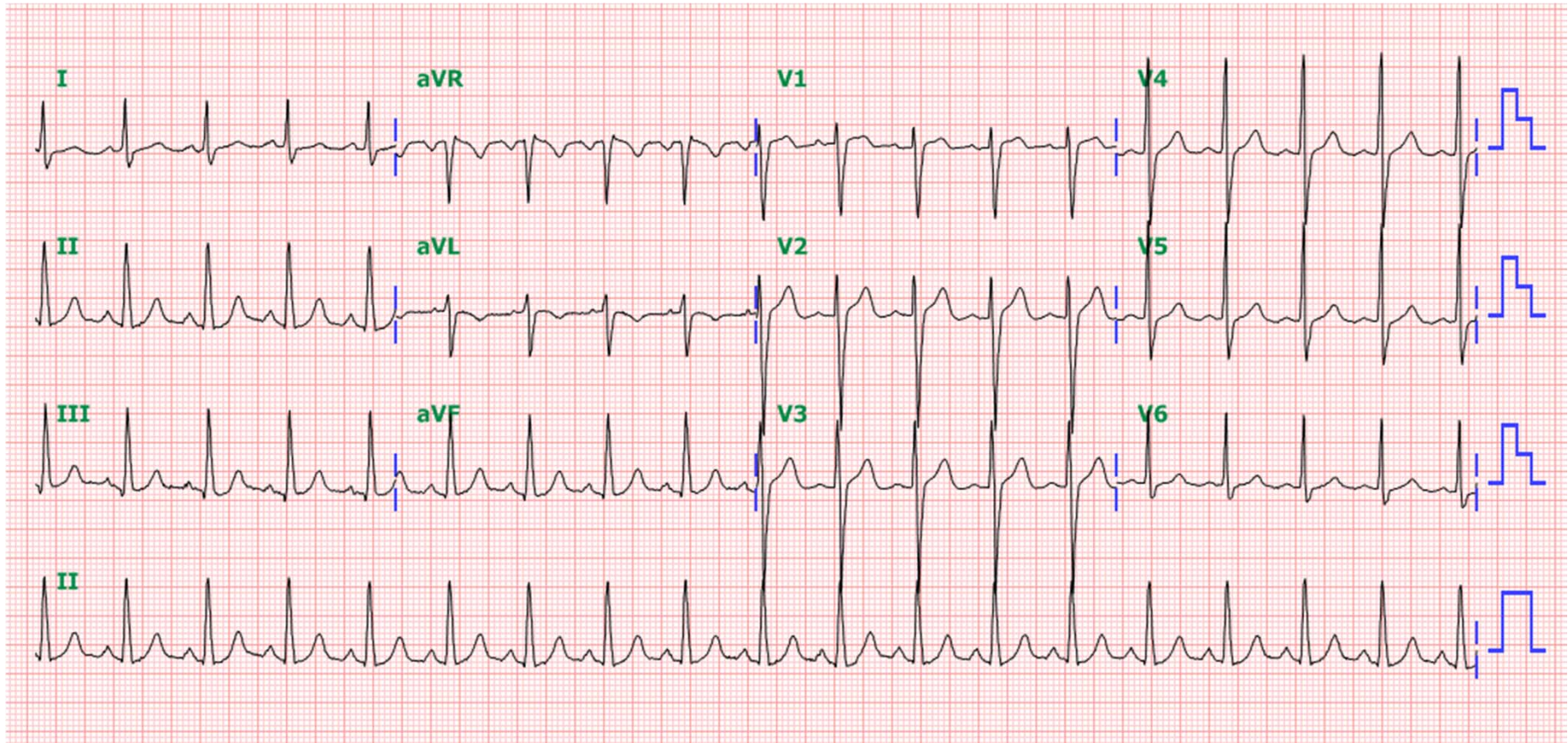# Preoperative Risk Stratification in Patients with HF for Non-Cardiac surgery
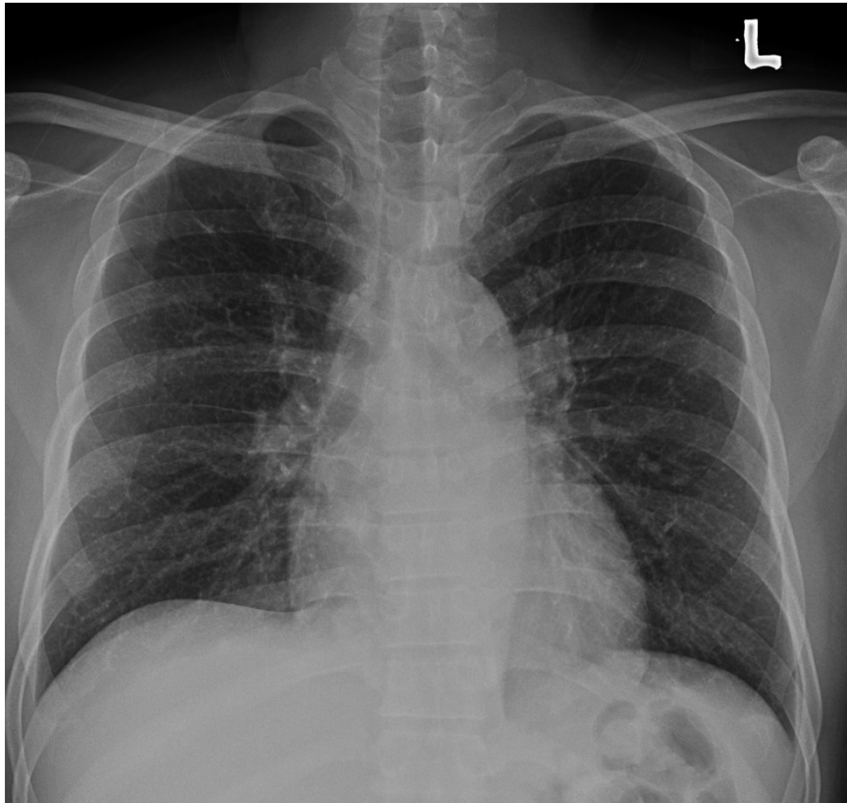
성균관의과대학 삼성서울병원

순환기내과 최진오

Case

- M/51
- 방광종양으로 TUR-B 시행 받은 환자
- 수술 후 respiratory distress 보이며 hypoxia 있어 응급 consultation됨
- 수개월전 고혈압성 심장질환이라 듣고 약 복용 중
- BP 80/50mmHg, HR 115, RR 22/min
- Neck vein distension (+), rale (+)
- 수술 전후 수액이 약 2500cc infusion 되었음

