Implementation and outcomes of point-of-care testing in the emergency department of a large urban academic medical center

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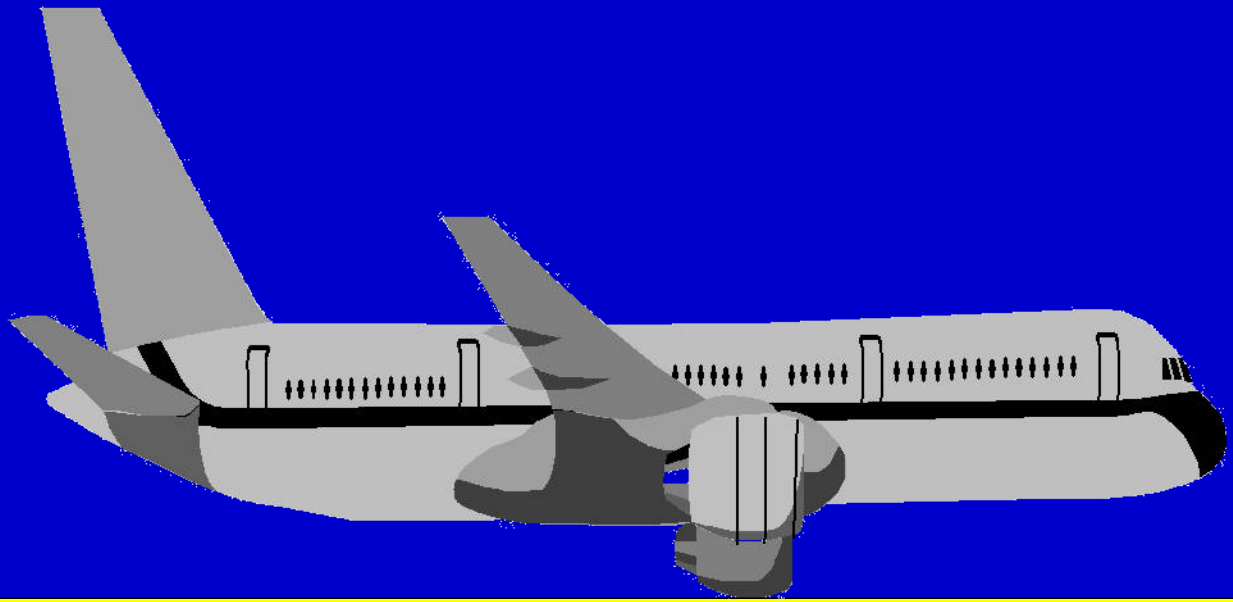
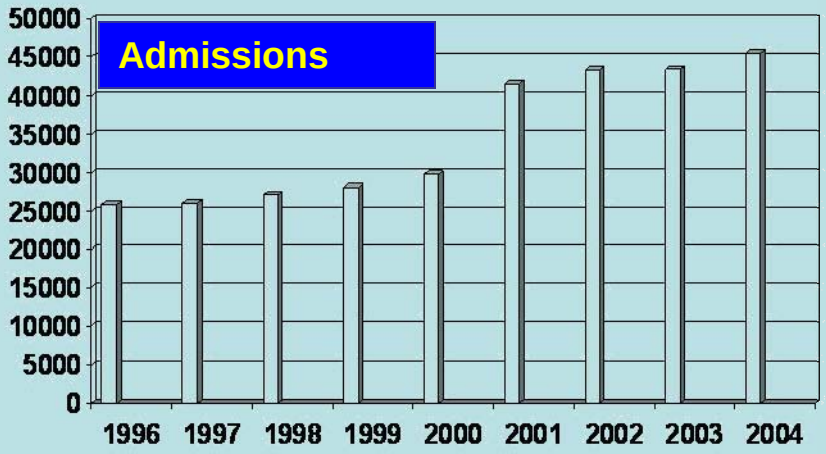
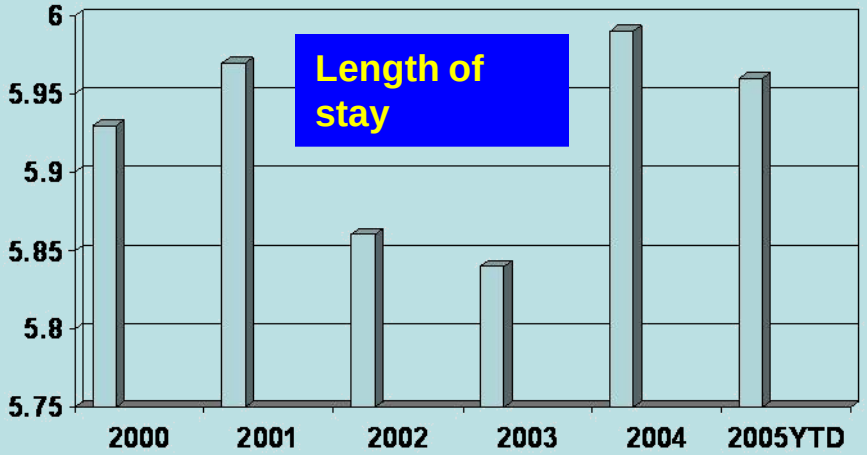
Selected slides courtesy James Januzzi, MD

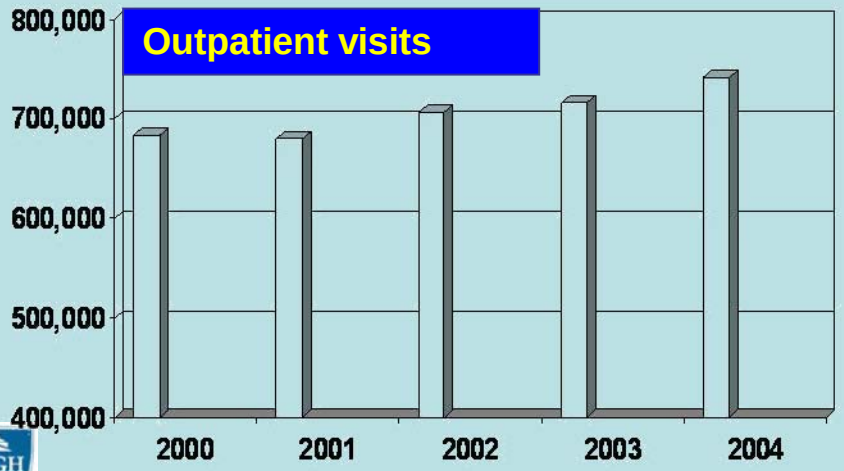


Laboratory Testing On Airline Flights

Massachusetts General Hospital: Trends







Types Of Outcomes

- **Medical outcomes:** Live longer, better
  - Very difficult to document
- **Financial outcomes:** Save money, more cost effective
  - Complex and difficult to document
- **Operations outcomes:** Improve length of stay, improve efficiency, streamline processes
  - Easier to document

