospital of Montpellier, France)

Definition:

Acute coronary syndrome (ACS) is a term that refers to the entire spectrum of acute MI, including acute myocardial infarction with and without ST-segment elevation and unstable angina. The final classification of Q-wave or non-Q-wave MI or unstable angina is a retrospective process that is not possible for 24 hours or more after presentation.

Pop Quiz:

At 6 pm you are called to the E.R. to evaluate an 82 y.o. woman who has been transferred from an outlying hospital for evaluation of chest pain that started one hour earlier. Lab sent from the other hospital showed a troponin level of 0. The patient continues to have chest pain, and EKG shows 2-5 mm of ST elevation in 2, 3, aVF, V5 and V6.

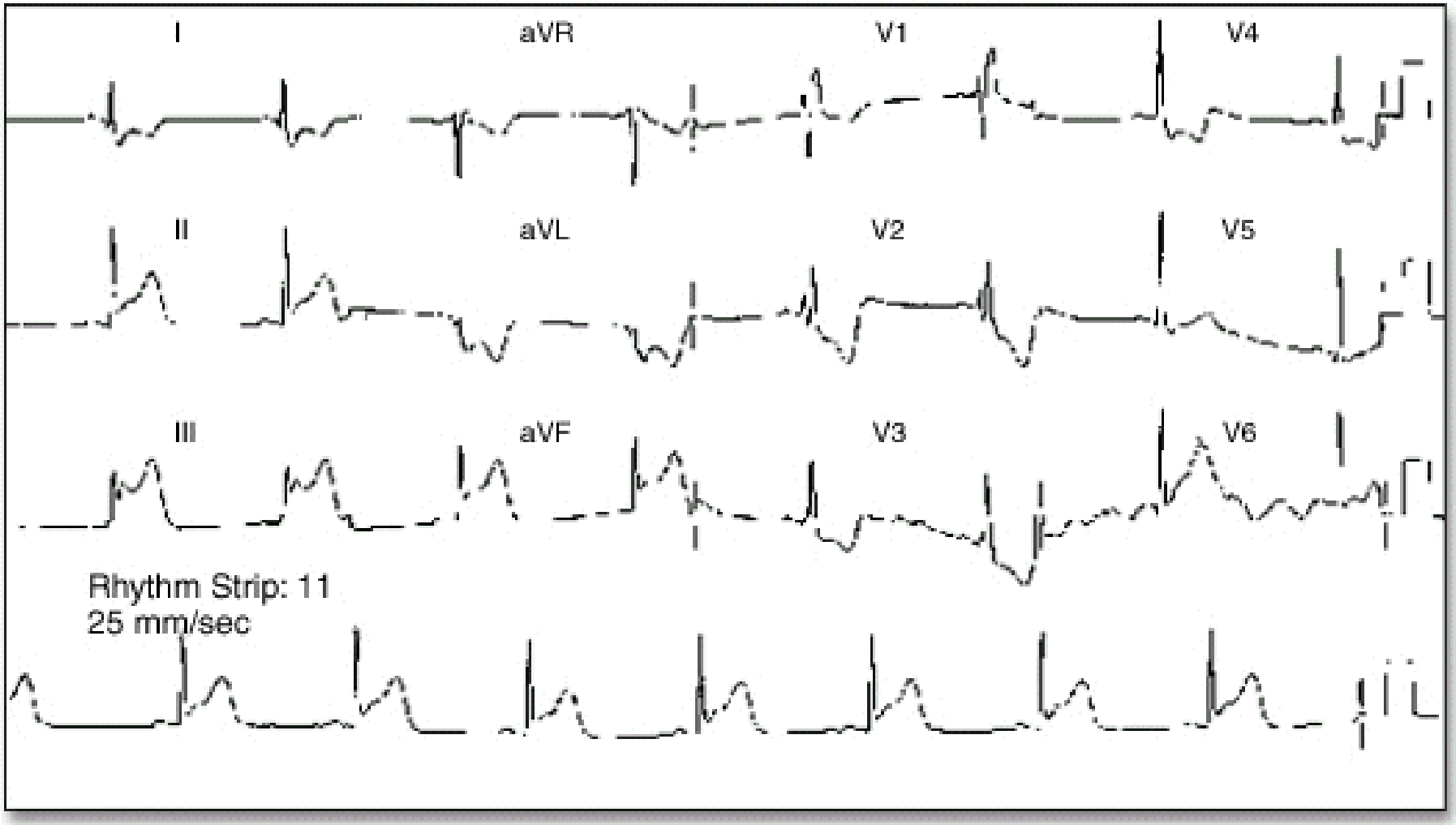
Your next move should be to

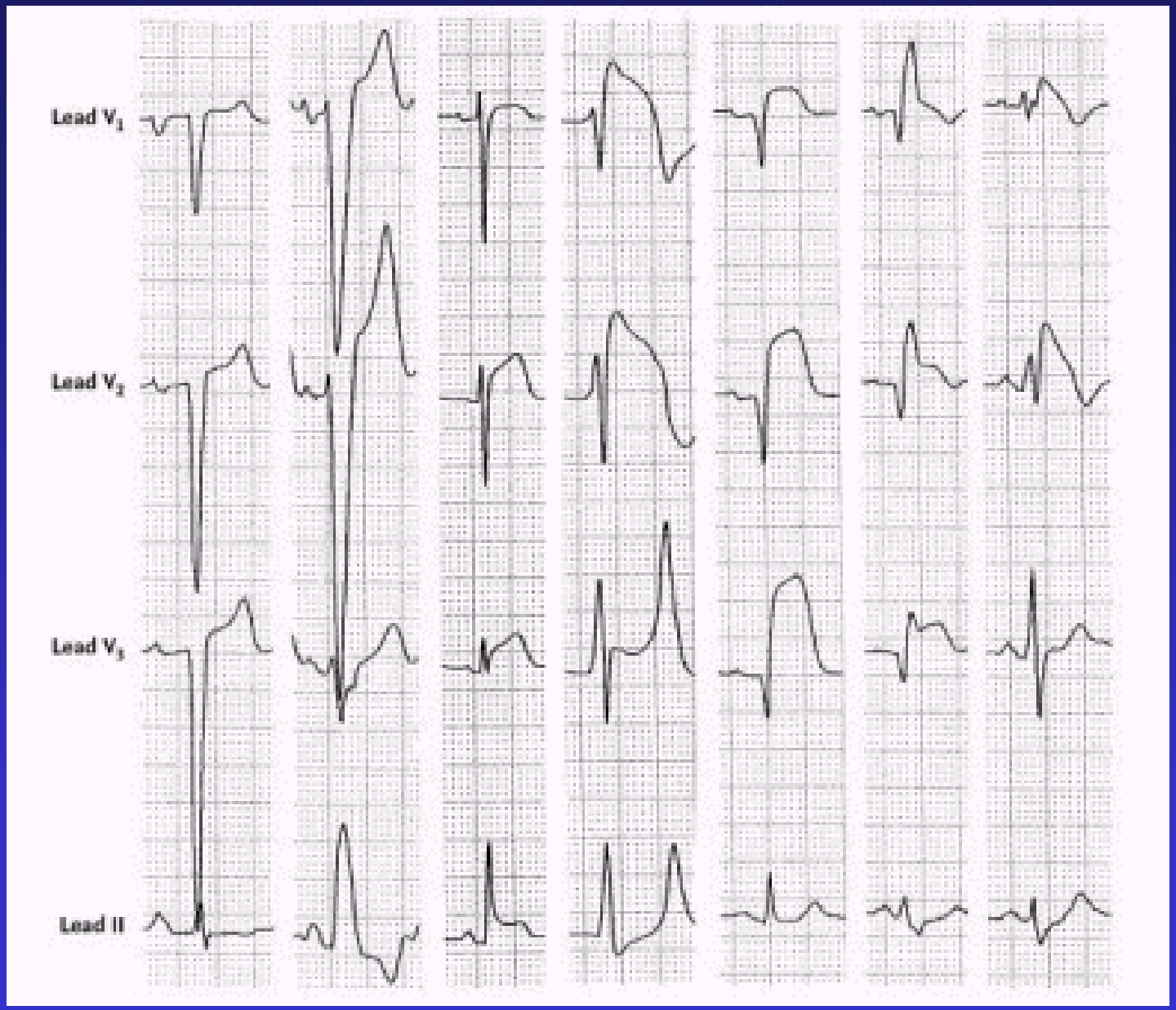
(a) Admit the patient to the ICU

(b) Get more enzyme results

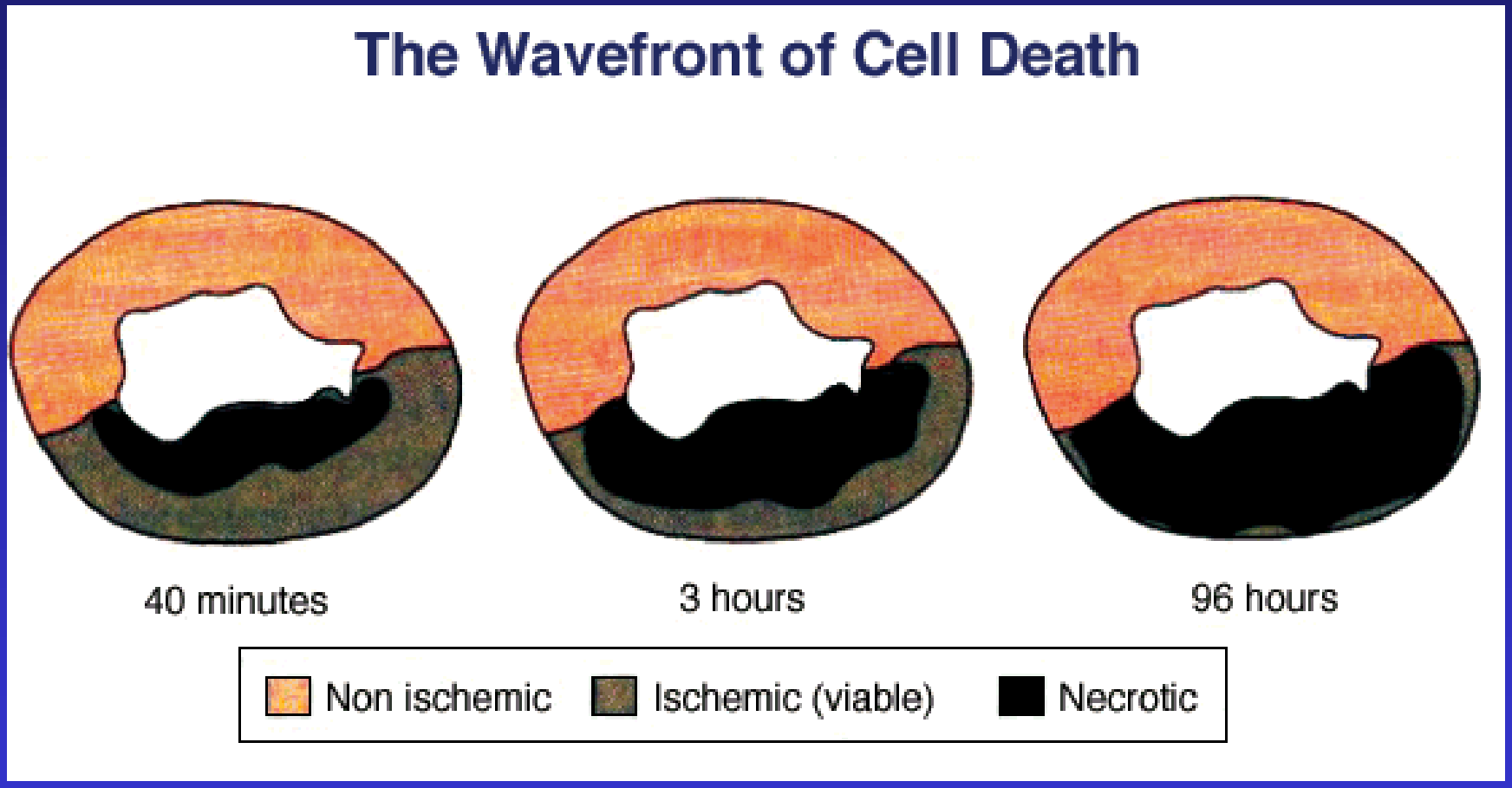
(c) Take the patient directly to the Cath Lab

