2015 Aug 17 11:00-11:45
conference hall: Canterbury

When Telemedicine meet Acute Chest Pain Patients

How we use in-hospital tele-ECG to improved quality of care and improved D2BT of STEMI patients

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No disclosure to declare

Cheng Hsin General Hospital





- Since 1967
- 1,030 Bed (Famous in cardiovascular disease managemetn)
- 19 cardiologist
- Coronary angiography 3,000 pt/year
- Coronary intervention > 1,500 pt/year

- Telemedicine since 2007
    - TeleECG: > 4,300 pts / HomeBP, glucose: > 1,700

Our Solution for Telemedicine
different solution for different people

- Trans-telephonic ECG event analysis and on-line consultation
- Off-line one month post event ECG analysis
- Off-line one week post event ECG analysis
- Home BP, Home blood sugar monitoring
- In-hospital tele-ECG analysis and PPCI activation
- Pre-hospital tele-ECG transmission and analysis, PPCI activation











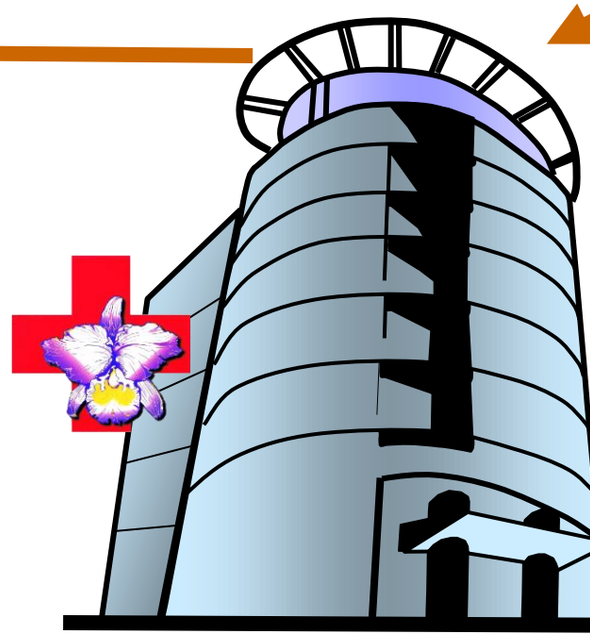
Home Tele-ECG transmission to call center



on-line
consultation and
give adequate
suggestion

Clinical
assessment and
recommendation





ECG/ vital signs/
clinical data/
medical history

Internet / 3G web





- 365/24 Tele-Care-Services Center in Cheng Hsin General Hospital

Why We apply **In-hospital TeleECG triage** for **Chest Pain Patients**

- Ambulance to Hospital **< 20min** in Taiwan
- Most of chest pain management **delay** occurred **in-hospital** not pre-hospital
- **Too many things** need to do for chest pain patients **at ED**. It is **hard** to balance between working loading and Quality

Chest pain

Incidence and Importance

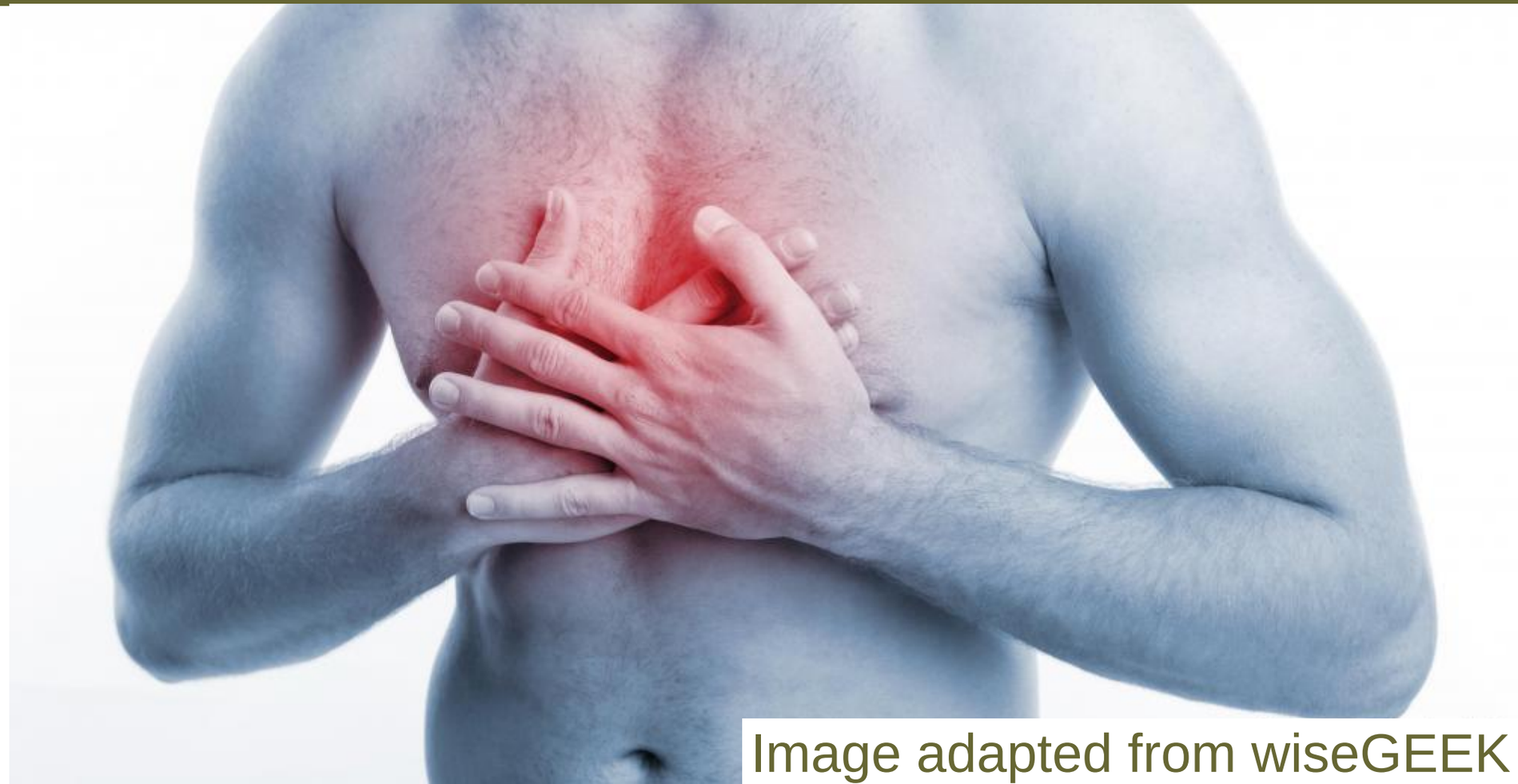
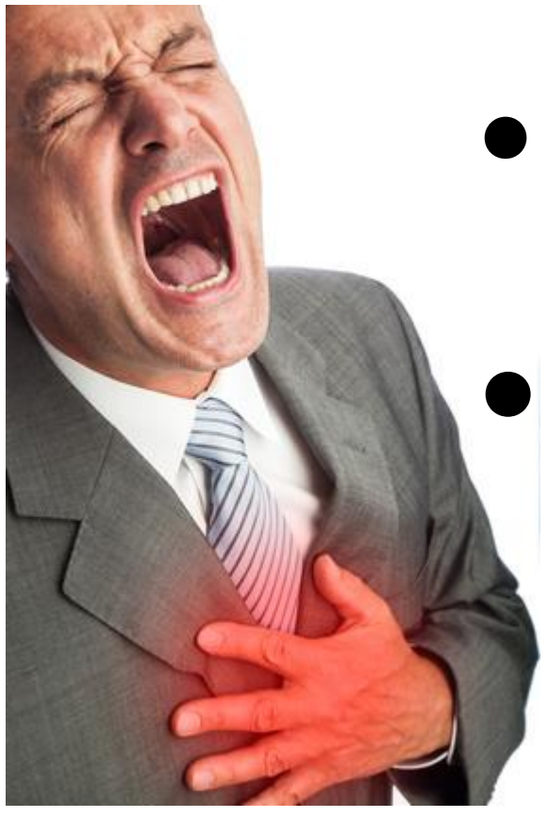


Image adapted from wiseGEEK

Chest pain:
A common but important symptoms



- **6 million /year** chest pain visited to emergency departments (ED) in the United States (US)
- **2nd** most common ED complaint
- **12~ 15%** of all cases of chest pain in the ED is ACS

McCaig, L, Burt, C. National Hospital Ambulatory Medical Care Survey: 2003 Emergency Department Summary. In: Advance Data from Vital and Health Statistics. Centers for disease control and prevention, Atlanta, GA 2005.

How many Chest Pain Presentation Become Myocardial Infarction at ED of Cheng Hsin General Hospital

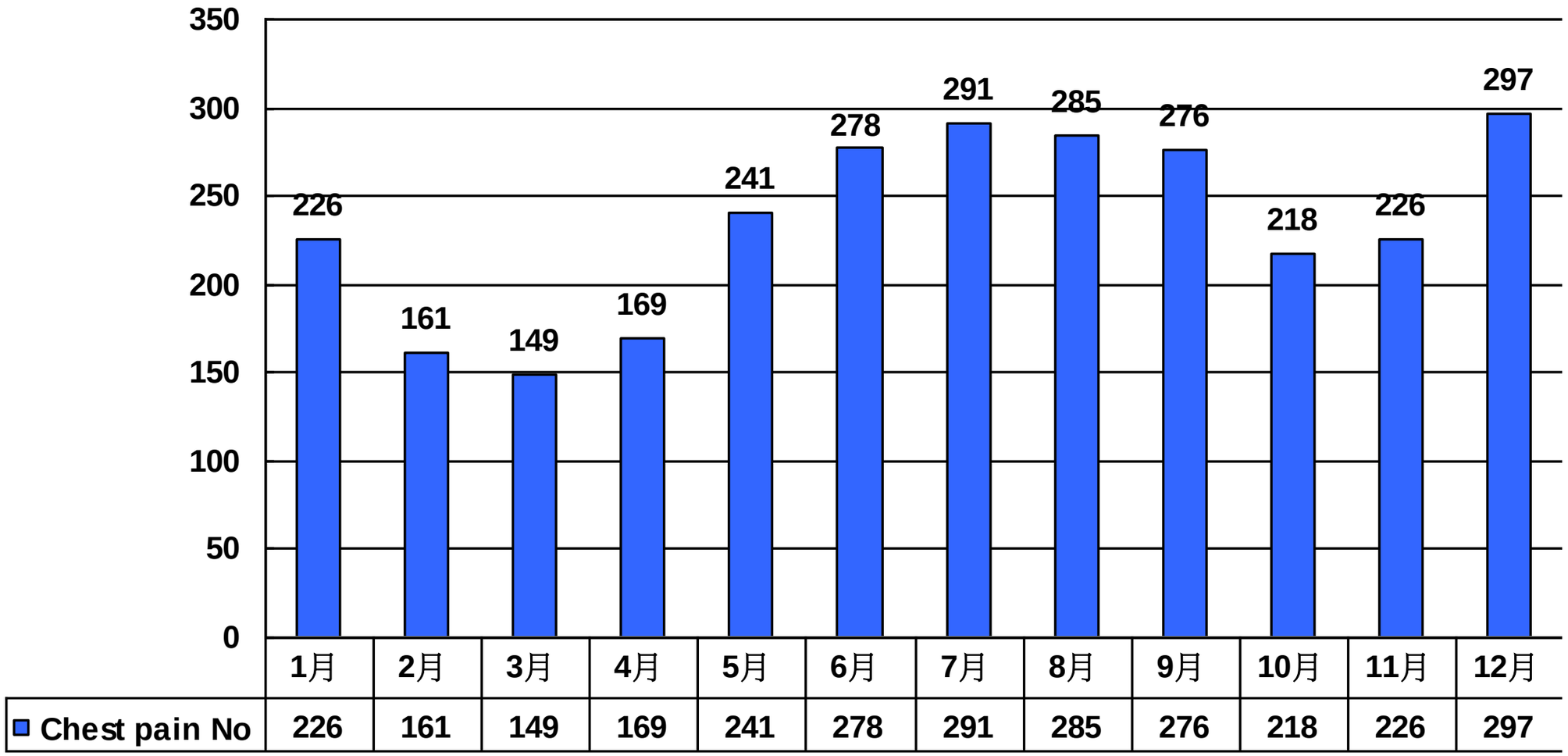


Cheng Hsin General Hospital



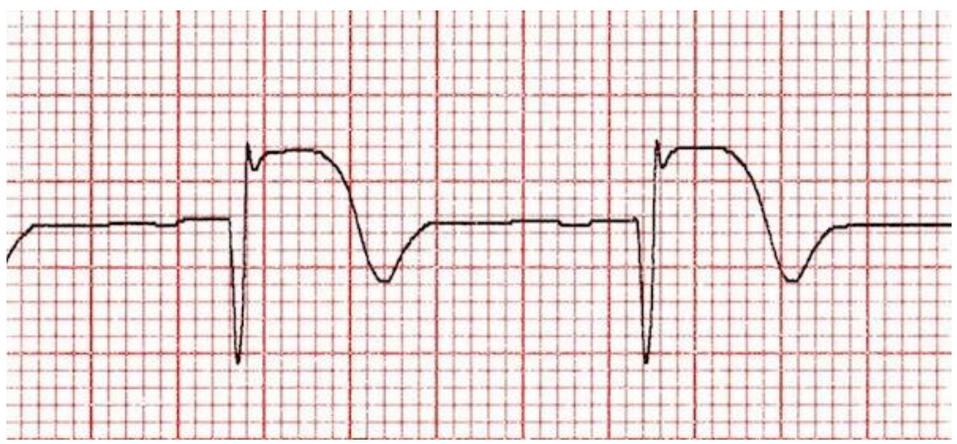
2014 ED Chest pain pts

- N = 2,817 (Average 235 /month)



Most important diagnosis for chest pain patient

1. **ST elevation MI** (STEMI)
2. **Non ST-elevation MI** (NSTEMI)
3. **Unstable angina** (UA)

