Management of Massive and Submassive Pulmonary Embolism

한양의대 내과

박태선

Topics – Pulmonary Embolism (PE)

- Pathophysiology
- Risk stratification
- Treatment in the acute phase

Case review

My Life and Pulmonary Embolism

`98	`99~`05	`05~`09	`10~`13	`13~`15	`16~
OO학원	의과대학, KMA	수련	공보의	임상강사	중환자실 전문의
	족보 저혈압 RV dysfunction Thrombolysis	**중환자실, 응급실** **Medical Alert Team** **Echo. @** Thrombolysis Urokinase?	**여수 병원선 511호** 고속버스 4.5 시간 No thrombophilia Survivial	**중환자실 6개월** Airway diseases VTE, PE, PH	**Shock** **Respiratory failure** **`17 심초음파 인증의** **`19 신속대응팀 창설** ER, GW ICU : acute PE

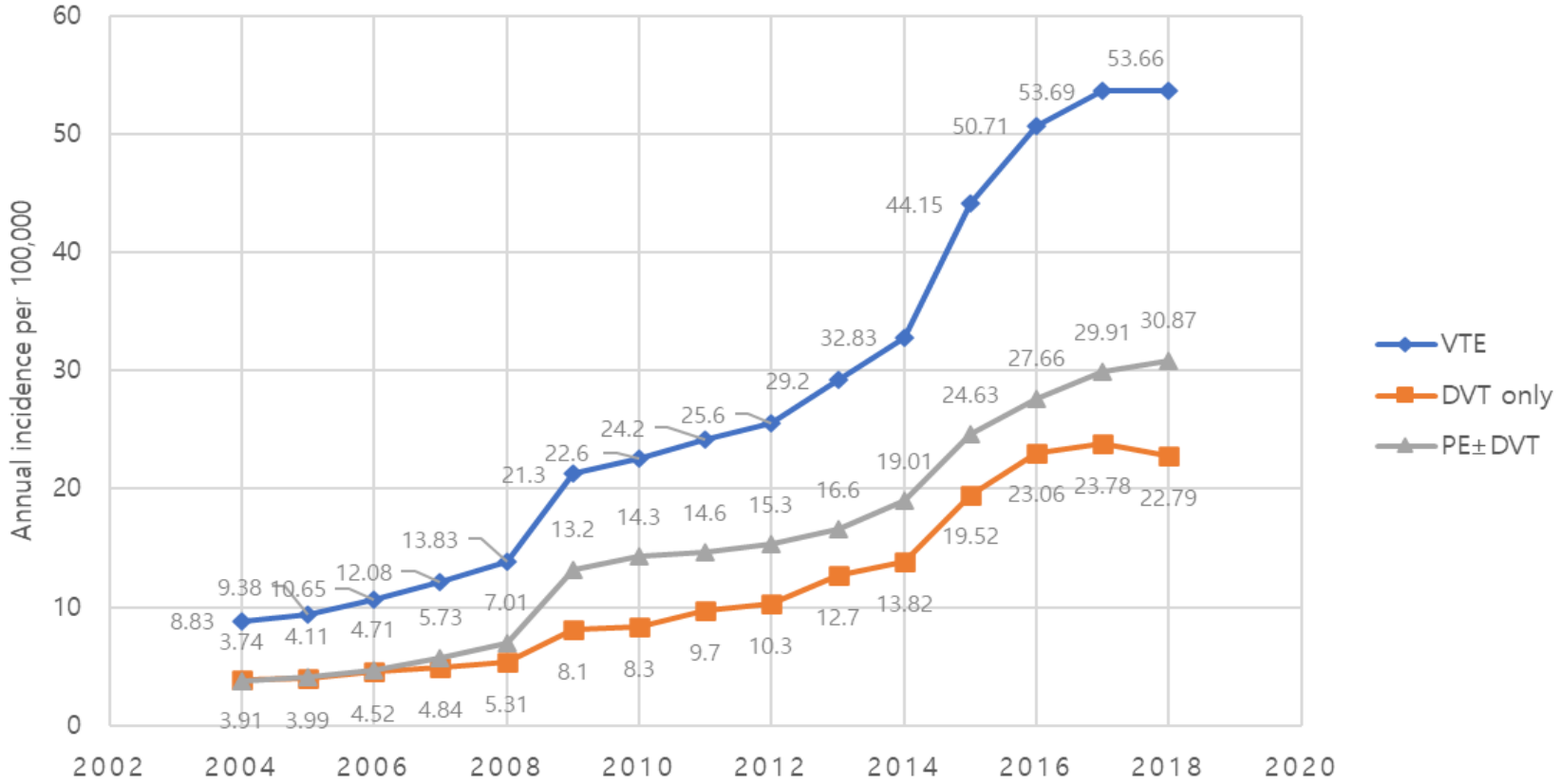
Annual Incidence of Venous ThromboEmbolism (VTE) in Korea

Old age

Operation

Knee/Hip op.

Cancer



J Korean Med Sci. 2022 May 2;37(17):e130

증례 1

F/75

C/C:

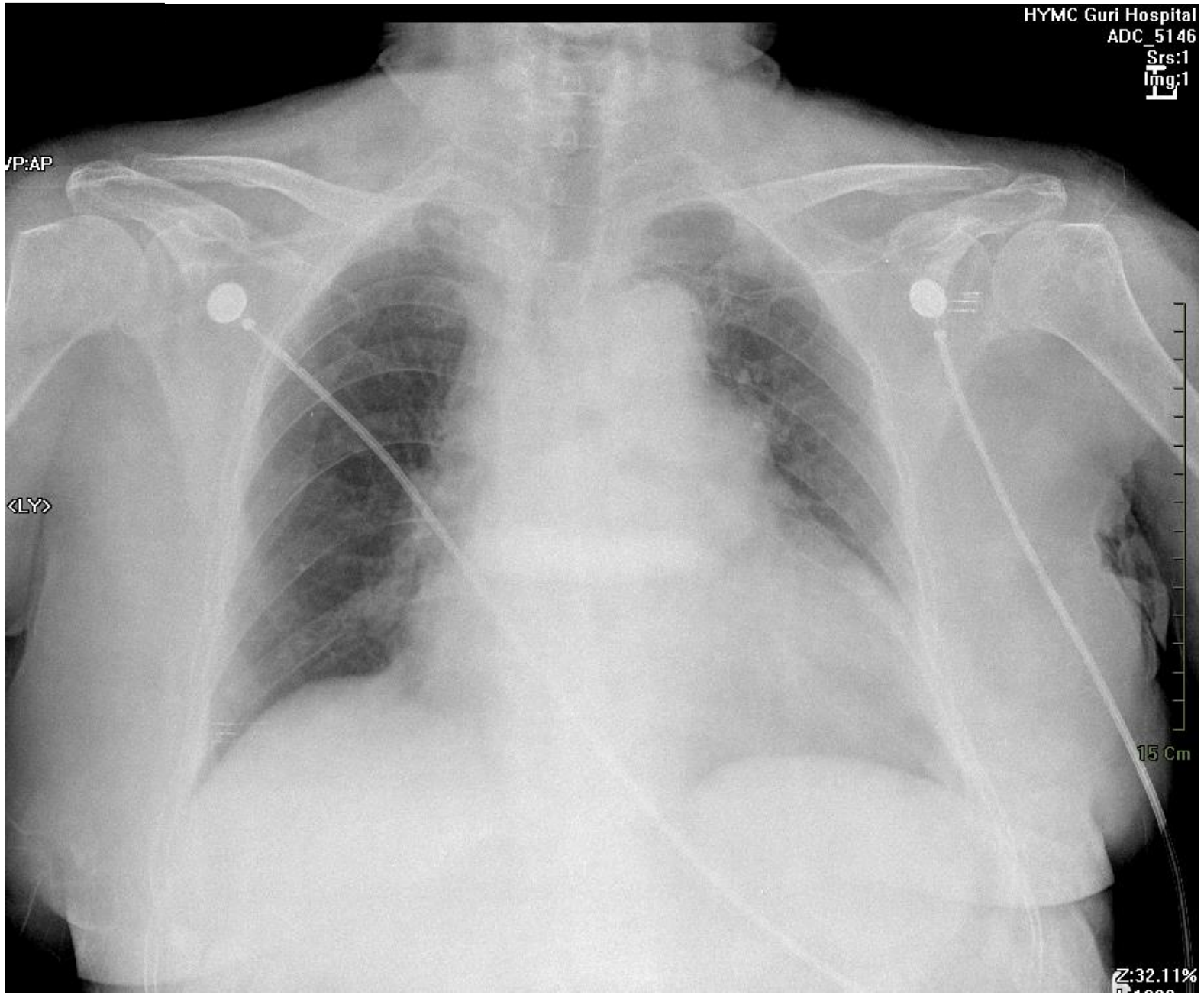
-dyspnea, NYHA II (onset: 3 weeks ago)

Brief Hx:

-3주 전부터 시작된 호흡곤란 발생, 1주전부터 악화

-심장내과 외래 통해 일반병실로 당일 입원

-입원 후 저산소성 호흡부전으로 입원 3시간 만에 중환자실로 전동


HYMC Guri Hospital
ADC_5146
Srs:1
Img:1
VP:AP
<LY>
15 Cm
Z:32.11%

Lab Findings

ABGA: 7.31 – 27.9 – **62.0** – 14.1

Lactate: **5.5** [0.7 – 2.5]

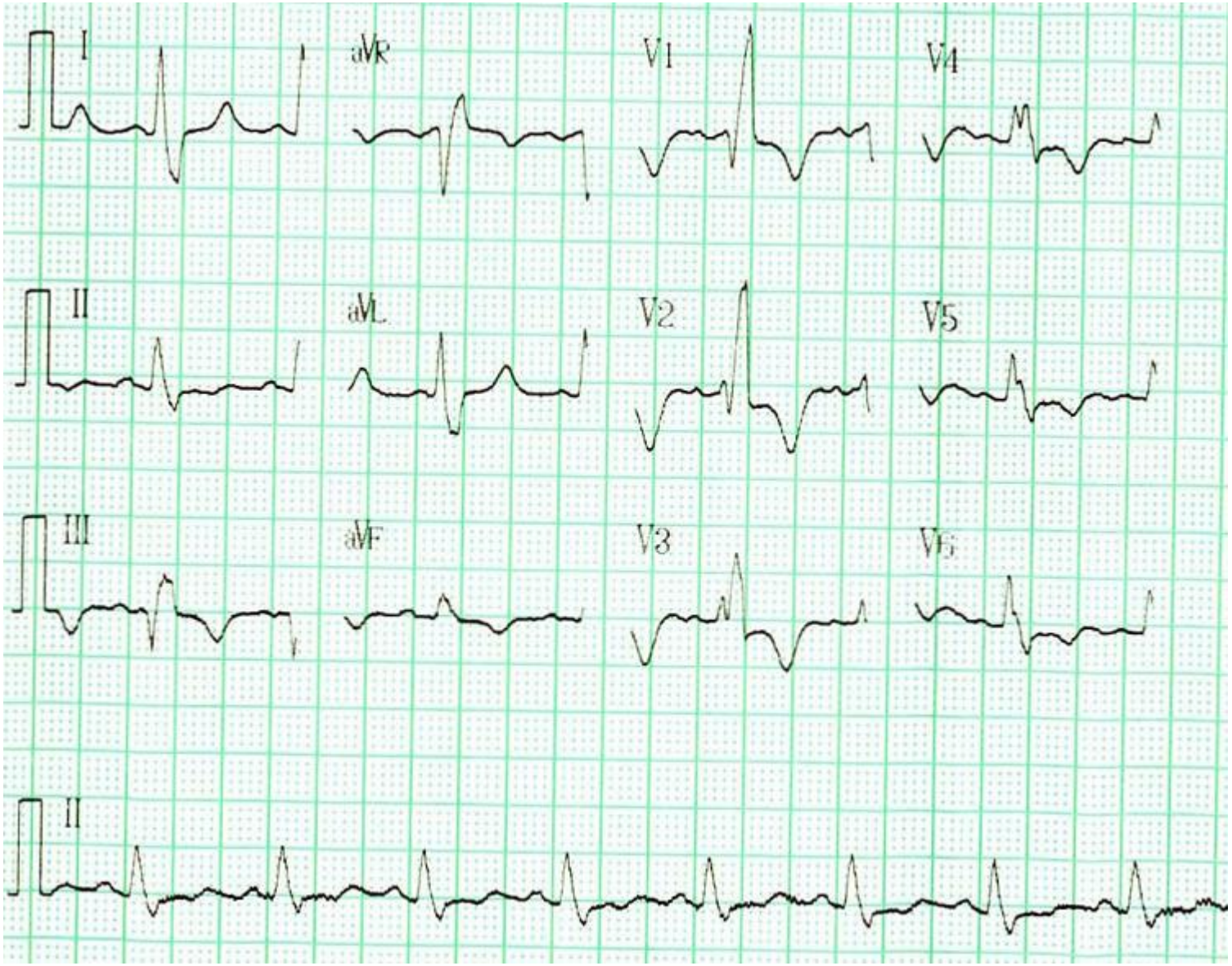
D-dimer: **978** [0 – 250]

BNP: **2821.0** [0 – 100]

CK-MB 6.2 [0.3 – 4]

TnI: **0.42** [0 – 0.04]