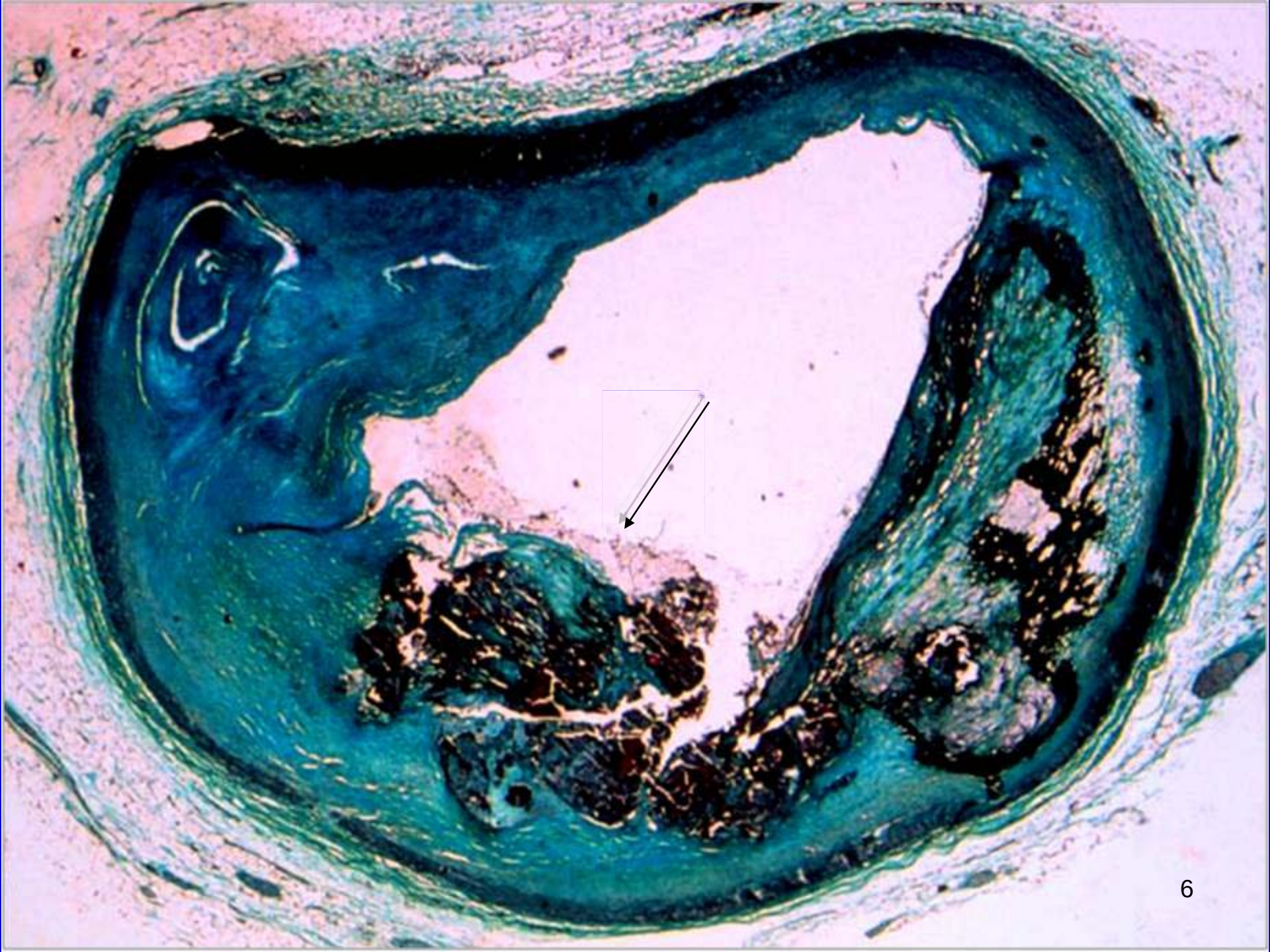
Cardiac Markers

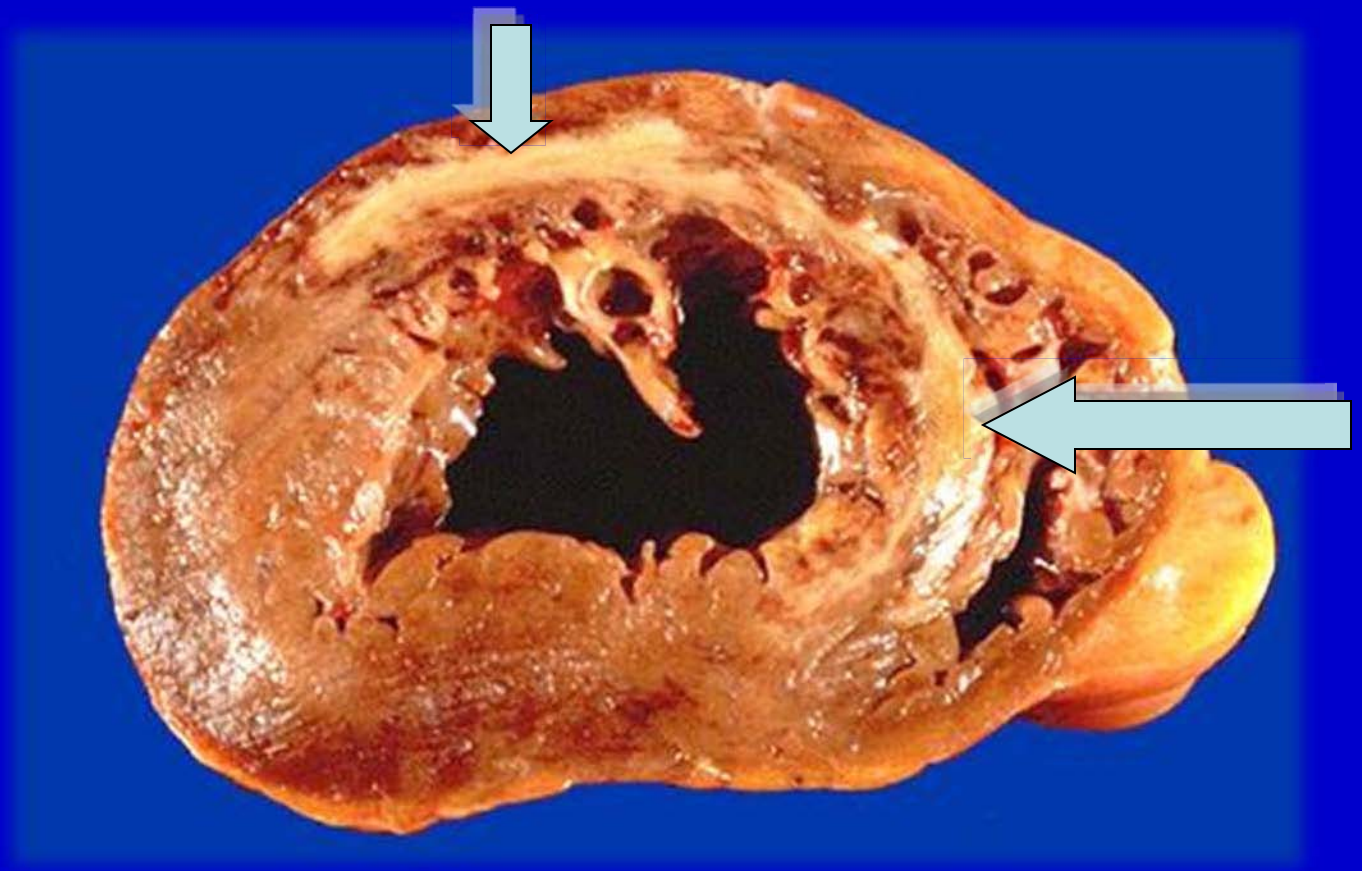
CK-MB, Troponin, Natriuretic peptides

Useful to Assess for:

Acute Coronary Syndromes

Congestive Heart Failure



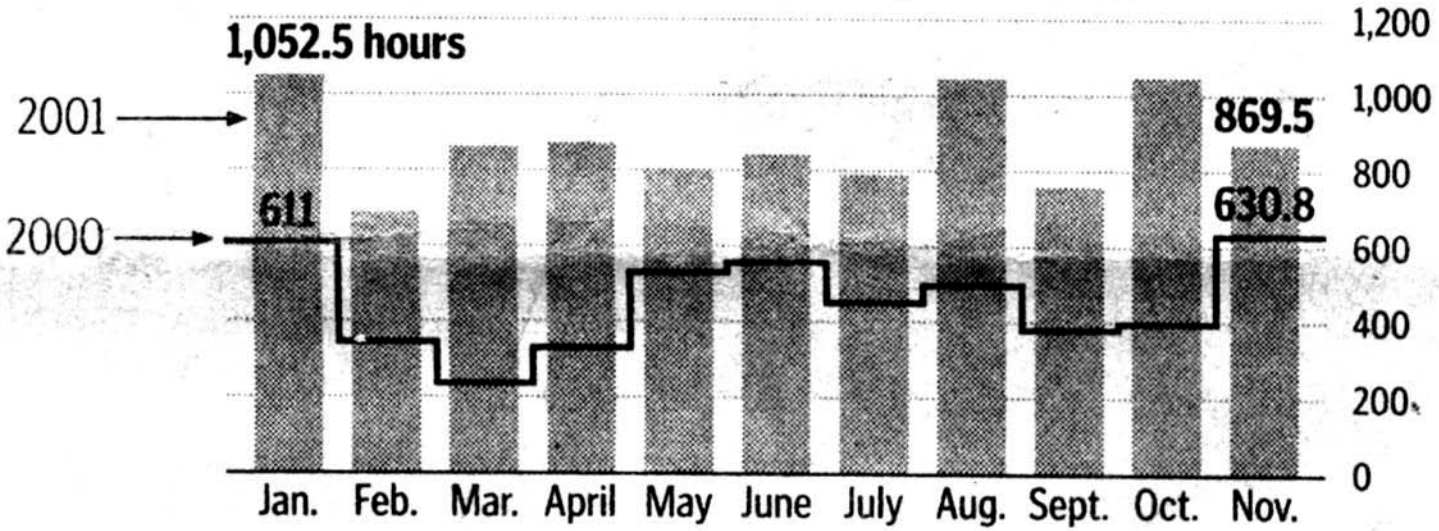


Ambulances diverted

Boston-area hospital emergency rooms, burdened by overcrowding, closed their doors to ambulances this year at record levels, even when compared with last year, when health officials were already concerned.

More diversions

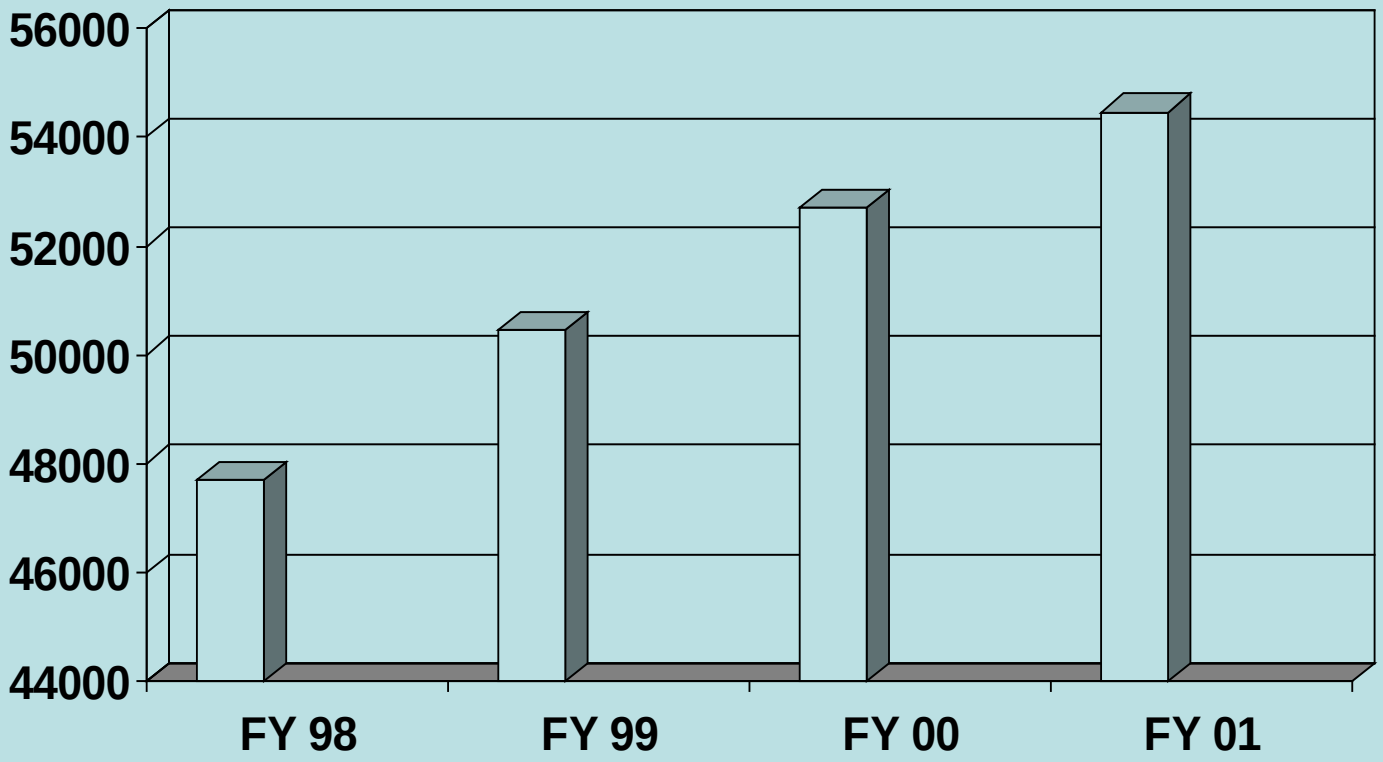
Number of hours that Boston-area ERs turned away ambulances