ECG
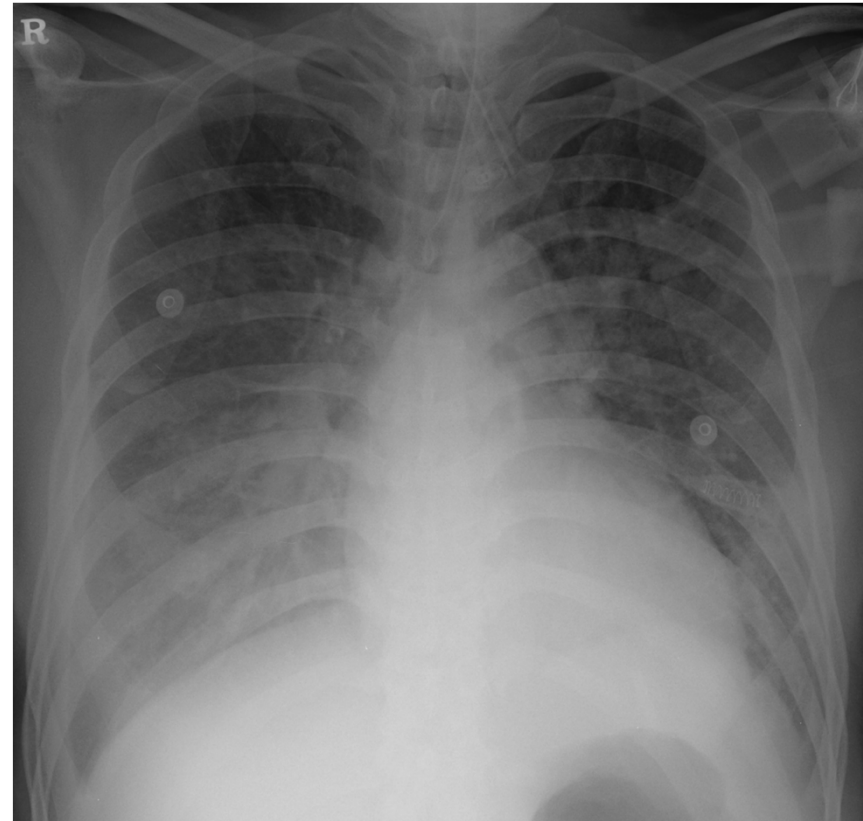
CPA

PreOp

PostOP

EchoCG

LVEF 26%
LVEDD/ESD= 66/54mm
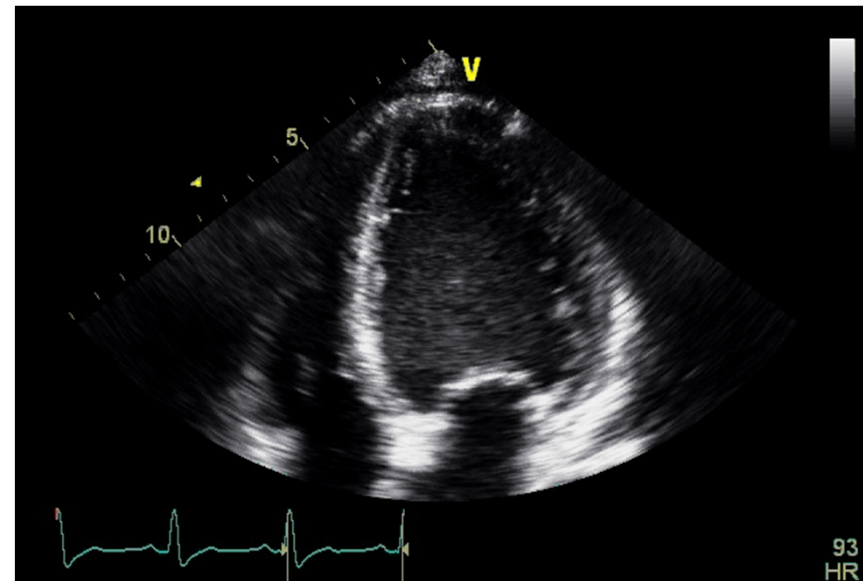**Mild MR**
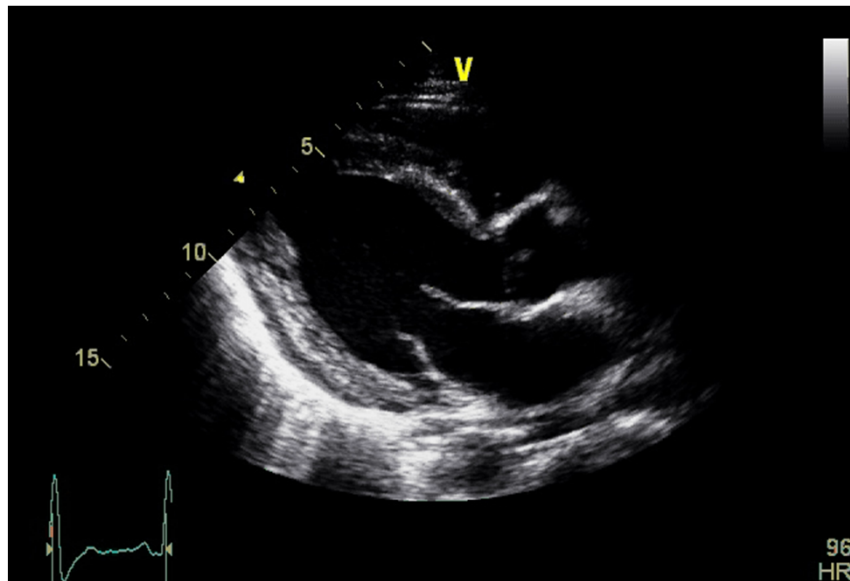
Hospital course