EKG



일반 병실에서의 경과

15:00 혈압 100/50, 심박수 96, **호흡수 44**, 체온 36.6, **산소포화도 77%**

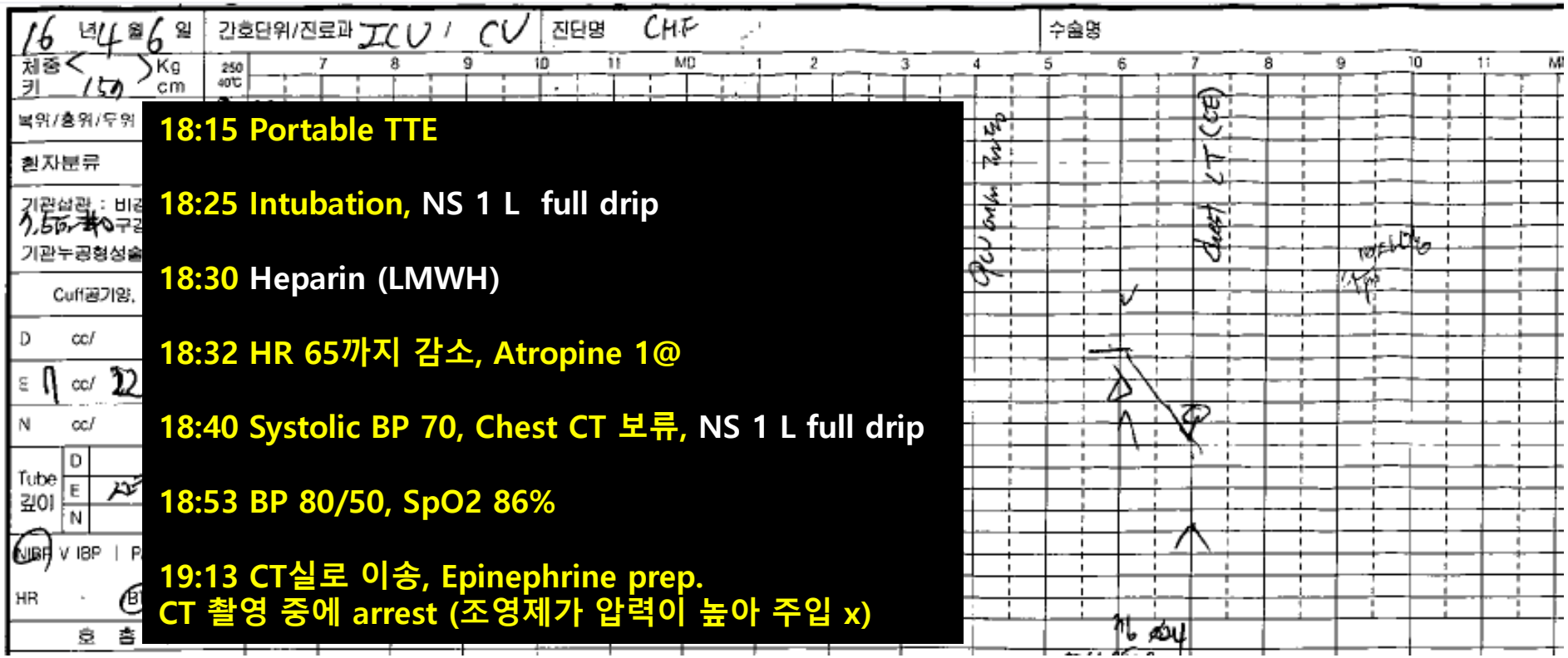
15:40 **혈압 70/50**, 심박수 100, 호흡수 32

O_2: nasal prong → reservoir bag 15 L/min

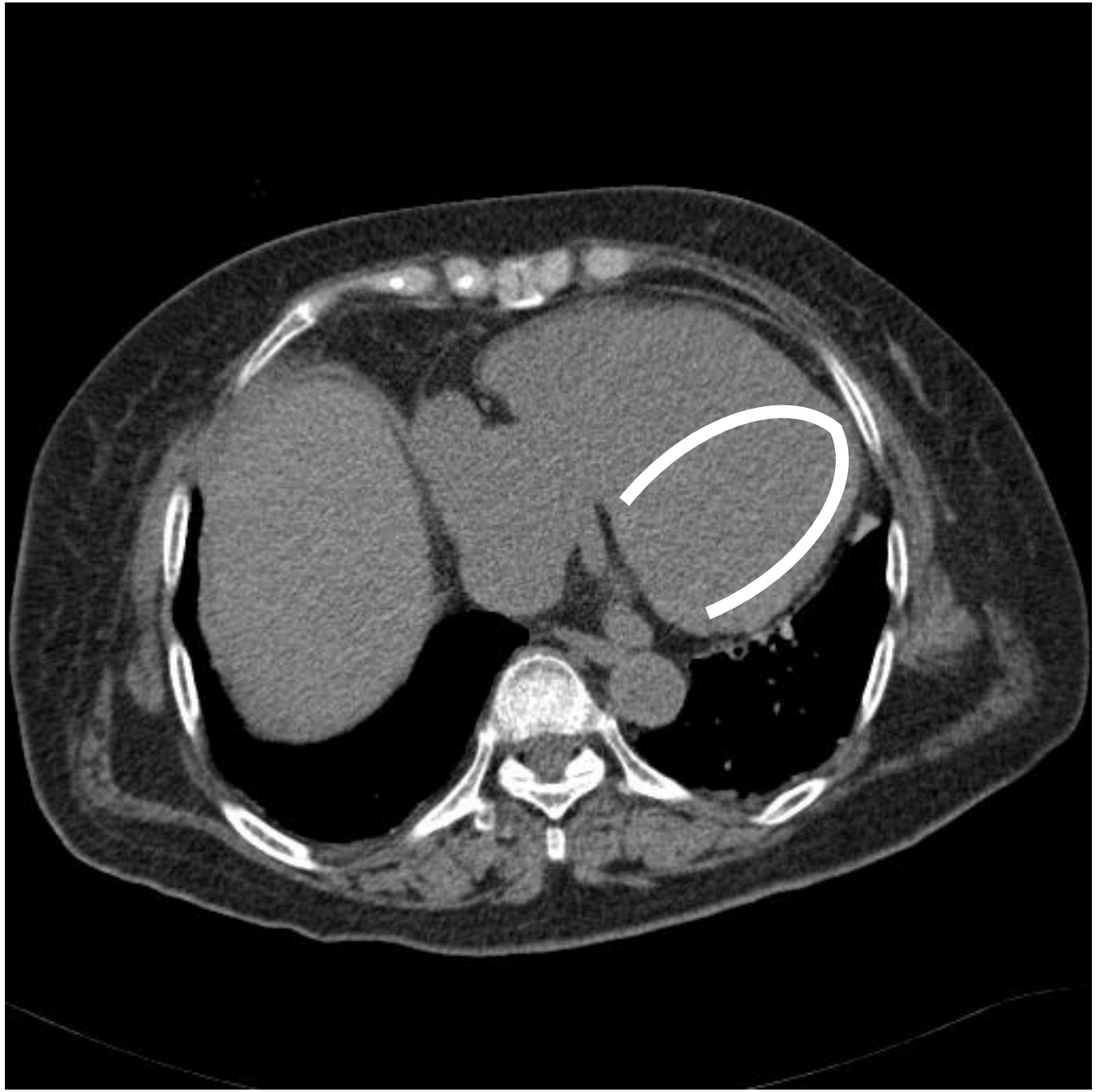
Dobutamine, NTG

18:00 ICU로 전동

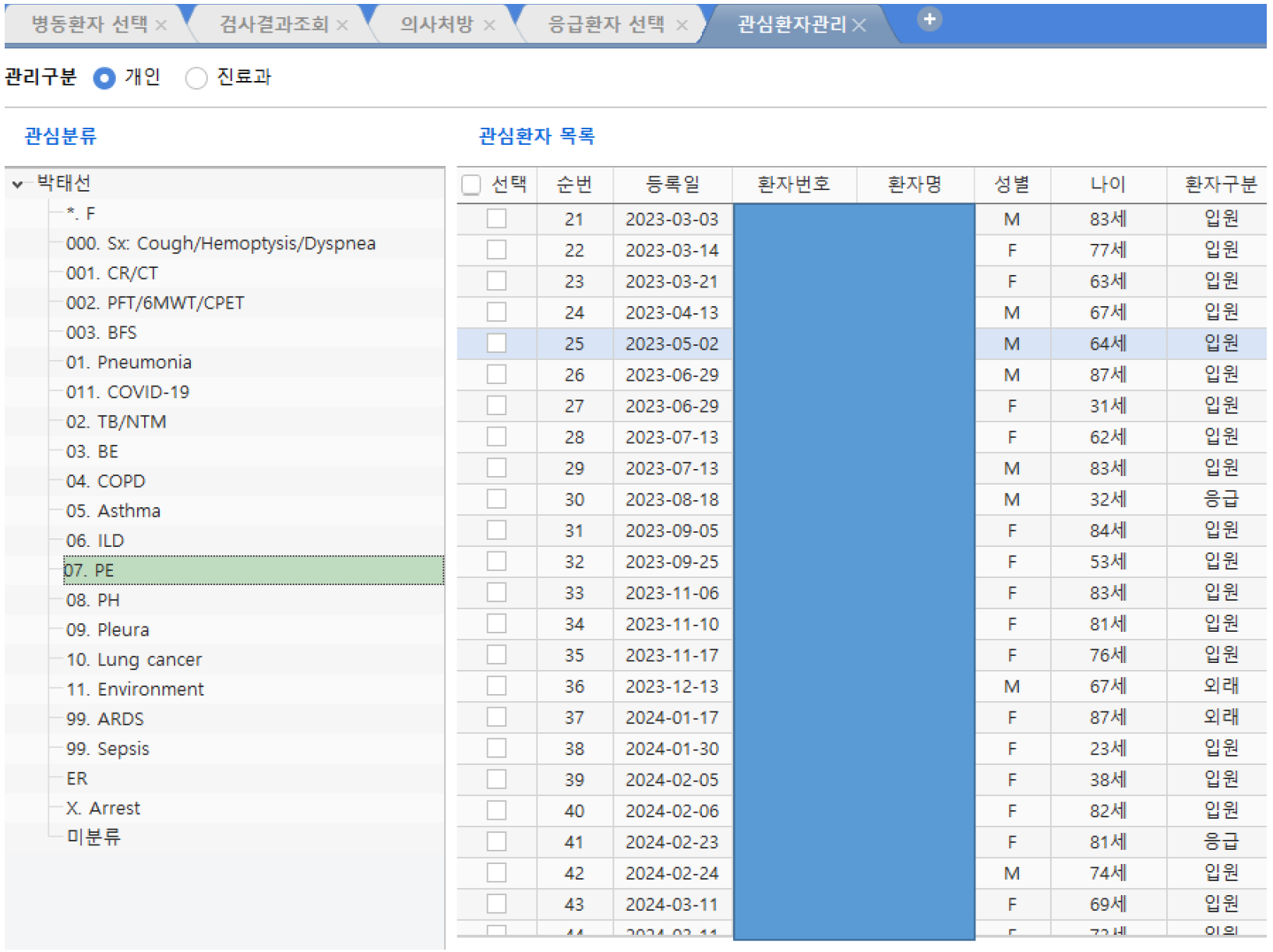
ICU에서의 경과



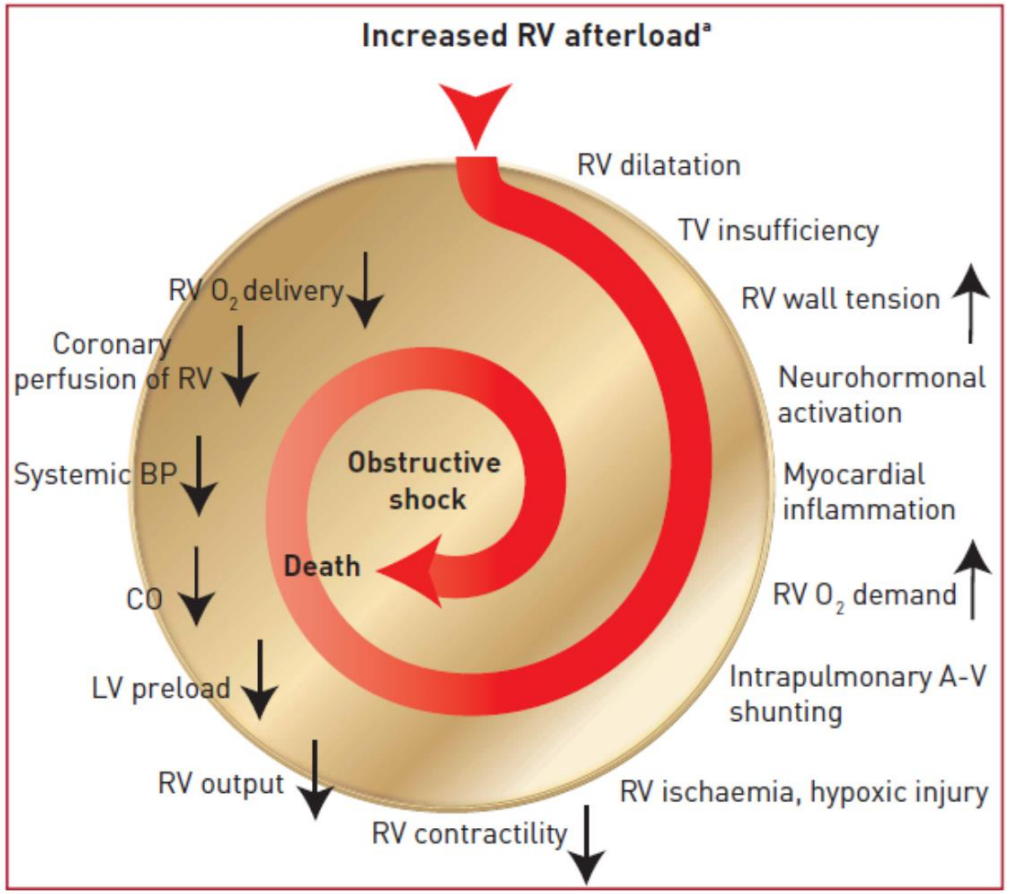
<Bedside Echocardiography Report>
Collapsed LV by RV dilatation
Pericardial effusion (-)
LV contractility는 정상이나 RV가 너무 커서 LV cavity가 거의 보이지 않을 정도임
RV는 거의 정지된 상태로 contraction이 없음
Pulmonary trunk 및 both main pulmonary artery를 관찰하였을 뚜렷한 embolism은 보이지 않았음.
Clinical impression: acute pulmonary thromboembolism and RV failure