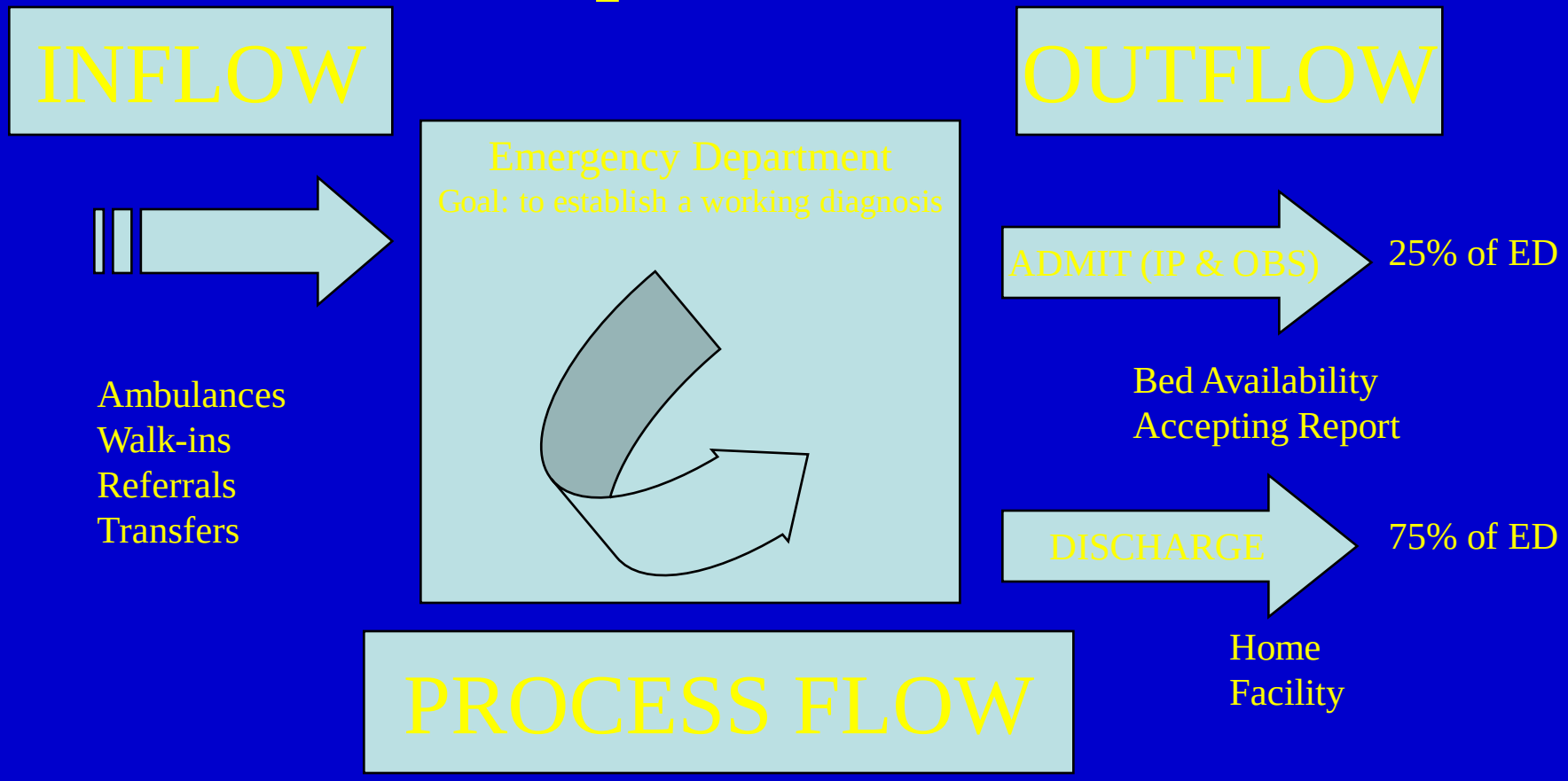
SOURCE: Boston Dept. of Public Health

GLOBE STAFF GRAPHIC

Crisis In The Emergency Room: ED Visits FY 98-01 YTD (June)



Patient Flow - Emergency Department



Form Interdepartmental Team

Laboratory

Physicians

Nursing

Administration

Project Manager

Mission: Eliminate the laboratory as a contributor to prolonged ED LOS

Selected Literature Review On The Utility Of ED POCT

Parvin C. et al. Clin Chem 1996;42:711-717

- Five analytes (electrolytes)
- No impact on ED LOS

Kendall et al. BMJ 1998;316:1052-1057

- Same analytes (hct, lytes, blood gases)
- Medical decisions made 74 minutes faster
- 7% of cases critical management changes based on POCT result
- No impact on ED LOS

But……

Maybe the docs in these studies were sitting around waiting for the rest of the tests

What if the menu were different or expanded

Step 1: Define Menu And Establish Goals

Test	Goal (In Lab)
Glucose	5 Minutes
Urine HCG	15 Minutes
Urinalysis	15-30 Minutes
LFT	30 Minutes
Cardiac	30 Minutes

Subsequently added Rapid Strep A, Influenza A/B, RSV, Drugs of abuse, D-Dimer

Understanding Turnaround Time: An Emergency Department Example

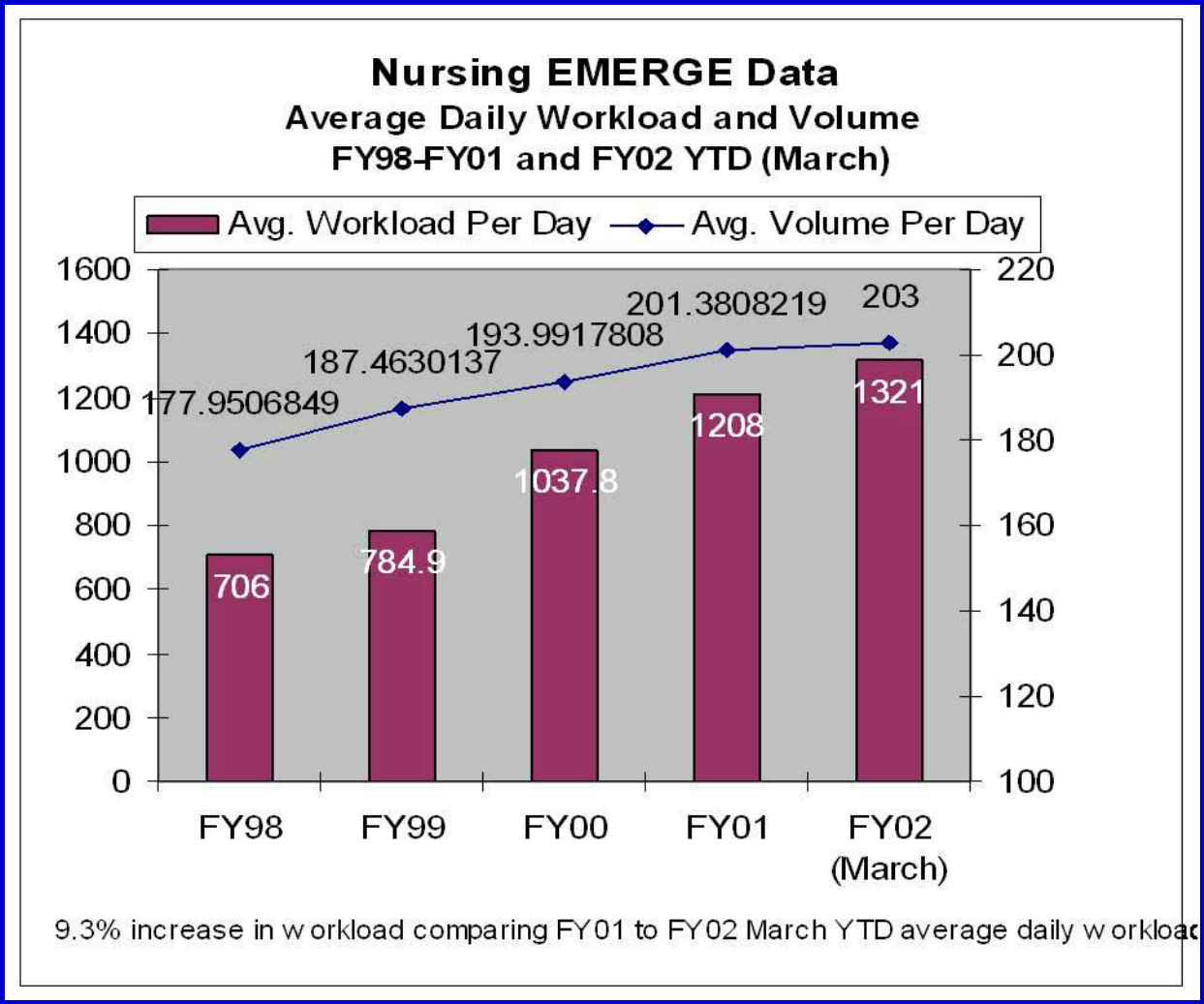
Phase Of Testing	Total TAT = 220 Minutes
Preanalytic	42%
Analytic	30%
Postanalytic	28%

Conclusion; POCT is the only way to meet turnaround time goals

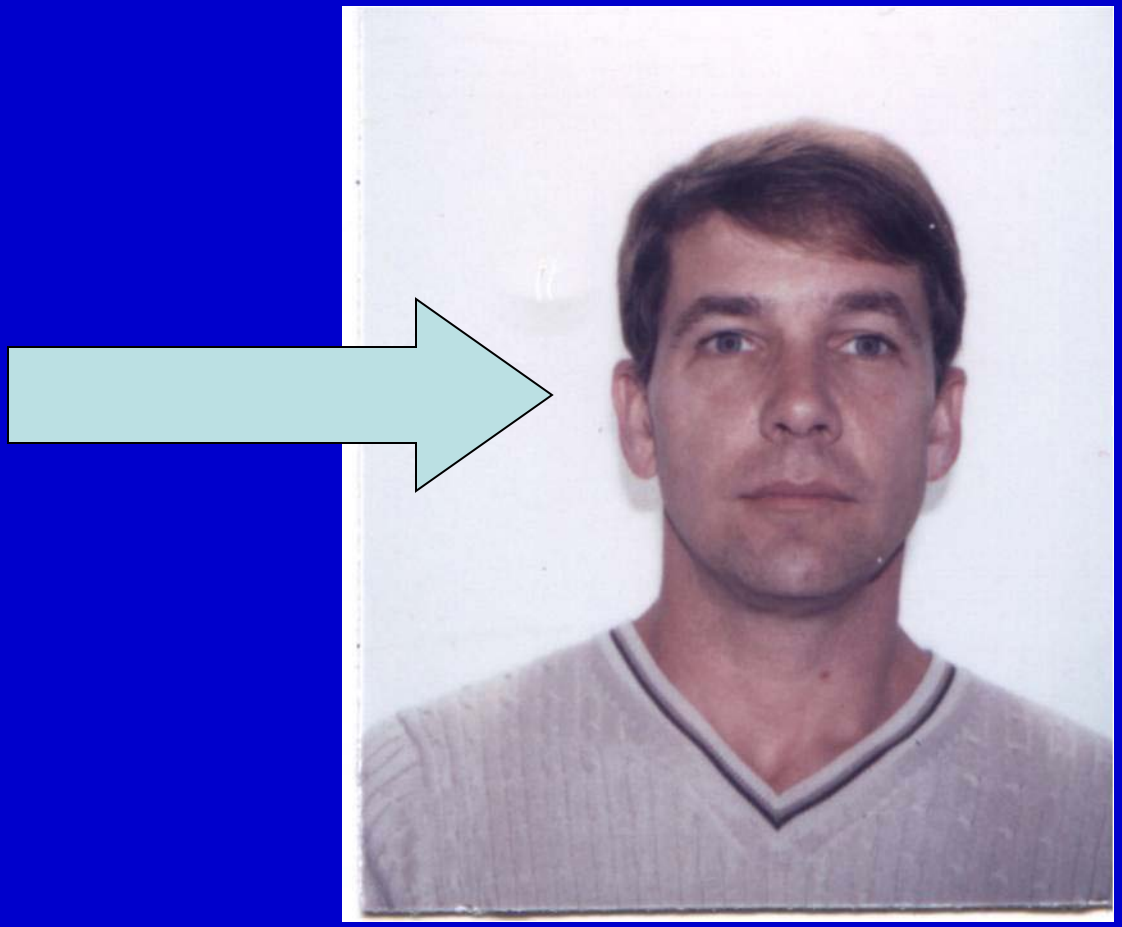
Next Question

Who's Going To Do The Testing ?