- IV lasix 사용후 증상호전
- ACEi, BB, oral diuretic 사용 후 호전
- NTproBNP F/U
  HD#2: 7316 pg/ml
  HD#13: 580 pg/ml
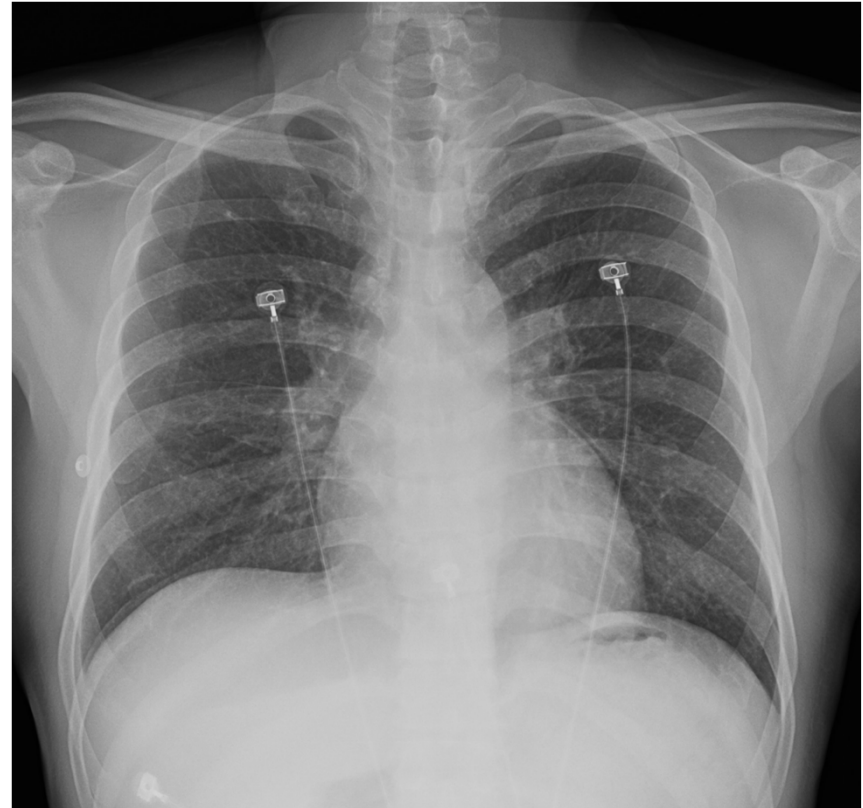
Perioperative HF in noncardiac surgery

- HF as a risk factor
  - Preoperative HF as a risk factor for other cardiac complications after surgery

- HF as a perioperative event
  - Postoperative HF as a cardiac complication of noncardiac surgery

Perioperative HF

- HF occurs in 1~6% after major surgery
  - Risk 6-25% in CAD, prior HF or VHD
  - DM, renal failure, high risk vascular surgery
  - Intraop excessive volume of fluid administered

Goldman, NEJM 1977

A multi-factorial index of cardiac risk in the non-cardiac surgical setting.

Nine independent risk factors are evaluated on a point scale:

• Third heart sound (S3)	11	→ N/A
• Elevated jugular venous pressure	11	→ chest PA congestion!
• Myocardial infarction in past 6 months	10	
• ECG: premature arterial contractions or any rhythm other than sinus	7	
• ECG shows >5 premature ventricular contractions per minute	7	
• Age >70 years	5	
• Emergency procedure	4	
• Intra-thoracic, intra-abdominal or aortic surgery	3	
• Poor general status, metabolic or bedridden	3	→ functional class IV

Scores <6   → Death 0.2%, Cardiovascular complication 0.2%

Scores <26   → Death 4%,   Cardiovascular complication 17%

Scores >25   → Death 56%, Cardiovascular complication 22%

HF AS A RISK FACTOR FOR POSTOPERATIVE CARDIAC COMPLICATIONS

Revised Goldman cardiac risk index (RCRI)

Six independent predictors of major cardiac complications

High-risk type of surgery (examples include vascular surgery and any open intraperitoneal or intrathoracic procedures)

History of IHD (history of MI or a positive exercise test, current complaint of chest pain considered to be secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q waves; do not count prior coronary revascularization procedure unless one of the other criteria for IHD is present)

History of HF

History of cerebrovascular disease

DM requiring treatment with insulin

Preoperative serum creatinine >2.0 mg/dL (177 µmol/L)

Rate of cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest

No risk factors - 0.4 percent (95% CI: 0.1-0.8)

One risk factor - 1.0 percent (95% CI: 0.5-1.4)

Two risk factors - 2.4 percent (95% CI: 1.3-3.5)

Three or more risk factors - 5.4 percent (95% CI: 2.8-7.9)

ACC/AHA guideline 2007 on perioperative care for noncardiac surgery

Table 2. Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery (Class I, Level of Evidence: B)

Condition	Examples
Unstable coronary syndromes	Unstable or severe angina* (CCS class III or IV)†
	Recent MI‡
Decompensated HF (NYHA functional class IV; worsening or new-onset HF)	
Significant arrhythmias	High-grade atrioventricular block
	Mobitz II atrioventricular block
	Third-degree atrioventricular heart block
	Symptomatic ventricular arrhythmias
	Supraventricular arrhythmias (including atrial fibrillation) with uncontrolled ventricular rate (HR greater than 100 beats per minute at rest)
	Symptomatic bradycardia
	Newly recognized ventricular tachycardia
Severe valvular disease	Severe aortic stenosis (mean pressure gradient greater than 40 mm Hg, aortic valve area less than 1.0 cm^2, or symptomatic)
	Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)

ACC/AHA guideline 2007 on perioperative care for noncardiac surgery

Table 2.   Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery (Class I, Level of Evidence: B)

Decompensated HF
- ## NYHA Fc IV
- ## Worsening HF
- ## New-onset HF

Symptomatic ventricular arrhythmias

Supraventricular arrhythmias (including atrial fibrillation) with uncontrolled ventricular rate (HR greater than 100 beats per minute at rest)

Symptomatic bradycardia

Newly recognized ventricular tachycardia

Severe valvular disease

Severe aortic stenosis (mean pressure gradient greater than 40 mm Hg, aortic valve area less than 1.0 cm^2, or symptomatic)

Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)

Preop Evaluation

- **F/75**
- **고령 환자로 Bladder tumor로 수술 예정입니다.**
- **Preop cardiac Risk evaluation 으로 echocardiography 시행 위해 의뢰드리오니 고진 선처 부탁 드립니다.**

ACC/AHA guideline 2007 on perioperative care for noncardiac surgery

Recommendations for Preoperative Noninvasive Evaluation of LV Function

CLASS IIa

1. It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function.

Level of Evidence: C

2. It is reasonable for patients with current or prior HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function if not performed within 12 months.

Level of Evidence: C

CLASS IIb

1. Reassessment of LV function in clinically stable patients with previously documented cardiomyopathy is not well established.