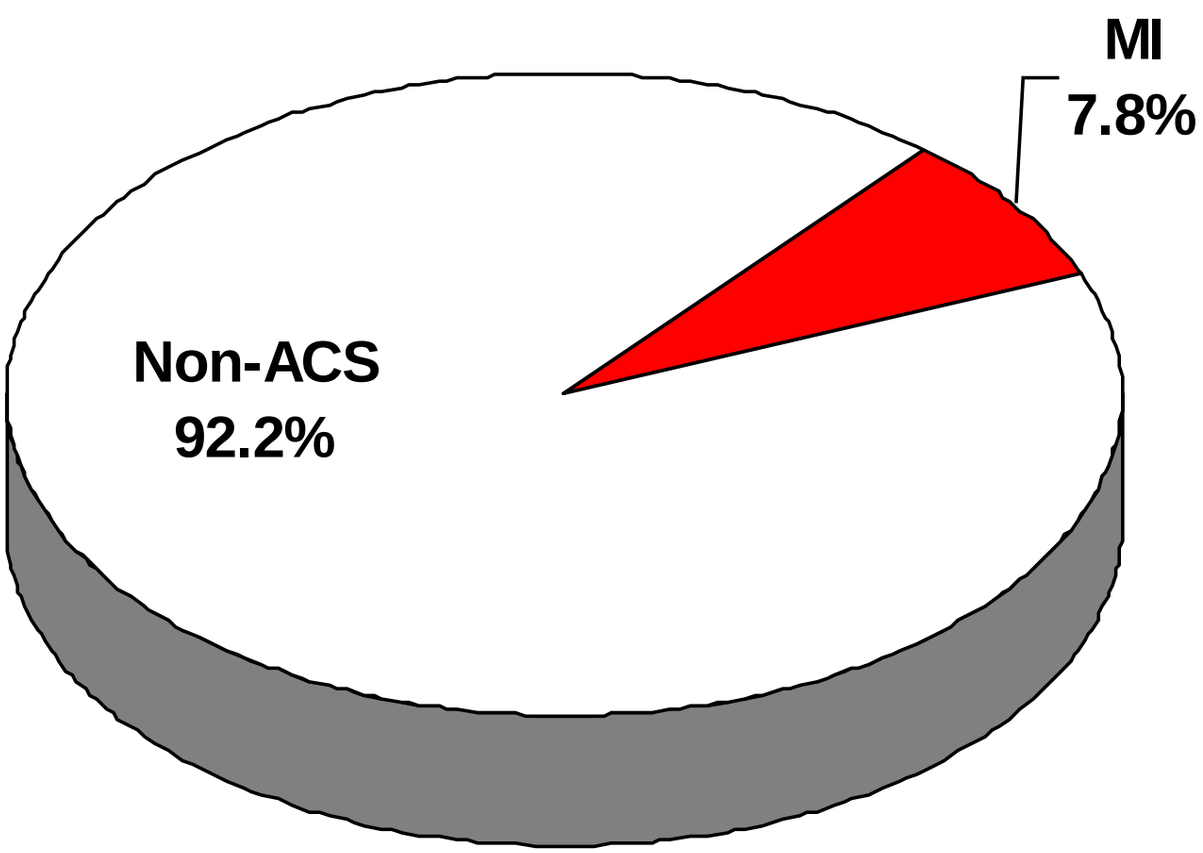


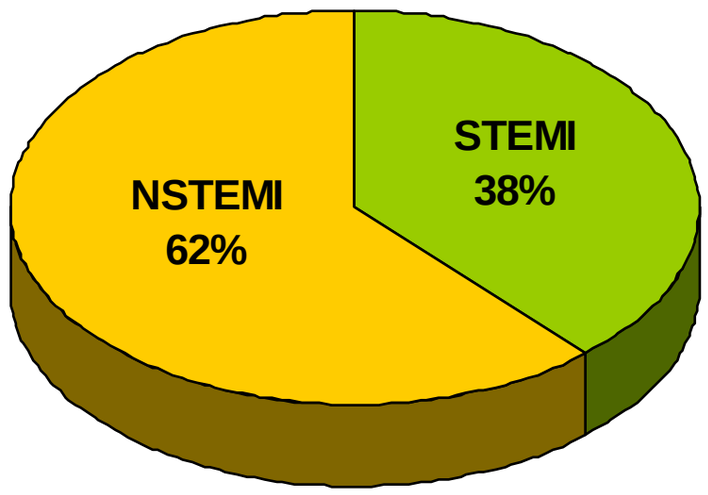
Cheng Hsin General Hospital



2014 ER diagnosis AMI

Only 7.8% in chest pain population

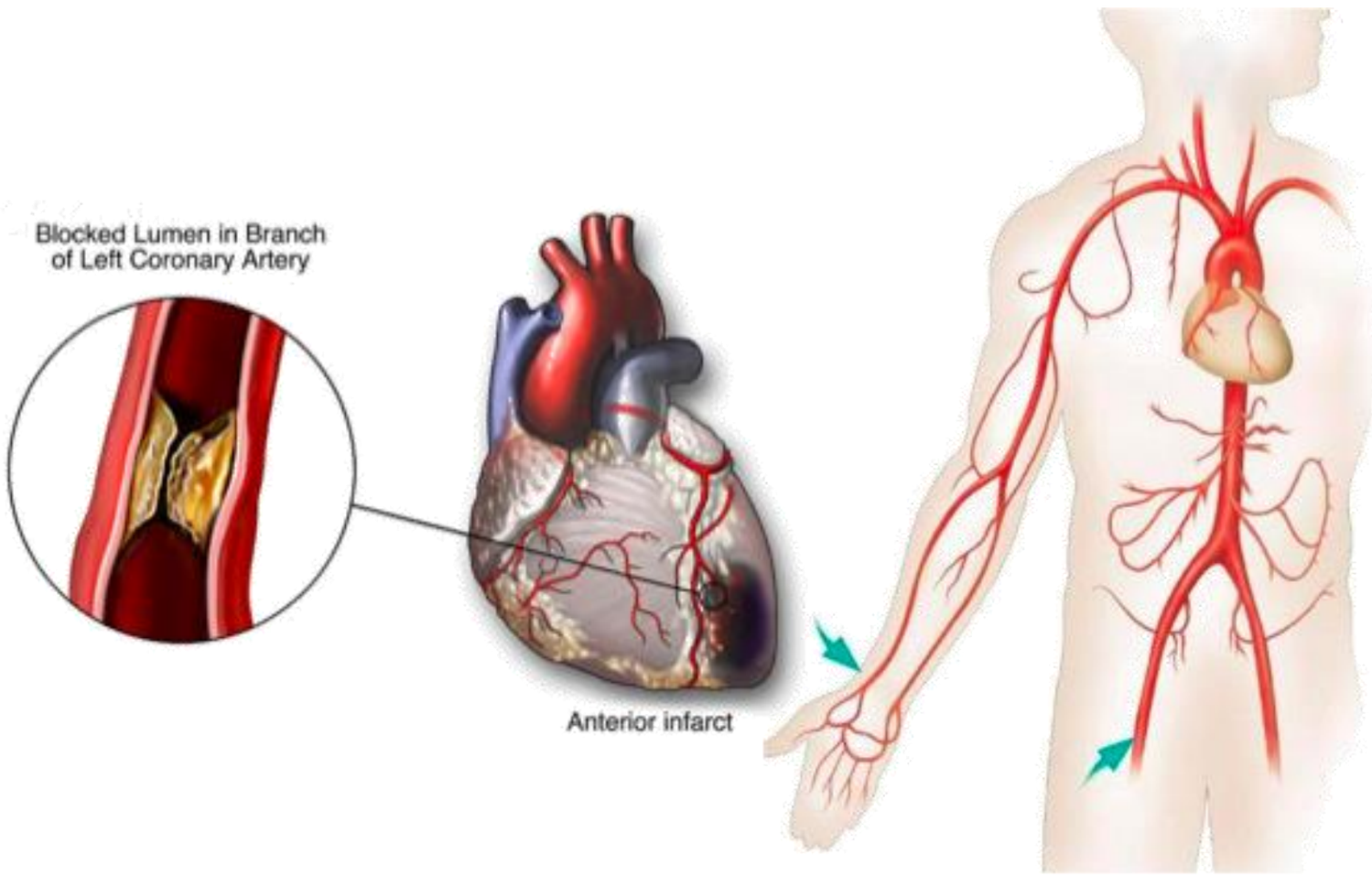


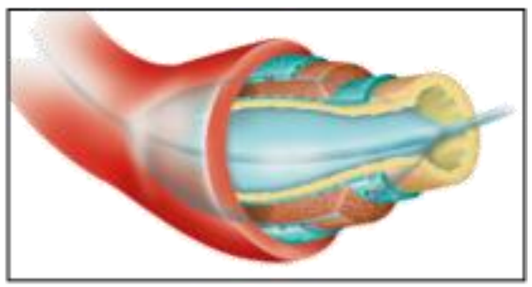


- **STEMI = 85**
- **NSTEMI = 136**

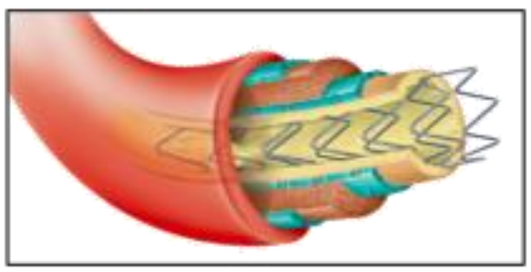
STEMI

- **Time is muscle**
- **Goal Door to balloon time < 90 min**





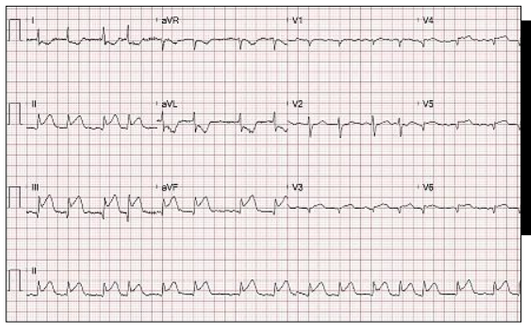
balloon



Stent



Chest pain



ECG is the most important step for diagnosis

ED

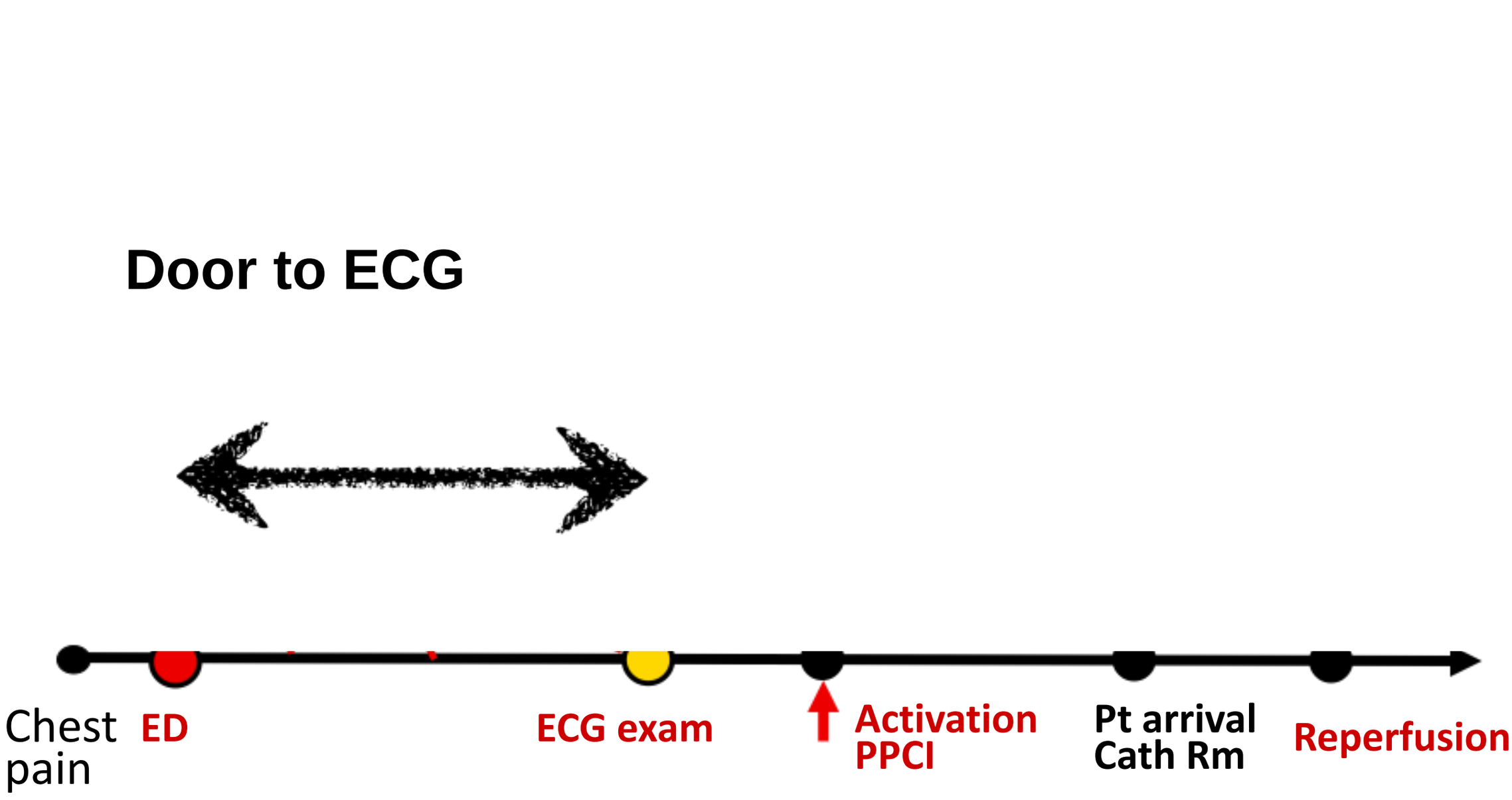
ECG → (10min) → Dx → (5min) → CV consult → Active emergent PCI team

30 min → Cath Staff ready

35min → Return pefusion

Door to ECG is an Long way to go

Door to ECG



ECG for everyone is good but Impossible

- Complete 12 lead ECG < 10min [3]

- **age ≥30** chest pain
  age ≥50 chest pain or other symptoms (SOB, altered mental status, upper extremity pain, syncope, generalized weakness)
  elderly (≥80 years) with abdominal pain or N/V [6]

- **repeated at 20~30 minute** intervals for ongoing pain suspected ACS

- A brief history and physical examination
- **Medication:** Aspirin, morphine … etc

3 Graff L, Annals Emerg Med. December 2000; 36:554.

6.Glickman SW, Am Heart J 2012; 163:372.

What's wrong in current strategy

What's Telemedicine Could do to Improve / Speed up Chest pain patient Assessment at ED

Dilemma 1

How to make diagnosis earlier ?

Chest pain pt is not the only emergent condition.
There is Always something more emergent

Delay Diagnosis /
Mis-diagnosis /
Delay activation /
of ECG for STEMI patient

Solution 1

Chest Pain Observation units (CPUs) or Clinical Decision Units (CDUs)

- **Class I recommendation** in the ACC/AHA guidelines [3].
- **82 % discharge rate** In a 1000 mostly low risk patients, [33].



3.Anderson JL,J Am Coll Cardiol 2007; 50:e1.
33.Gibler WB, Ann Emerg Med 1995; 25:1.

Chest pain Units (CPU) could / should Do

- **Identification of chest pain patient**
- **Divers chest pain patients burden in ED**
- **Full evaluation and disposition of chest pain patient**



Chest pain Unit: Ideal Goal

- **Improved** chest pain patient assessment **quality**
- **Shorten D2EKG time** in chest pain patients
- **Achieve D2BT < 90min** in STE patient
- **Decrease misdiagnosis** rate for ACS
- **Improved hard outcomes** (as Death, re-MI,... etc.)
- **Shorter ED stay** of chest pain patients



The Real world is !!

- ED patients overloaded
- ED physicians shortage
- Nursing / PA shortage
- Time limited for assessing of patients
- legal issue in clinical practice





Balance between patients and health-care provider

Care Quality



Health-care provider



- **Decreased** ED physician/ Nursing/ PA work **burden** without sacrifice quality

Solution 2

In-hospital Tele-ECG process

Key influenced point

Time interval in each process

Old

EP evaluation

A Cardiologist arrival ED Complete patient evaluation

B Cath Lab Staff arrival

Timeline

Chest Pain Onset

ED

ECG Exam

Activate PPCI

Patient arrival Cath Lab

Balloon (reperfusion)

New

Tele-ECG process

CV attending ECG reading & decide PPCI

EP evaluation

A Cardiologist arrival ED Complete patient evaluation

B Cath Lab Staff arrival

Timeline

Chest Pain Onset

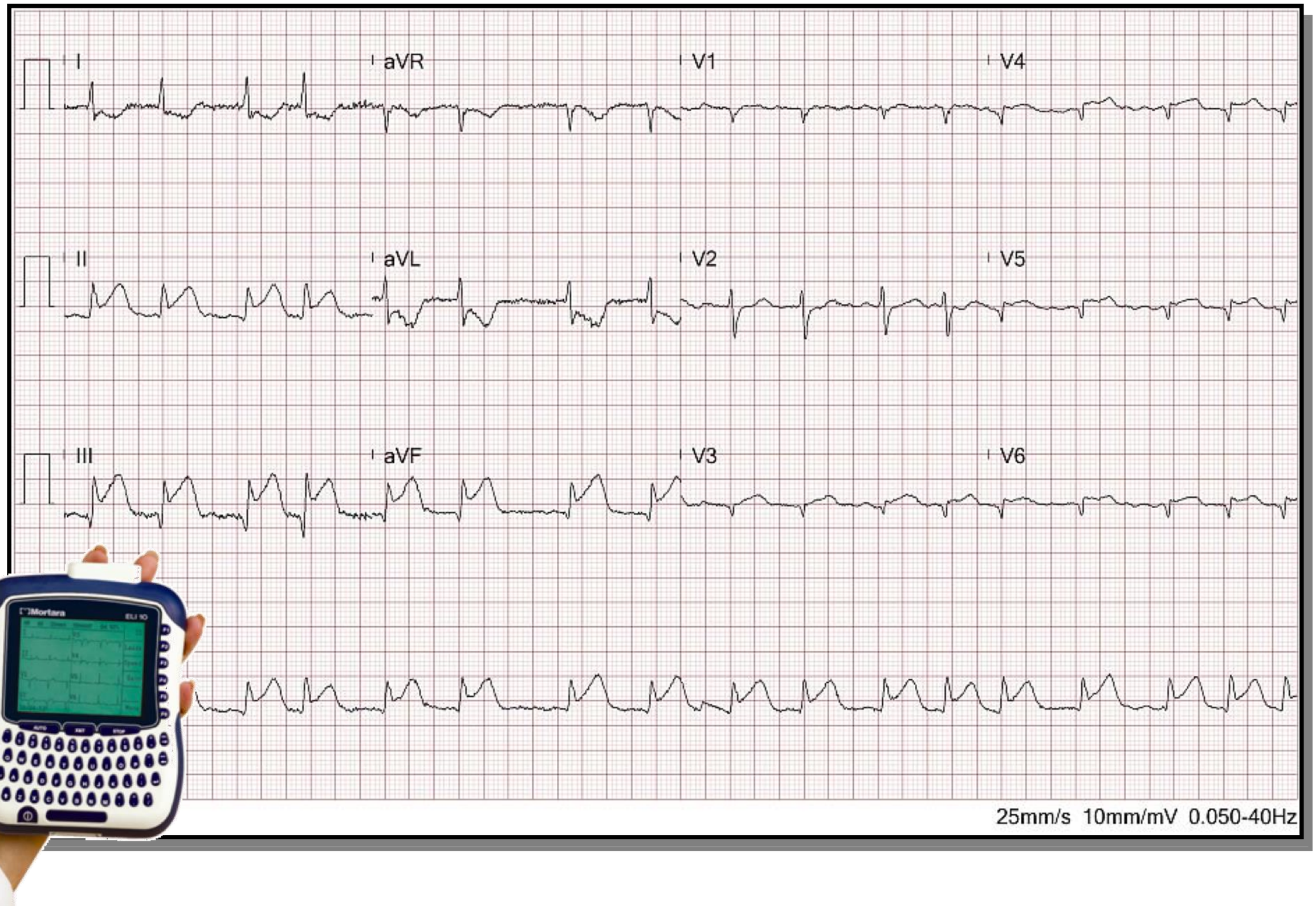
ED

ECG Exam

Early Activate PPCI

Patient arri
Cath Lab

Signal Quality of ECG





How to get document data without increase work loading ?