Inferior ST Elevation Infarction

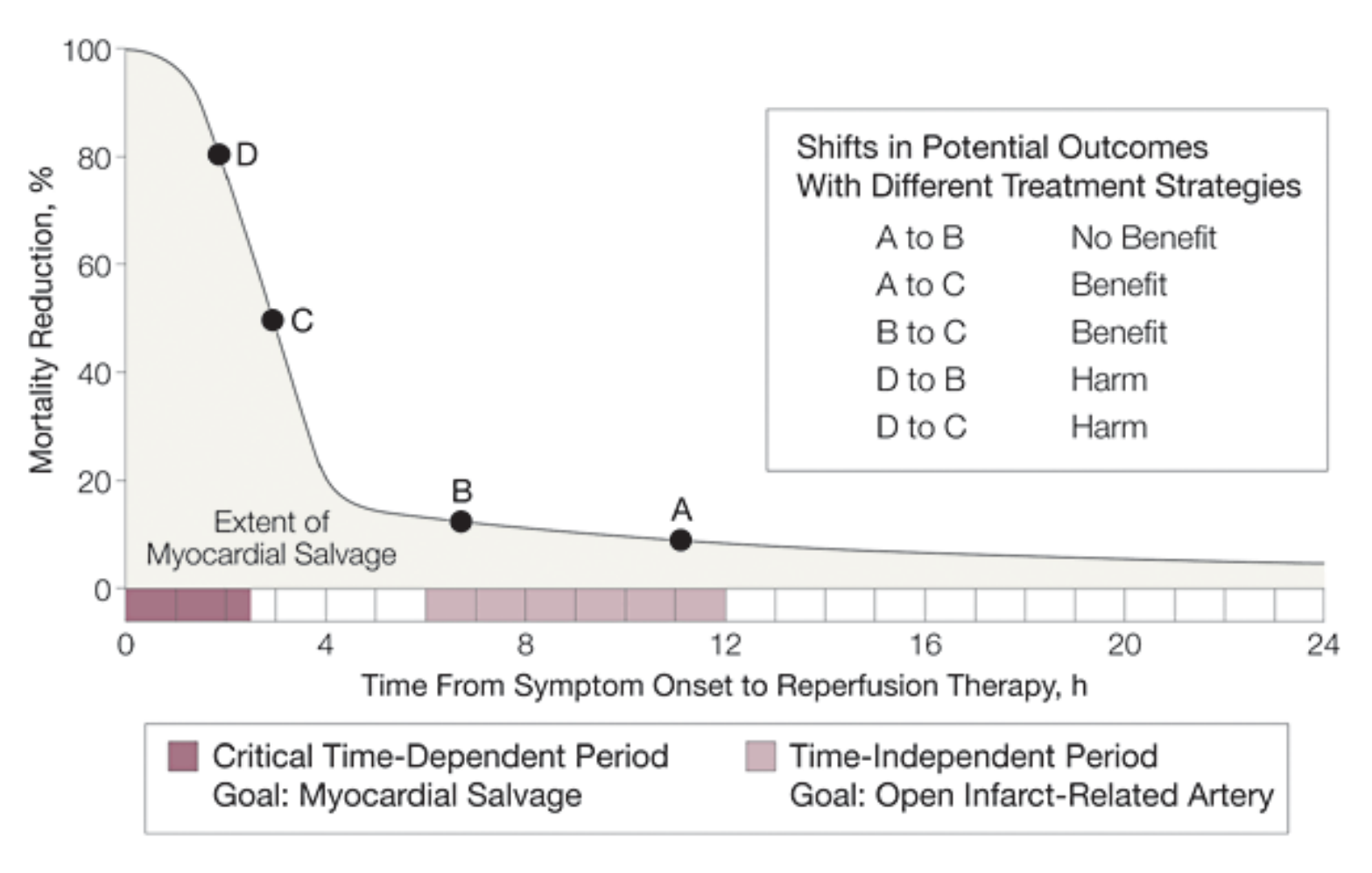



LVH
LBBB
Acute Pericarditis
Hyper-kalemia
Acute ASMI
Acute ASMI
Brugada Syndrome
Lead V1
Lead V2
Lead V3
Lead II

Time and Infarction Size



Time, Mortality and Infarction Size



Gersh BJ et al. JAMA. 2005;293:979-986

Angioplasty vs. Thrombolysis for Acute ST-Elevation MI

Clinical Outcome at 30 Days

Outcome	Referral Hospitals			Invasive-Treatment Centers			All Hospitals		
	Fibrinolysis Group (N=562)	Angioplasty Group (N=567)	p Value	Fibrinolysis Group (N=220)	Angioplasty Group (N=223)	p Value	Fibrinolysis Group (N=782)	Angioplasty Group (N=790)	p Value
	no. (%)			no. (%)			no. (%)		
Death	48 (8.5)	37 (6.5)	0.20	13 (5.9)	15 (6.7)	0.72	61 (7.8)	52 (6.6)	0.35
Reinfarction	35 (6.2)	11 (1.9)	<0.001	14 (6.4)	2 (0.9)	0.002	49 (6.3)	13 (1.6)	<0.001
Disabling Stroke	11 (2.0)	9 (1.6)	0.64	5 (2.3)	0	0.02	16 (2.0)	9 (1.1)	0.15
Composite Endpoint	80 (14.2)	48 (8.5)	0.002	27 (12.3)	15 (6.7)	0.05	107 (13.7)	63 (8.0)	<0.001

Andersen HR, Nielsen TT, Rasmussen K, Thuesen L. A comparison of coronary angioplasty with fibrinolytic therapy in acute myocardial infarction (DANAMI-2). N Engl J Med. 2003;349:733-42

Pop Quiz:

At 6 pm you admitted an 82 y.o. woman to a monitor bed after 2 hours of chest discomfort, shortness of breath and EKG showing non-specific ST-T abnormalities. Following treatment in the E.R. she became symptom-free. At 3am you are notified by the laboratory that her troponin is 3.0 (normal <0.07). The patient is sleeping peacefully. She is being treated with an ACS protocol.