Level of Evidence: C

CLASS III

1. Routine perioperative evaluation of LV function in patients is not recommended.

Level of Evidence: B

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Comparative prognostic value of clinical risk indexes, resting 2D echocardiography, and dipyridamole stress thallium-201 myocardial imaging for perioperative cardiac events in major nonvascular surgery patients.
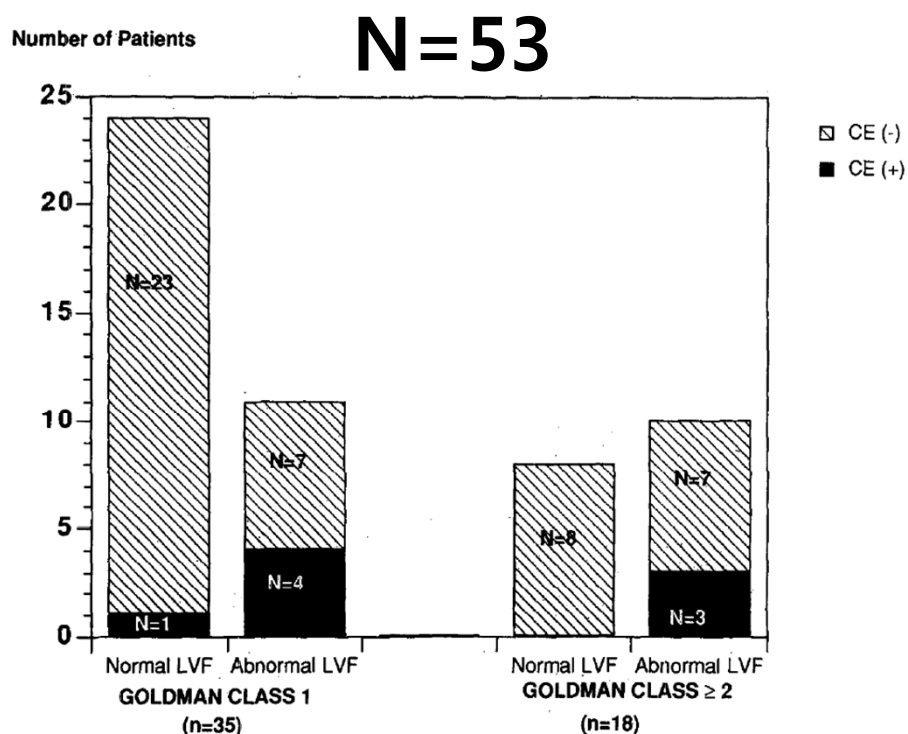
N=53

Fig. 2. Incidence of postoperative pulmonary edema in 53 patients, stratified by Goldman class and echocardiographic left ventricular function. (CE, Cardiac events.)

Table IV. Significant predictors by univariate and multivariate regression analysis for postoperative cardiac events (A), death and myocardial infarction (B), pulmonary edema (C).

Predictors	Any cardiac events	
	Univariate p value	Multivariate p value
A		
ECHO LV systolic dysfunction	0.007	0.042
Redistribution of thallium	0.002	0.026
History of MI	0.054	0.292
Usage of nitrate	0.072	0.459
B		
Redistribution of thallium	0.026	0.018
Thallium fixed defects	0.074	0.023
Usage of nitrate	0.067	0.369
C		
Echo LV systolid dysfunction	0.003	0.023
Redistribution of thallium	0.004	0.076
Fixed thallium defect	0.055	0.316
Usage of nitrate	0.017	0.093

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Annals of Internal Medicine

Echocardiography for Assessing Cardiac Risk in Patients Having Noncardiac Surgery

Ethan A. Halm, MD; Warren S. Browner, MD, MPH; Julio F. Tubau, MD; Ida M. Tateo, MS; and Dennis T. Mangano, PhD, MD, for the Study of Perioperative Ischemia Research Group

Patients: 339 consecutive men who were known to have or were suspected of having coronary artery disease and were scheduled for major noncardiac surgery.

Measurements: Information from detailed histories, physical examinations, and electrocardiographic and laboratory studies was routinely collected. Transthoracic echocardiography was done before surgery to assess ejection fraction, wall motion abnormalities (reported as the wall motion score [range, 5 to 25 points]), and left ventricular hypertrophy

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- **LVEF less than 40% was a significant predictor of the combined cardiac outcome of postoperative cardiac ischemia, HF, and ventricular tachycardia**

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Incremental Value of Echocardiographic Information over Clinical Risk Factors for Predicting All Cardiac Complications

| Prediction model (n=339)	Sensitivity	Specificity	PPV	NPV	Accuracy	C-statistics
Clinical model	0.06	0.98	0.50	0.81	0.81	0.69
Clinical model + EF*	0.14	0.98	0.60	0.83	0.82	0.71
Clinical model + EF <30%	0.12	0.98	0.67	0.82	0.82	0.70
Clinical model + EF <40%	0.17	0.98	0.73	0.83	0.83	0.70
Clinical model + EF <50%	0.03	0.98	0.33	0.81	0.80	0.70
Clinical model + WMSI	0.11	0.98	0.54	0.82	0.81	0.71

Annals of Internal Medicine

Echocardiography for Assessing Cardiac Risk in Patients Having Noncardiac Surgery

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- **LVEF less than 40 percent was a significant predictor of the combined cardiac outcome of postoperative cardiac ischemia, HF, and ventricular tachycardia**

- **Conclusions: The data did not support the use of transthoracic echocardiography for the assessment of cardiac risk before noncardiac surgery. Echocardiographic measurements had limited prognostic value and suboptimal operating characteristics.**

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Comparison of Transthoracic Echocardiography with NT-proBNP as a Tool for Risk Stratification of Patients Undergoing Major Noncardiac Surgery

Comparison of risk predictors
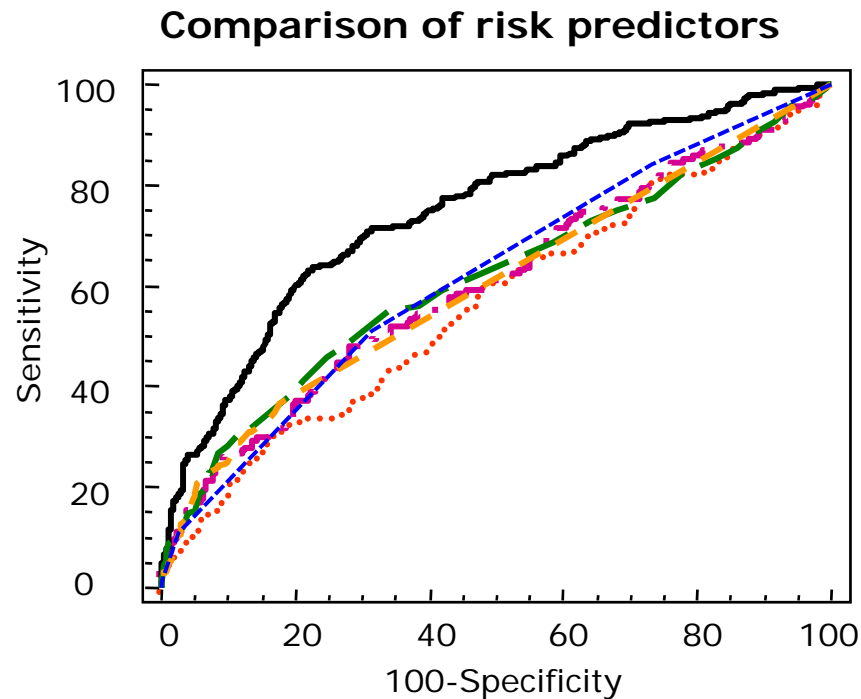
N=1923

Conclusions: Preoperative echocardiography was modestly predictive of perioperative cardiovascular events but was inferior to NT-proBNP. Moreover, it did not show an incremental value to the clinically determined risk. Our results did not support routine evaluation of echocardiography before non-cardiac surgery.