PE Pt List


병동환자 선택
검사결과조회
의사처방
응급환자 선택
관심환자관리
관리구분
개인
진료과
관심분류
박태선
*. F
000. Sx: Cough/Hemoptysis/Dyspnea
001. CR/CT
002. PFT/6MWT/CPET
003. BFS
01. Pneumonia
011. COVID-19
02. TB/NTM
03. BE
04. COPD
05. Asthma
06. ILD
07. PE
08. PH
09. Pleura
10. Lung cancer
11. Environment
99. ARDS
99. Sepsis
ER
X. Arrest
미분류
관심환자 목록
선택
순번
등록일
환자번호
환자명
성별
나이
환자구분
21 2023-03-03 M 83세 입원
22 2023-03-14 F 77세 입원
23 2023-03-21 F 63세 입원
24 2023-04-13 M 67세 입원
25 2023-05-02 M 64세 입원
26 2023-06-29 M 87세 입원
27 2023-06-29 F 31세 입원
28 2023-07-13 F 62세 입원
29 2023-07-13 M 83세 입원
30 2023-08-18 M 32세 응급
31 2023-09-05 F 84세 입원
32 2023-09-25 F 53세 입원
33 2023-11-06 F 83세 입원
34 2023-11-10 F 81세 입원
35 2023-11-17 F 76세 입원
36 2023-12-13 M 67세 외래
37 2024-01-17 F 87세 외래
38 2024-01-30 F 23세 입원
39 2024-02-05 F 38세 입원
40 2024-02-06 F 82세 입원
41 2024-02-23 F 81세 응급
42 2024-02-24 M 74세 입원
43 2024-03-11 F 69세 입원

Pathophysiology of PE



A vast <u>spectrum</u> of clinical presentation

Asymptomatic~Hypotension

Shock

Sudden cardiac arrest

Hemodynamic compromise

"RV failure"

– the main driver of mortality

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To Reduce Mortality associated with PE

- **PE related mortality**
  - 19.4 ~ 32.3 / 100,000 individual
  - In-hostpital mortality 7%
  - **Mortality 33% (22-65%) in patients with hemodynamic compromise including cardiac arrest**
    - **Occuring suddenly or before therapy can be initiated!!!**

J. Clin. Med. 2024, 13, 257

To Reduce Mortality associated with PE

- Ealry diagnosis for **hemodynamic compromise**
  - **D-dimer → CT: not feasible**
  - **Echocardiography (point-of-care)** to detect acute cor pulmonale
- **Accurate risk assessment** at initial diagnosis to guide appropriate treatment

Pulmonary Embolism Outcome: A Prospective Evaluation of CT Pulmonary Angiographic Clot Burden Score and ECG Score

Clot burden $\not\propto$ PE outcome

TABLE 3: Univariate Analysis of Comorbid Conditions and 12-Month Mortality Rate

Patient No.	Condition	Odds Ratio	95% CI		*p*
			Lower	Upper	
1	Recent surgery[a]	9.64	1.20	77.25	0.0328
2	Diastolic blood pressure < 70 mm Hg	3.09	0.93	10.28	0.06
3	Systolic blood pressure > 140 mm Hg	2.15	0.44	10.34	0.34
4	PaO_2 < 60 mm Hg	1.80	0.50	6.40	0.36
5	Previous PE or DVT	1.52	0.31	7.46	0.60
6	COPD	1.65	0.37	7.32	0.50
7	Clot burden	1.00	0.97	1.04	0.70
8	History of smoking	1.03	0.83	1.27	0.80
9	Heart failure	0.94	0.25	3.52	0.93
10	History of myocardial infarction	0.86	0.10	7.75	0.90
11	Male sex	0.81	0.25	2.67	0.73
12	Age > 65 years	0.56	0.17	1.83	0.34
13	Active malignancy[a]	0.08	0.02	0.28	< 0.0001

Note—PE = pulmonary embolism, DVT = deep venous thrombosis, COPD = chronic obstructive pulmonary disease.

[a]Significantly associated with 12-month all-cause mortality rate in patients diagnosed as having pulmonary embolism.

AJR 2008; 190:1599–1604

Risk Stratification

Nomenclature – “Hemodynamic“

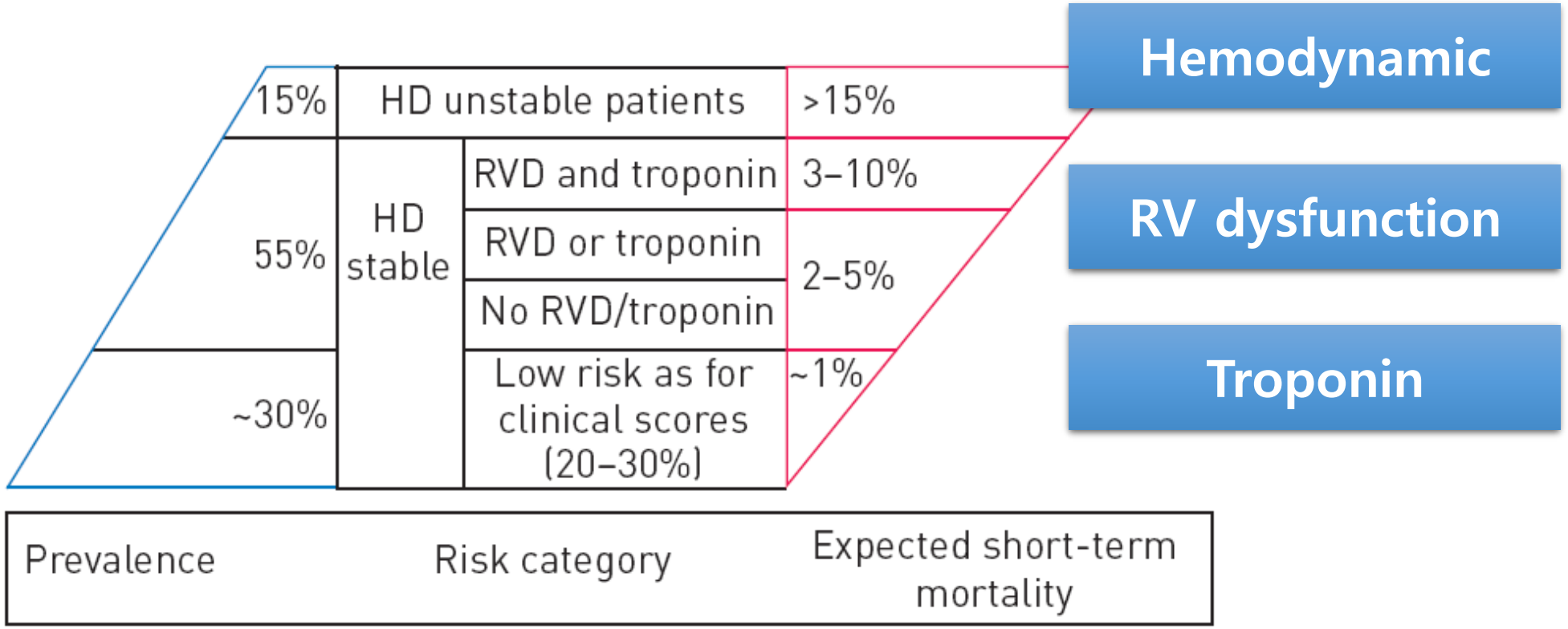
2019 ERS/ESC guideline

- **High-risk**
- **Intermediate-risk**
  - **Intermediate-high**
  - Intermediate-low
- Low-risk

2011 AHA guideline

- **Massive**
- **Submassive**
- Low-risk

Expected Prevalence and Short-term Mortality in PE



Eur Respir J 2015; 45: 1142–1149

Classification of PE Severity (Risk Assessment) – the Risk of Early (in-hospital or 30 day) Death

Early mortality risk		Indicators of risk			
		Haemodynamic instability[a]	Clinical parameters of PE severity and/or comorbidity: PESI class III–V or sPESI ≥I	RV dysfunction on TTE or CTPA[b]	Elevated cardiac troponin levels[c]
High		+	(+)[d]	+	(+)
Intermediate	Intermediate-high	–	+[e]	+	+
	Intermediate-low	–	+[e]	One (or none) positive	
Low		–	–	–	Assessment optional; if assessed, negative

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Indicator of Risk:
"Hemodynamic Instability"

(1) Cardiac arrest	(2) Obstructive shock [68–70]	(3) Persistent hypotension
Need for cardiopulmonary resuscitation	Systolic BP <90 mmHg or vasopressors required to achieve a BP ⩾90 mmHg despite adequate filling status *And* End-organ hypoperfusion (altered mental status; cold, clammy skin; oliguria/anuria; increased serum lactate)	Systolic BP <90 mmHg or systolic BP drop ⩾40 mmHg, lasting longer than 15 min and not caused by new-onset arrhythmia, hypovolaemia, or sepsis

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Indicator of Risk:
"Pulmonary Embolism Severity Index (PESI)"

Parameter	Original version [226]	Simplified version [229]
Age	Age in years	1 point (if age >80 years)
Male sex	+10 points	–
Cancer	+30 points	1 point
Chronic heart failure	+10 points	1 point
Chronic pulmonary disease	+10 points	
Pulse rate ⩾110 b.p.m.	+20 points	1 point
Systolic BP <100 mmHg	+30 points	1 point
Respiratory rate >30 breaths per min	+20 points	–
Temperature <36°C	+20 points	–
Altered mental status	+60 points	–
Arterial oxyhaemoglobin saturation <90%	+20 points	1 point
Risk strata[a]	**Class I: ⩽65 points** very low 30 day mortality risk (0–1.6%) **Class II: 66–85 points** low mortality risk (1.7–3.5%) **Class III: 86–105 points** moderate mortality risk (3.2–7.1%) **Class IV: 106–125 points** high mortality risk (4.0–11.4%) **Class V: >125 points** very high mortality risk (10.0–24.5%)	**0 points** 30 day mortality risk 1.0% (95% CI 0.0–2.1%) **⩾1 point(s)** 30 day mortality risk 10.9% (95% CI 8.5–13.2%)

BP: blood pressure; b.p.m.: beats per minute; CI: confidence interval. [a]Based on the sum of points.