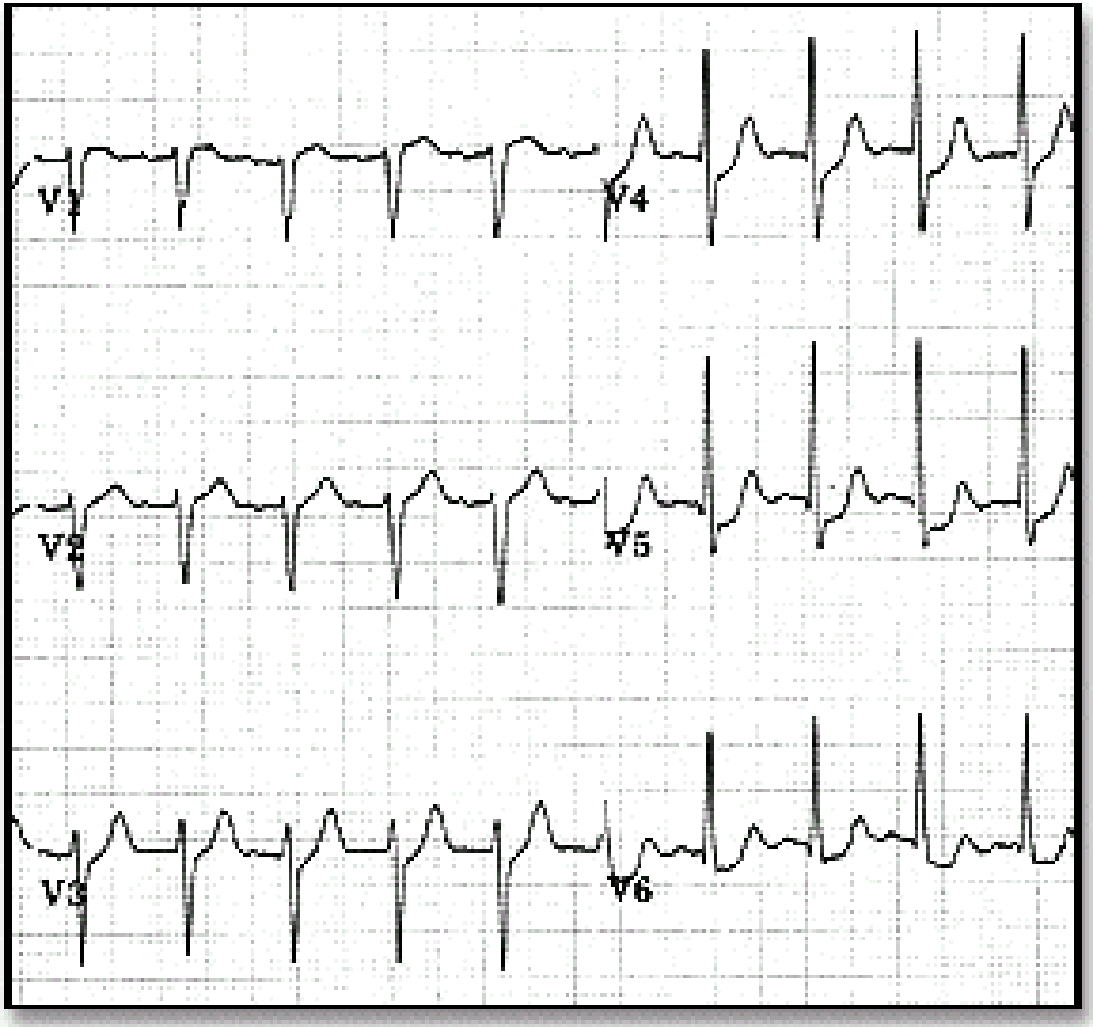
Your next move should be to

(a) Move the patient to the ICU

(b) Make the patient NPO except for clear liquids, start low dose I.V. fluids, avoid caffeine

(c) Obtain a 7:15 am Cardiology consult

Typical ST Depression



MI Options

1. Watchful waiting.
2. Myocardial perfusion scanning.
3. Coronary angiography with possible angioplasty.

ACC Round Table on Management of Acute Coronary Syndrome, October 2004.

Moderator: Dolph Hutter, M.D., Professor of Medicine, Harvard

Deepak Bhatt M.D., Interventional Cardiologist, Cleveland Clinic Foundation

James Tcheng M.D., Interventional Cardiologist at Duke, Associate Professor of Medicine at Duke University Medical Center

Glenn Levine M.D., Chief of Critical Care and Director of the Cath Lab at the Houston VA, Associate Professor of Medicine at Baylor College of Medicine

DOLPH HUTTER, MD: And then would you call your referral hospital and say, "I've got this guy. I want to send him in."

GLENN N. LEVINE, MD*: I would. Again, I don't think that, unless the patient is having active chest pain with dynamic ST depressions in front of your eyes, in which case I would emergently take the person to the lab, I don't think we have data that this person needs to be emergently taken to the lab.*

DOLPH HUTTER, MD: Well, that's a good point.

GLENN N. LEVINE, MD: Versus, say, urgently taken to the lab.

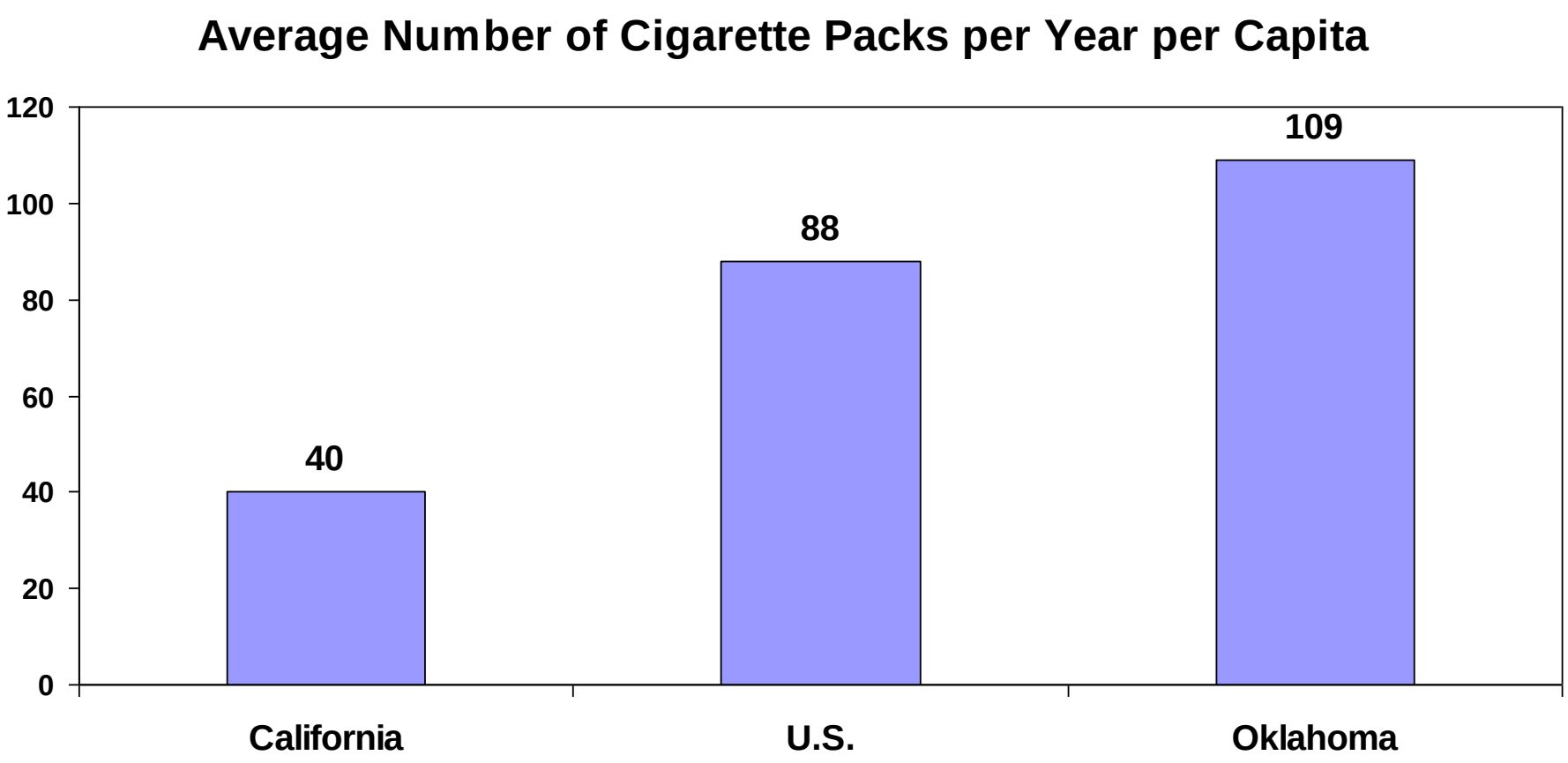
DOLPH HUTTER, MD: *All right. That's a good point. So if a guy comes in at two o'clock in the morning and he's got the markers, but you put him on the programs, which we'll discuss subsequently, you say, "Look, let's get him in there. They can take a look at him next morning." Is that reasonable? If he's stable?*