No record, No Quality control, But

Who should Responsible for record

Who had time to record

Data dependent on Staff to **Remember** recording in chart

1. **ED door time**: (triage nurse, PA. ED doctor)
2. **EKG time:** (triage nurse, PA, intern, fellow, VS)
3. **PPCI activation time:** (nurse, PA, intern, resident, fellow, VS)
4. **Cath Room ready time:** (CV Fellow, technician, CV VS)
5. **Patient sent to Cath Room time:** (ED nurse, resident, fellow)
6. **Patient arrival Cath Room time:** (ED nurse, resident, fellow, technician）
7. **Puncture time :** (by Fellow, VS)
8. **Balloon time:** Wire pass lesion / Balloon/ Thrombuster Time

- STEMI patient **ED medication remind** (Bokey, plavix, statin, BB) : (ED physician, nurse, PA)

Dilemma 3

Change is difficult

Learning

New system,

New protocol,

New staffs in ED is **challenging**

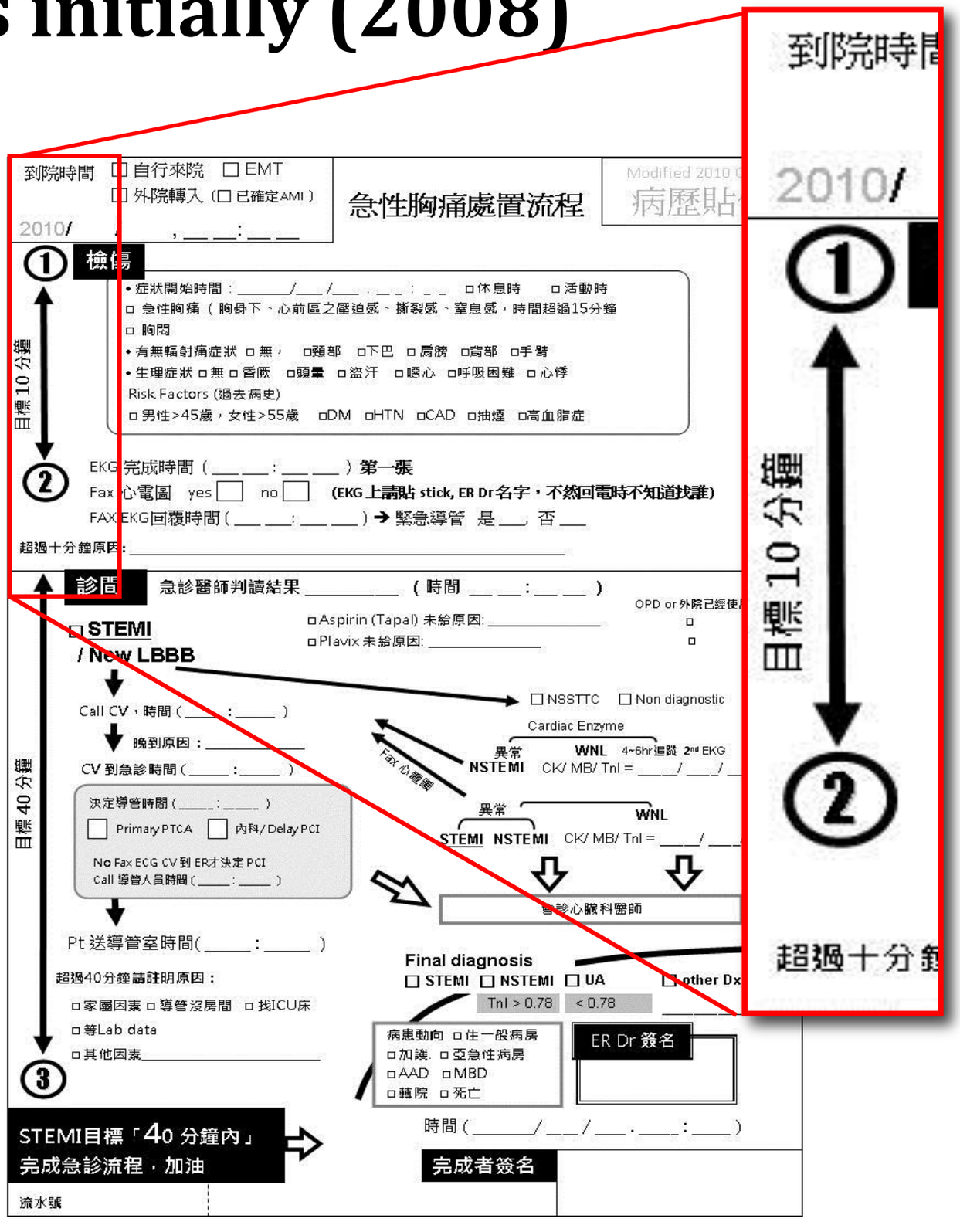
Make change to be lovely and welcome
Less effort, but more efficient

1. **Simplified** protocol with figuration **(easy to remember)**
2. **Internalized** protocol in daily activity **(keep protocol going)**
3. **Auto-recording** all parameter in practice **(initial assessment system / Prescription system / discharging system / billing system) (minimized paper work)**
4. **Summary** all data in management system **(monitor quality and performance, feedback to 1st line staff every month)**

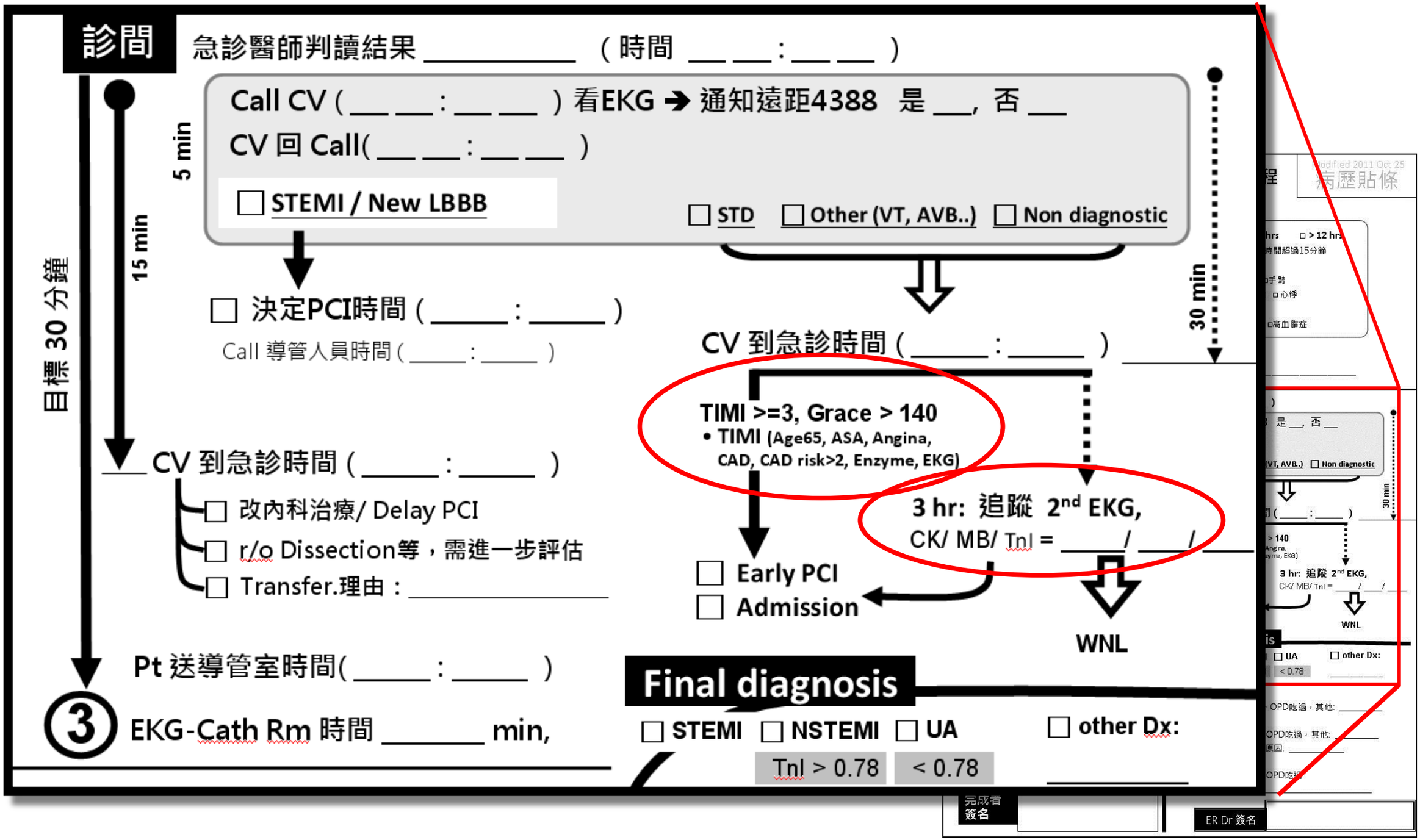
1 Special Paper Flow Chart for chest pain patients initially (2008)

12 versions of protocol changed

- **As simplified** as possible
- **Less check point** as possible
- **One page** for all condition
- **Time interval reminder**
- **Record any reasons for delay**



1 Standardized flow chart 2010 computerized





Too Busy or Forgot to keep record (ICD-9 old MI, new MI)

Use Chest Pain Tag to **Tracing** patient **diagnosis** and **Dispatching**

4 Internalized Chest Pain Tag in Triage nursing system

- Tracking Risk Factor like PCI, CABG, smoking habits
- Chest pain Tag==> Trigger associated function

2012年4月3日起
檢傷分類 資訊系統 新增PCI、CABG、抽菸史，
及 快速掛號 及 註記胸痛 之功能



掛號資料

問診

日期 2011/12/09 昨 今 值班醫師 蔡曜聰 醫師搜尋 胸痛 創傷 PACS EKG

掛號醫師 2284 林健盛

身份別 35 健保

待診	級	ICD	床號	姓名	病歷號碼	性別	身份證字號	出生日期	急診	通報	PS	問診時間
	3			呂宜珈	5450844	女	A231471596	94/05/20				

胸痛中心

病歷號碼： 5450844　　病患姓名： 呂宜珈

（胸痛中心－類別註記）

Chest Pain　Stemi　Nstemi　Unstable Angina

Once Patent Tagged chest pain.
Physician request to give diagnosis before Finish

錯誤訊息

發現以下錯誤

==========

(1)《類別註記》必須勾選其中一項！

確定

健保資料　輸入福重卡

殘障手冊 否 是

卡別年度 100

就醫序號 0010　*1:未領 *2:換發

就醫類別 04　*3:18歲以下

分負擔

轉入院所　查詢

血型　體重　公斤

F7查詢　F12完成

(4200,2400)



Forgot to record Time points
Didn't synchronized clock / watch

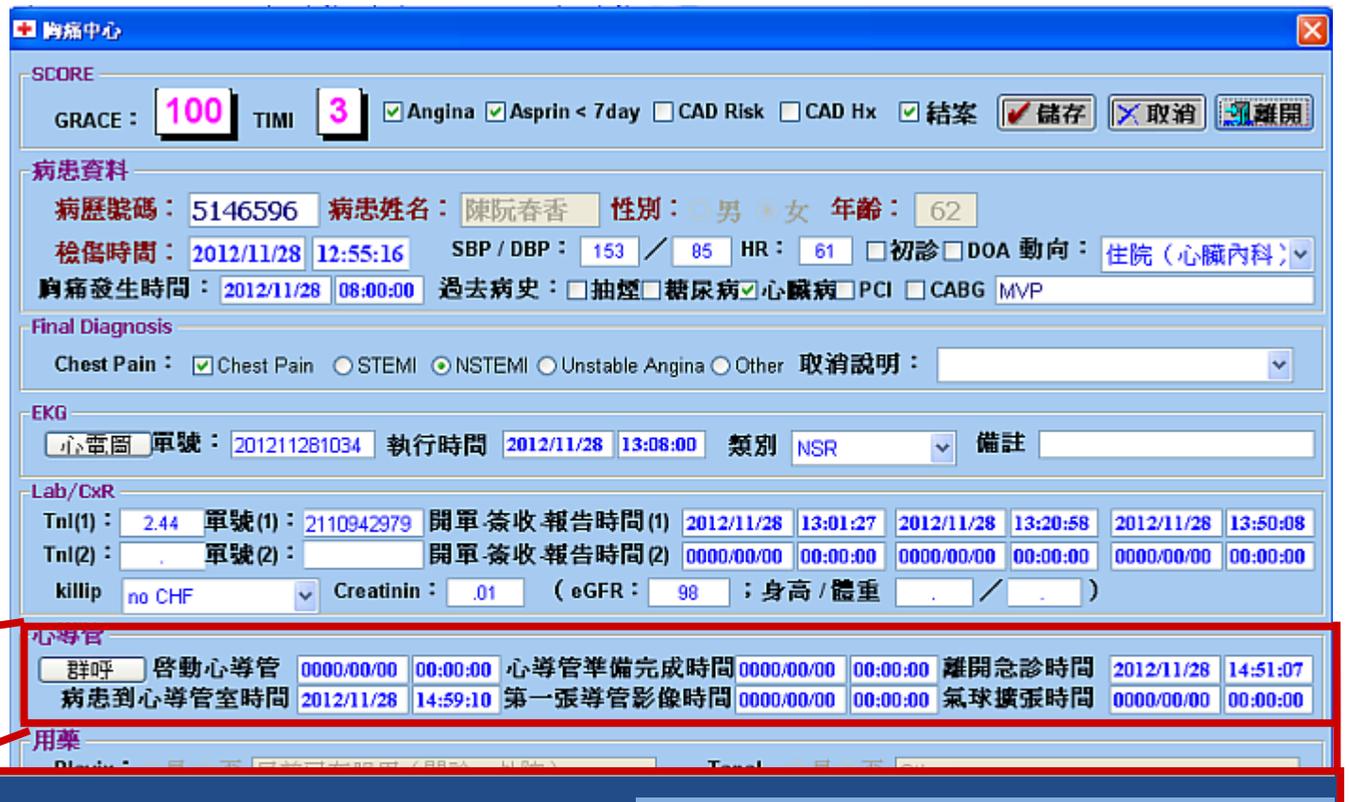
Use RFID to record time points without need key-in