——————	NT-proBNP	0.748 (95% CI = 0.727 – 0.768)
- - - - - -	RCRI	0.622 (95% CI = 0.599 – 0.644)
— — —	LVEF	0.614 (95% CI = 0.591 – 0.637)
— — —	RWMI	0.603 (95% CI = 0.580 – 0.626)
–·–·–·–	LA volume index	0.593 (95% CI = 0.599 – 0.659)
··········	E/E`	0.567 (95% CI = 0.536 – 0.597)

SJ Park et al KCJ in press

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ESC guideline 2009

Recommendations on resting echocardiography

Recommendations	Class[a]	Level[b]
Rest echocardiography for LV assessment should be considered in patients undergoing high-risk surgery	IIa	C
Rest echocardiography for LV assessment in asymptomatic patients is not recommended	III	B

[a]Class of recommendation.
[b]Level of evidence.
LV = left ventricular.

Comparative prognostic value of clinical risk indexes, resting 2D echocardiography, and dipyridamole stress thallium-201 myocardial imaging for perioperative cardiac events in major nonvascular surgery patients.
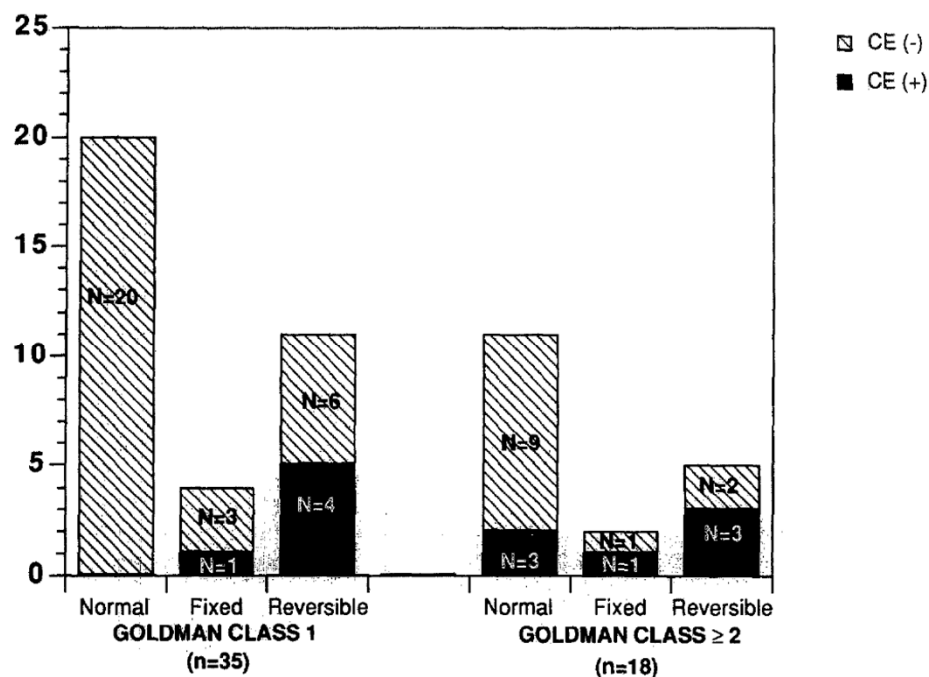

Fig. 1. Incidence of postoperative cardiac events in 53 patients, stratified by Goldman class and dipyridamole thallium scintigraphy. (CE, Cardiac events.)

Table IV. Significant predictors by univariate and multivariate regression analysis for postoperative cardiac events (A), death and myocardial infarction (B), pulmonary edema (C).

Predictors	Univariate p value	Multivariate p value
	Any cardiac events	
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Value of myocardial viability estimation using dobutamine stress echocardiography in assessing risk preoperatively before noncardiac vascular surgery in patients with LVEF<35%
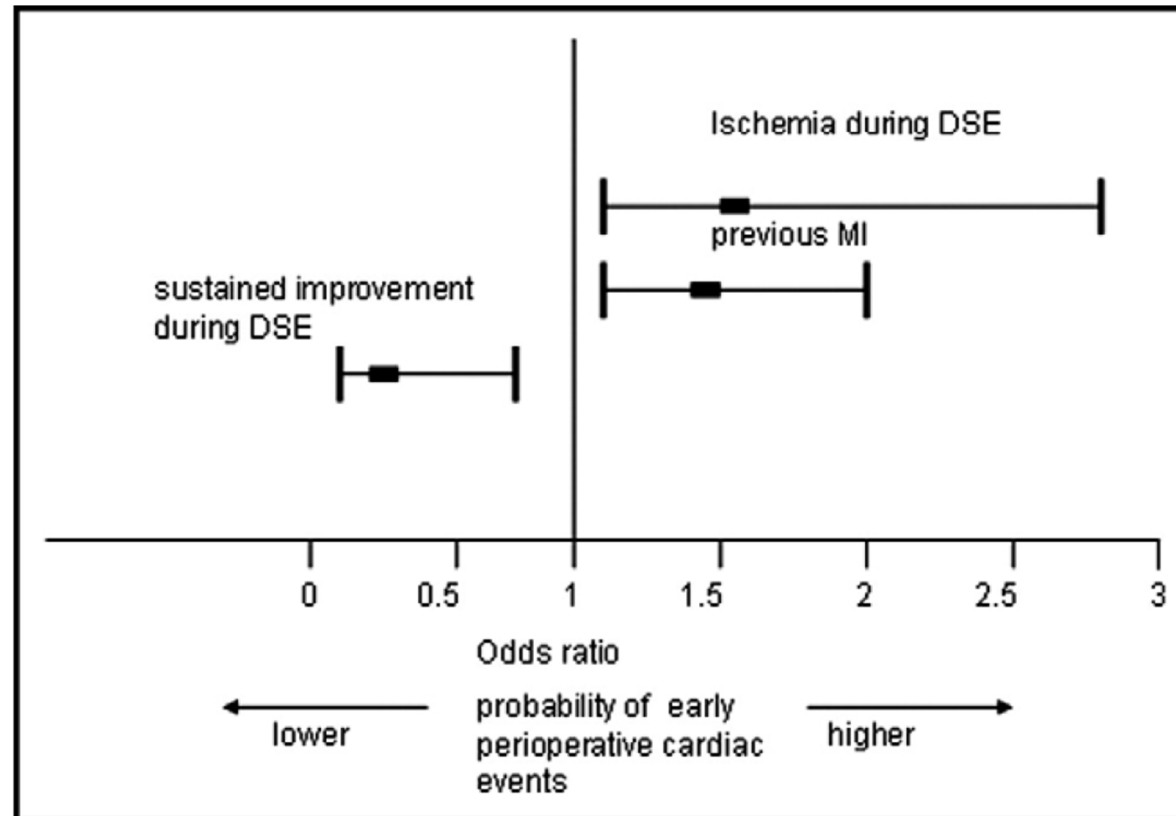
N=295

Independent multivariate predictors of cardiac events within 30 days after major vascular surgery in patients with LV ejection fraction < 35%.