GLENN N. LEVINE, MD: *I think that's appropriate, and I don't think we have any data at this point that for a non-ST elevation ACS patient who is not having active chest pain, that he needs to be emergently taken to the cath lab.*

DEEPAK BHATT, MD: *Yes, I think Glenn and Jimmy are right on the mark. Really, the bulk of data support an early invasive strategy. Exactly how early, there is some ongoing investigation to see whether even earlier is better. But for right now, I'd say in a stabilized patient within 48 hours or so is an appropriate time frame.*

State Bird of Oklahoma?

Planning a Lower-Risk America



Report shows Costa Ricans live longer than Oklahomans NELLIE KELLY World Staff Writer, 02/20/2003

Planning a Lower-Risk America

Leading causes of death

Age-adjusted death rates per 100,000 population in 2000

	Oklahoma	U.S.	Percent difference
Coronary heart disease	238	196	21%
Cancer	207.7	201	3%
Chronic obstructive pulmonary disease	157.2	125.5	25%
Stroke	70	61	15%
Unintentional injury	45.7	35.5	29%

Tulsa World

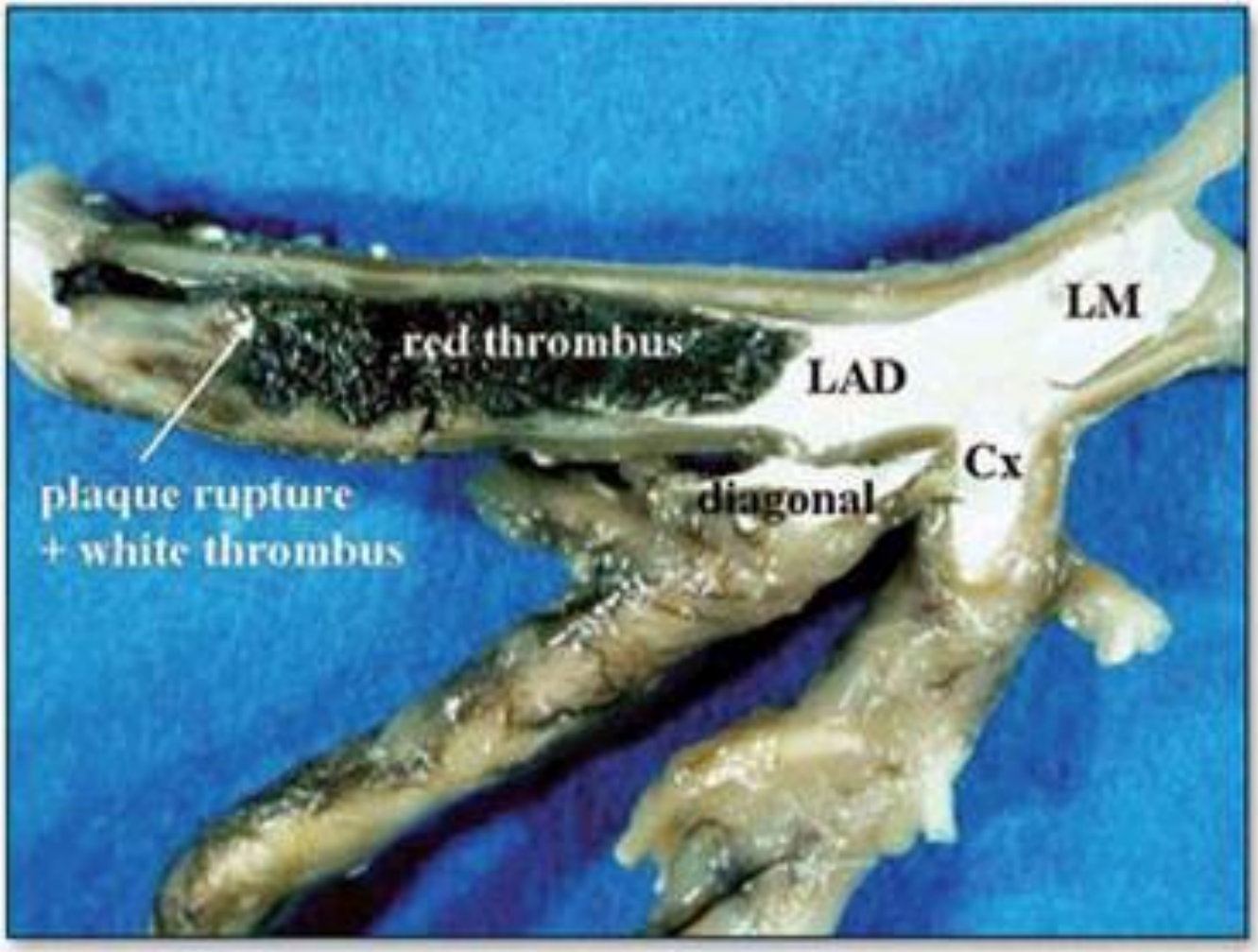
Oklahoma is the only state whose death rate has been increasing since 1990.