NURSES ARE SWAMPED



And Docs Are Incompetent

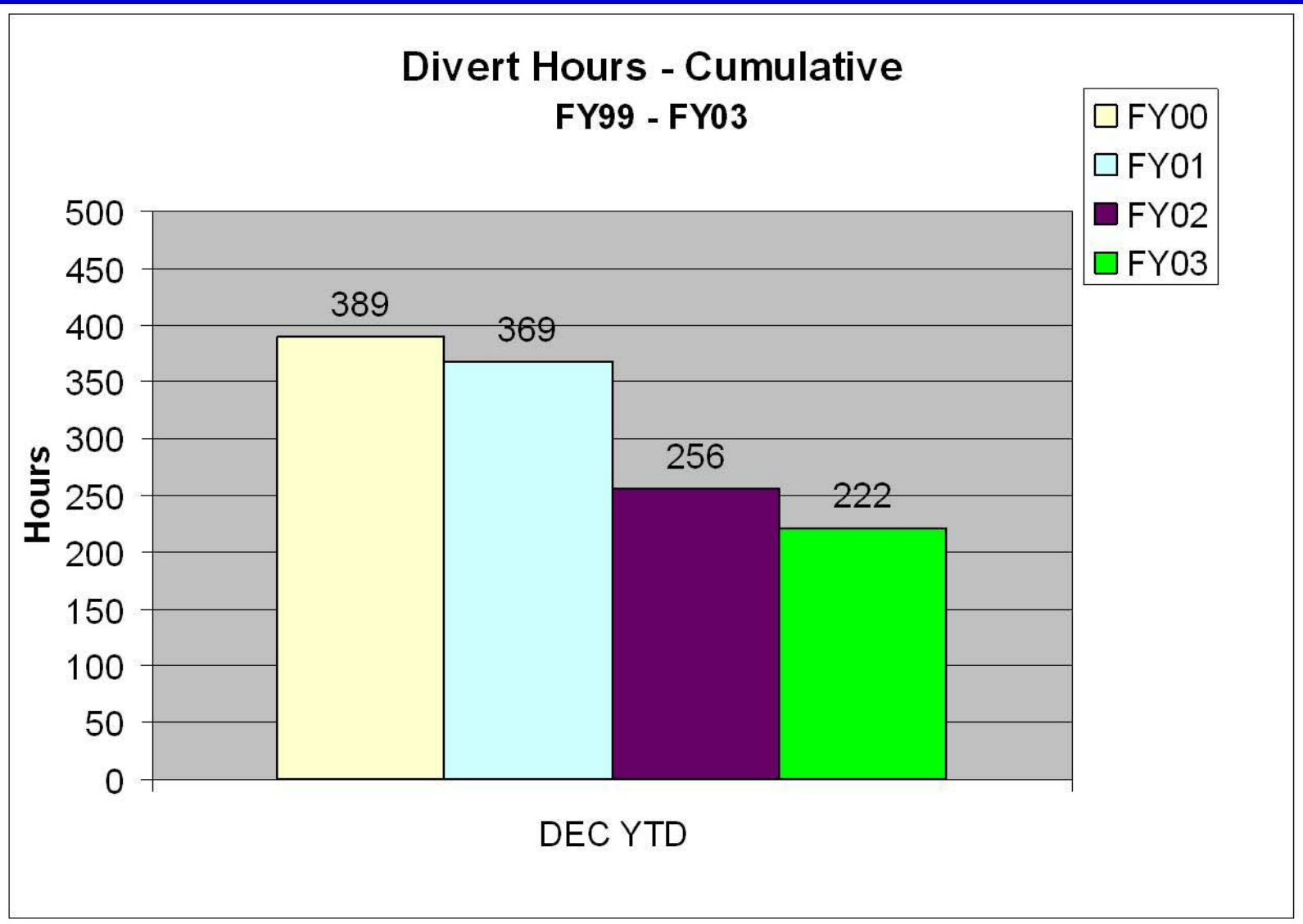


In Lab Turnaround Time Before And After POCT

Test	TAT (min) Central Lab	TAT (min) POCT	Change
Urinalysis	40	4	-36 (90%)
Pregnancy	78	5	-73 (94%)
Glucose	10	6	-4 (60%)
Cardiac	110	17	-93 (85%)
Mean	**59.5**	**8**	**-51.5 (87%) p=0.02**

ED Length Of Stay Before And After POCT

Test	ED LOS (min) Pre POCT	ED LOS (min) Post POCT	Change
Urinalysis	395	358	37
Pregnancy	386	346	40
Glucose	NA	NA	NA
Cardiac	386	338	47
Mean	**389**	**347**	**41 p=0.006**

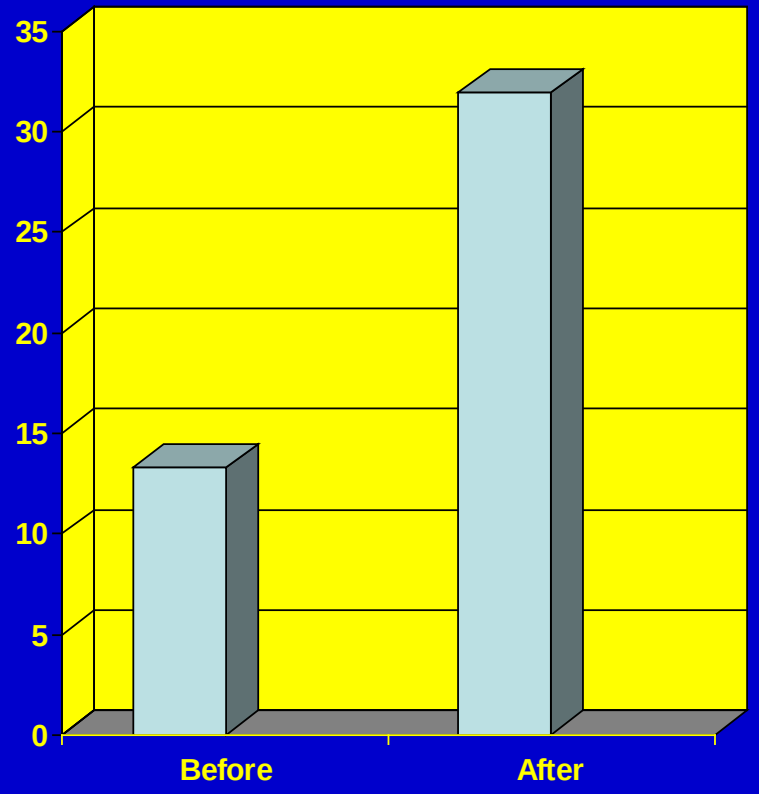

Divert Hours - Cumulative
FY99 - FY03
FY00
FY01
FY02
FY03
Hours
500
450
400
350
300
250
200
150
100
50
0
389
369
256
222
DEC YTD