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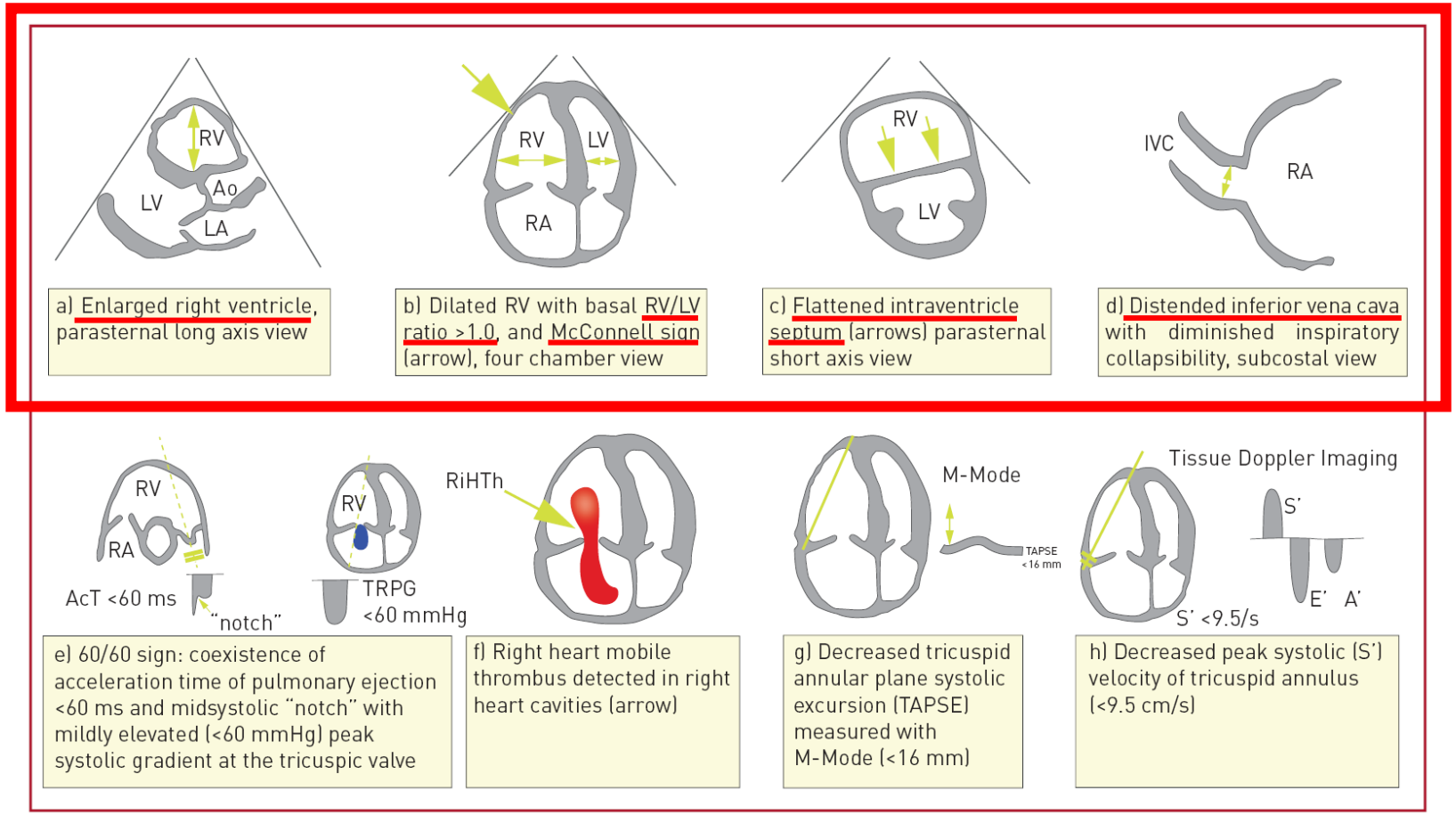
Indicator of Risk:
"RV Pressure Overload" – TTE



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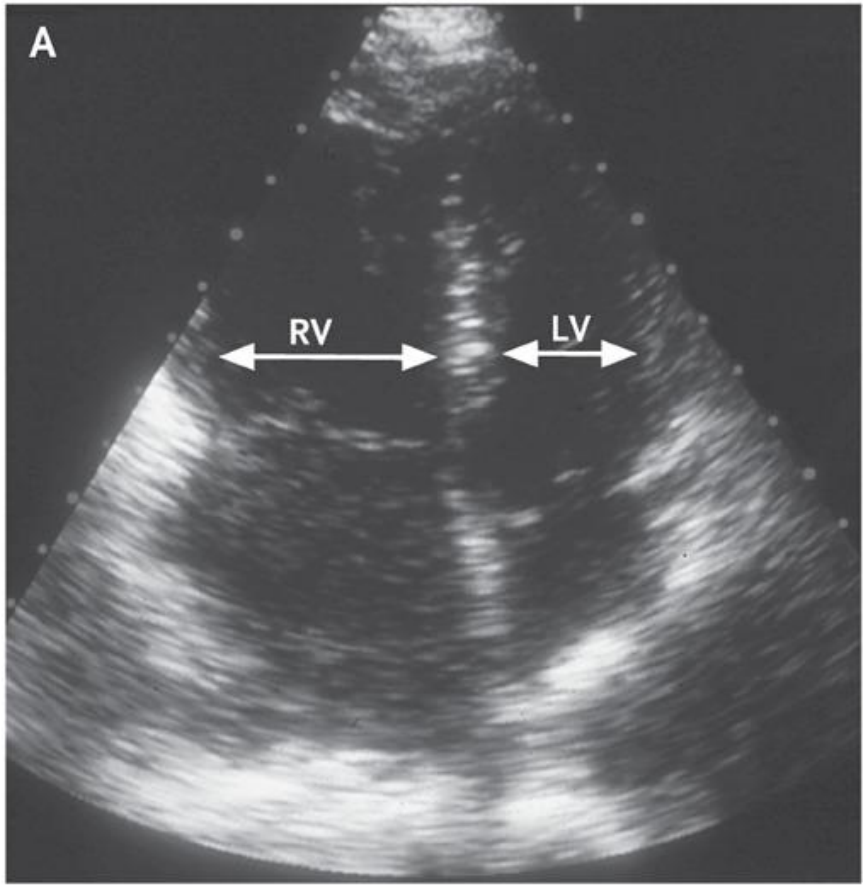
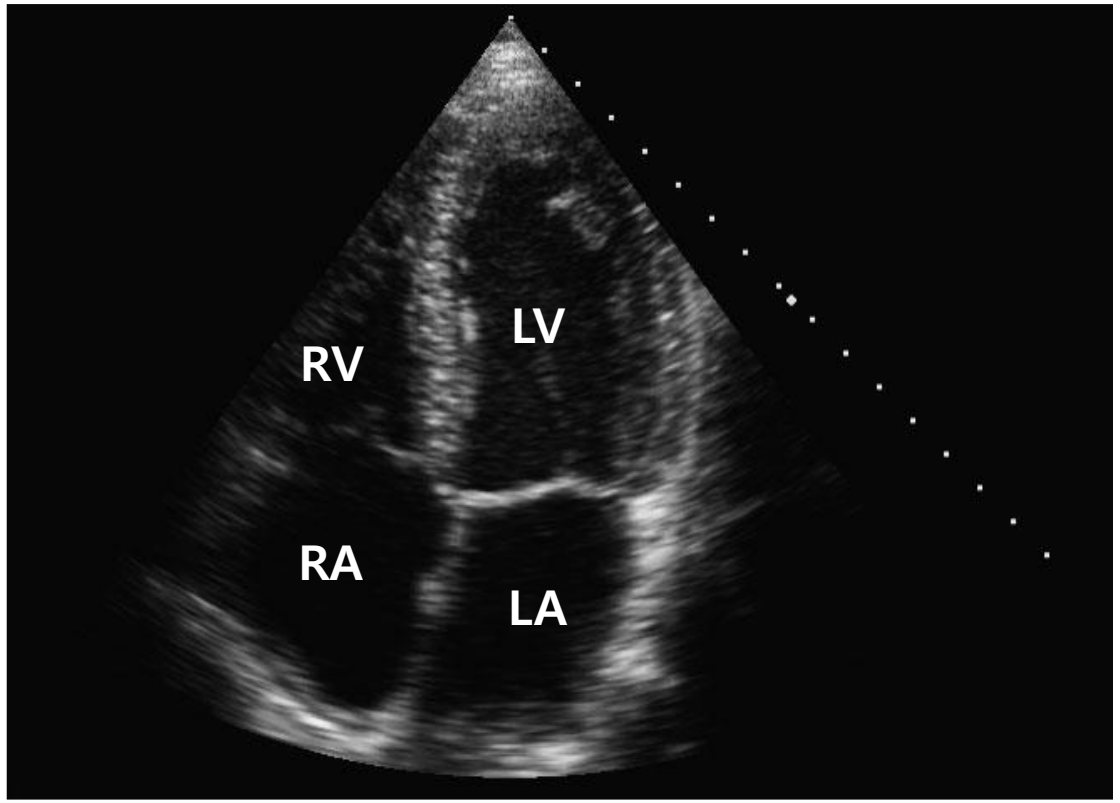
Point-Of-Care UltraSound (POCUS)

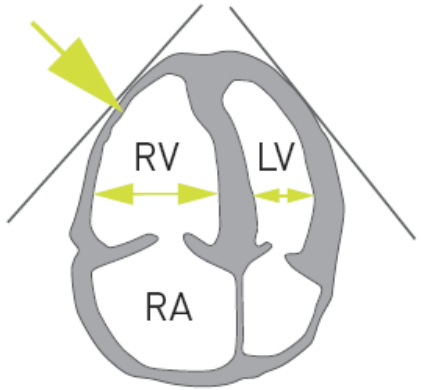
- Hypotension/Shock/Arrest
- Dyspnea/Hypoxemia or Hypoxia
- **3 Es**
  - **E**jection fraction (EF)
  - **E**ffusion (tamponade)
  - **Equality (embolism)**