Exercise tolerance

Poor exercise tolerance, as measured by patient self report, predicts serious postoperative events including cardiac events

Inability to walk four blocks and climb two flights of stairs was 71 percent sensitive and 47 percent specific for serious postoperative complications

Table 4. Patient Characteristics Associated With an Increased Risk for All Serious Perioperative Complications*

Patient Characteristics	No. of Patients With Complications/Total	Odds Ratios (95% CI)†	
		Age-Adjusted	Multivariable Model‡
Poor exercise tolerance	70/343	2.13 (1.33-3.42)	1.94 (1.19-3.17)
Smoking ≥20 pack-years	59/280	2.01 (1.29-3.13)	2.16 (1.36-3.44)
Coronary disease	32/142	1.64 (1.01-2.66)	NS
Peripheral vascular disease	20/76	1.97 (1.12-3.48)	NS
Prior myocardial infarction	19/72	1.98 (1.11-3.54)	NS
Congestive heart failure	19/52	3.38 (1.83-6.26)	2.88 (1.52-5.48)
Ventricular arrhythmia	14/44	2.55 (1.29-5.03)	NS
Dementia	5/10	4.54 (1.26-16.33)	5.54 (1.51-20.41)
Parkinson disease	5/8	8.26 (1.93-35.37)	8.14 (1.76-37.67)

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Summary of preop screening for HF

- Value of detecting LV dysfunction preoperatively is less clear
  - Cost of test
  - Limited evidence of demonstrable benefit
  - Lack of data on how results should affect management

- No recommendation for routine preoperative echocardiography or other LV functional testing either
  - To detect previously unidentified HF
  or
  - To evaluate known HF that appears clinically compensated

- Recommended for patients with dyspnea of unknown origin, and for patients with current or prior HF with worsening dyspnea or other change in clinical status

- Assessing exercise capacity by asking patients the number of blocks they can walk and the number of stairs they can climb appears to be an inexpensive way to stratify risk

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Preop Mx of HF patients Principle

- Perioperative cardiac risk
  - Roughly doubled if preop clinical signs of HF (+)

- History of HF (+) and Sx (-)
  - should continue HF medication

- Decompensated HF should be treated before surgery
- Delay of surgery may be appropriate until stablized

  - Cf) Limited evidence that treatment of HF reduces this risk

Case

F/63

Obstructive jaundice

Hx of Breast cancer, chemoTx related DCM

Whipple operation 수술 전 심장 위험도 평가 위해 의뢰됨

On ARB, BB, and Diuretics

Chest pain (-), dyspnea (-)

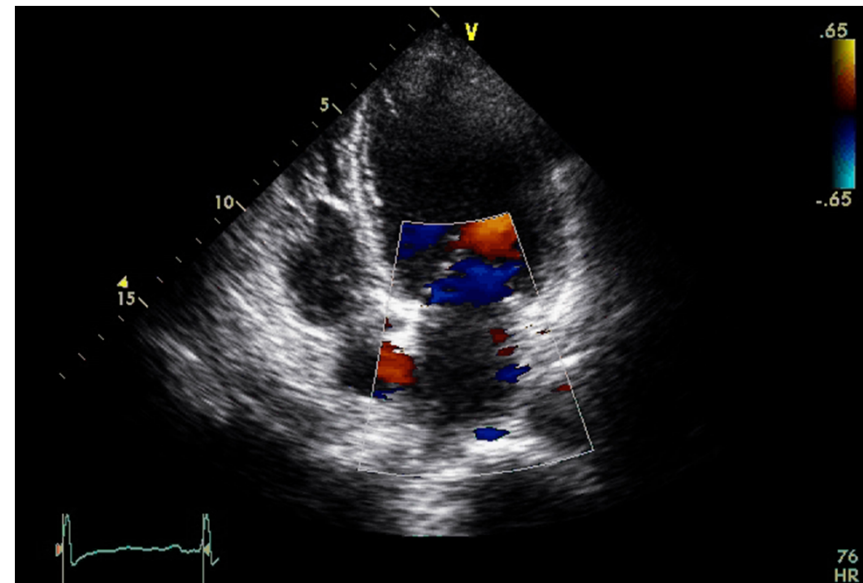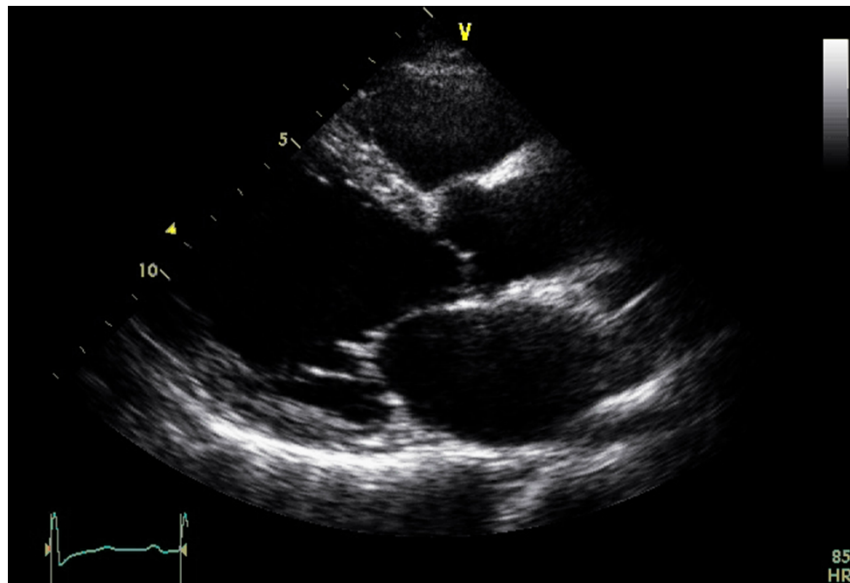**BP 116/64, HR 78**

Rale (-)