Cardiac Caveats

Rate Of Chest Pain Discharge

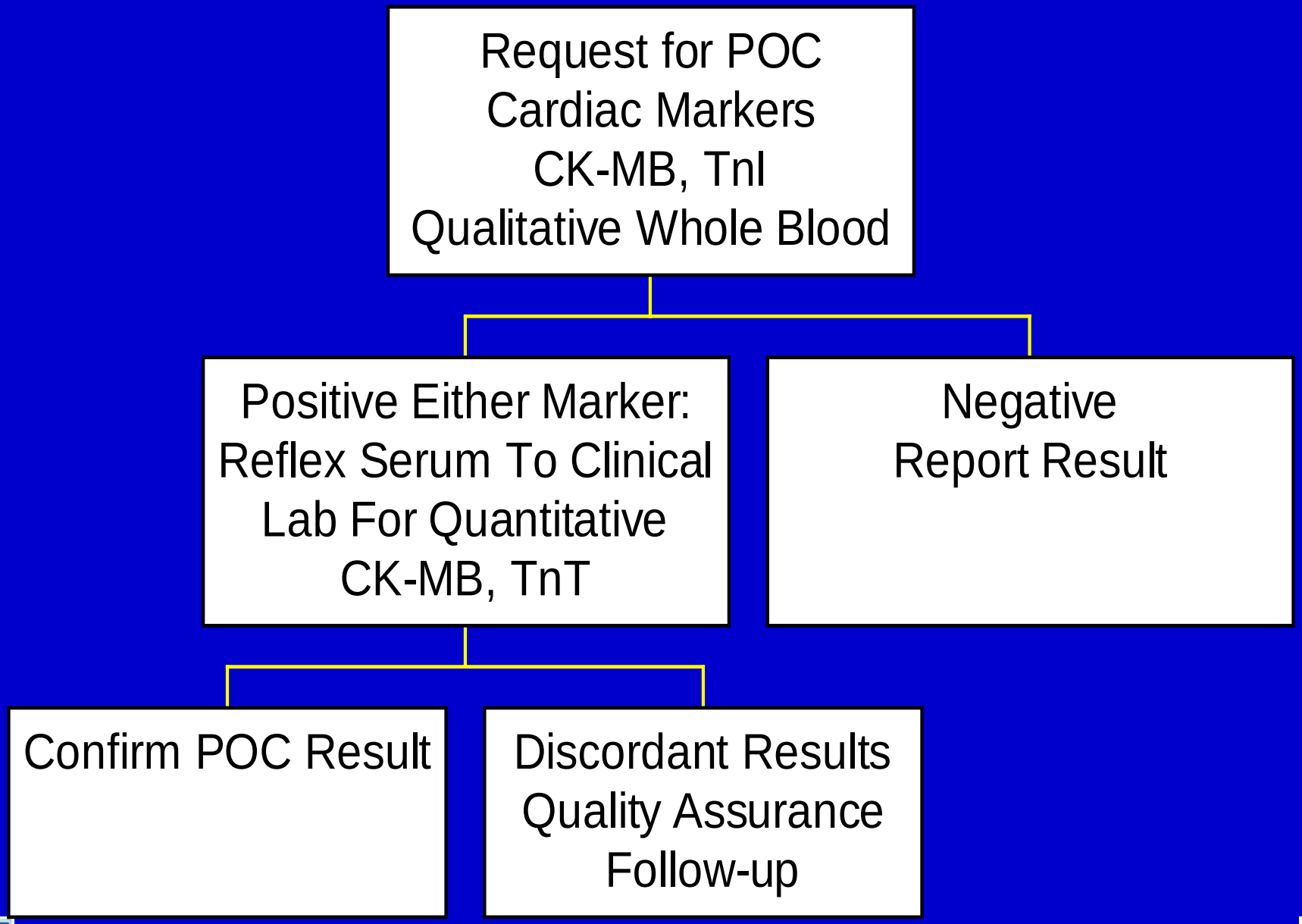
Before Kiosk: 13.3 %

After kiosk: 31.9 %



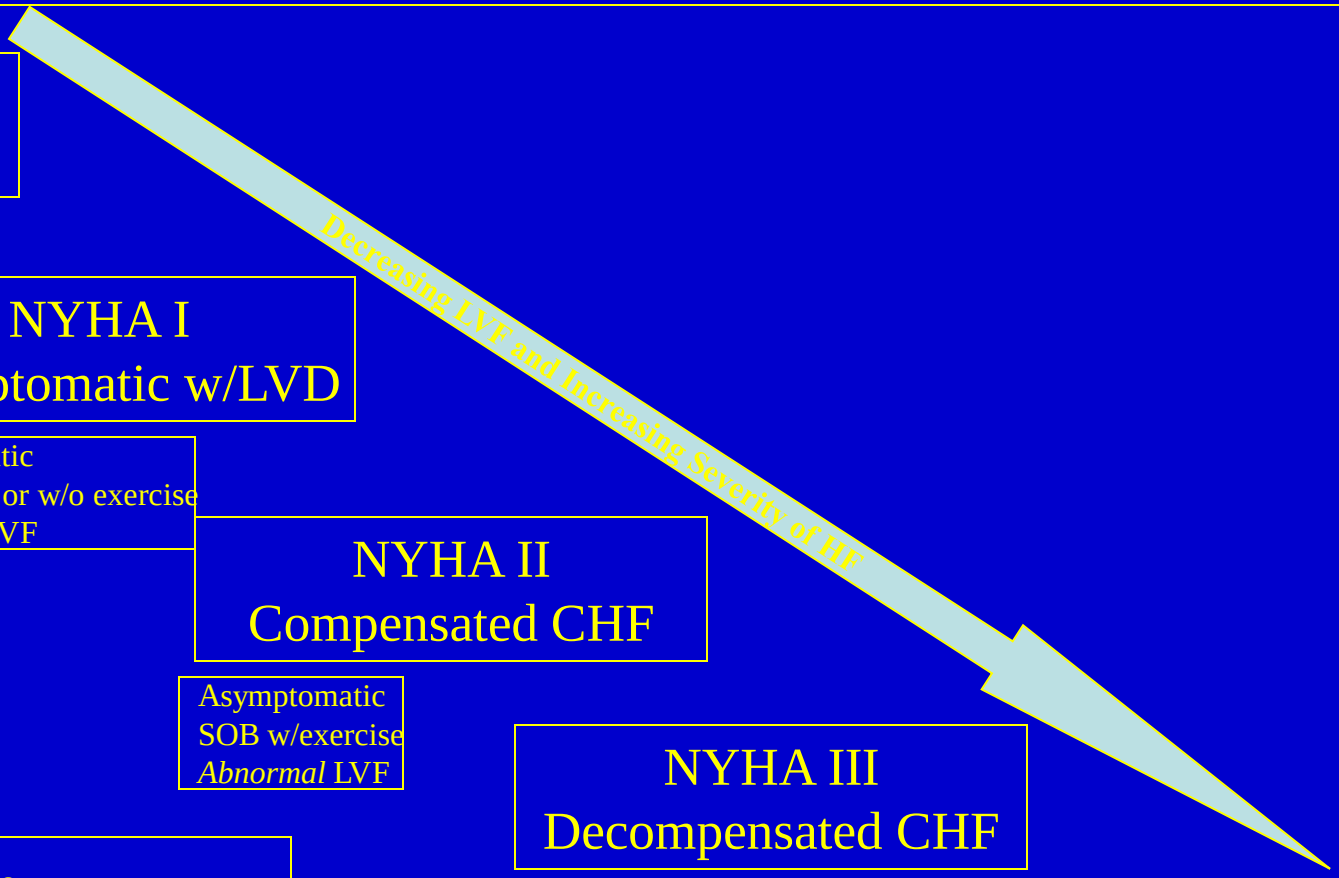
Implementation Caveats: Cardiac Markers Cutoffs

MGH Laboratory	CK: 60-400 M/ 40-150 F MB: <6.7 TnT: <0.1
Example Of POCT	CK: Not Avail. MB: <10 TnI: <0.4


Request for POC
Cardiac Markers
CK-MB, TnI
Qualitative Whole Blood
Positive Either Marker:
Reflex Serum To Clinical
Lab For Quantitative
CK-MB, TnT
Negative
Report Result
Confirm POC Result
Discordant Results
Quality Assurance
Follow-up

Outcomes And The Value Of Natriuretic Peptides

Evolution of Clinical Stages of CHF



Healthy

Asymptomatic
No SOB w/ or w/o exercise
Normal LVF

NYHA I
Asymptomatic w/LVD

Asymptomatic
No SOB w/ or w/o exercise
Abnormal LVF

NYHA II
Compensated CHF

Asymptomatic
SOB w/exercise
Abnormal LVF

NYHA III
Decompensated CHF

Symptomatic
Marked SOB w/exercise
Abnormal LVF

NYHA IV
Refractory CHF

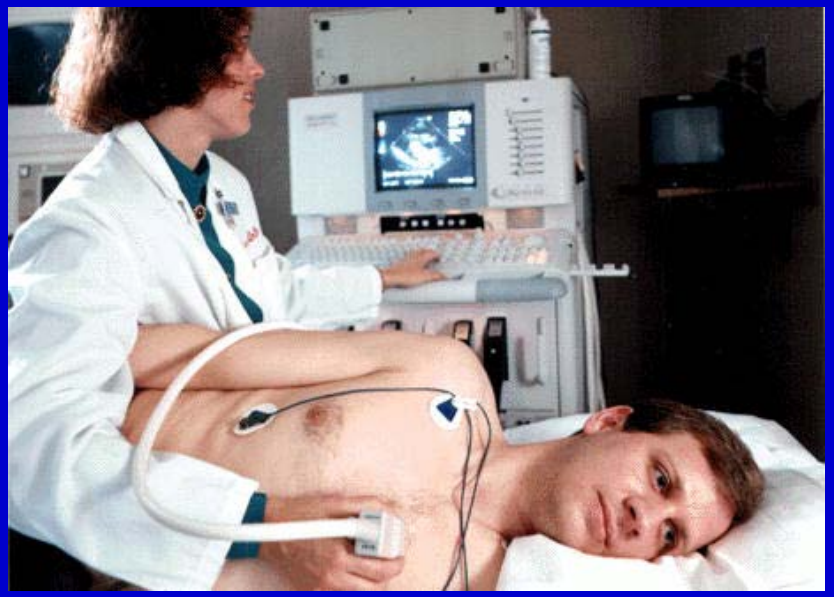
Symptomatic at rest
SOB w/o exercise
Abnormal LVF even w/R_x

CHF = congestive heart failure
NYHA = New York Heart Association
SOB = shortness of breath
LVD = left ventricular dysfunction
LVF = left ventricular function
R_x = therapy

Assessment of CHF

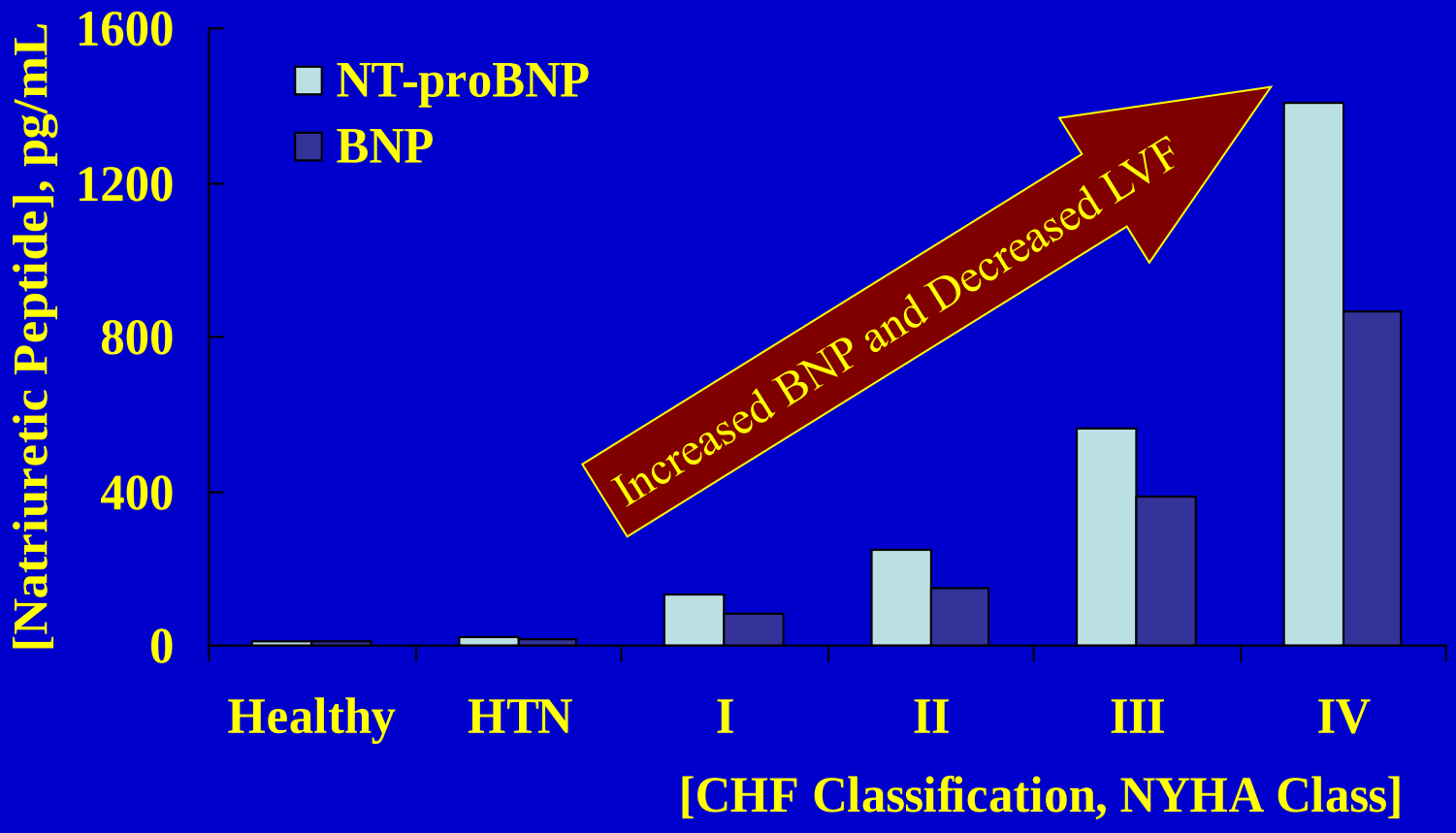
No gold standard for the evaluation of CHF exists!
Clinical findings are unreliable especially in
mild –moderate failure: Hence the need for better markers