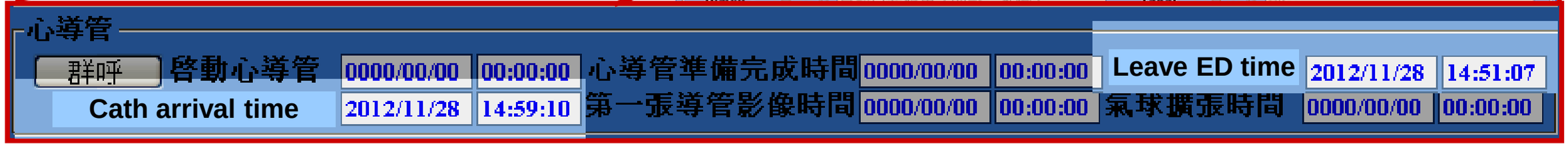
Time server synchronized time
Twice a day in all computer

5 RFID Wristband (minimized paper work)

- Auto-transmission of Time point while Leaving ED, Arrival Cath Room







5 Before system applied

1. ED door time: (triage nurse, PA. ED doctor)
2. EKG time: (triage nurse, PA, intern, fellow, VS)
3. PPCI activation time: (nurse, PA, intern, resident, fellow, VS)
4. Cath Room ready time: (CV Fellow, technician, CV VS)
5. Patient sent to Cath Room time: (ED nurse, resident, fellow)
6. Patient arrival Cath Room time: (ED nurse, resident, fellow, technician）
7. Puncture time : (by Fellow, VS)
8. Balloon time: Wire pass lesion / Balloon/ Thrombuster Time

- STEMI patient ED medication remind (Bokey, plavix, statin, BB) : (ED physician, nurse, PA)

5 After apply new system Only 1 Time point left for manual recording

1. ED door time: **ED Nursing statin system feedback**
2. EKG time: **(Wireless ECG transmission**
3. PPCI activation time: **(CPU system feedback)**
4. Cath Room ready time: (CV Fellow, technician, CV VS)
5. Patient sent to Cath Room time: **(RFID)**
6. Patient arrival Cath Room time: **(RFID)**
7. Puncture time : **(1st cath imaging time)**
8. Balloon time: Wire pass lesion / Balloon/ Thrombuster Time **(Cath Sys.)**

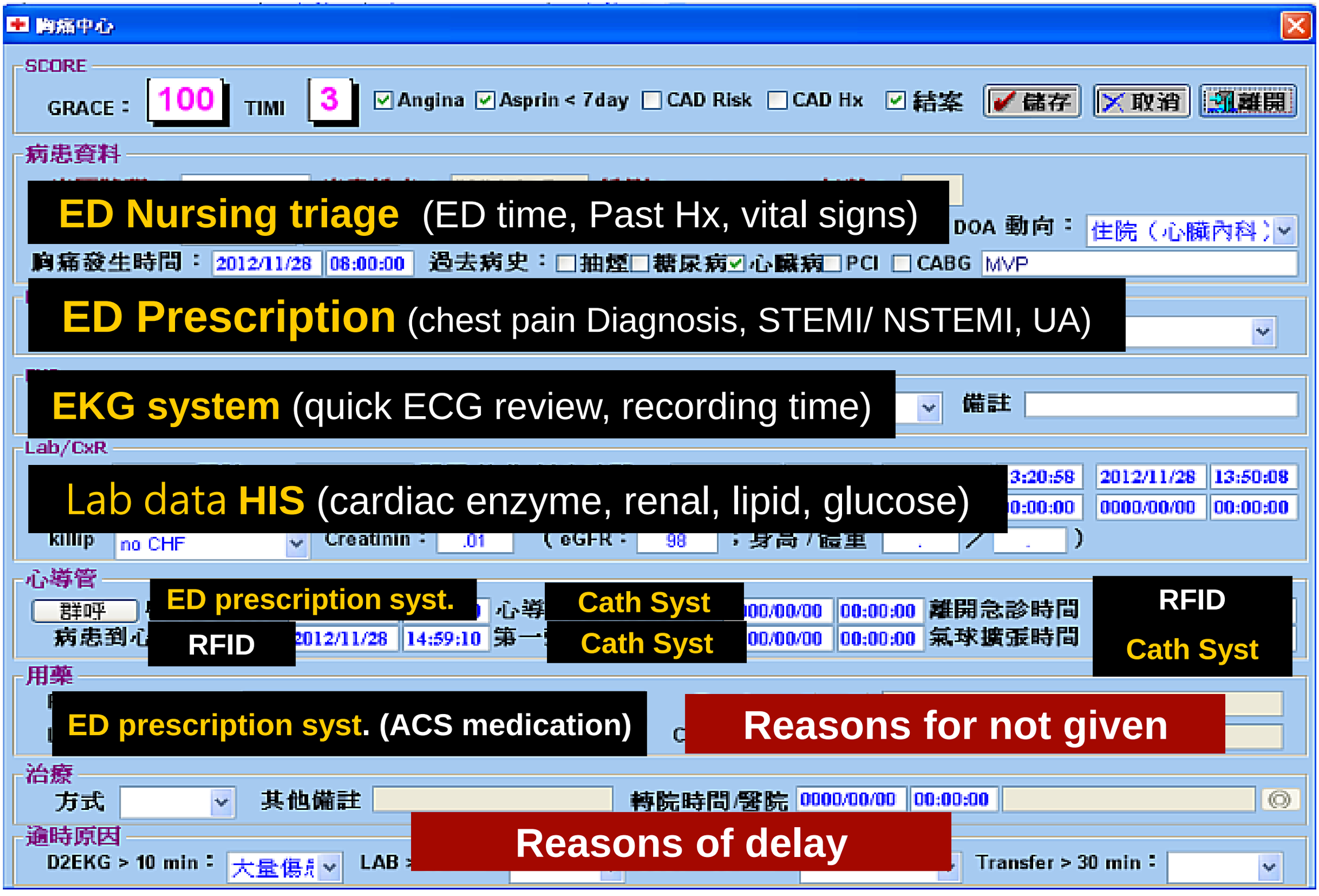
- STEMI patient ED medication remind (Bokey, plavix, statin, BB) : **(CPU system reminder / check up)**



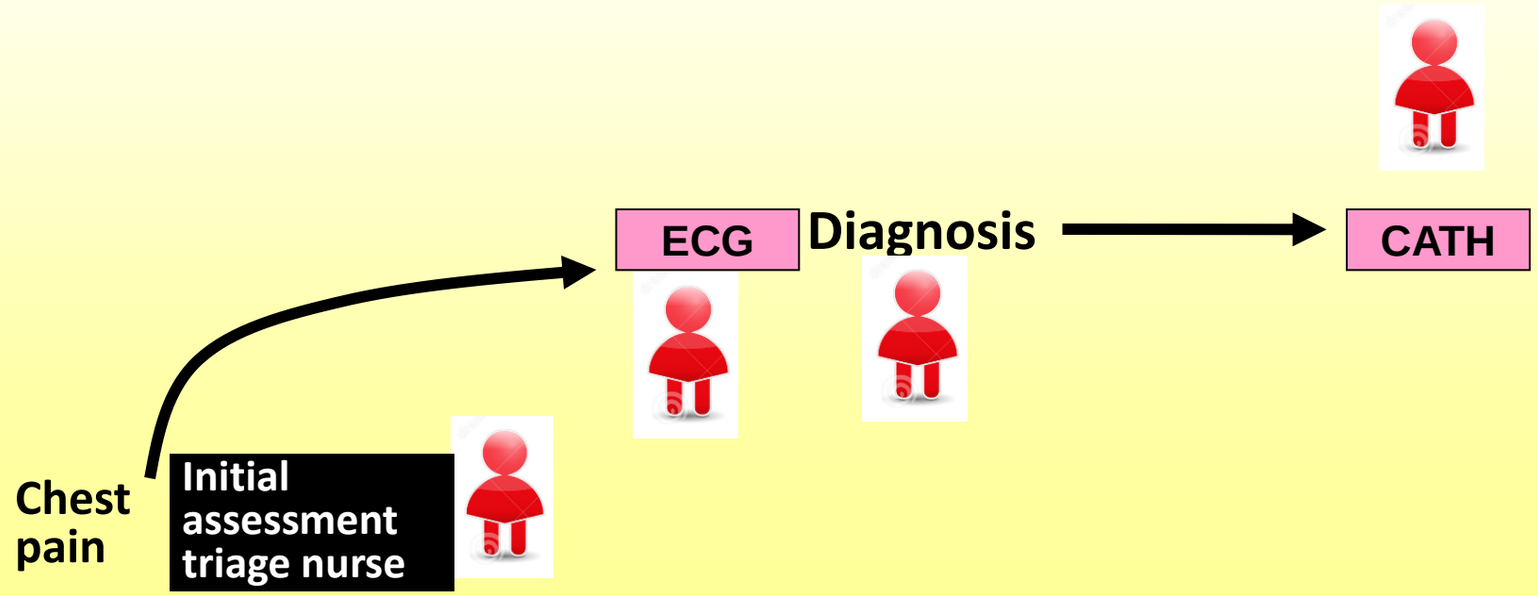
Collect All Quality control parameter is time consuming

Chest pain system collect All data from different systems Real-time Data could export for statistics

6 Chest pain system collect data from different systems



6 Manpower Saving

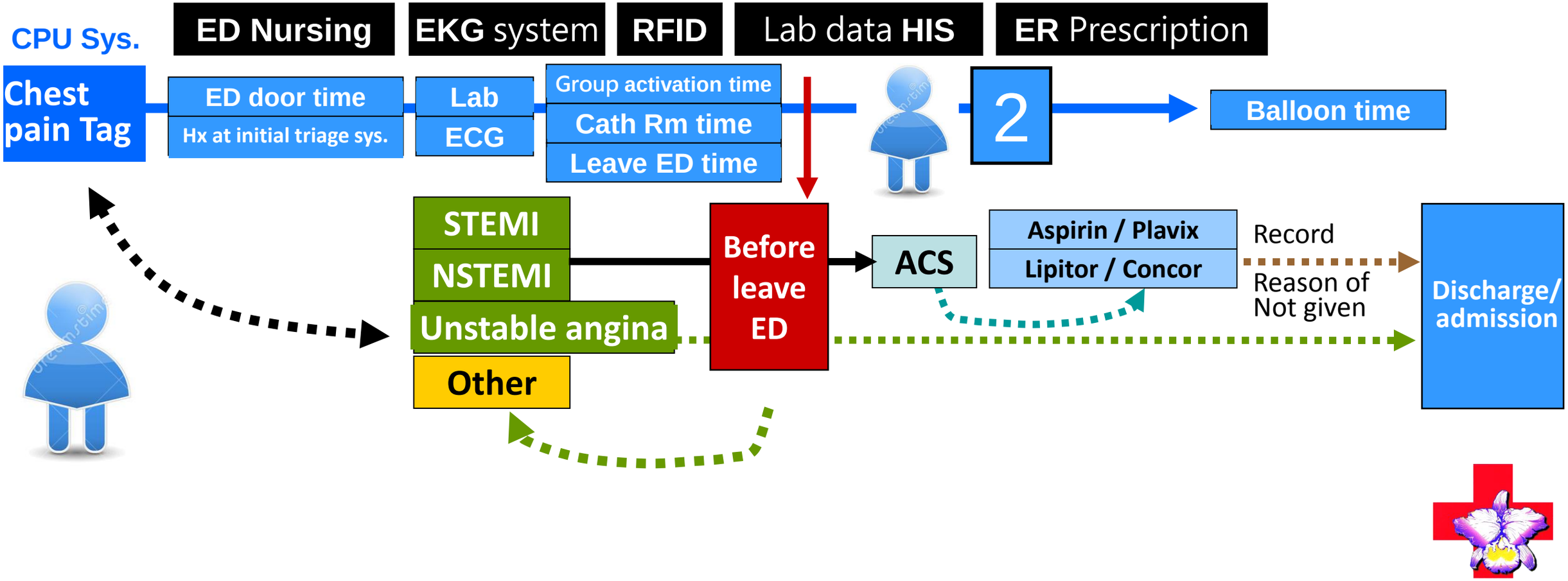


ED door time ?
ECG time ?
STEMI/ NTEMI ??
Contact cardiologist
Medication (Aspirin/ Plavix / concor/ lipitor)
Why not given ??
Leave ED time ?
Cath Rm time ?

9

Retrospective Charting

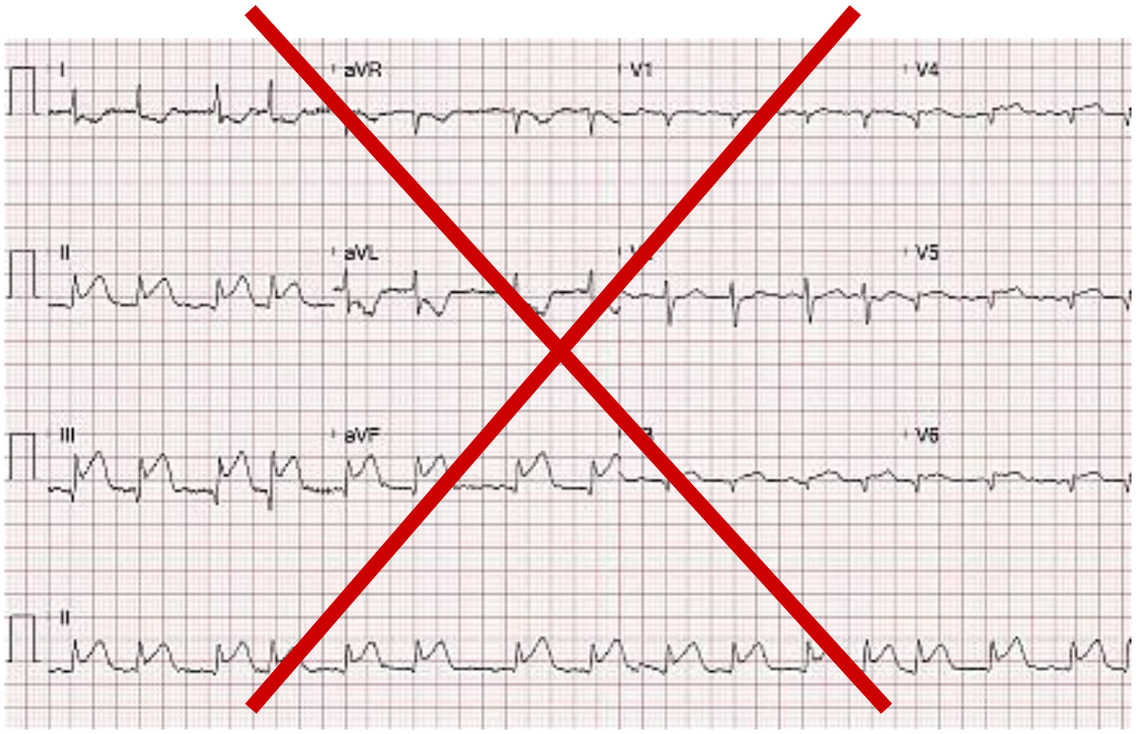
D2EKG > 10min
(manual check reasons)



Another critical chest pain population:

NSE-MI

Non-ST elevation myocardial infarction

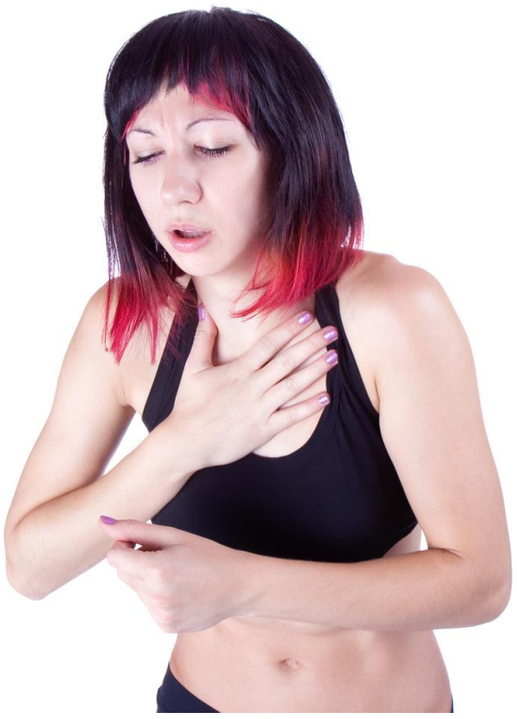


NSTEMI-more complex

- **more work up** and assessment are **needed**
  - Detail **history taking**
- **serial ECG** follow up or monitoring
  - **serial cardiac TnI** follow up
  - close **vital signs** monitoring (BP, HR, oxygenation)
- **Non-CAD work-up** (aortic dissection, pulmonary embolism, GI, muscle skeletal....etc)