"Equality" – Four Chamber View in TTE

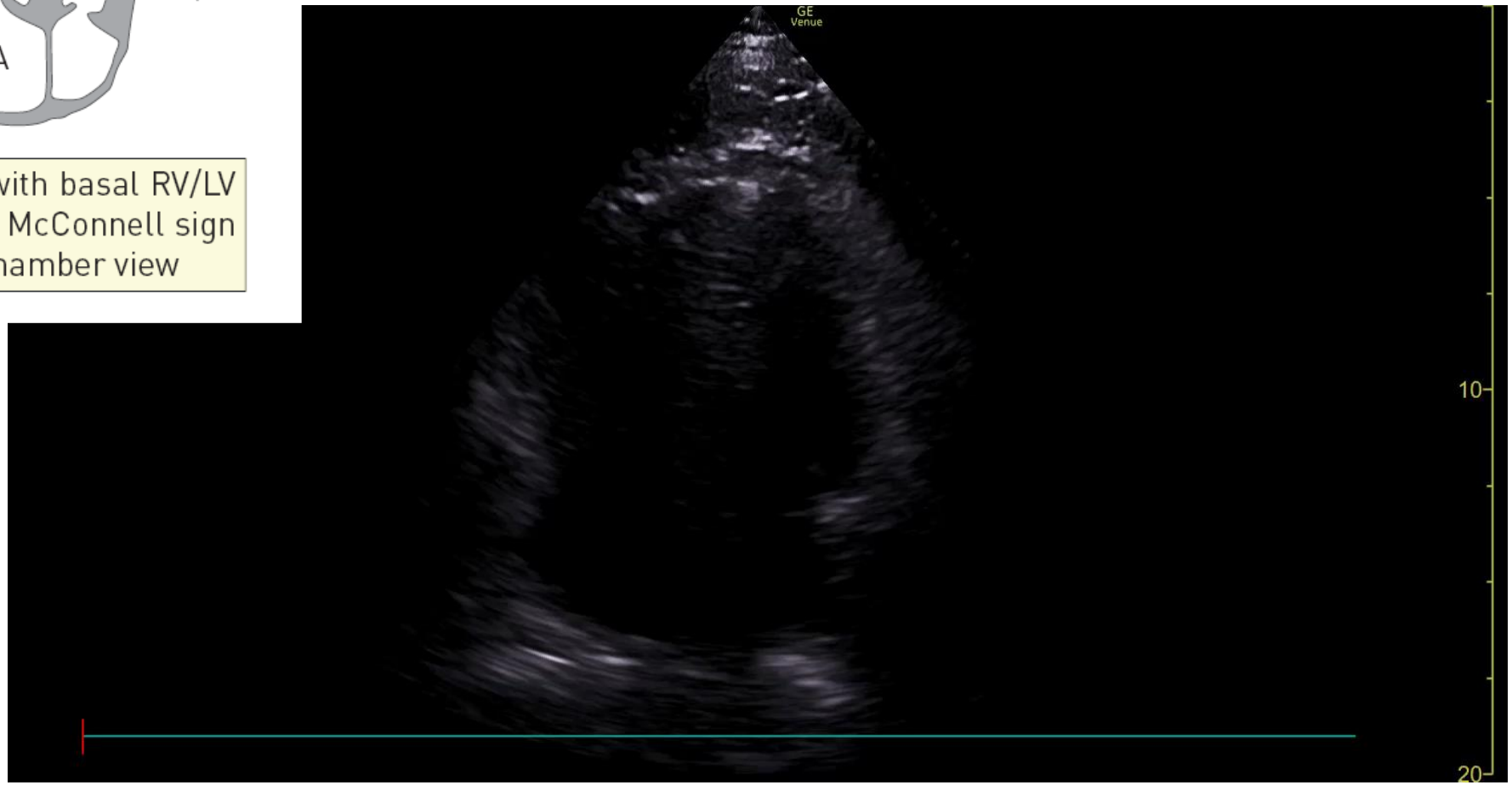


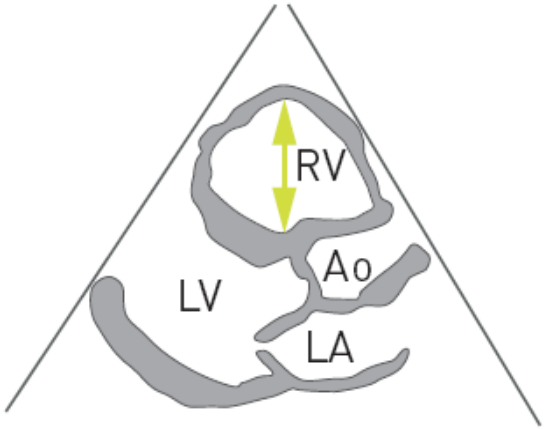


N Engl J Med 2010; 363:266-274

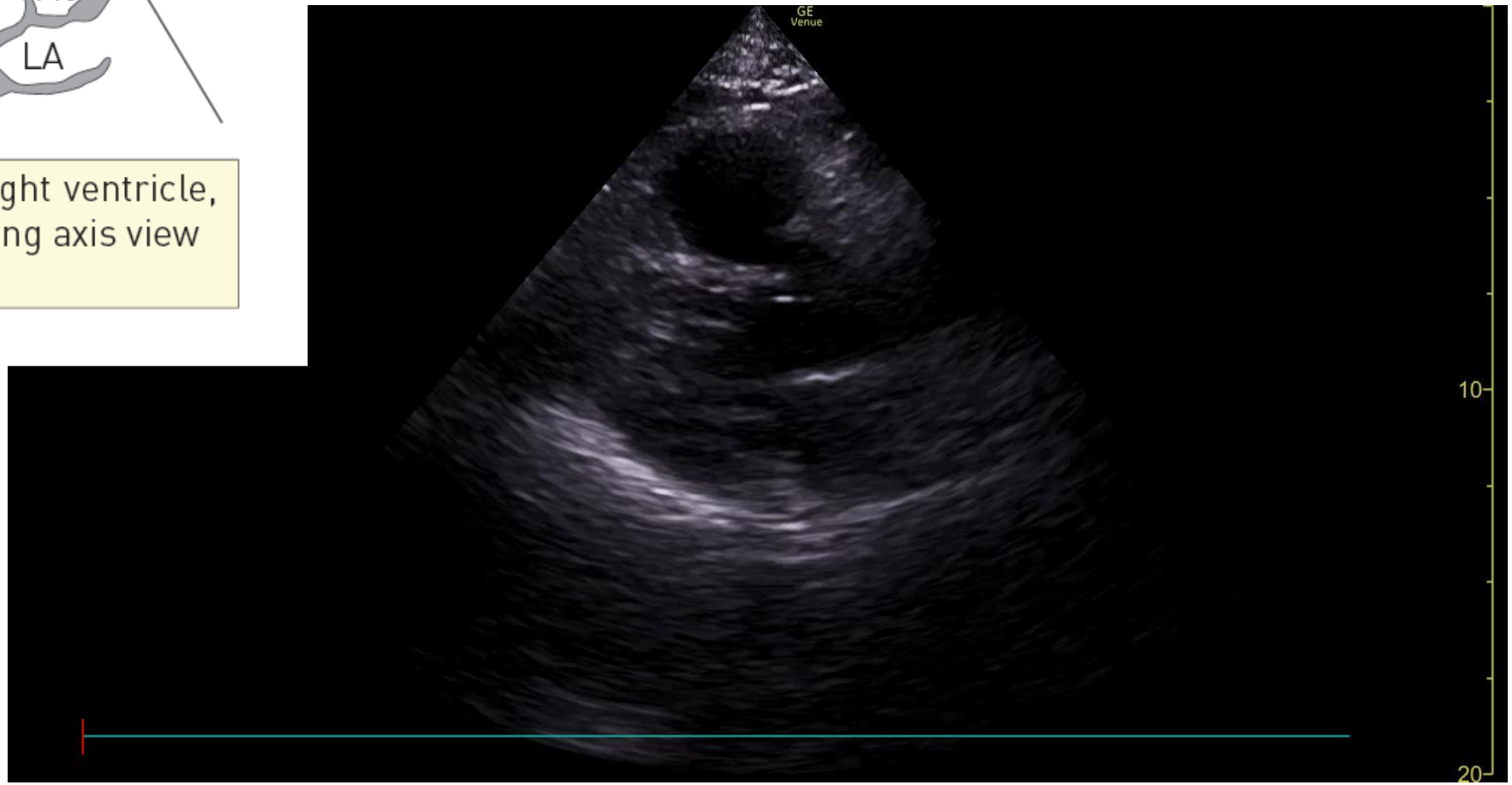


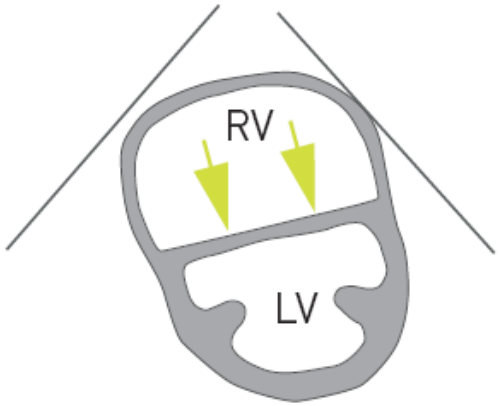
b) Dilated RV with basal RV/LV ratio >1.0, and McConnell sign (arrow), four chamber view



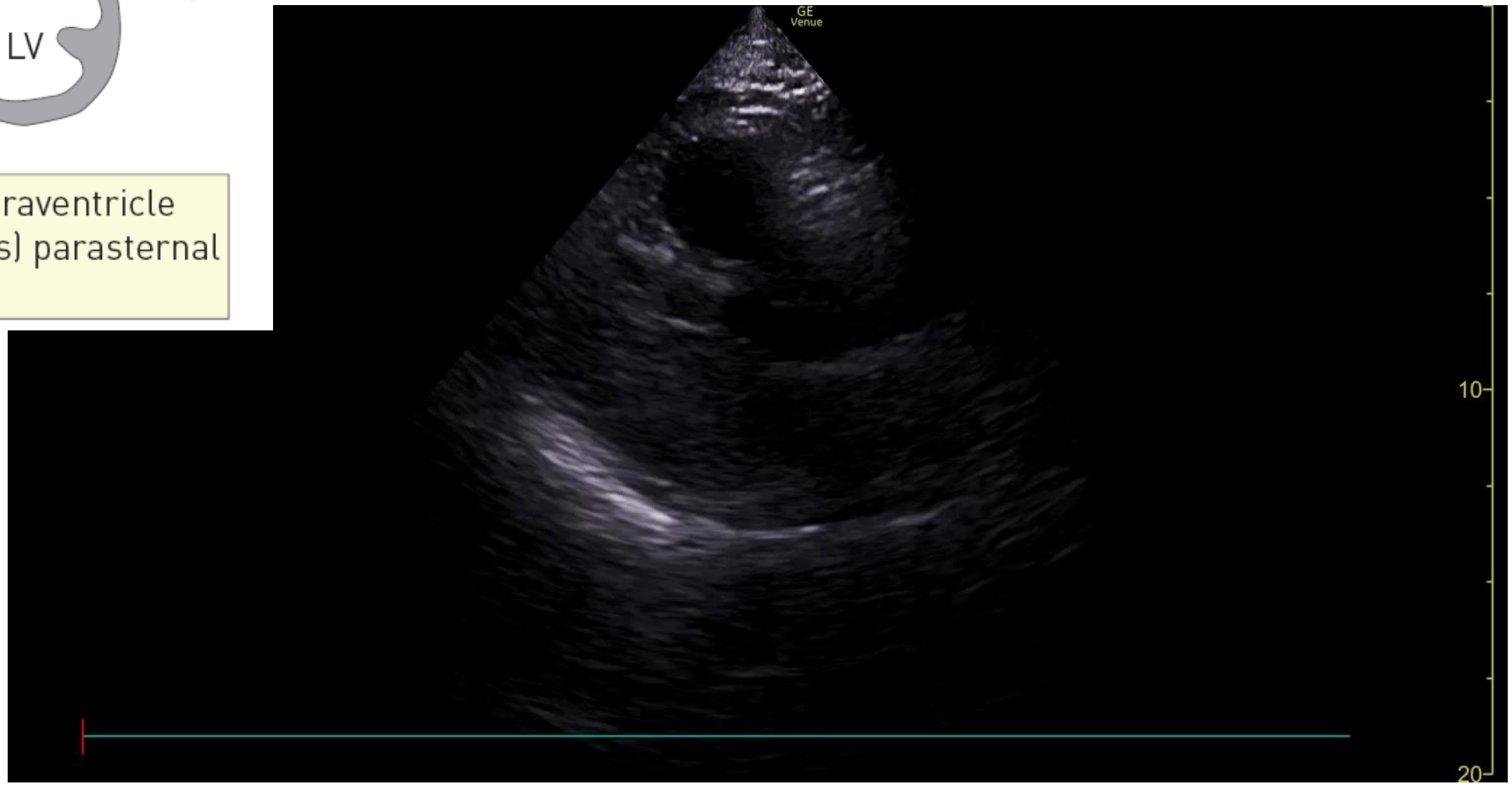


a) Enlarged right ventricle, parasternal long axis view



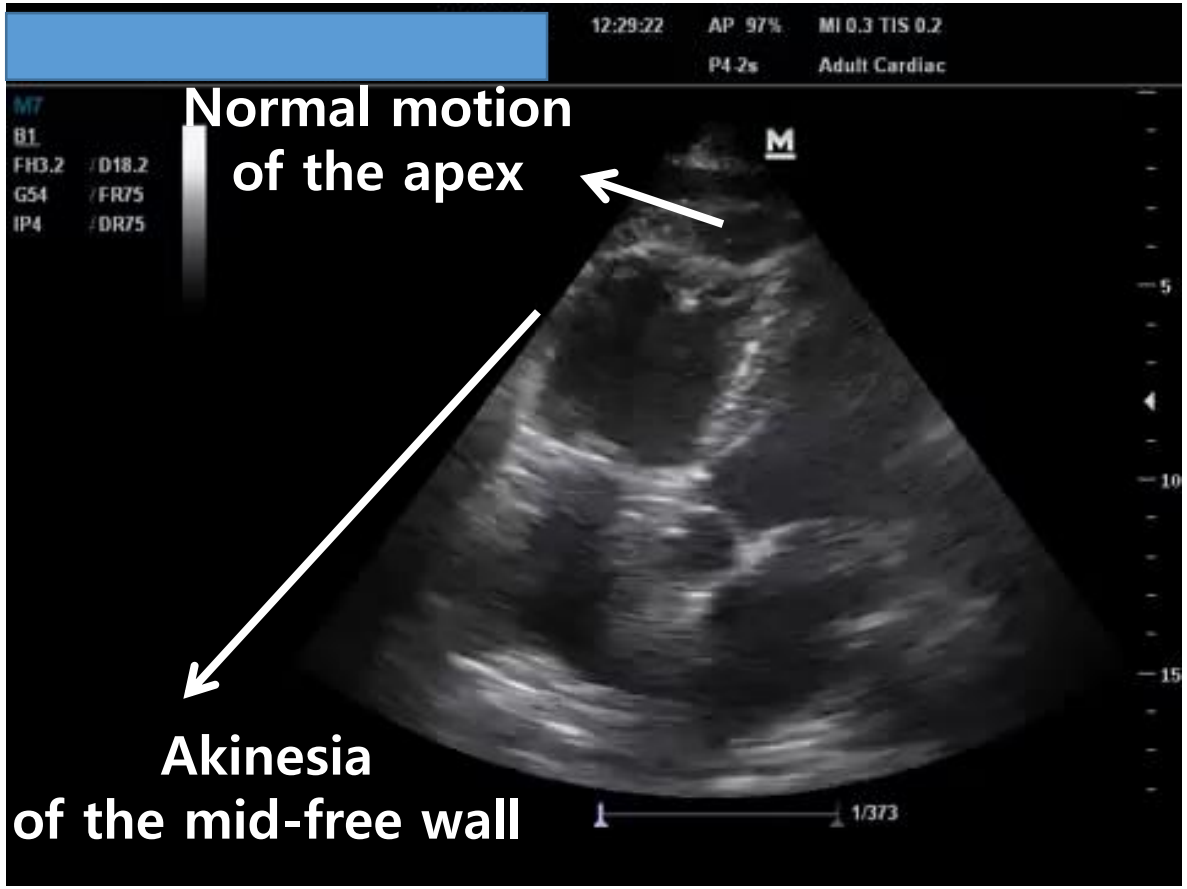


c) Flattened intraventricle septum (arrows) parasternal short axis view



McConnell's Sign

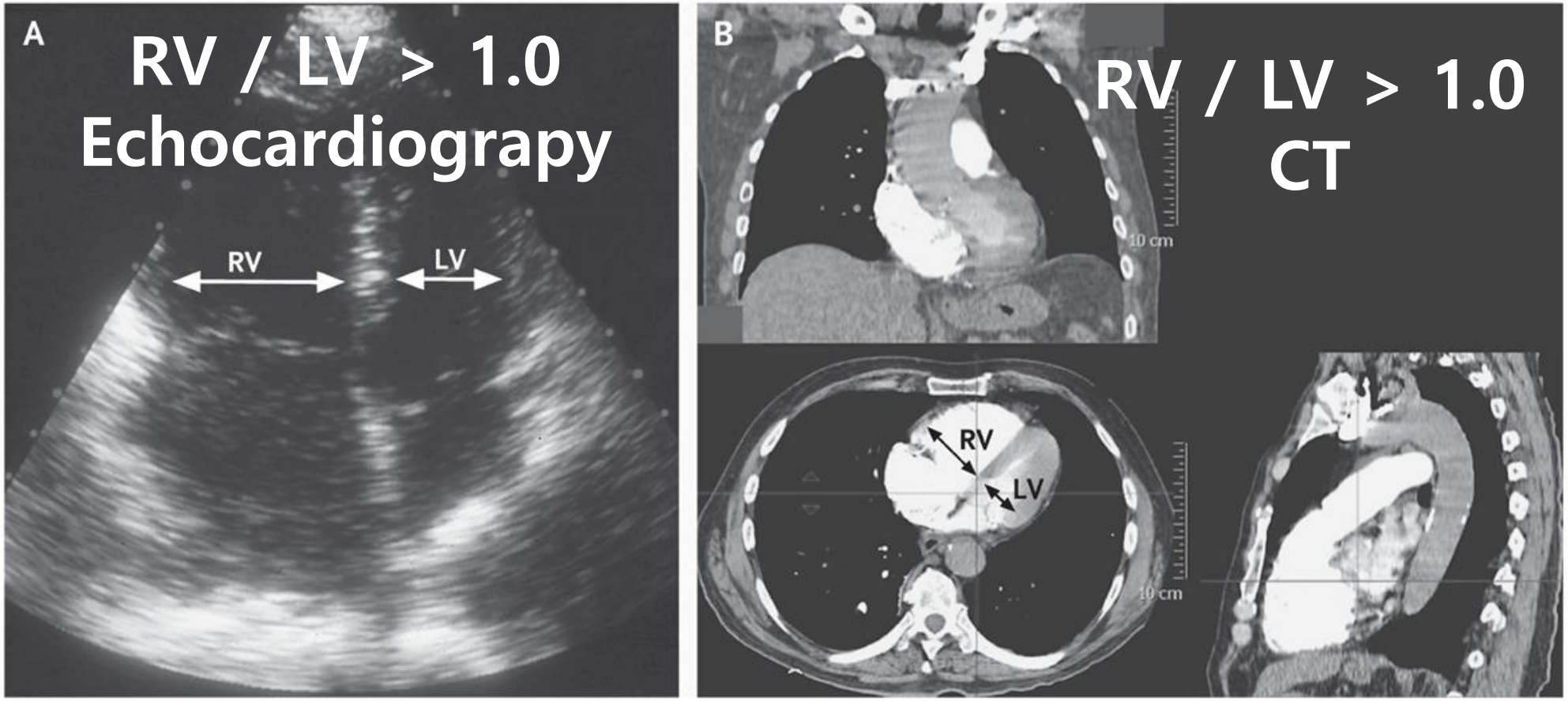
Sensitivity **77%**
Specificity **94%**



Cf. Primary pulmonary HTN
→ Abnormal motion of all regions of the RV

Am J Cardiol. 1996; 78: 469–473.