History and Physical

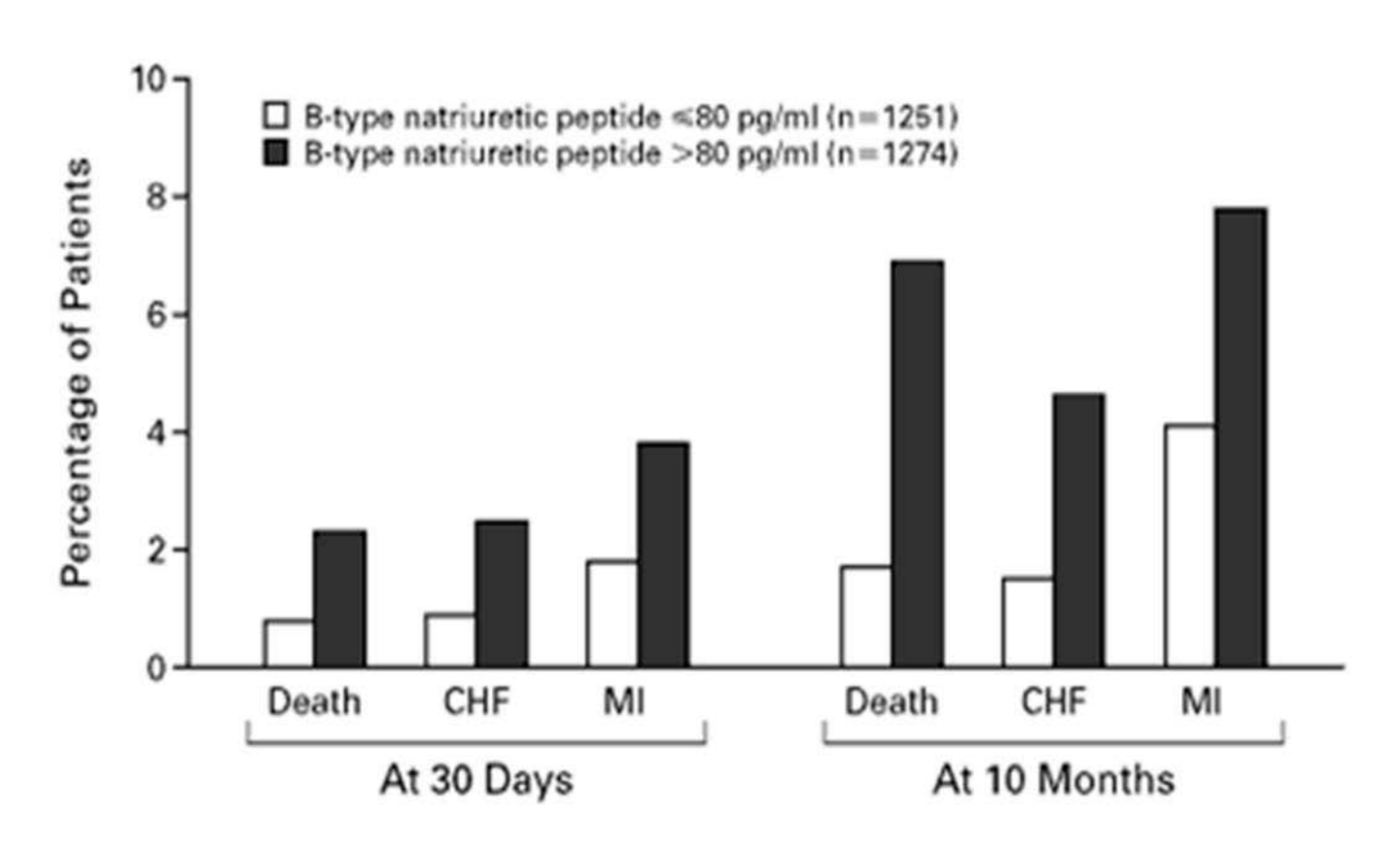


Laboratory Testing

BNP And NT-proBNP And Severity Of Heart Failure

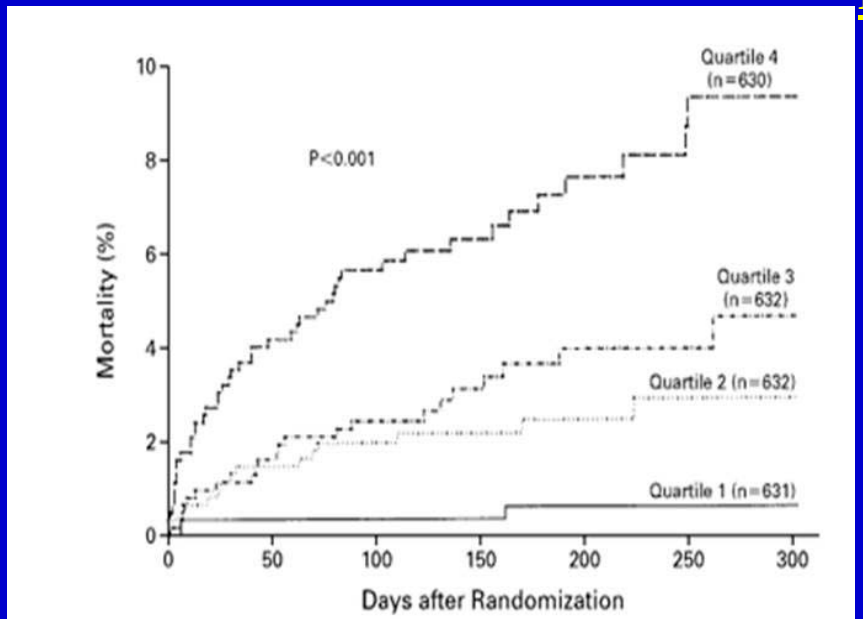


Prognosis: Incidence of Death, CHF, and MI In Patients Stratified Based on BNP Level



Source: DeLemos et al. NEJM 2001;345:1014-21.

Prognosis: Value of BNP in Predicting Mortality at 10 Months in Patients With an Acute Coronary Syndrome (ACS) Stratified According to BNP Level at Enrollment



No. at Risk							
Quartile 1	631	615	550	431	321	218	104
Quartile 2	632	603	525	390	283	159	64
Quartile 3	632	615	529	384	266	168	72
Quartile 4	630	594	487	345	227	146	58
Total	2525	2427	2091	1550	1097	691	298

BNP Range, pg/mL

- ◀ 138-1457
- ◀ 82-138
- ◀ 44-82
- ◀ 5-44

Source: DeLemos J et al. NEJM 2001;345:1014-21

Mueller et al, NEJM Feb 12, 2004

Evaluated BNP in ED for management of dyspnea

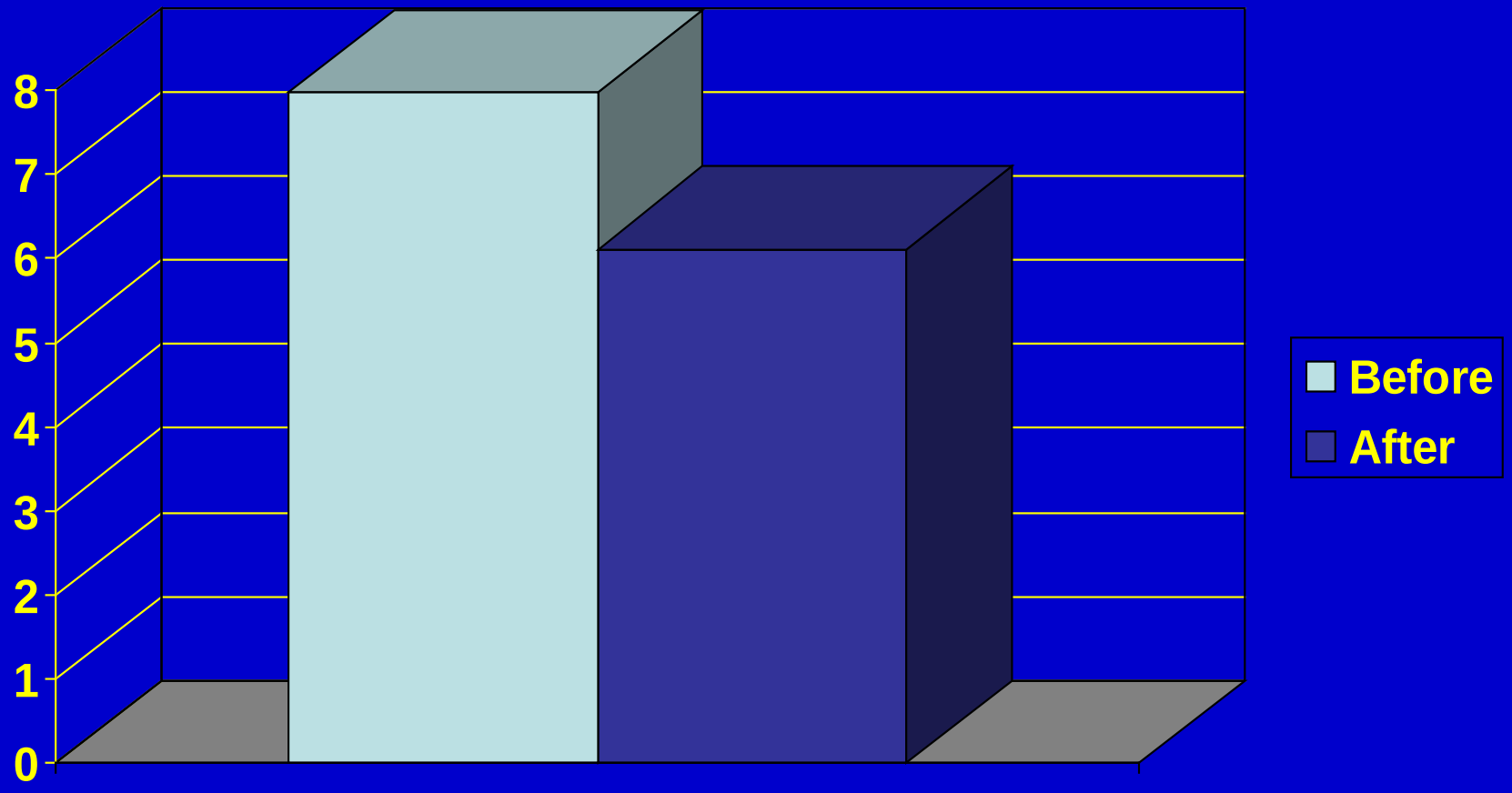
Two groups: With and without BNP

Median time to discharge: 11 days reduced to 8

Mean Cost: $7,264 reduced to 5,410

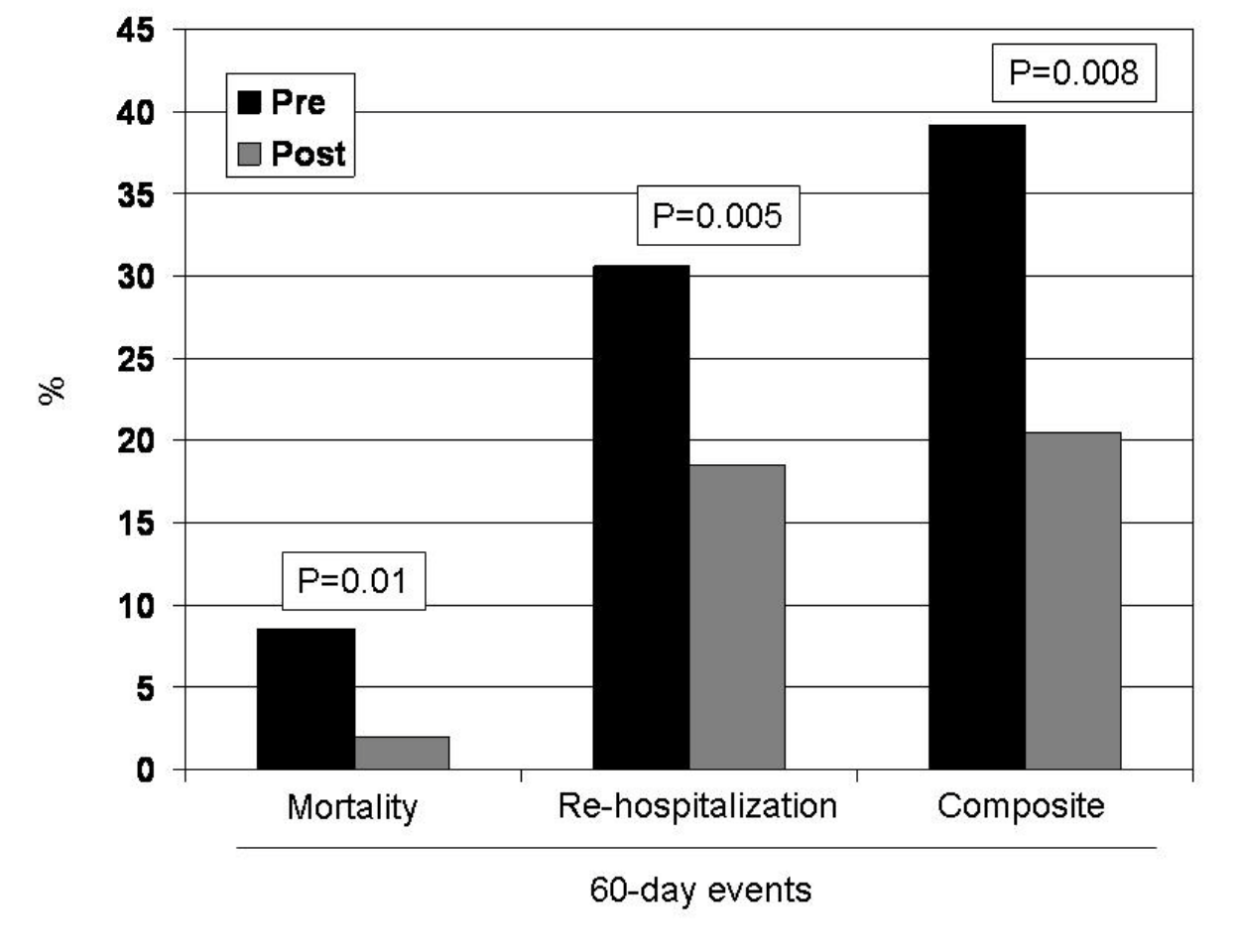
Question: Is this transferable to the US where CHF LOS is approximately 7 days