Chest pain etiology is heterogeneity

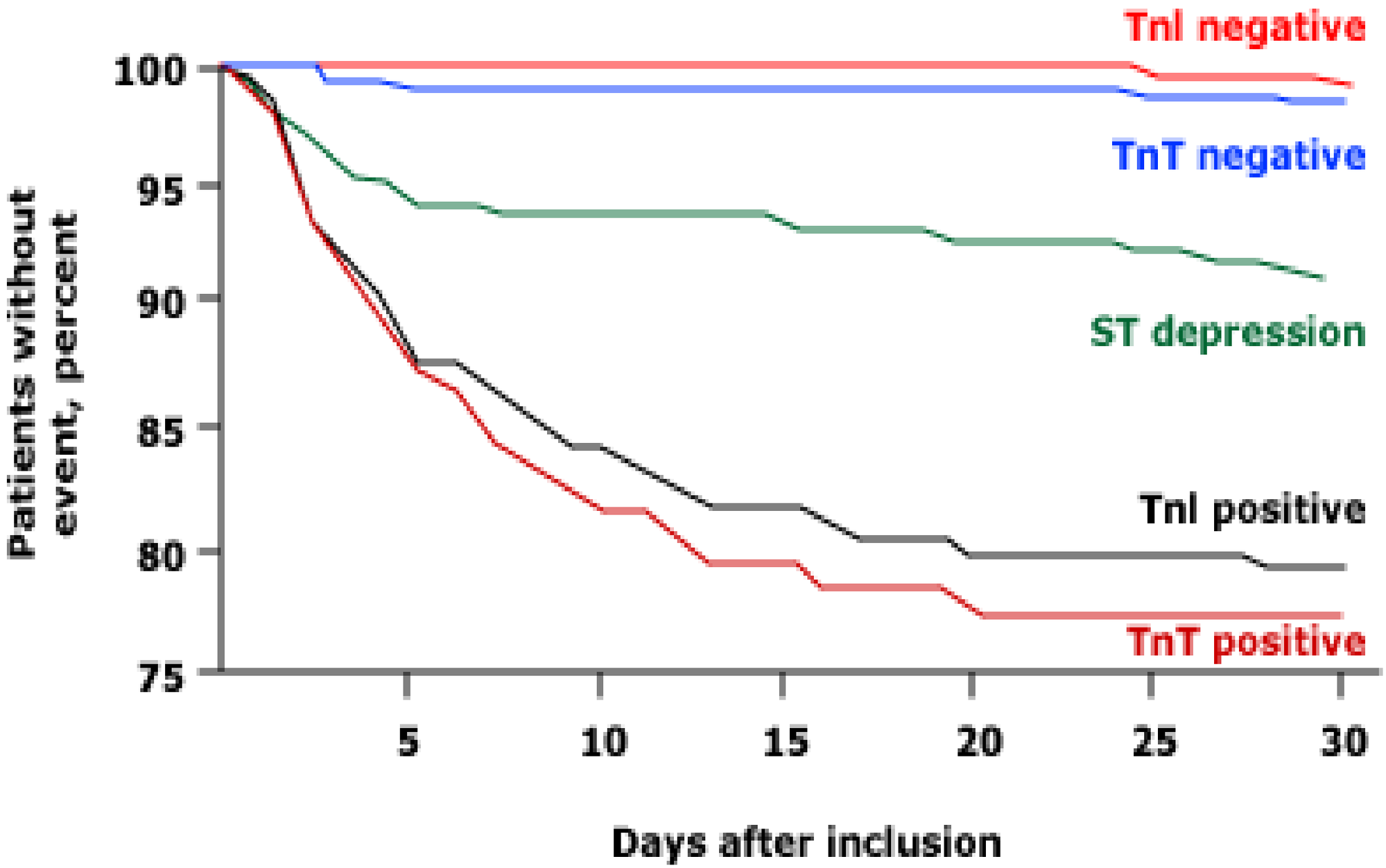
1. **Cardiovascular**
   Angina, MI, myocarditis, pericarditis, aortic dissection
2. **Pulmonary disease**
   pulmonary embolism, pneumonia, pleuritis, pneumothorax, pulmonary HTN
3. **GI**
   GERD, esophagial spasm, Malorii wise, peptic ulcer, biliary tract disease, pancreatitis
4. **Muscle-skeletal**
   costochrondritis, spinal disease, panic disorder



Balancing between **Sensitivity** and **Specificity** and **Cost**

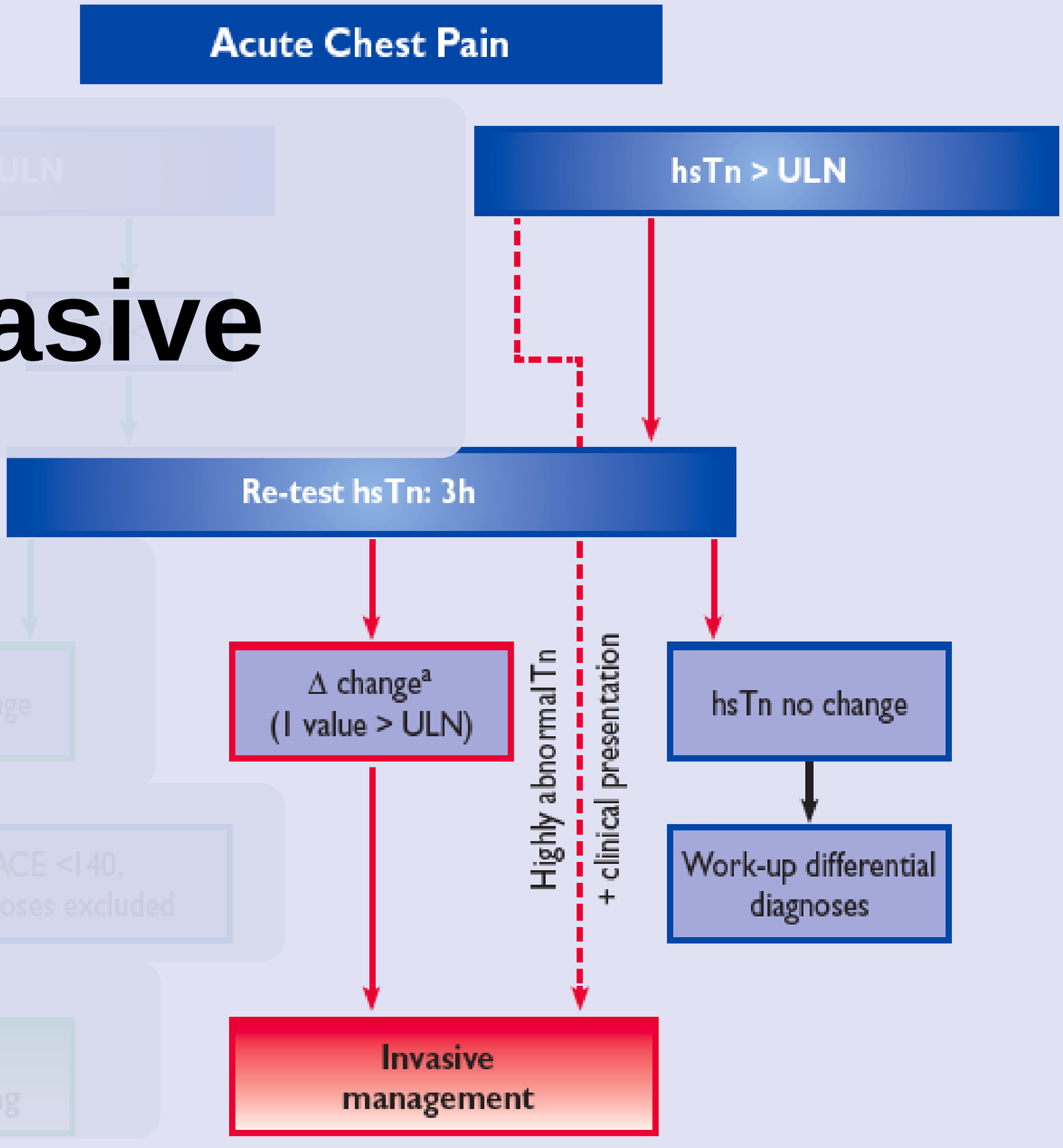
- **Blood test (TnI, CPK, MB isoenzyme)**
- other biochemistry work up (D-dimer, BNP or NT-proBNP, hs-CRP, PCT (prolactin), WBC with D/C)
- CxR
- Echocardiography
- Chest CT scan

Most outcome predictive by Cardiac Troponin I/T



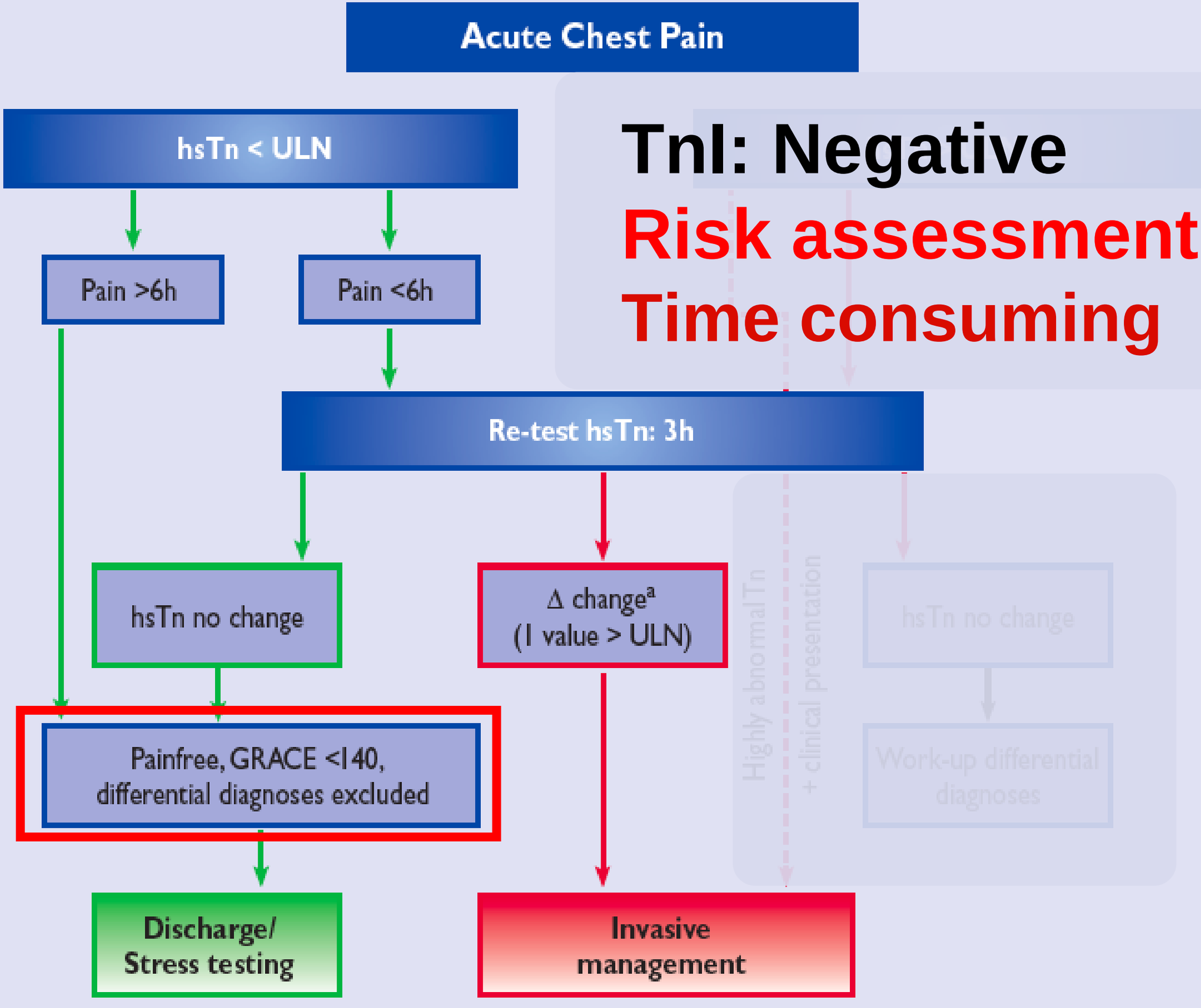
Data from Hamm CW, Braunwald E. Circulation 2000; 102:118.

TnI (+)
Go invasive



• **Chronic or acute renal dysfunction**
• Severe congestive **heart failure** – acute and chronic
• **Hypertensive crisis**
• **Tachy- or bradyarrhythmias**
• **Pulmonary embolism**, severe pulmonary hypertension
• Inflammatory diseases, e.g. **myocarditis**
• Acute neurological disease, including **stroke**, or subarachnoid haemorrhage
• Aortic dissection, aortic valve disease or hypertrophic cardiomyopathy
• Cardiac contusion, ablation, pacing, cardioversion, or endomyocardial biopsy
• Hypothyroidism
• Apical ballooning syndrome (Tako-Tsubo cardiomyopathy)
• Infiltrative diseases, e.g. amyloidosis, haemochromatosis, sarcoidosis, sclerodermia
• Drug toxicity, e.g. adriamycin, 5-fluorouracil, herceptin, snake venoms
• Burns, if affecting >30% of body surface area
• Rhabdomyolysis
• Critically ill patients, especially with respiratory failure, or sepsis

TnI (+) Not always ACS



TnI: Negative

Risk assessment

Time consuming

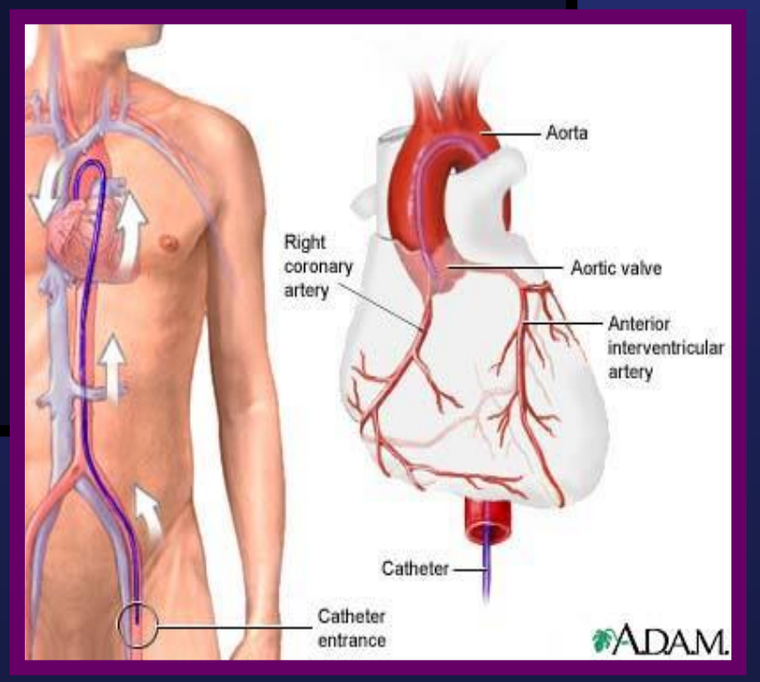
Risk identification

- **TIMI score**
  - –Thrombolysis in Myocardial infarction
- **GRACE score**
  - –Global Registry of Acute Cardiac Events