Na 140, Cr 0.38, NT-proBNP 473 pg/ml
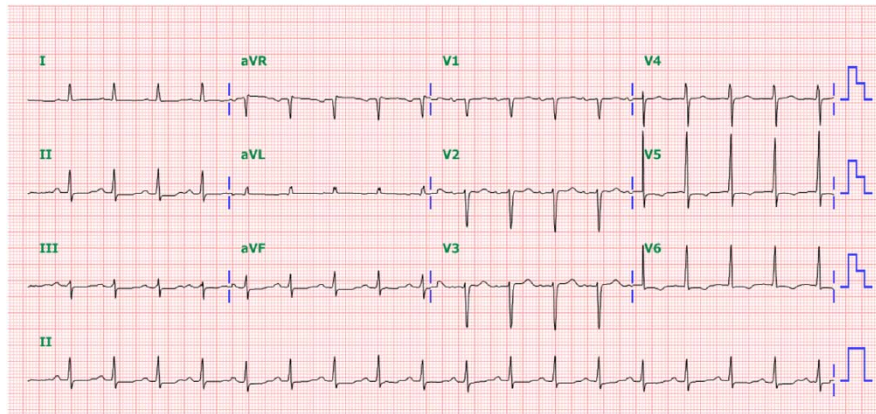
Echo

LV EDD/ESD=62/50 mm

EF=30%

E/E' 19.3

RVSP = 26mmHg

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Intraoperative fluid management

- "Avoid volume overload and careful monitor…"

회신

1. Active cardiac condition
   – ACS: (-)
   – Decompensated HF: (-)
   – Significant arrhythmia: (-)
   – Severe valvular disease: (-)
2. Clinical risk factors
   – Hx of CAD: (-)
   – Hx of HF: (+)
   – Hx of CVA: (-)
   – DM: (-)
   – HTN: (-)
   – CKD: (-)
3. Functional class: > 4 Mets

회신

- 이 환자의 수술 중 및 수술 후 심혈관 질환 발병위험도는 moderate 입니다.
- 수술 후 3일간 ECG, cardiac enzyme, CXR F/U 및 NT-proBNP 1회 F/U하시기 바랍니다.
- 흉통, 호흡곤란, hemodynamic instability 발생 시 순환기내과 연락바랍니다
- 외래 약물(ARB, BB, diuretics) 유지하세요
- 수술전 마취과 의뢰하여 periop cardiac event 및 fluid control에 유의하고 특히 volume overload되지 않도록 주의가 필요합니다.

Recommendations for Perioperative Use of Pulmonary Artery Catheters (PAC)

CLASS IIb

1. Use of a PAC may be reasonable in patients at risk for major hemodynamic disturbances that are easily detected by a PAC; however, the decision must be based on 3 parameters: patient disease, surgical procedure (ie, intraoperative and postoperative fluid shifts), and practice setting (experience in PAC use and interpretation of results), because incorrect interpretation of the data from a PAC may cause harm.
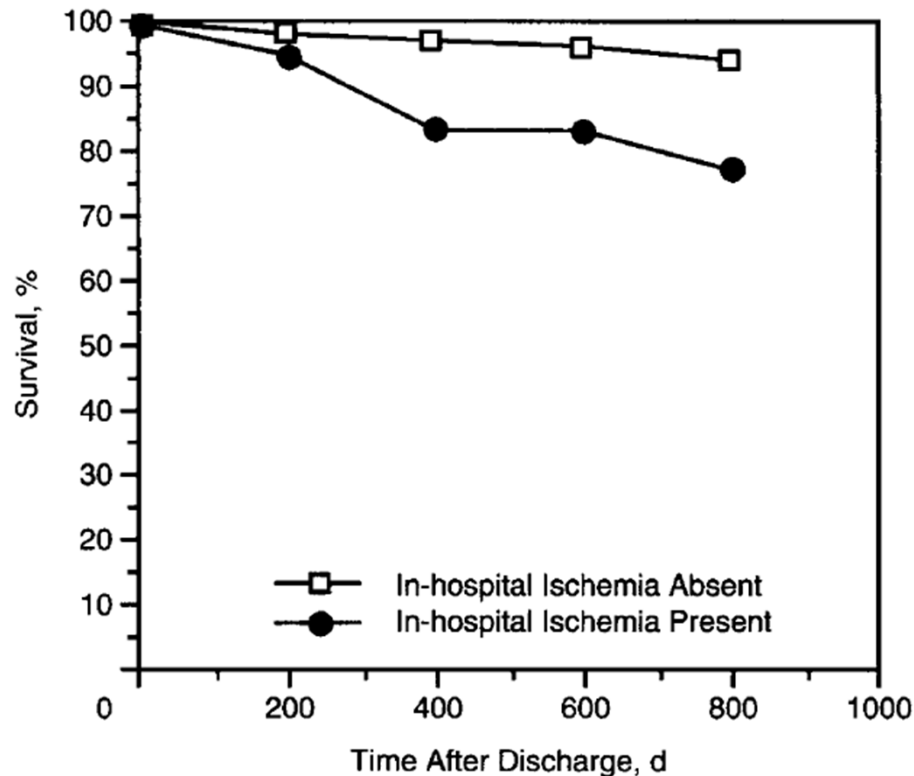
Level of Evidence: B

CLASS III

1. Routine use of a PAC perioperatively, especially in patients at low risk of developing hemodynamic disturbances, is not recommended.

Level of Evidence: A

Long-term Cardiac Prognosis Following Noncardiac Surgery

Fig 2.—Freedom from cardiac complications occurring after hospital discharge in patients with and without postoperative myocardial ischemia detected by ambulatory monitoring.

JAMA. 1992;268:233-239

- Postop MI or ischemia is major determinant of prognosis

- Postoperative pulmonary edema without myocardial ischemia
  - Not worse prognosis compared to pt without pulmonary edema

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Biomarkers

- Characteristic that can be objectively measured and evaluated and which is an indicator of abnormal biological and pathogenic processes or responses to therapeutic interventions

- cTnI, cTnT, BNP, NT-proBNP, CRP, etc

Biomarkers

- BNP/NT-proBNP
  - Produced in cardiac myocytes in response to increases in myocardial wall stress.
  - Important prognostic indicators in HF, ACS, and stable IHD in non-surgical settings

- Pre-operative BNP and NT-proBNP levels have additional prognostic value for long-term mortality and for cardiac events after major non-cardiac vascular surgery in several studies