Acute Heart Failure: Hospital Length Of Stay Before And After Implementation Of Natriuretic Peptide Testing



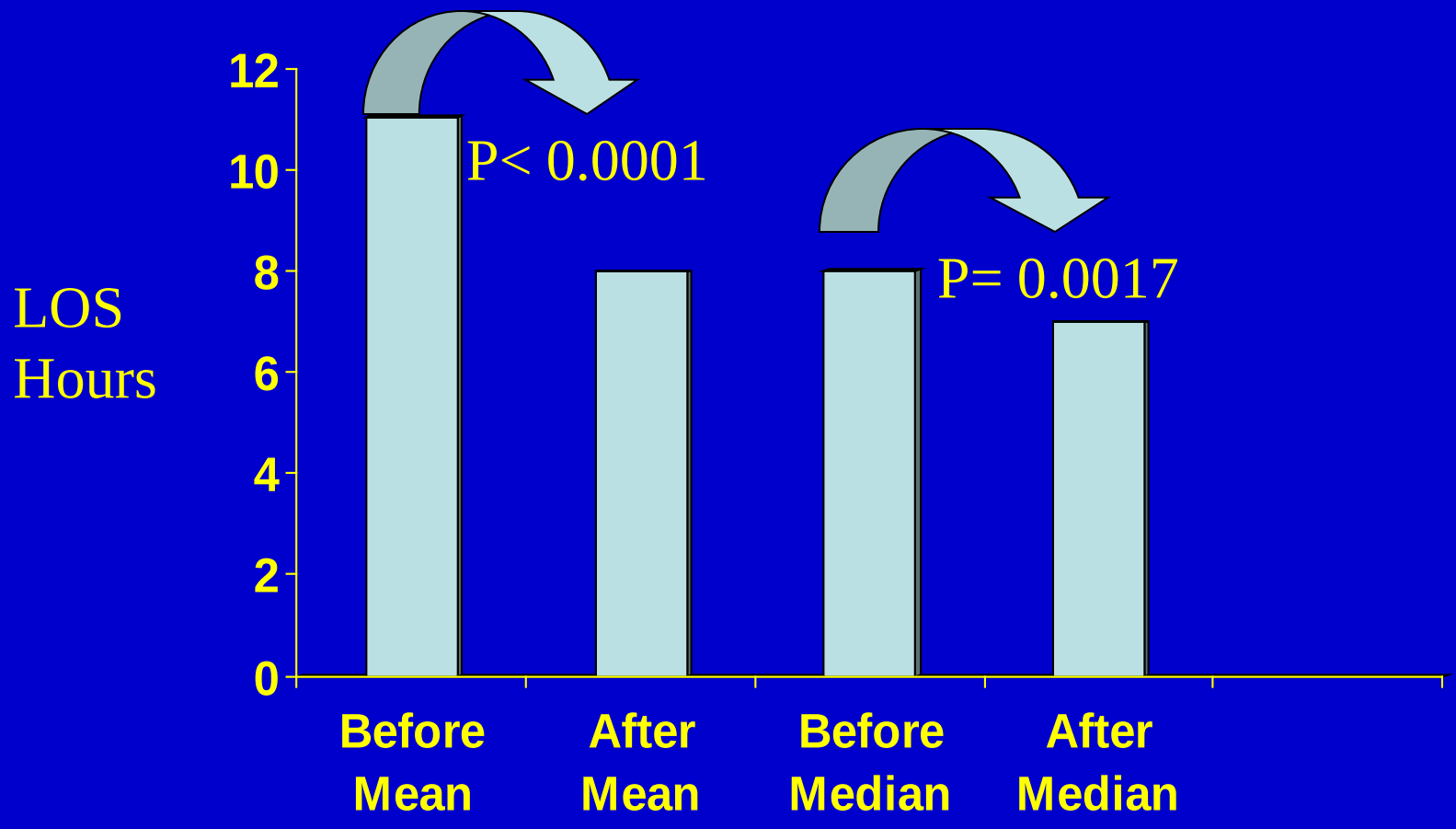
Net Change 1.86 Days (23 %): Mann Whitney Two Tailed U Test p= 0.03

Outcomes: 60 day Mortality And Rehospitalization




DO NOT FEED
OR MOLEST
ALLIGATORS
$500.00 FINE
Florida Statute 372.667
NOTICE
NO
SWIMMING

Figure 1: ED Length Of Stay (Mean And Median) Before And After Implementation Of Point-Of-Care Urine Drugs Of Abuse Testing



Interpretive Comments With ED DOA Report

Interpretive Comments Appended to Reports for Positive and Negative Results of Urine Testing for Drugs of Abuse by the Triage Testing System

Result	Comment
Positive results	
Benzodiazepines	This ED laboratory assay detects lorazepam (Ativan) use. The central laboratory urine benzodiazepines test generally does not.
Opiates	This assay is not sensitive for detection of oxycodone and oxymorphone.
Tetrahydrocannabinol	False-positives may be caused by use of pantoprazole (Protonix).
Tricyclics	True-positive ED laboratory urine tricyclic antidepressant results are associated with subtherapeutic and higher serum concentrations of amitriptyline, nortriptyline, imipramine, desipramine, and doxepin. False-positive results can be caused by use of cyclobenzaprine (Flexeril).
Negative results	
Tricyclics	False-negative ED laboratory urine tricyclic antidepressant results are associated with clomipramine (Anafranil) use.

ED, emergency department.

D-Dimer

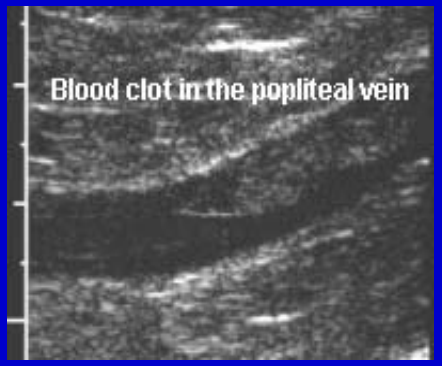
Deep Vein Thrombosis (DVT)

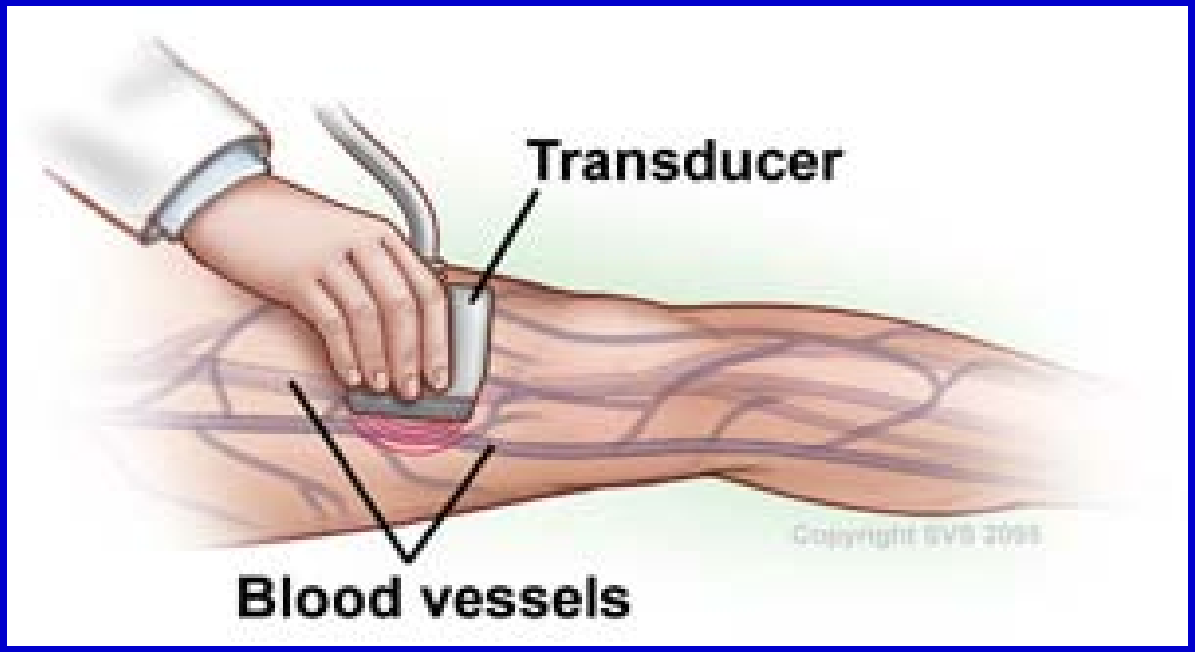
- DVT is a blood clot (called “thrombus”)
- It occurs in major veins, usually in the legs
- More than two million Americans develop DVT each year
- If DVT is not treated immediately, the blood clot may reach the lungs and cause a potentially fatal pulmonary embolism
- 90% of blood clots resulting in a PE stem from a DVT

Ileo-femoral DVT

Duplex Venous Ultrasonography (Ultrasound)

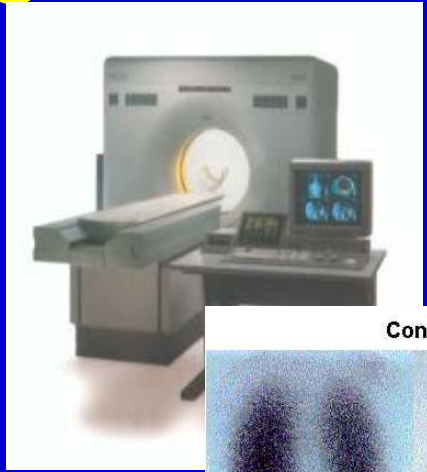
- Most used test. Sensitivity 95% for proximal DVT and 75% for symptomatic calf vein thrombosis

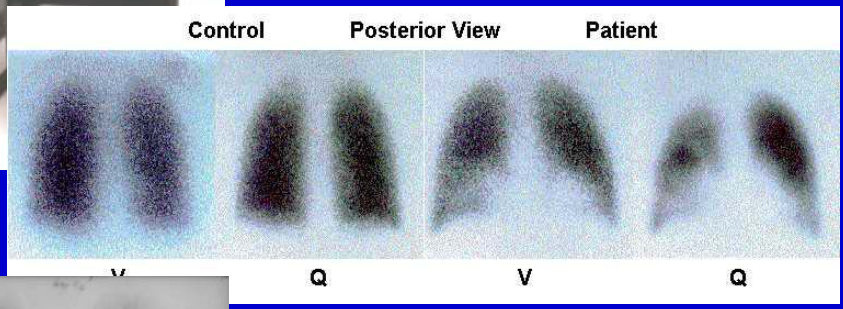




Current practice in PE diagnosis?