Kelly AM, Emerg Med J. 2013 Jan;30(1):15-8. Epub 2012 Feb 10

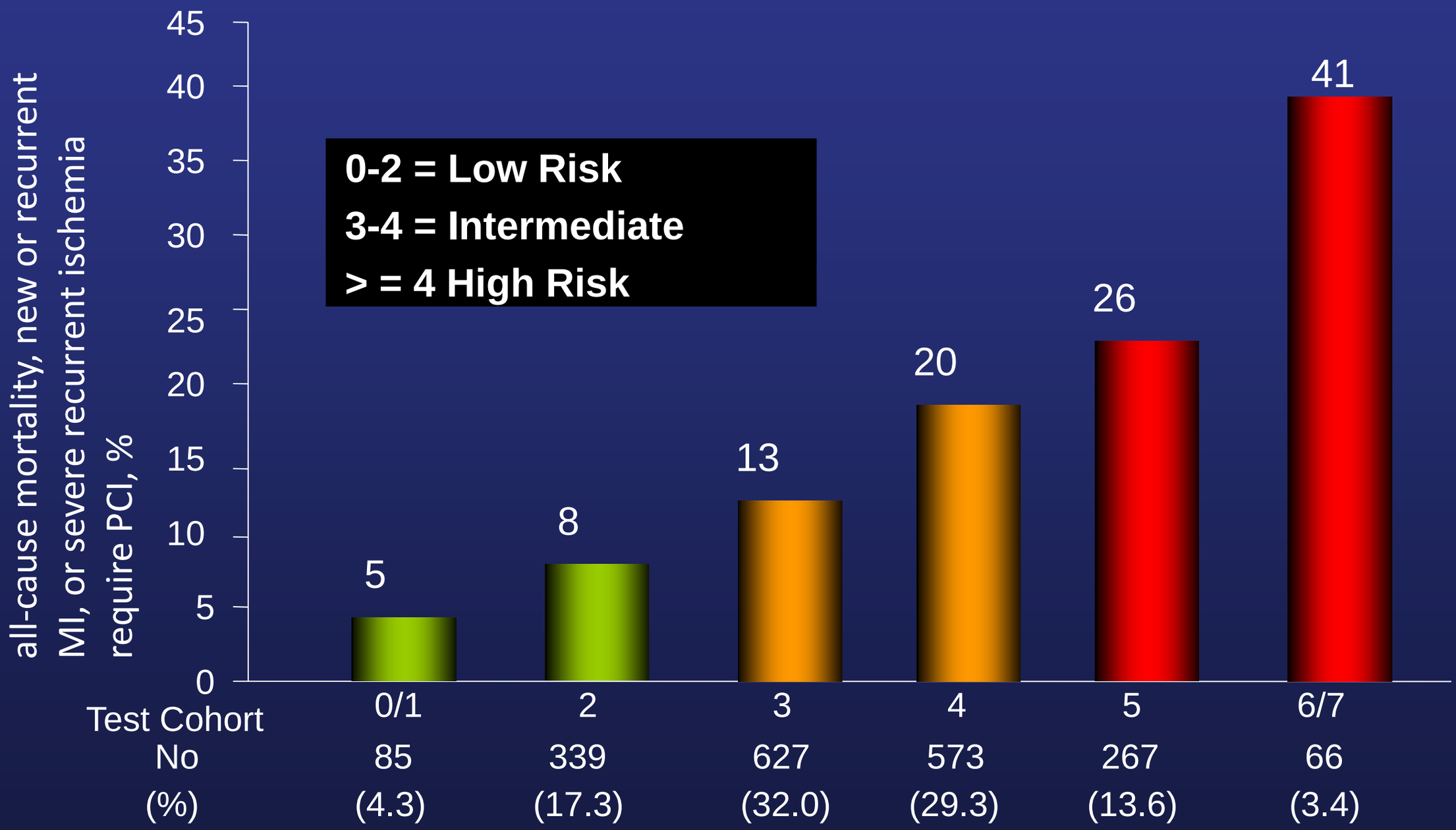
TIMI Risk Score (3A 2C 2E)
for UA/ Non STEMI (TIMI 11B and Essence)

- Age➔ ≥ 65 old
- Angina➔ ≥ 2 angina symptoms in 24 hours
- Aspirin➔ use Aspirin ≤ 7
- CAD risk➔ ≥ 3 CVD risk factor
- CAD hx➔ piror CAD ≥ 50%
- EKG➔ STT change while symptoms
- Enzyme➔ elevated cardiac enzyme



Animan et al. JAMA 2000; 284:835.

TIMI score vs 14 day
mortality, re-MI, emergent PCI rate



Antman et al. JAMA 2000, 284:835-842



Not time to Scoring in crazy busy working times at ED

Auto collection needed information for scoring and Risk stratification

7 GRACE Score

(Global Registry of Acute Coronary Events)

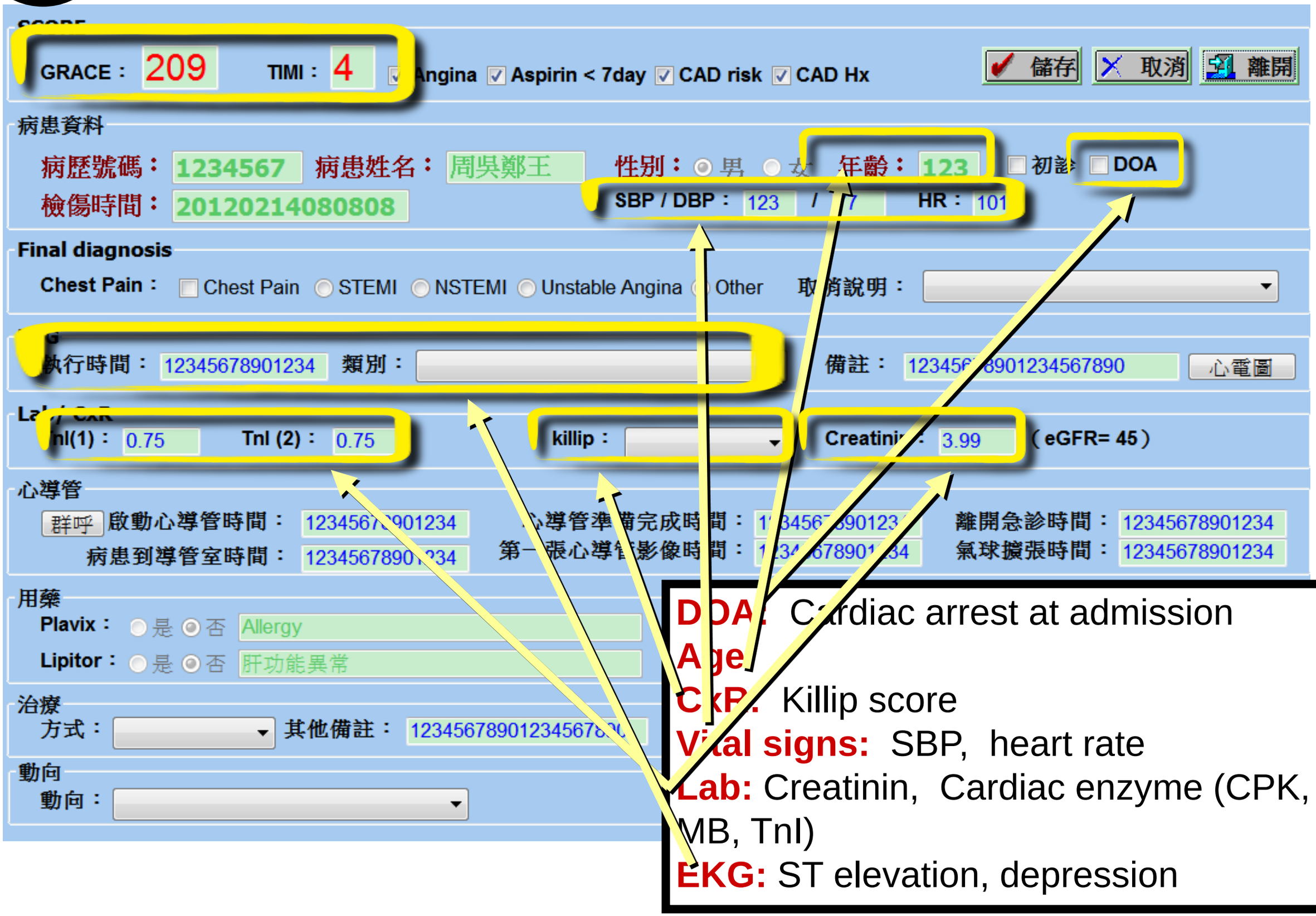
- **DOA:** Cardiac arrest at admission
- **Age**
- **CxR:** Killip score
- **Vital signs:** SBP, heart rate
- **Lab:** Creatinin, Cardiac enzyme (CPK, MB, TnI)
- **EKG:** ST elevation, depression

Killip Score	Points	SBP mm Hg	Points	Heart Rate Beats/min	Points	Age years	Points	Serum Creatinine µmol/l	Points
I	0	≤ 80	58	≤ 50	0	≤ 30	0	0 - 34	1
II	20	80 - 99	53	50 - 69	3	30 - 39	8	35 - 70	4
III	39	100 - 119	43	70 - 89	9	40 - 49	25	71 - 105	7
IV	59	120 - 139	34	90 - 109	15	50 - 59	41	106 - 140	10
		140 - 159	24	110 - 149	24	60 - 69	58	141 - 176	13
		160 - 199	10	150 - 199	38	70 - 79	75	177 - 353	21
		≥ 200	0	≥ 200	46	80 - 89	91	≥ 353	28
						≥ 90	100		

Other Risk Factors	Points
Cardiac Arrest at Admission	39
ST-Segment Deviation	28
Elevated Cardiac Enzyme Levels	14

Total Points	≤ 60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	≥ 250
Probability of In-Hospital Death, %	≤ 0.2	0.3	0.4	0.6	0.8	1.1	1.6	2.1	2.9	3.9	5.4	7.3	9.8	13	18	23	29	36	44	≥ 52

7 Auto-scoring of GRACE, TIMI score



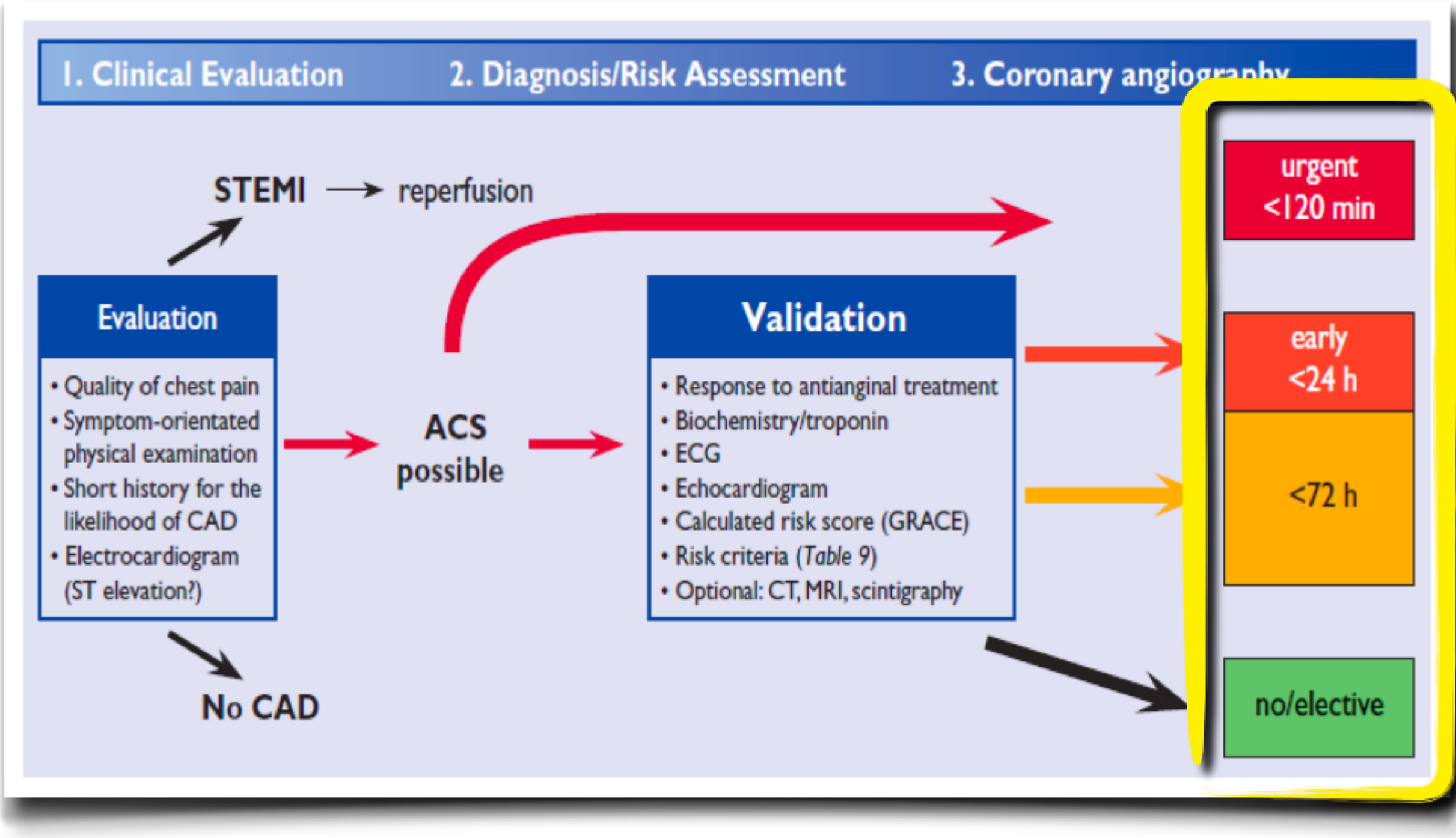
DOA: Cardiac arrest at admission
Age
CkP: Killip score
Vital signs: SBP, heart rate
Lab: Creatinin, Cardiac enzyme (CPK, MB, TnI)
EKG: ST elevation, depression

7

Risk category (tertile)	GRACE risk score	In-hospital death (%)
Low	≤108	<1
Intermediate	109–140	1–3
High	>140	>3

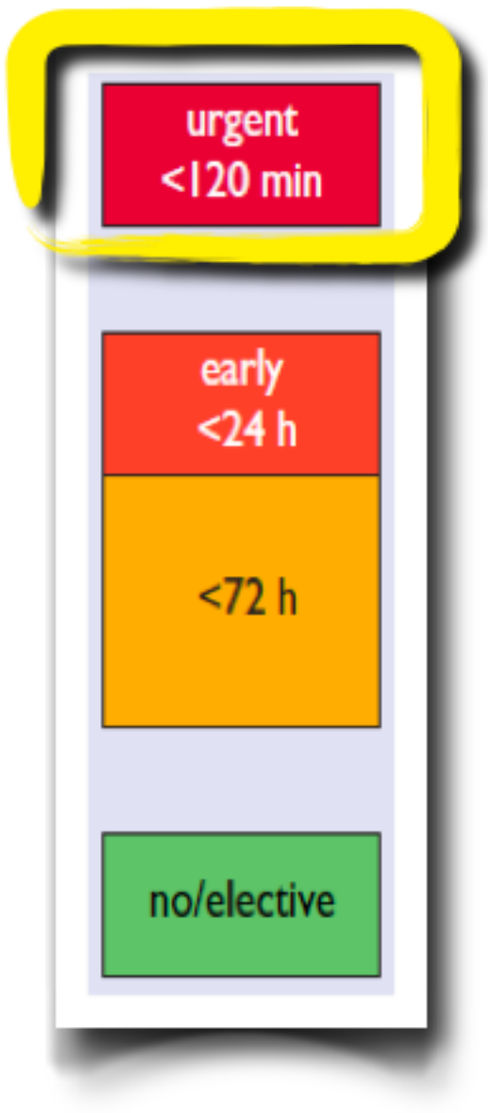
Risk category (tertile)	GRACE risk score	Post-discharge to 6-month death (%)
Low	≤88	<3
Intermediate	89–118	3-8
High	>118	>8

Some **NSTEMI** need **Early Intervention**



2 hour (Urgent CAG)