Assessment of cardiac risk before non-cardiac surgery: brain natriuretic peptide in 1590 patients
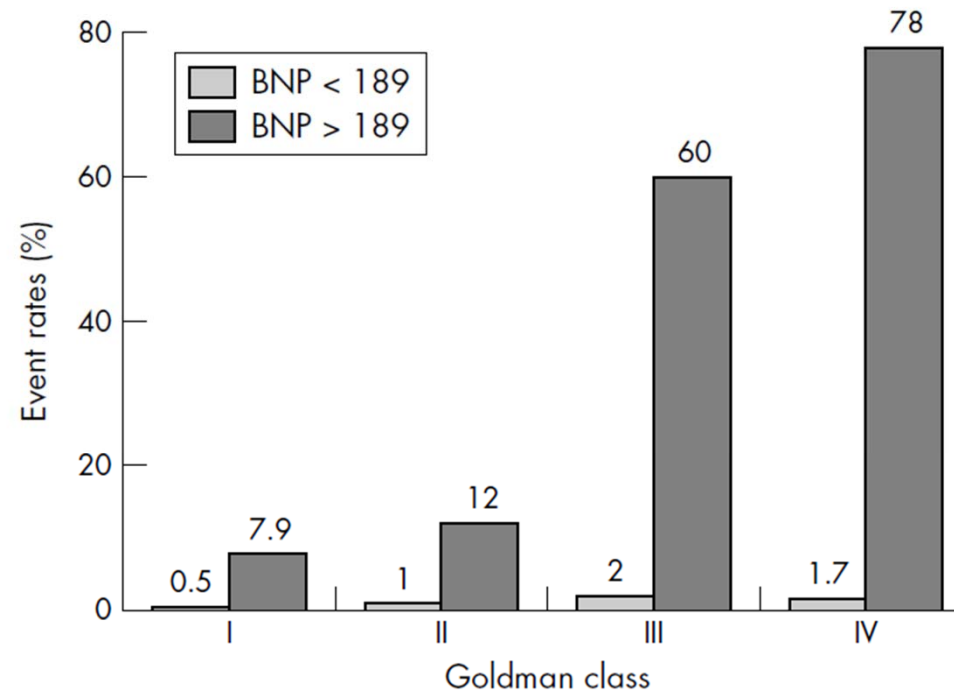
J Dernellis, M Panaretou

Figure 1 Predictive value of brain natriuretic peptide (BNP) in relation to presence or absence of events. Progressive increase in risk of events is stratified by the Goldman index. In each Goldman class BNP > 189 pg/ml identified a significantly increased risk than BNP ⩽ 189 pg/ml. Numeric values indicate percentage of event rates.

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ESC guideline 2009

Recommendations/statements on biomarkers

| Recommendations/statements	Class[a]	Level[b]
NT-proBNP and BNP measurements should be considered for obtaining independent prognostic information for perioperative and late cardiac events in high-risk patients.	IIa	B
Routine biomarker sampling to prevent cardiac events is not recommended	III	C

[a]Class of recommendation.
[b]Level of evidence.
BNP = brain natriuretic peptide; NT-proBNP = N-terminal pro-brain natriuretic peptide.

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Preoperative NT-proBNP and CRP predict perioperative major cardiovascular events in non-cardiac surgery

N=2054

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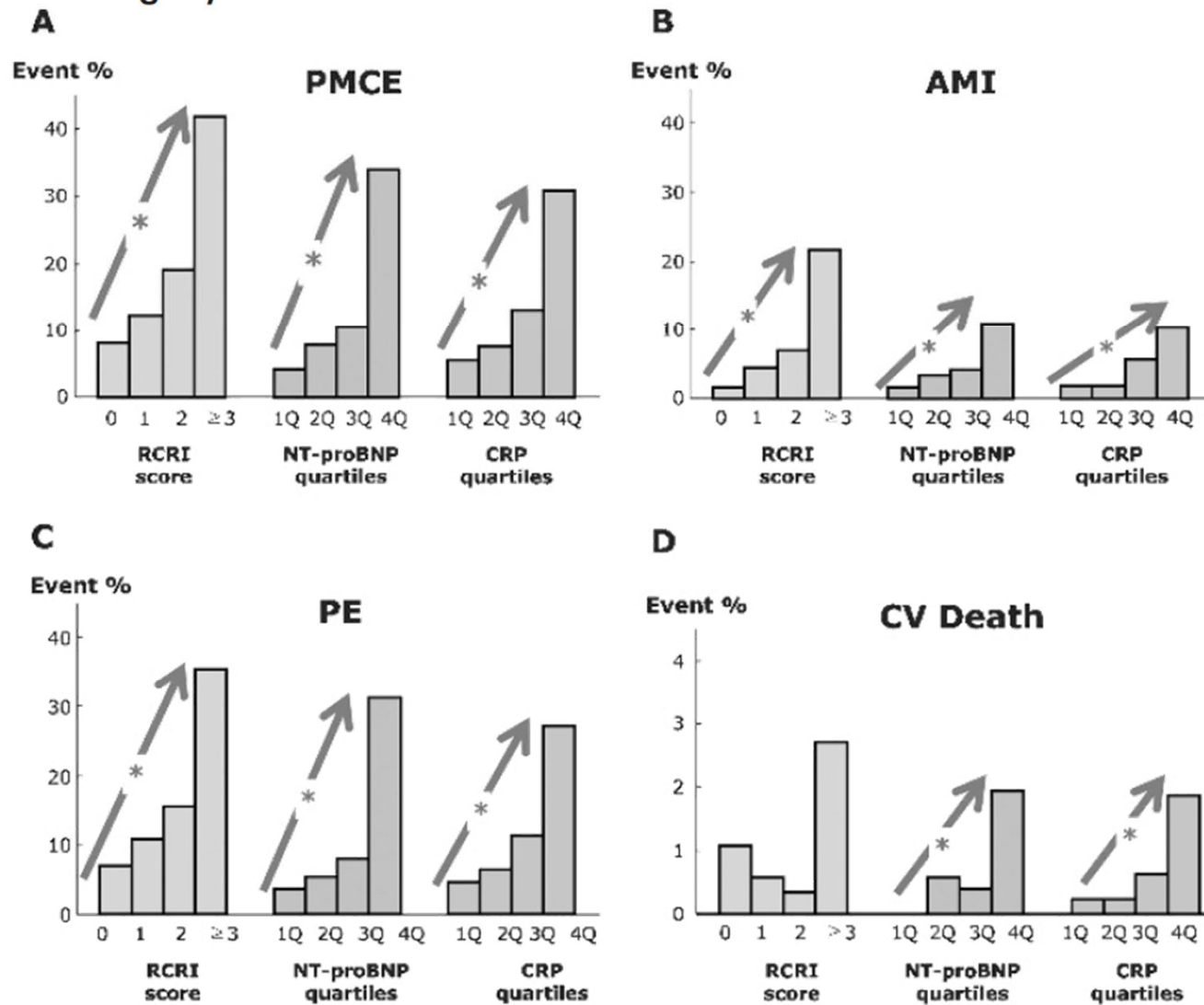
Take home messages

- Echocardiography is not routinely indicated for assessing LV systolic function in clinically stable patients.
  - Echocardiography is reasonable in patients with symptoms or signs of new or worsening HF.
  - BNP/NT proBNP can be useful in high risk group
  - History taking about the distance they can walk and number of stairs they can climb can help stratify risk.

- Signs of HF at the time of surgery probably confer greater risk than a history of prior HF that is compensated at the time of the preoperative examination.

- Without new or active myocardial ischemia, postoperative pulmonary edema does not affect long-term prognosis.