January 3, 2002: Fattest cities in the US. Number 11 = Tulsa

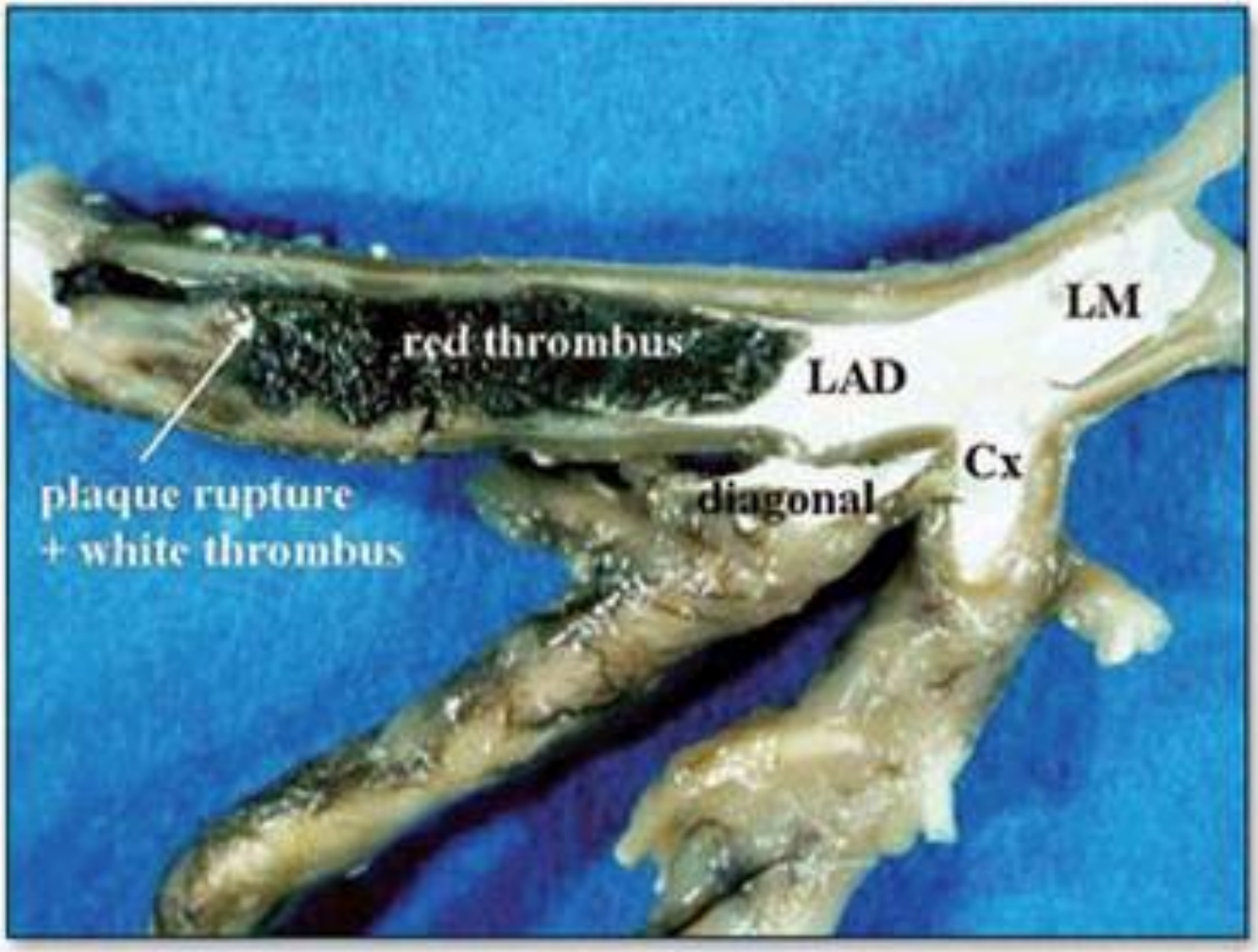
Summary

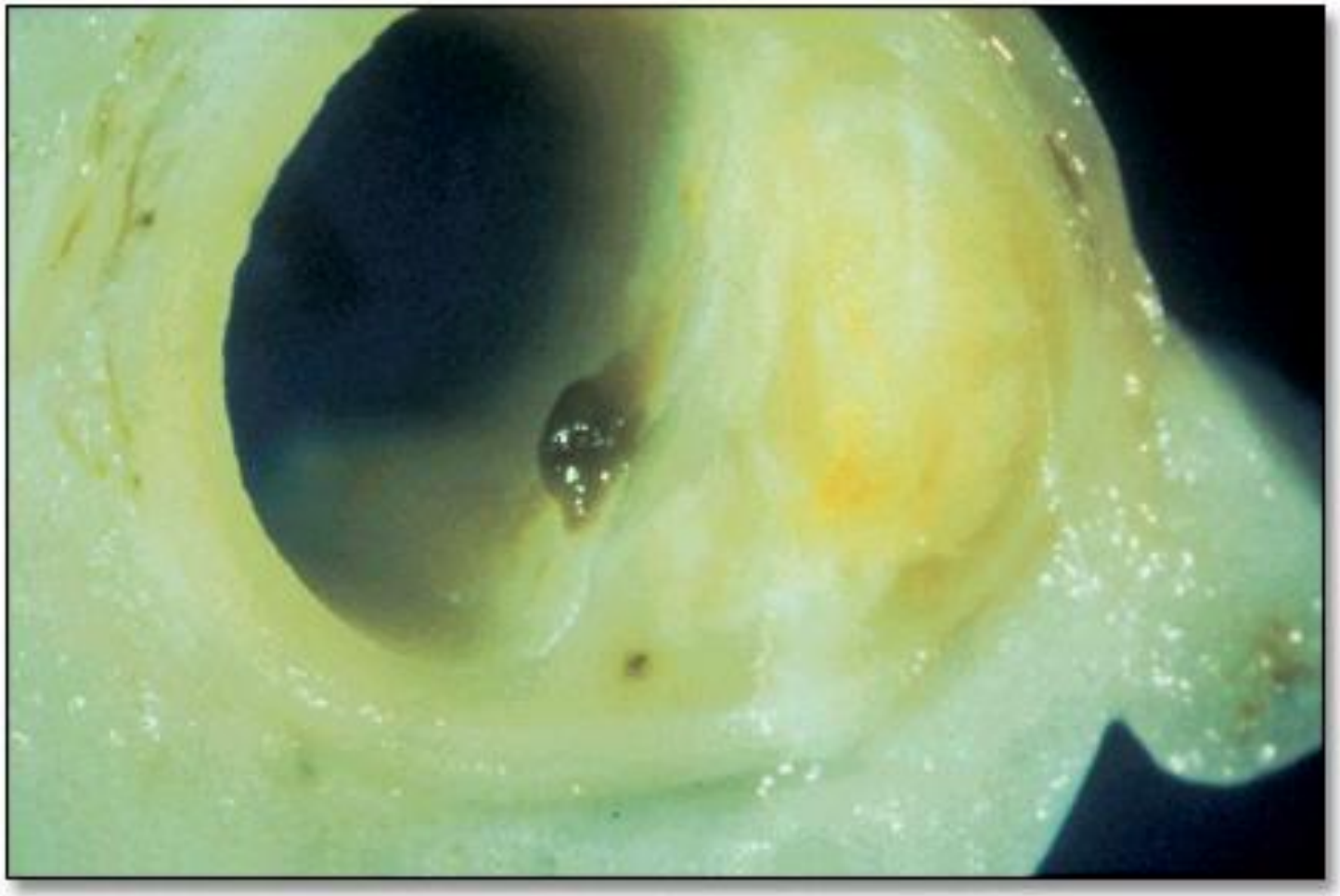
1. Troponin-measurement technology represents a remarkable advance in the ability to gauge injury to myocardial cells.
2. The astonishing sensitivity of this technique, with abnormal results beginning at a level of ~4-10 millionths of total heart mass, renders our previous notions of the nature and significance of myocardial injury obsolete.
3. Because of the extreme sensitivity of troponin in detecting heart injury, careful usage of terms must be employed. It is suggested that the designation “myocardial infarction” be limited to non-micro ischemic myocardial damage. Troponin elevation due to non-ischemic causes should probably be called “[statement of magnitude] myocardial injury due to [nature of process].”
4. Troponin elevations in a variety of illnesses have illuminated aspects of pathophysiology that were previously unsuspected.
5. Clinical response to any lab test result must be guided by the context framing the test. This principle applies emphatically in the case of troponin measurement.