Group 1

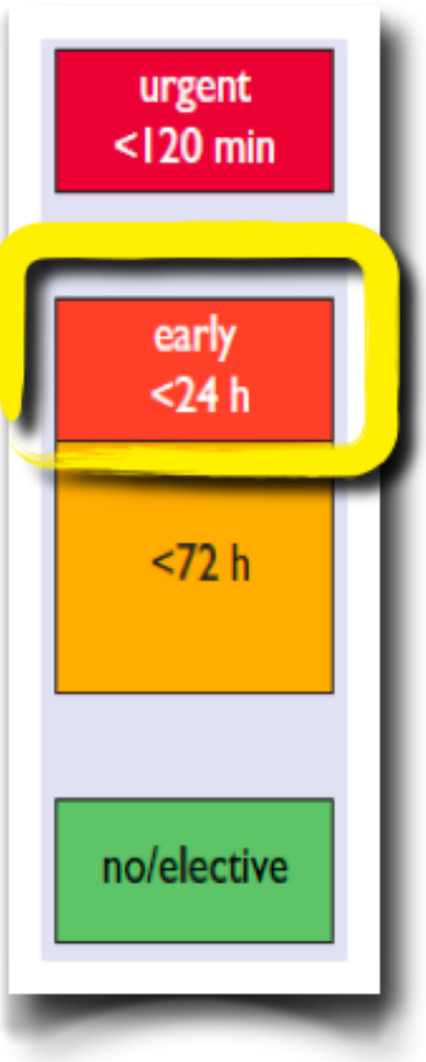


TnI (+) (POC), dynamic STT change plus

- **Refractory ischemia**
- **associated heart failure**
- **Hemodynamic instability**
- **Ventricular arrhythmia (VT, Vf)**

< 24 hour (Early invasive)

Group 2



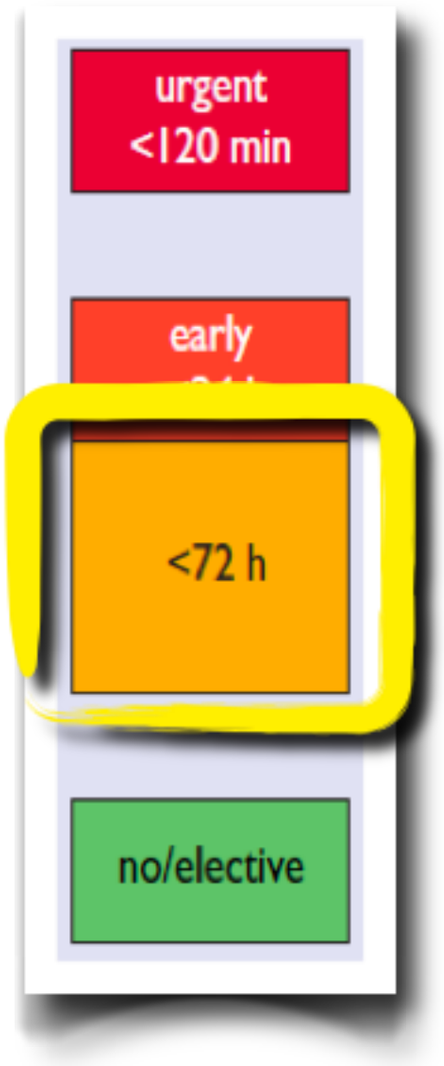
Based on TIMI score risk

（modified TIMI score 3A, 2C, 2E)

- **Persistent or recurrent of angina (A1)**
- **cardiac Troponin I positive (E1)**
- **Dynamic ST or T wave (symptomatic or Asymptomatic) (E2)**

72 hour CAG (Indication)

Group 3 AHA/ACC + TIMI score

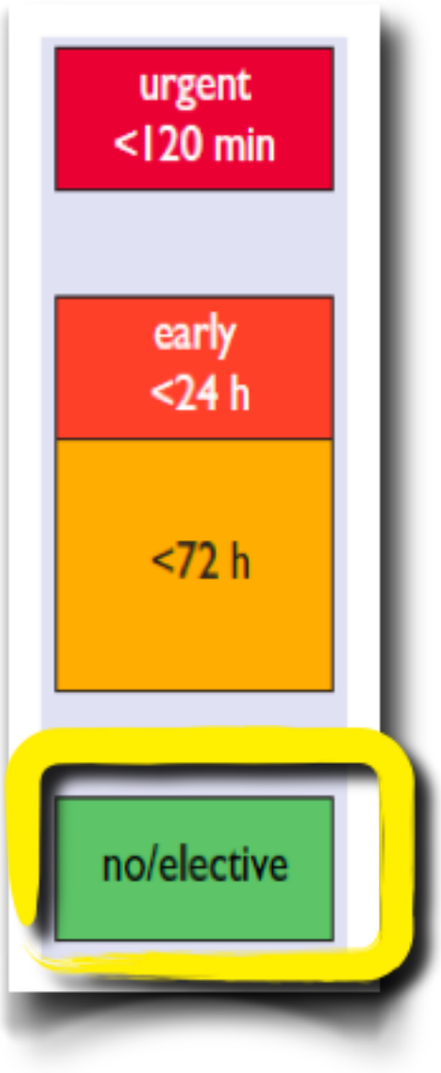


- **Significant CAD** (C1)
  - Documented by CAG, MDCT scan: (≥ 2VD > 50%)
  - TL201 scan: moderate to severe ischemia
  - Prior PCI (Recent PCI)
  - Prioir CABG
- **Risk factor (≥ 3)** (C2)
  - DM
  - HTN
  - Smoking
  - Hyperlipidemia
  - Family history of CAD (Male age < 55, Female < 60 years)
- **Previous Aspirin/ clopidogrel use (A2)**
- **Age ≥ 65 years old (A3)**
- CKD (eGFR < 60 ml/ min/ 1.73m2 BSA)
- Early post infarction angina
- Intermittent to high GRACE score ≥ 110
- LVEF < 40%

Primary
• Relevant rise or fall in troponin[a] • Dynamic ST- or T-wave changes (symptomatic or silent)
Secondary
• Diabetes mellitus • Renal insufficiency (eGFR <60 mL/min/1.73 m²) • Reduced LV function (ejection fraction <40%) • Early post infarction angina • Recent PCI • Prior CABG • Intermediate to high GRACE risk score (*Table 5*)

Conservative strategy
(no or elective angiography)

Group 4



- No recurrence of chest pain.
- No signs of heart failure.
- No abnormalities in the initial ECG or a second ECG (at 6–9 h)
- No rise in troponin level (at arrival and at 6–9 h)
- No inducible ischemia.

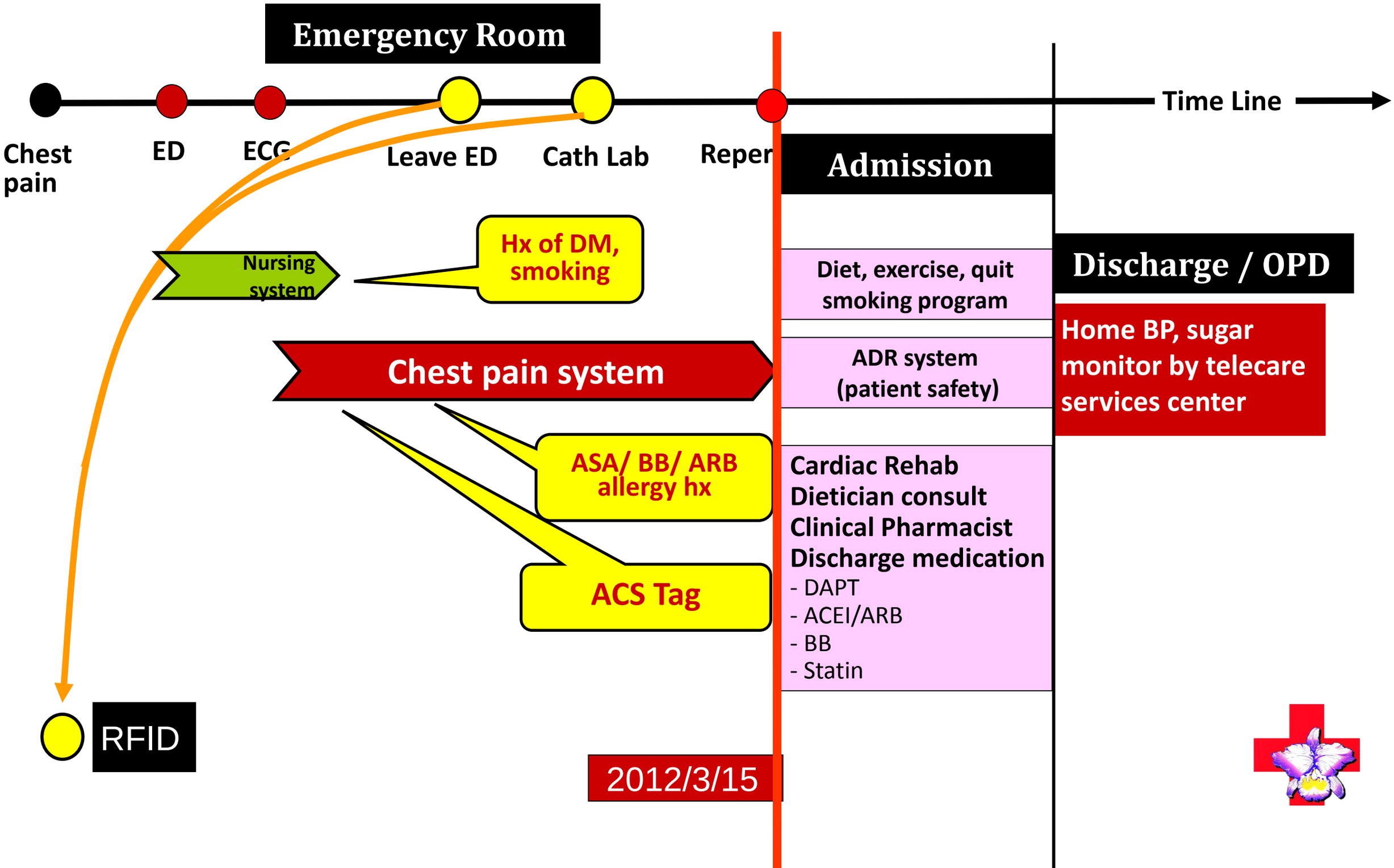
Dilemma 8

There are always New staff in ED,
Too many systems need to familiar
for young staff

Merge Chest pain system in Background,
No need to learn,
Just Do what your familiar to Do at ED

Bridging all information to admission/
discharging / health care

8 Total care of chest pain, MI patient from ED to Home care



Is Working ?

7 Short D2BT by In-hospital Tele-ECG triage

	Tele-ECG group (n =51)	Control group (n = 54)	Median difference	p-Value
Pre-hospital on-scene time (hours)	2.6 (1-9)	4.8 (1-8)	-2.2	0.191
Door-to-balloon time (minutes)	86 (75-95)	125 (90-127)	-39	< 0.0001
Door-to-balloon time＜90 minutes	76%	44%	33	0.0001
Door-to-ECG time (minutes)	6 (2-8)	9 (5-11)	-3	0.005
ECG-to-infarct team activation time (minutes)	7 (4-12)	25 (11-45)	-18	< 0.0001
Infarct team activation time- to-cath lab time (minutes)	42 (31-50)	44 (35-60)	-2	0.018
Cath lab-to-balloon time (minutes)	31 (23-38)	35 (25-50)	-4	0.011

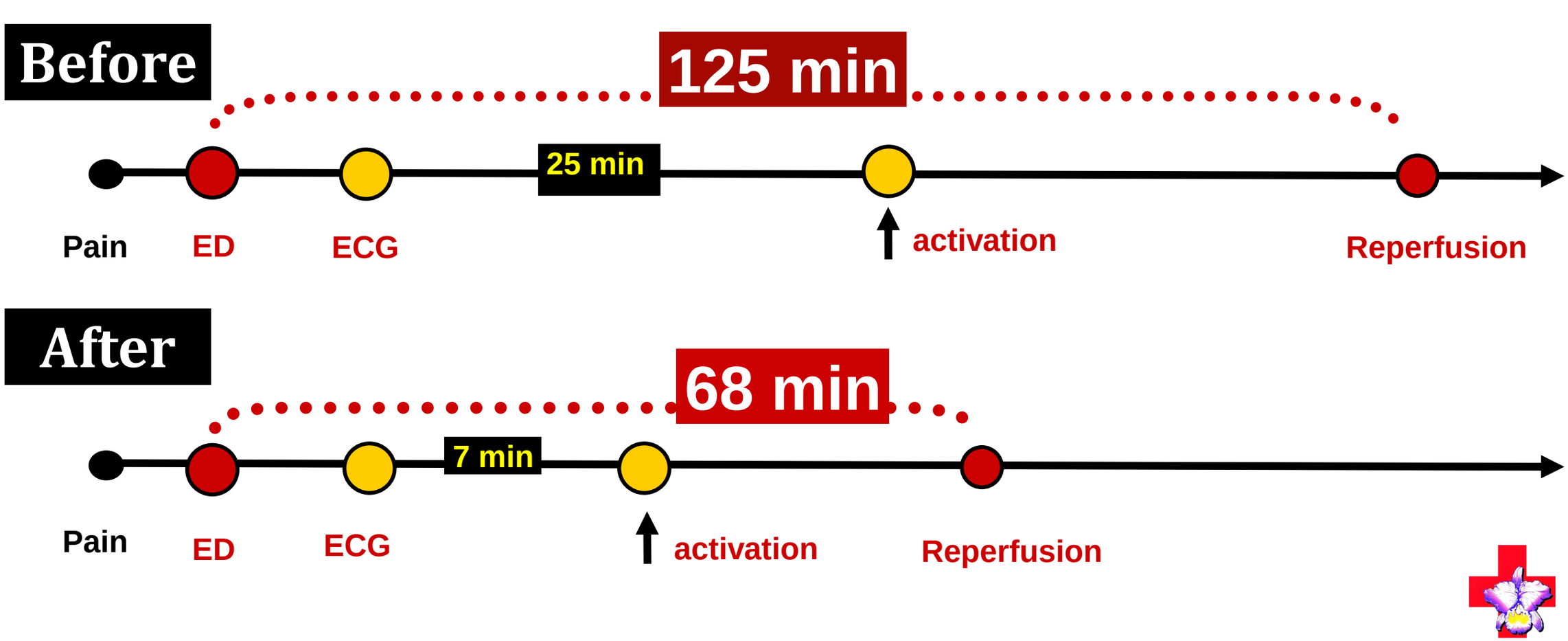
Values are expressed as median (inter-quartile range).