- Spiral CT
  - + non-invasive
  - + high sensitivity
  - - Time consuming
  - - Expensive
  - Lung Scan (V-Q Scan)
    - + less invasive than angiography
    - - Time Consuming
    - - Expensive
    - - Result can be uncertain
  - Angiography
    - + Clear diagnosis possible
    - - Invasive
    - - Expensive
    - - Time consuming





What Is D-Dimer

- A product of the enzymatic digestion of fibrin by plasmin in blood clots
- An elevated D-Dimer indicates ongoing fibrinolysis and by inference the presence of fibrin clots

Risk stratification or Pre-Test Probability

Wells Score for DVT

Symptom	Score
Active cancer (treatment ongoing or within previous 6 months or palliative)	1
Paralysis, paresis or recent plaster immobilization of the lower extremities	1
Recently bedridden > 3 days or major surgery within 4 weeks	1
Localized tenderness along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling 3 cm > asymptomatic side (measured 10 cm below tibial tuberosity)	1
Pitting oedema confined to the symptomatic leg	1
Collateral superficial veins (non-varicose)	1
Alternative diagnosis as likely or greater than that of DVT	-2

0 = low risk of DVT

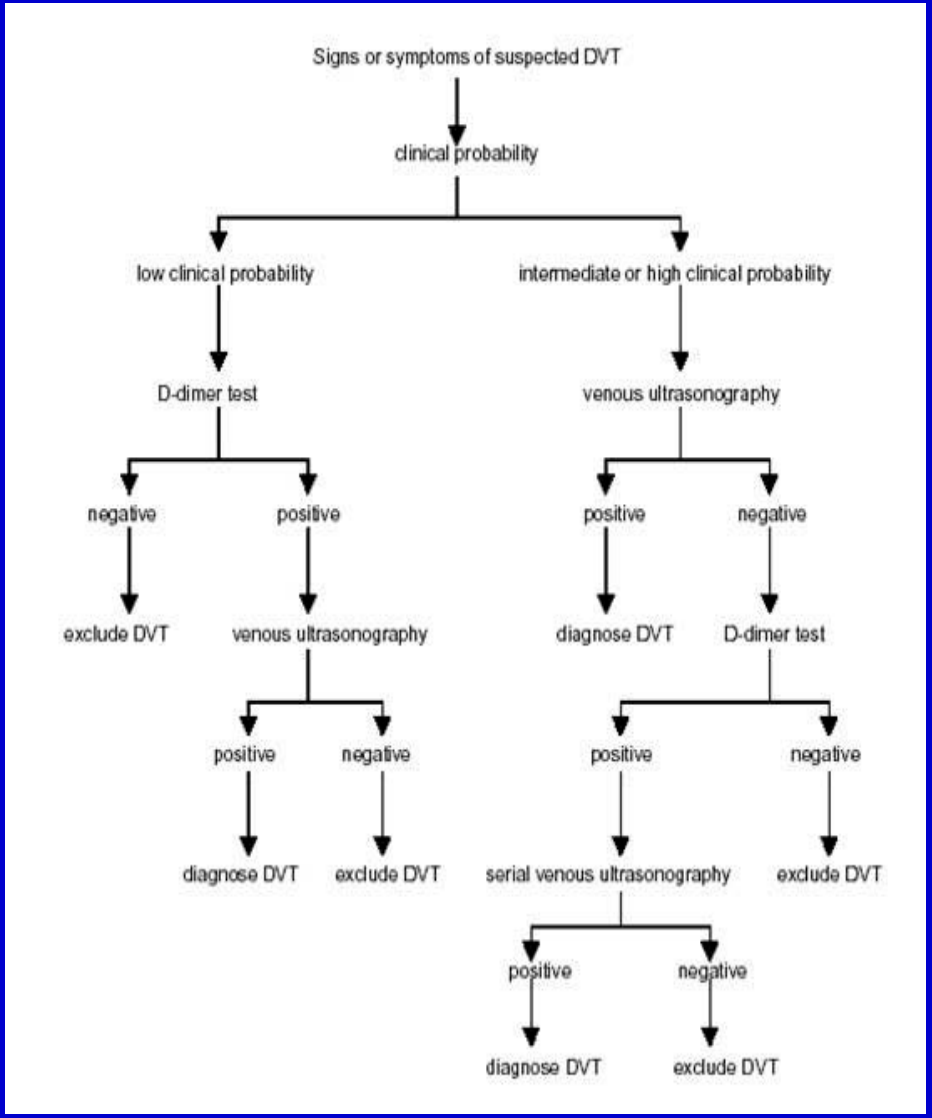
1 – 2 = medium risk of DVT

≥ 3 = high risk of DVT

Wells PS, Anderson DR, Bormanis J, Guy F, Mitchell M, Gray L, et al. Value of assessment of pretest probability of deep-vein thrombosis in clinical management. Lancet 1997;350:1796.

Algorithm for DVT

Pre-Test Probability Is A Critical Step In The Clinical Decision Making Process



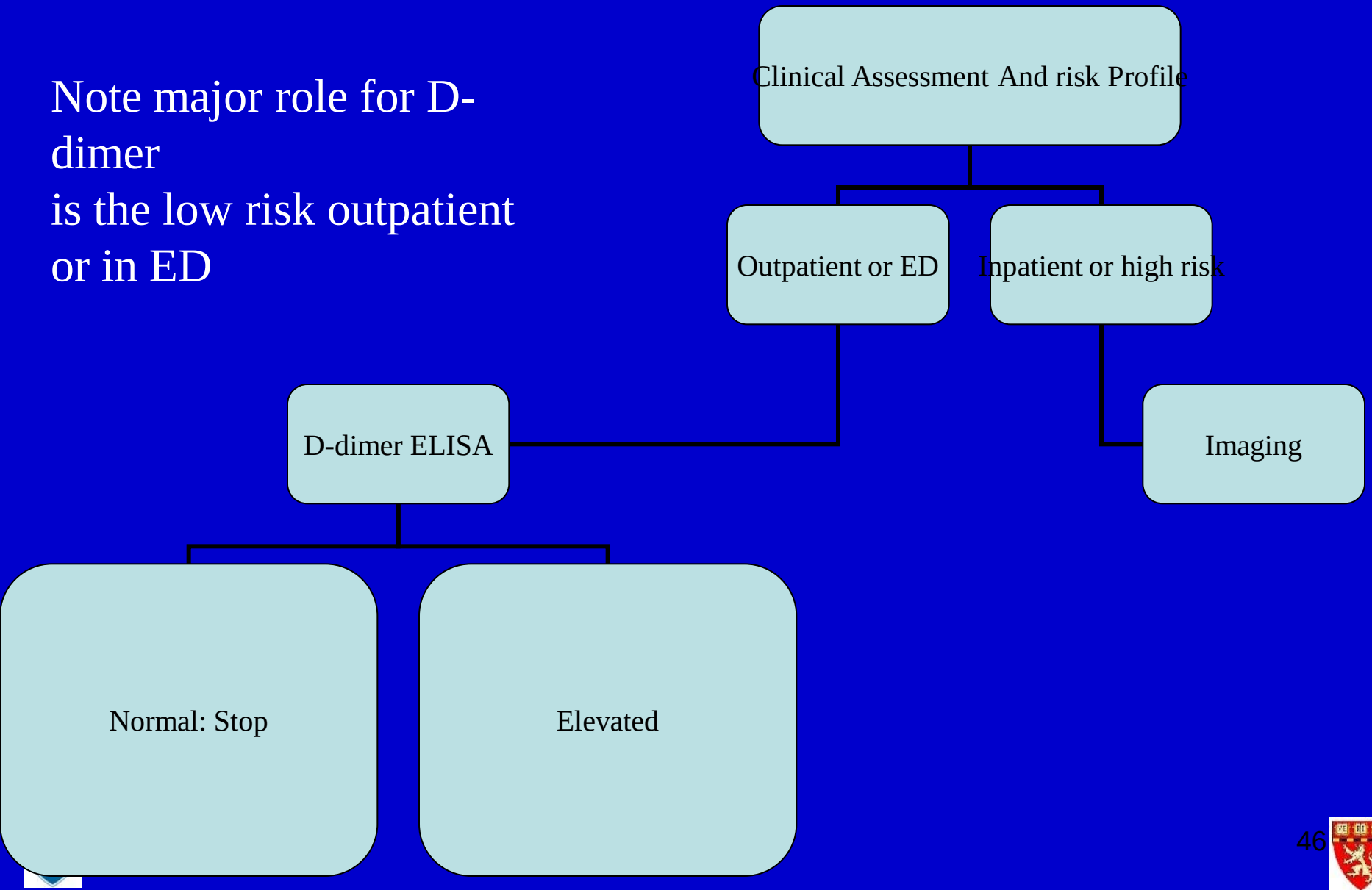
How Should Patients Be Evaluated for PE?

- Pretest probability (PTP) score should first be formally or informally calculated
  - Formal scoring systems include: Wells Score, Geneva Score, Charlotte Rule, Canadian Score (for PE)

Clinical Characteristics	Score
Clinical signs and symptoms of DVT	3
PE likely or more likely than alternative diagnosis	3
Heart rate greater than 100 beats/min	1.5
Immobilization (bedrest ≥ 30 days) or surgery in the previous 4 weeks	1.5
Previous DVT/PE	1.5
Hemoptysis	1.0
Malignancy (Receiving treatment, treated in the last 6 months, or palliative care)	1.0

Strategy For Diagnosis Of PE

Note major role for D-dimer
is the low risk outpatient or in ED



ED Length Of Stay (Hours) For Patients Tested For D-Dimer Before And After POCT

	Before POCT D-Dimer	After POCT D-Dimer
Mean LOS	8.46	7.14 p=0.016
Median LOS	6.20	5.88 p=0.026

Rate (percent) of hospital admission, discharge and admit to observe for patients before and after implementation of the rapid whole blood D-dimer test in the emergency department

	Before Implementation	After Implementation
Admitted	36.5	22.7
Discharged	42.9	50.2
Admit to observe	20.6	27.0

Models For POCT Testing

- Large ED: Volume and menu can justify a satellite lab in the ED
  - Advantage: Can do wide menu, no JCAHO worries
  - Disadvantage: Higher cost
- Smaller ED: In most cases will require POCT performed by physicians or nursing
  - Advantage: Much less expensive
  - Disadvantage: Regulatory compliance more challenging and difficult to expand to broad menu

Conclusions

The experience with point-of-care testing in the emergency department of the Massachusetts General Hospital

- Selected tests such as cardiac markers, urine drugs of abuse and d-dimer performed in the emergency department can:
- Reduce ED length of stay
- May reduce ED divert
- May impact rates of admission and discharge
- May in selected cases improve medical outcomes