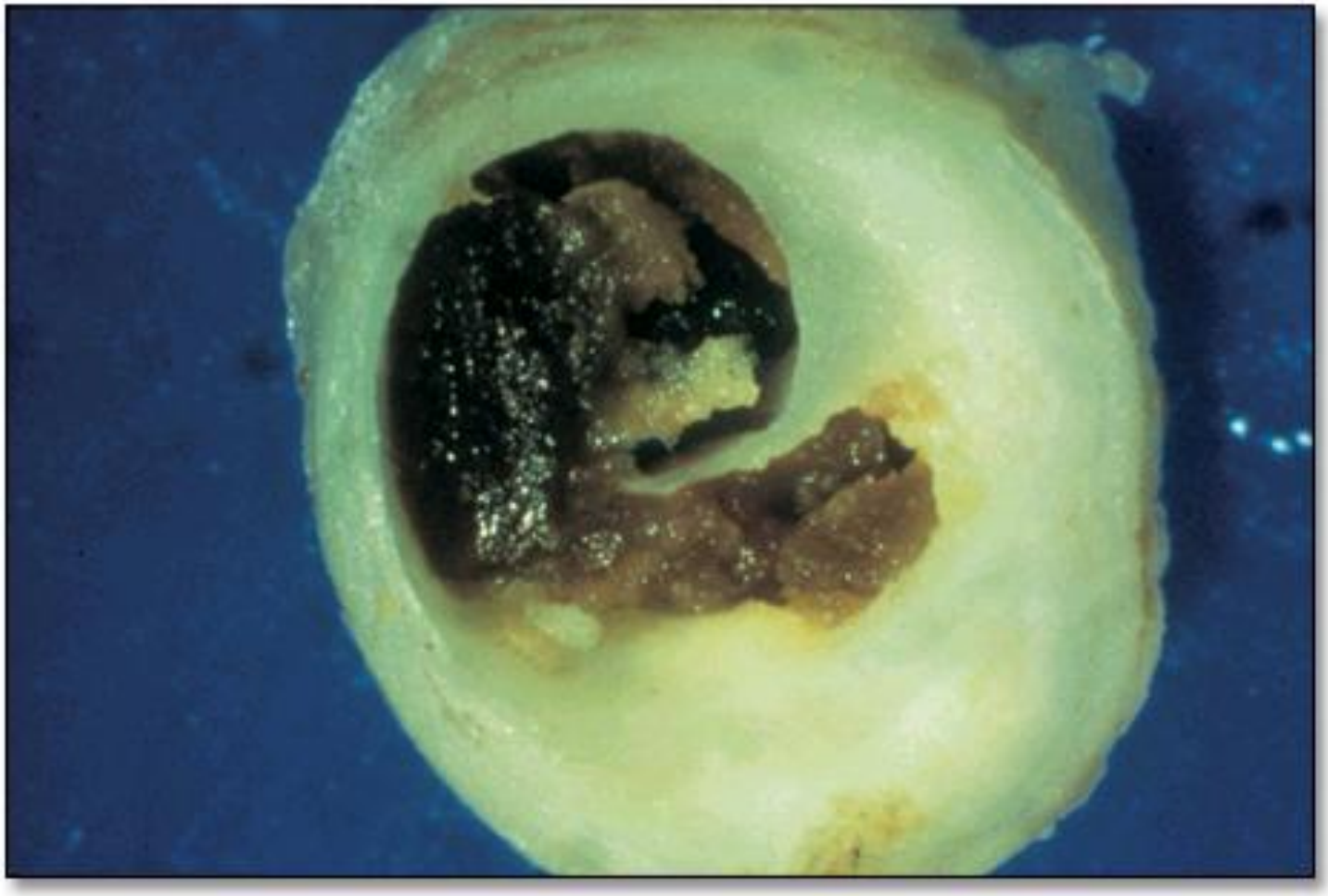
Secondarily Formed Venous-Type Stagnation Thrombosis