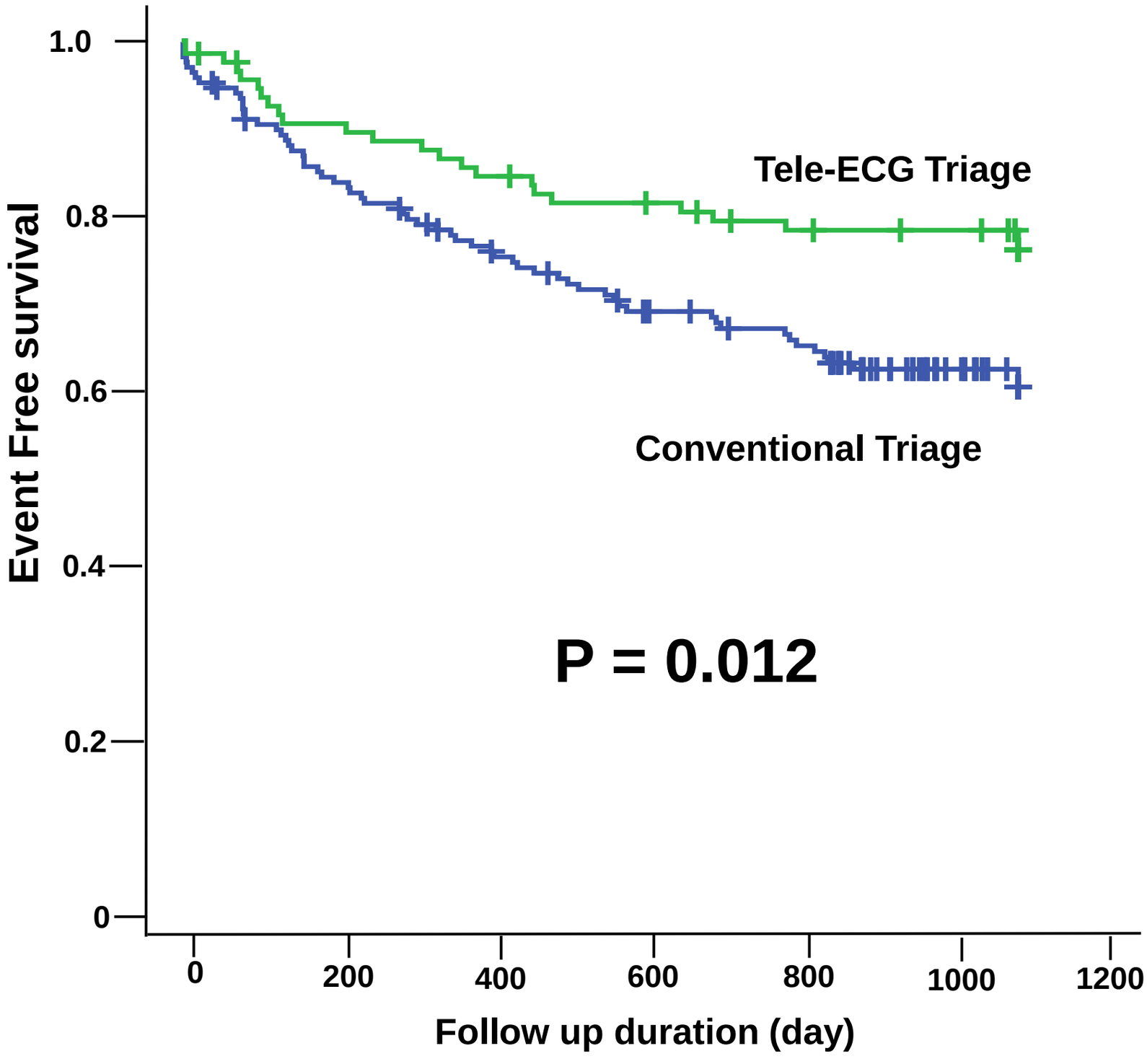
Chen KC, et al. Am J Cardiol. 2011 May 15;107(10):1430-5

7 Short D2BT by In-hospital Tele-ECG triage

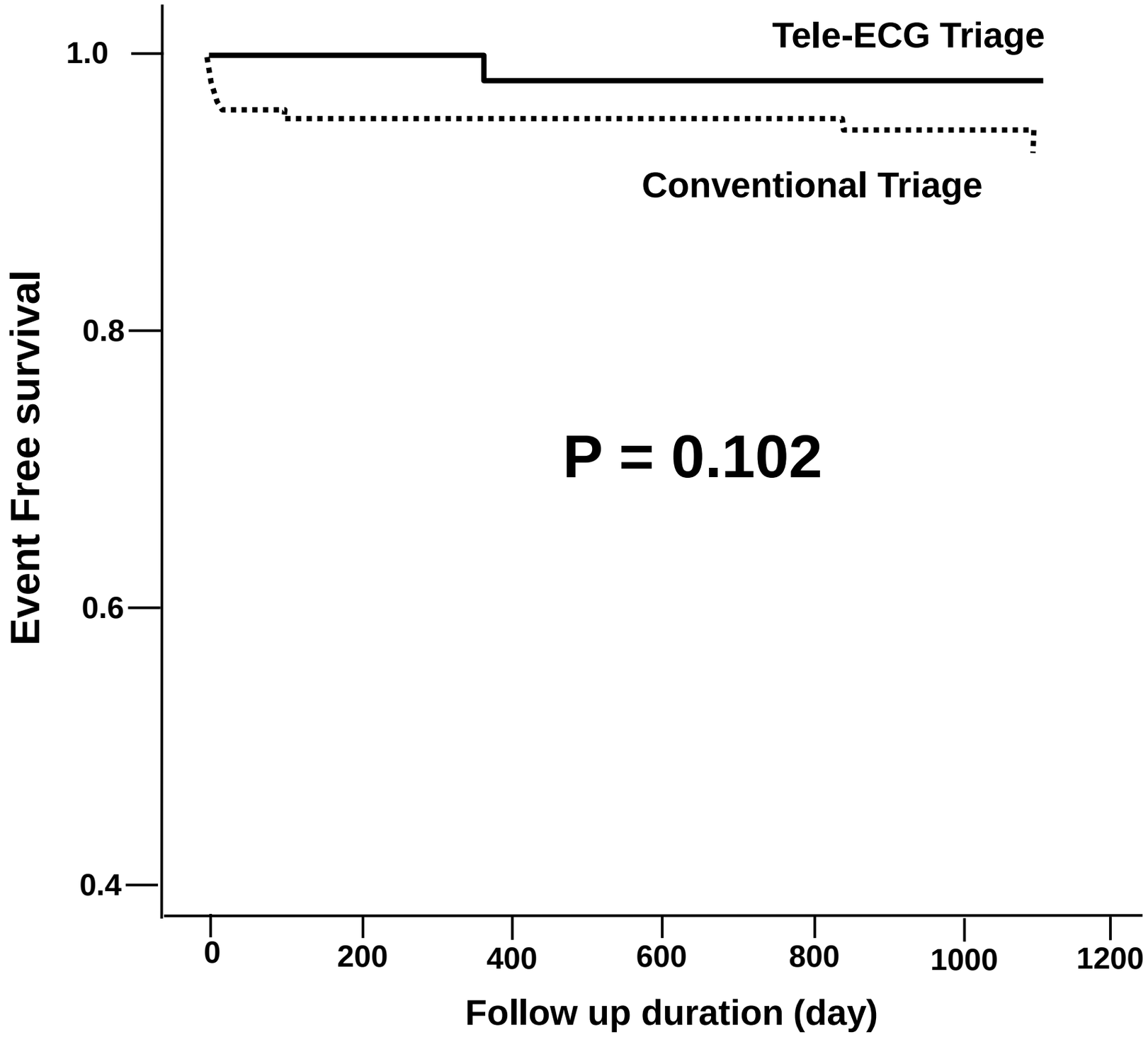
	After	Before	Difference
D2BT (median time)	68 min	125 min	-39
D2BT＜90min %	81%	44%	37%
ECG-Dx-activation time	7 min	25 min	-18



Cumulative Event Free Survival curves for
major adverse cardiac and cerebral adverse events (MACCE)

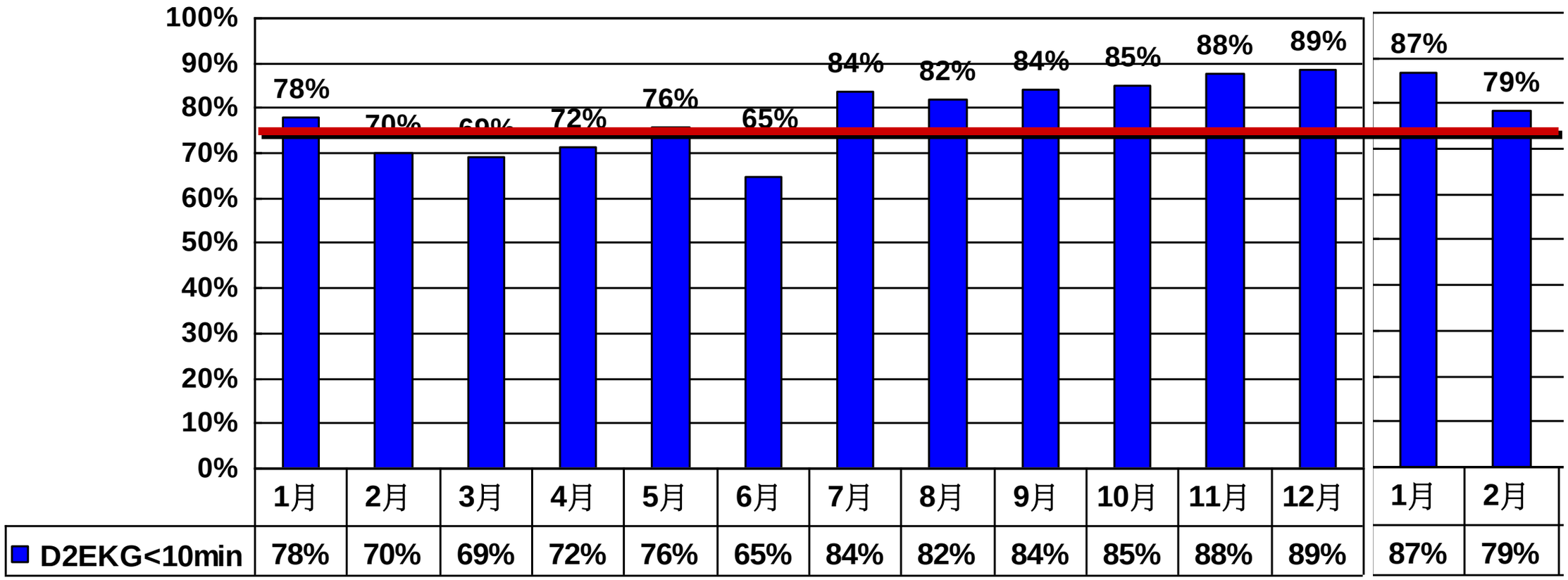


Mortality between 2 triage



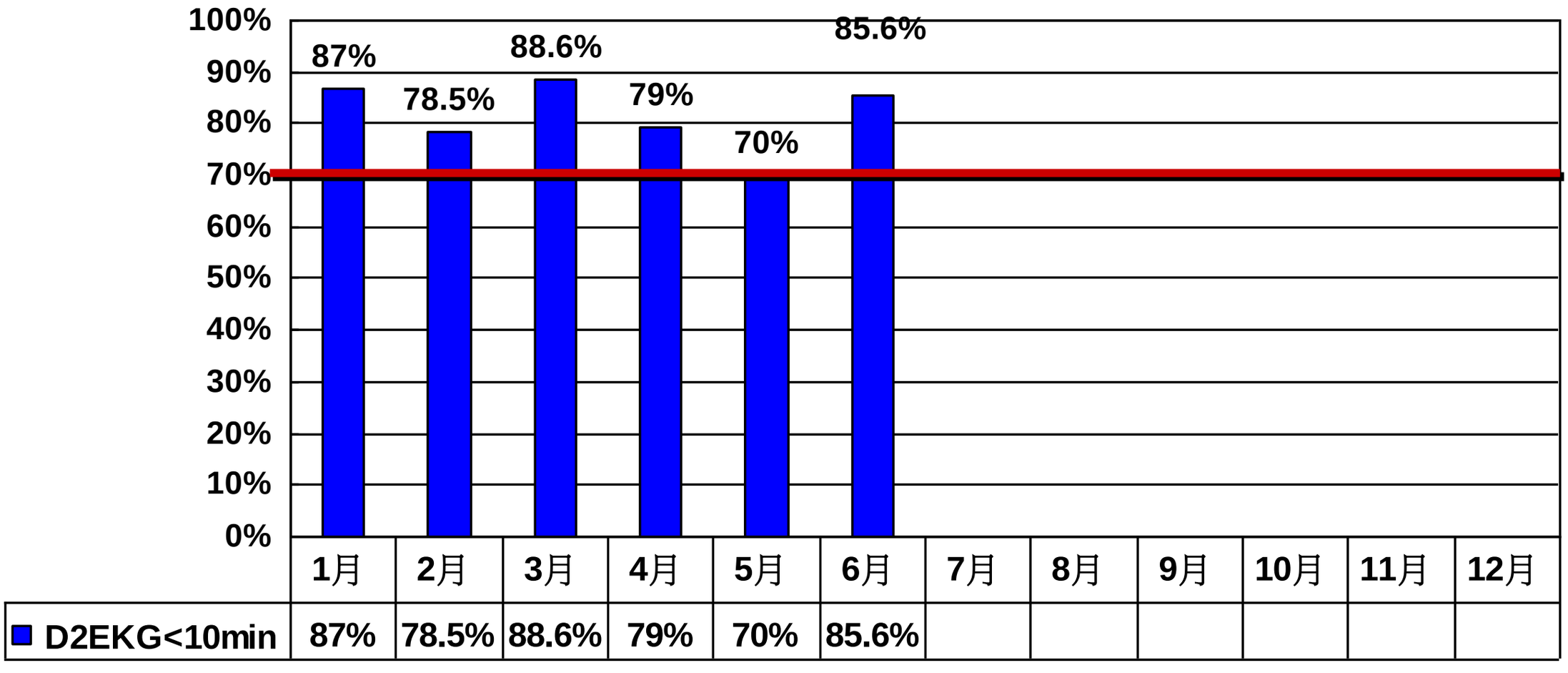
2014~ 2015/1-2 D2EKG time

- **Total D2EKG < 10min = 78% (> 70%)**
- **Median 1.5 min**



D2EKG < 10min (good performance till now)

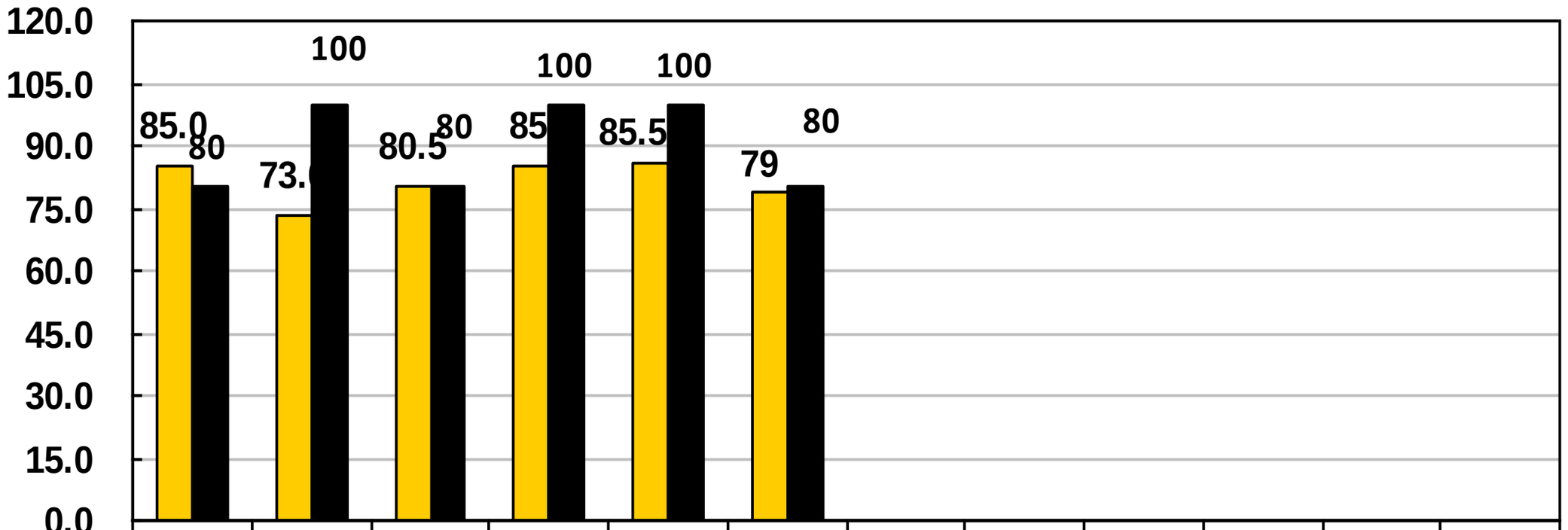
- 2015 Jan ~ June
- Total D2EKG < 10min = 80% (> 70%) Median 2 min



2015 Jan ~ June　Door to balloon time (D2BT)

- Total Median D2BT = 81 min (<90min)
- D2BT < 90min % = 90% (≥ 75%)

Not temprary



	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
D2BT	85.0	73.0	80.5	85	85.5	79						
<90min %	80	100	80	100	100	80						

Conclusion

- For chest pain patients, ECG should performed ASAP
- For NSTEMI, cTnI, history taking, GRACE / TIMI score can help to identify risk
- In-hospital TeleECG triage combined with information system automatic feedback may insure data-collection, quality control and manpower-saving
- Our in-hospital TeleECG triage combined with chest pain system could solve clinical problem by interrogating to daily practice without increase work loading
- TeleECG triage not only shorten D2BT but also associated better clinical outcomes

Thanks for your attention and welcome your comment



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