Indicator of Risk:
"RV Pressure Overload – CTPA"



N Engl J Med 2010; 363:266-274

Management of High-Risk PE

Management of High-Risk PE

- Hemodynamic support
- Reperfusion therapy

Hemodynamic Support in the Acute Phase – RV Failure in High-Risk PE

CVP 15 mmHg

Strategy	Properties and use	Caveats
Volume optimization Cautious volume loading, saline, or Ringer's lactate, ⩽500 mL over 15–30 min	Consider in patients with normal–low central venous pressure (due, for example, to concomitant hypovolaemia)	Volume loading can over-distend the RV, worsen ventricular interdependence, and reduce CO [239]
Vasopressors and inotropes Norepinephrine, 0.2–1.0 μg/kg/min[a] [240]	Increases RV inotropy and systemic BP, promotes positive ventricular interactions, and restores coronary perfusion gradient	Excessive vasoconstriction may worsen tissue perfusion
Dobutamine, 2–20 μg/kg/min [241]	Increases RV inotropy, lowers filling pressures	May aggravate arterial hypotension if used alone, without a vasopressor; may trigger or aggravate arrhythmias
Mechanical circulatory support Veno–arterial ECMO/extracorporeal life support [251, 252, 258]	Rapid short-term support combined with oxygenator	Complications with use over longer periods (>5–10 days), including bleeding and infections; no clinical benefit unless combined with surgical embolectomy; requires an experienced team

CO: cardiac output; BP: blood pressure; ECMO: extracorporeal membrane oxygenation; RV: right ventricle/ventricular. [a]Epinephrine is used in cardiac arrest.

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Reperfusion Therapy

- **Standard-dose systemic thrombolysis**
- **Half-dose systemic thrombolysis**
- **Surgical embolectomy**
- **Catheter-directed approaches**
  - Catheter-directed thrombolysis
  - Catheter-based embolectomy

Reperfusion Therapy –Thrombolysis

Molecule	Regimen	Contraindications to fibrinolysis
rtPA	100 mg over 2 h	**Absolute**
	0.6 mg/kg over 15 min (maximum dose 50 mg)[a]	History of haemorrhagic stroke or stroke of unknown origin
Streptokinase	250 000 IU as a loading dose over 30 min, followed by 100 000 IU/h over 12–24 h	Ischaemic stroke in previous 6 months
	Accelerated regimen: 1.5 million IU over 2 h	Central nervous system neoplasm
Urokinase	4400 IU/kg as a loading dose over 10 min, followed by 4400 IU/kg/h over 12–24 h	Major trauma, surgery, or head injury in previous 3 weeks
	Accelerated regimen: 3 million IU over 2 h	Bleeding diathesis
		Active bleeding
		Relative
		Transient ischaemic attack in previous 6 months
		Oral anticoagulation
		Pregnancy or first post-partum week
		Non-compressible puncture sites
		Traumatic resuscitation
		Refractory hypertension (systolic BP >180 mmHg)
		Advanced liver disease
		Infective endocarditis
		Active peptic ulcer

sue-type plasminogen activator. [a]This is the accelerated regimen for rtPA in
es used in extreme haemodynamic instability such as cardiac arrest.

<65 yr, 1.4 mg/kg (Min. 50 mg ~ Max. 100mg)
≥65 yr, 1.0 mg/kg (Max: 70 mg)

Actilyse dose: > 65 kg - 10 mg IVS, 이후 2시간 동안 90 mg 주입 (총 100 mg)
Actilyse dose: 60~65 kg - 10 mg IVS, 이후 2시간 동안 80 mg 주입 (총 90 mg)
Actilyse dose: 55~60 kg - 10 mg IVS, 이후 2시간 동안 70 mg 주입 (총 80 mg)
Actilyse dose: 50~55 kg - 10 mg IVS, 이후 2시간 동안 65 mg 주입 (총 75 mg)
Actilyse dose: 45~50 kg - 10 mg IVS, 이후 2시간 동안 55 mg 주입 (총 65 mg)
Actilyse dose: < 45 kg - 10 mg IVS, 이후 2시간 동안 50 mg 주입 (총 60 mg)

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증례 1 Review

2 L
조영제가
안 들어감

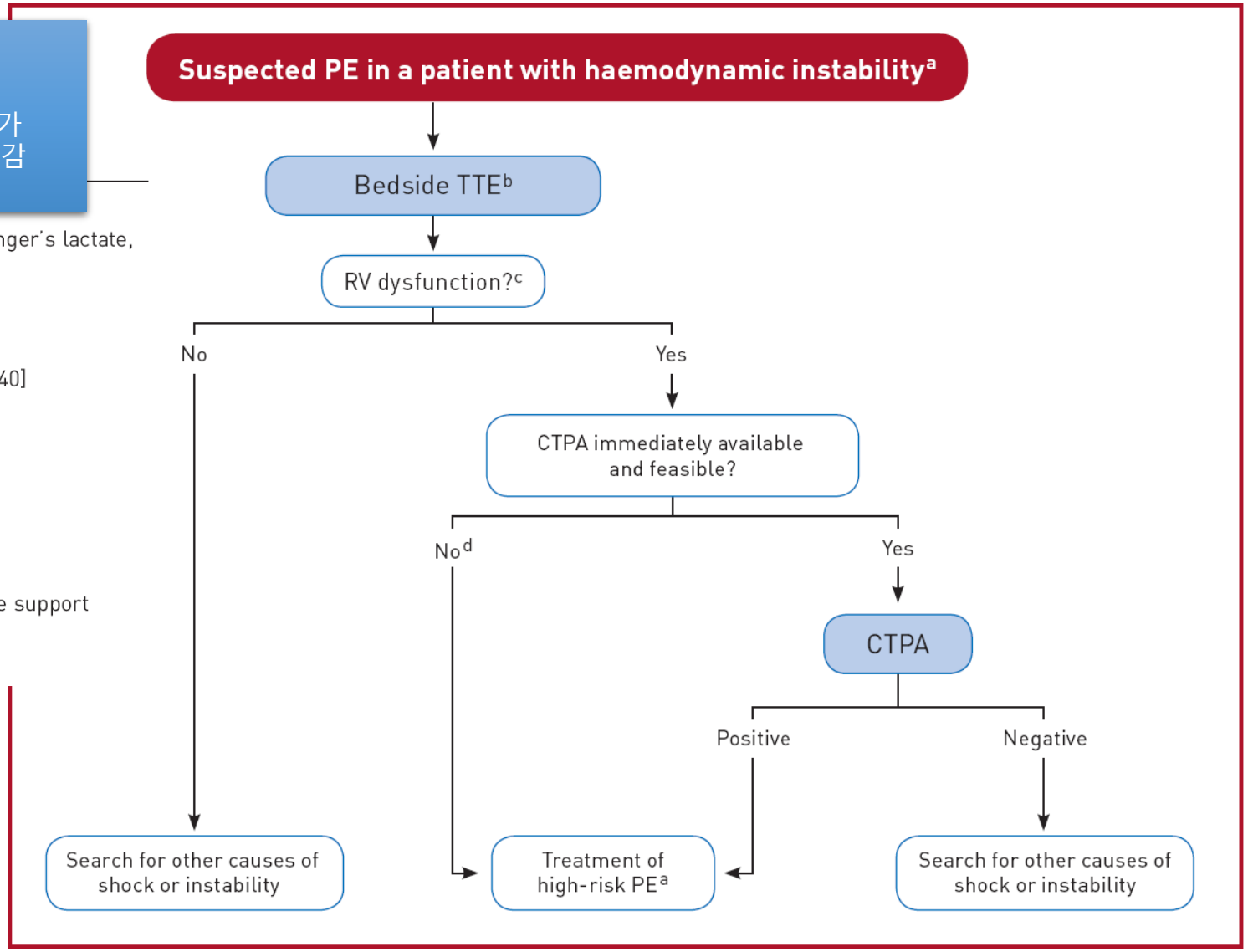
Strategy

Volume optimization
Cautious volume loading, saline, or Ringer's lactate, ⩽500 mL over 15–30 min

Vasopressors and inotropes
Norepinephrine, 0.2–1.0 μg/kg/min[a] [240]

Dobutamine, 2–20 μg/kg/min [241]

Mechanical circulatory support
Veno–arterial ECMO/extracorporeal life support [251, 252, 258]



CT – not feasible

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증례 2

M/86

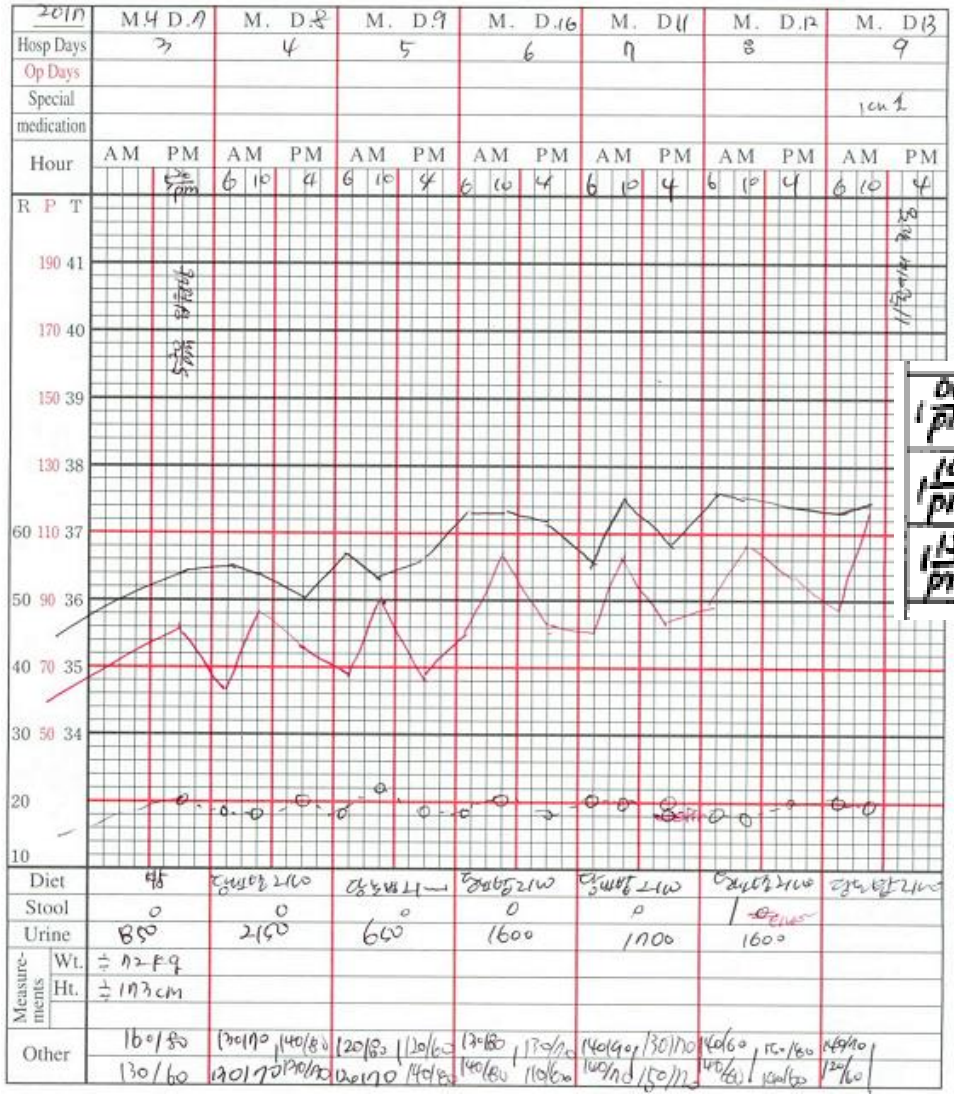
C/C:

general weakness, nausea

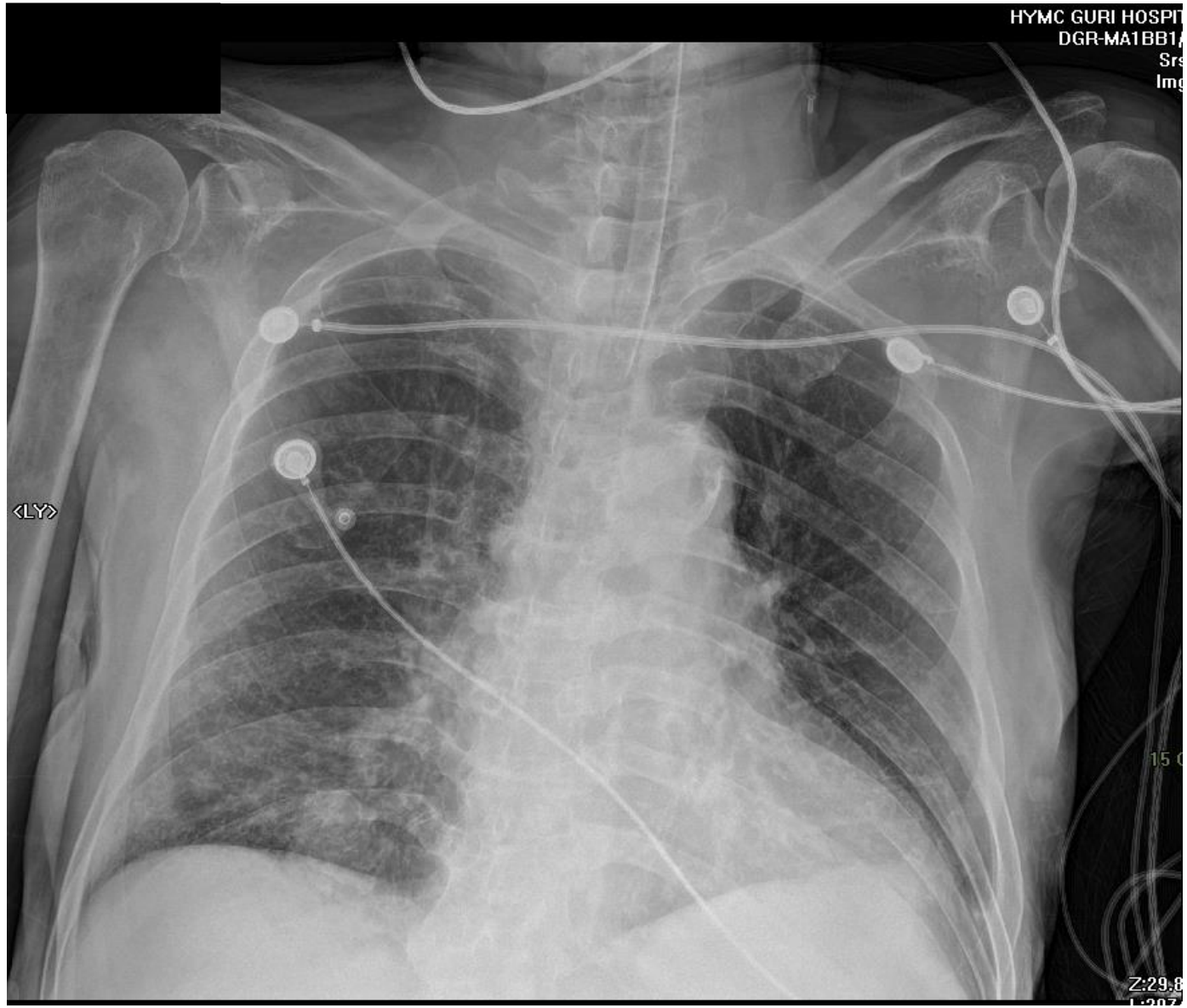
Brief Hx:

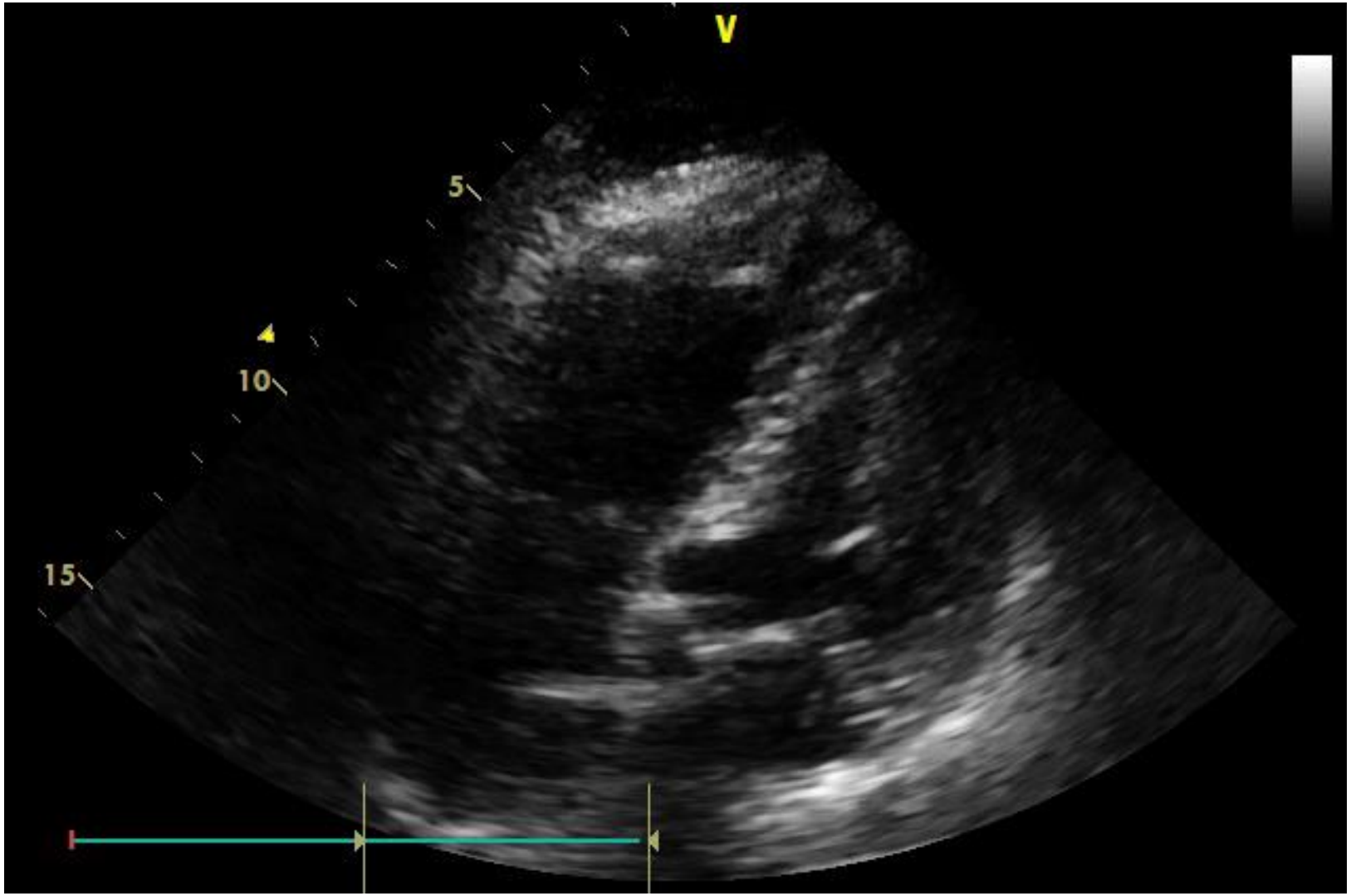
1주 전부터 nocturia로 비뇨기과에서 minirin 복용 시작, hyponatremia로 신장내과 입원

HD #9 – Cardiac Arrest

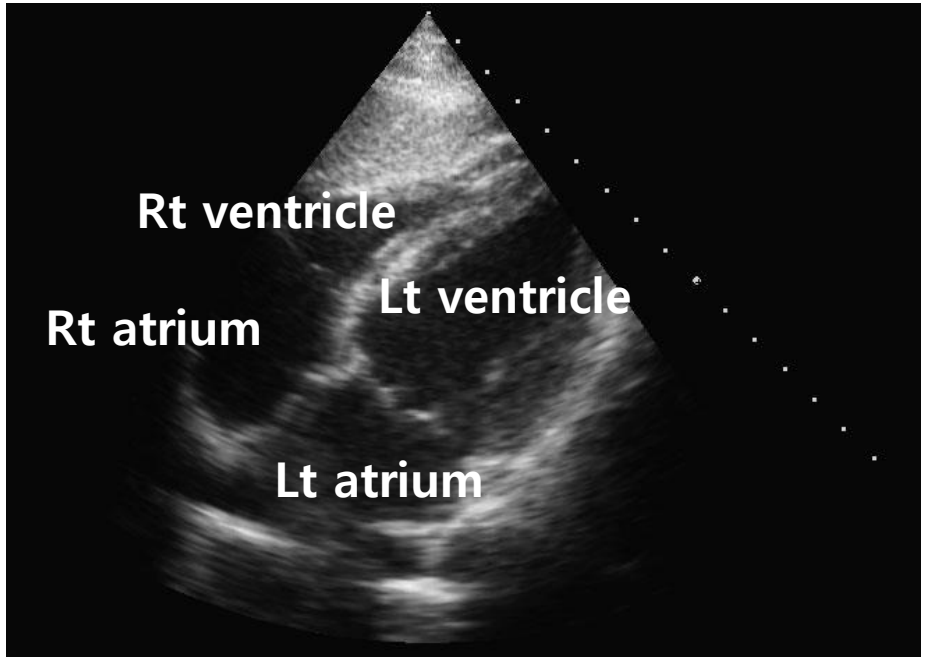


06 pm			Epi		Asystole	PEA	VT	VF		맥박, 호흡 없어 CPR 시행함
10 pm	"		✓		Asystole	PEA	VT	VF		
12 pm	"			Epi		Asystole	PEA	VT	VF	재발 관찰, 호흡 돌아옴