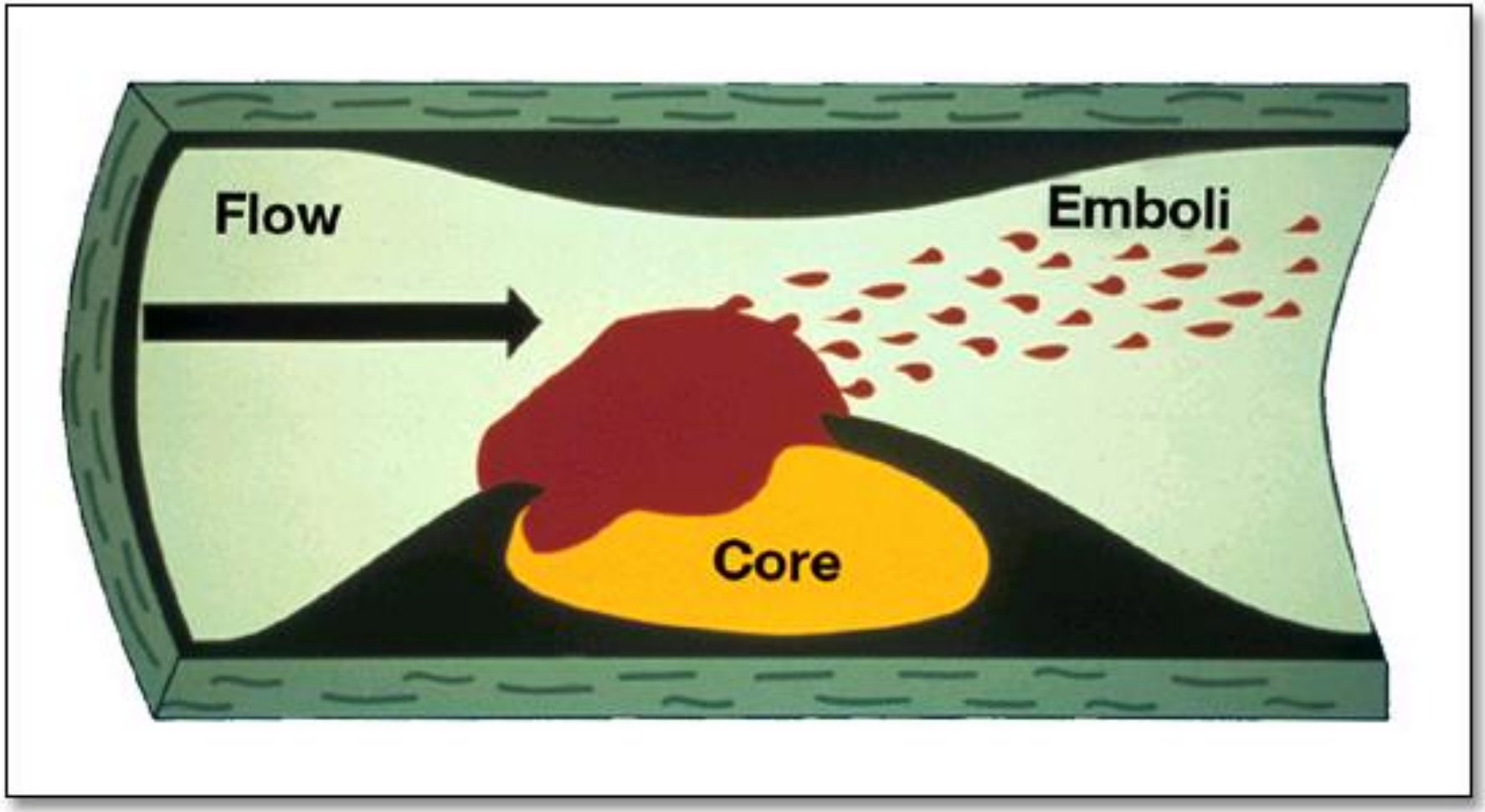


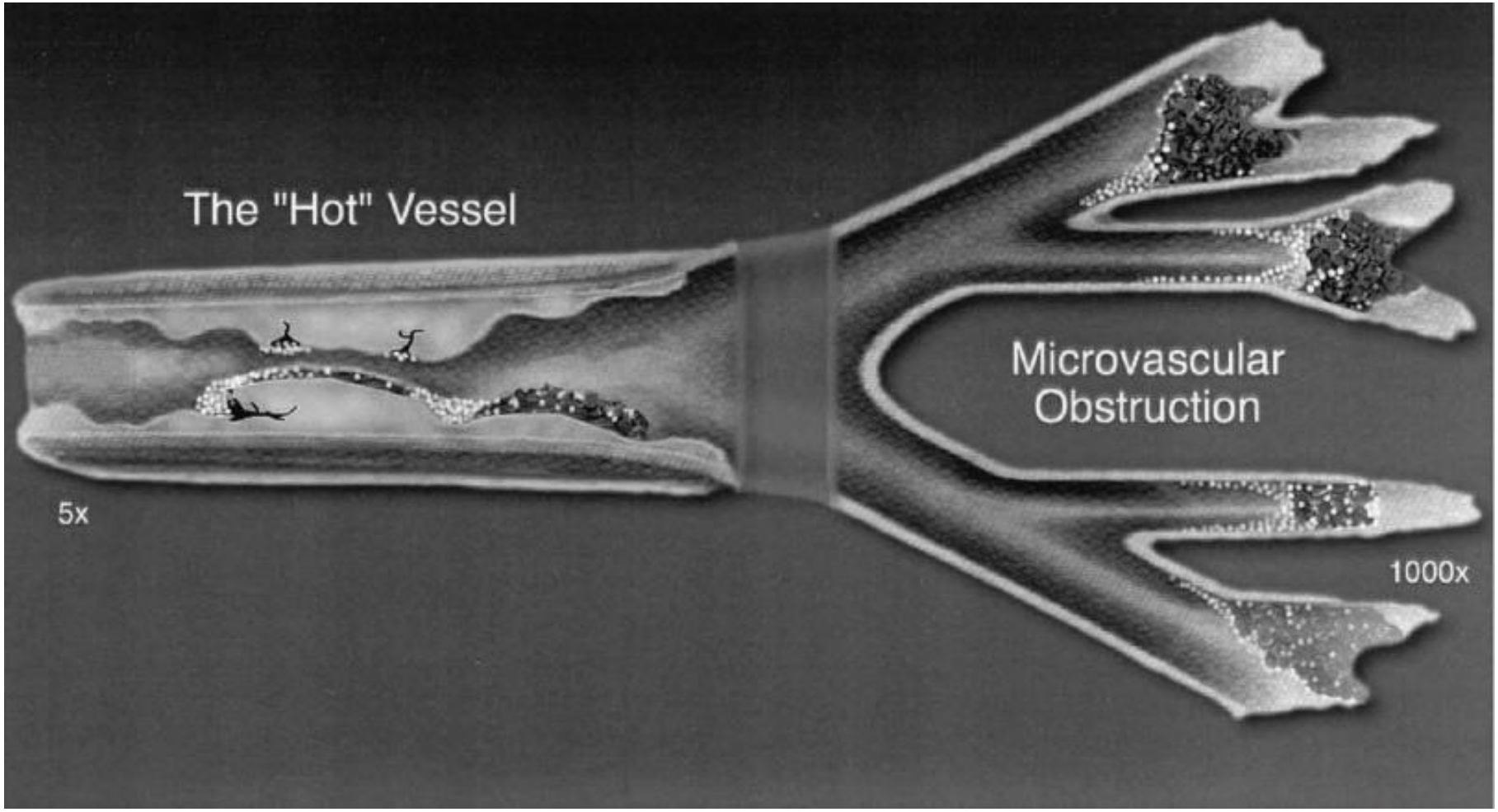
Secondarily Formed Venous-Type Stagnation Thrombosis








Flow
Emboli
Core


The "Hot" Vessel
Microvascular
Obstruction
5x
1000x