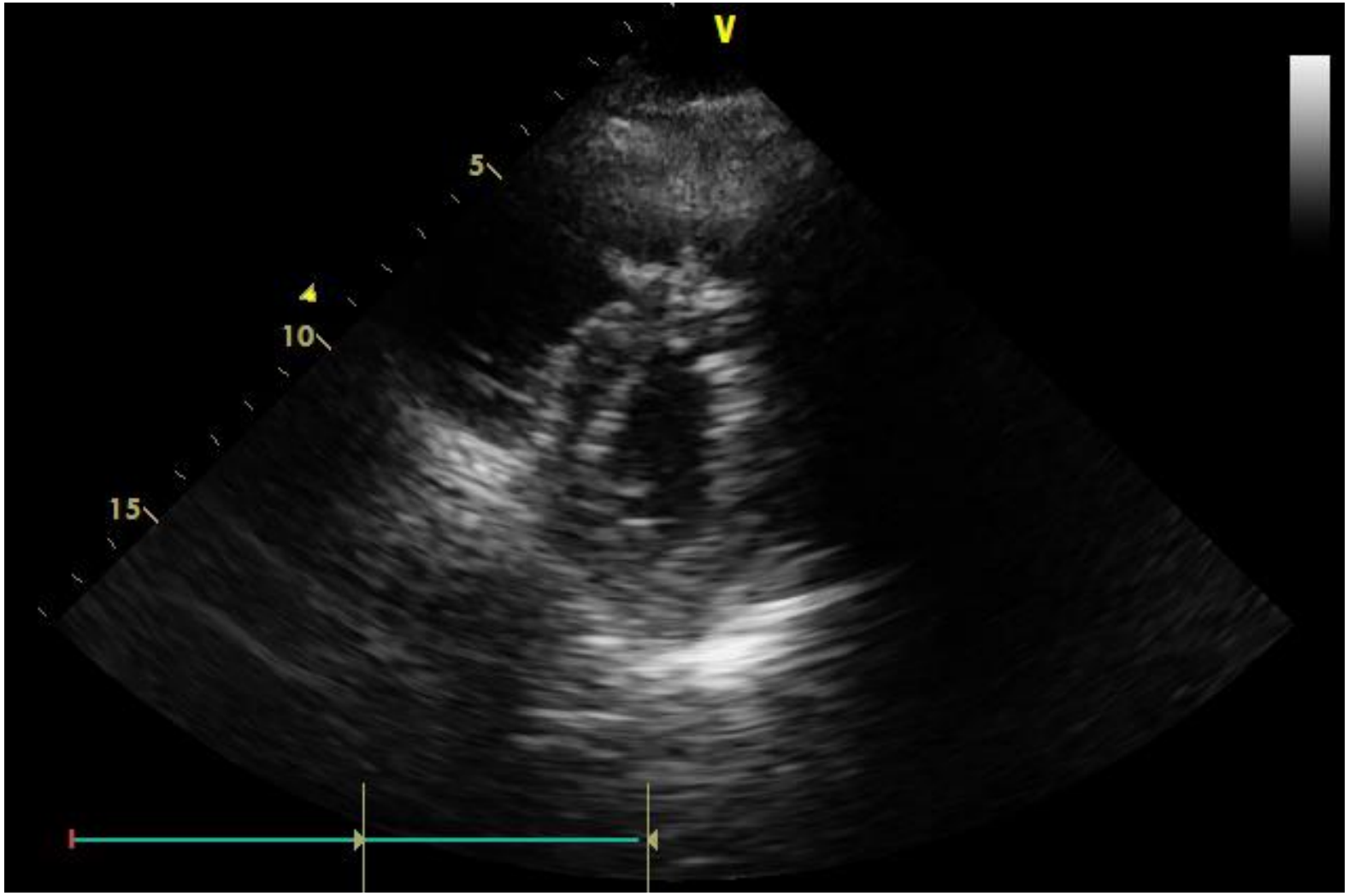

HYMC GURI HOSPI
DGR-MA1BB1
Srs
Img
<LY>

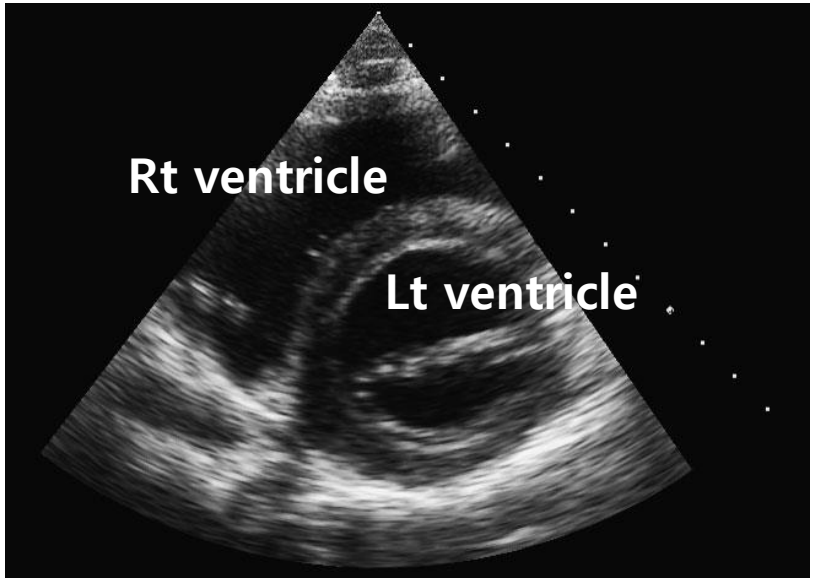


RV dilatation, RV > LV



Normal RV: LV = 0.6: 1.0





RV dilatation, “D”-shaped LV

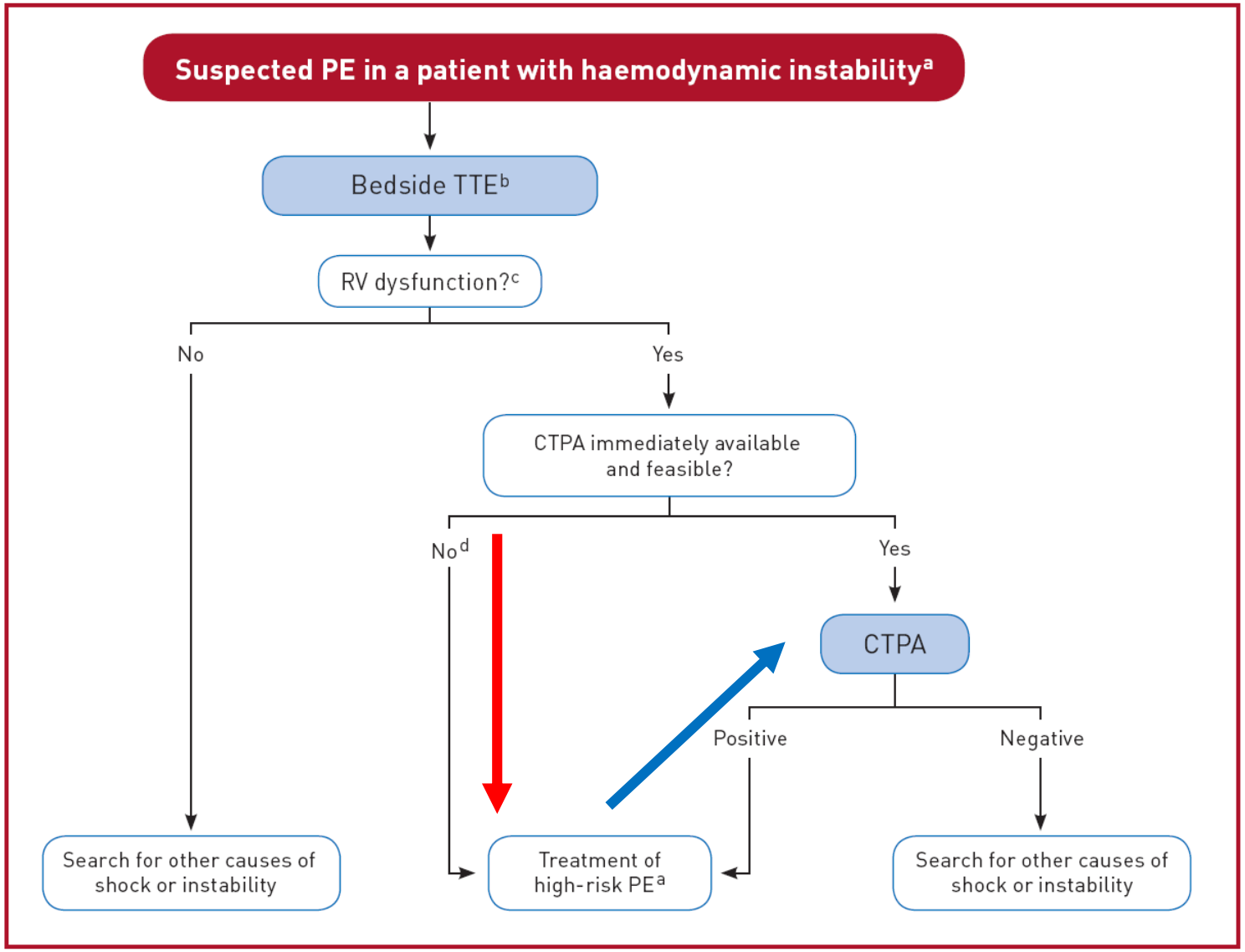
Lab Findings

- ABGA: 7.32 – 39.4 – 58.6 – 20.6
- Lactate: **4.8** [0.7 – 2.5]
- D-dimer: **>69,000** [0 – 250]
- CK-MB: 1.2 [0.3 – 4], TnI: **0.04** [0 – 0.04]
- EKG: sinus tachycardia

ICU Course

- Volume optimization: 0.9% NS 250 mL
- Norepinephrine
- Unfractionated heparin
- CT 촬영 및 thrombolysis 계획 중, 보호자 연명치료 모두 거부하여 사망

증례 2 Review



2019 ESC Guidelines

증례 3

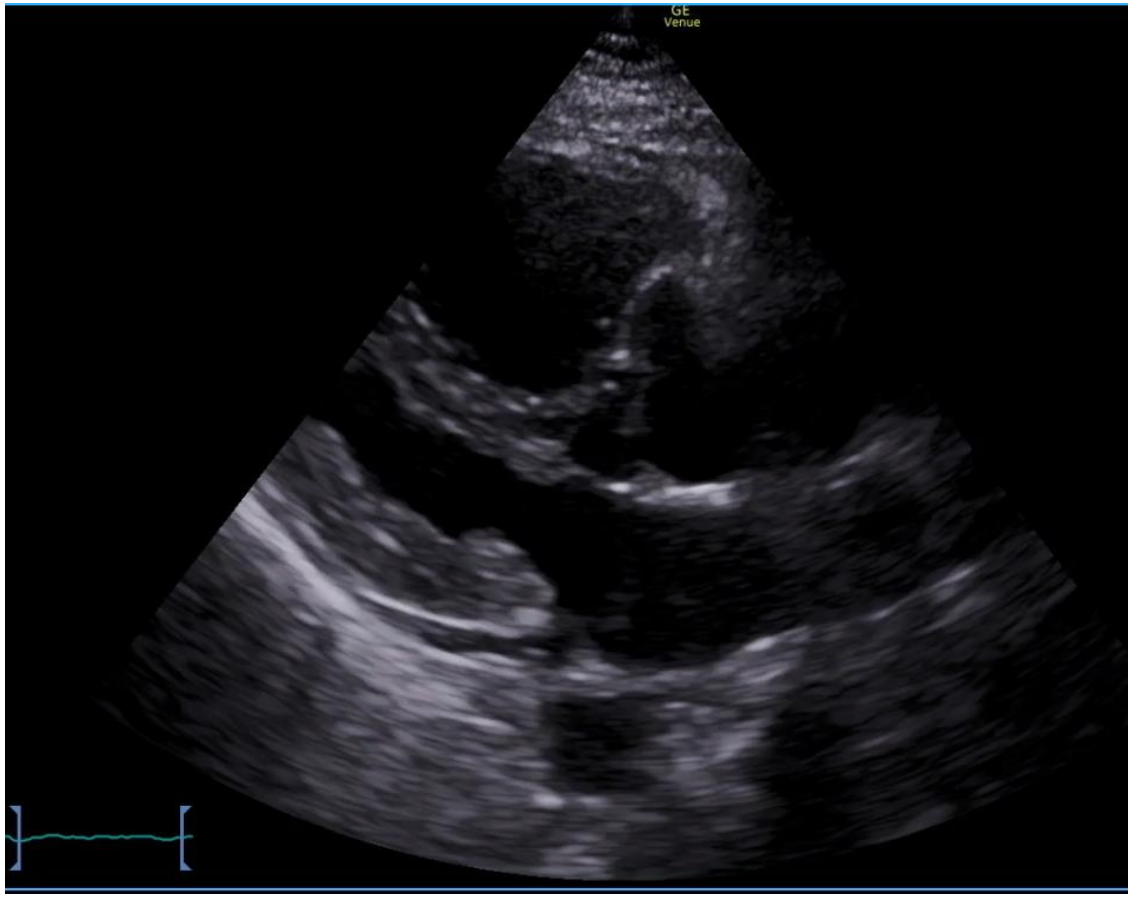
F/68

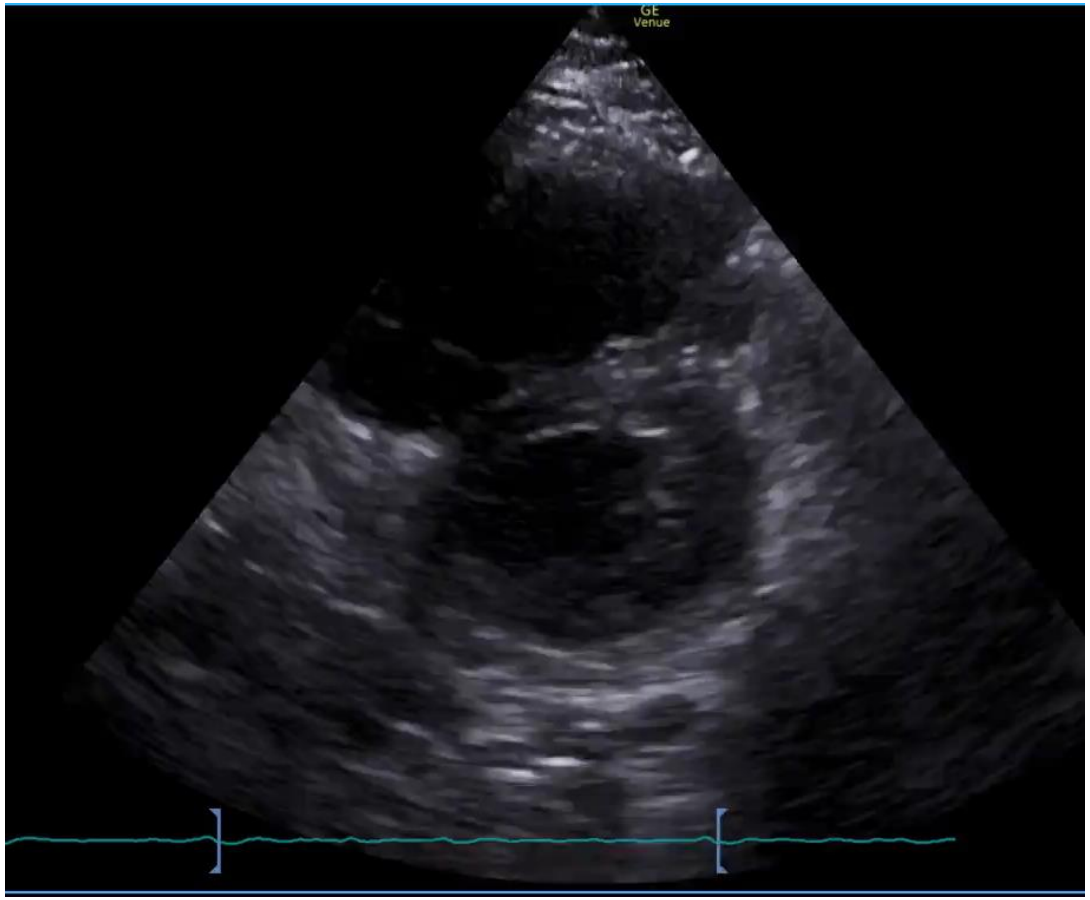
C/C:

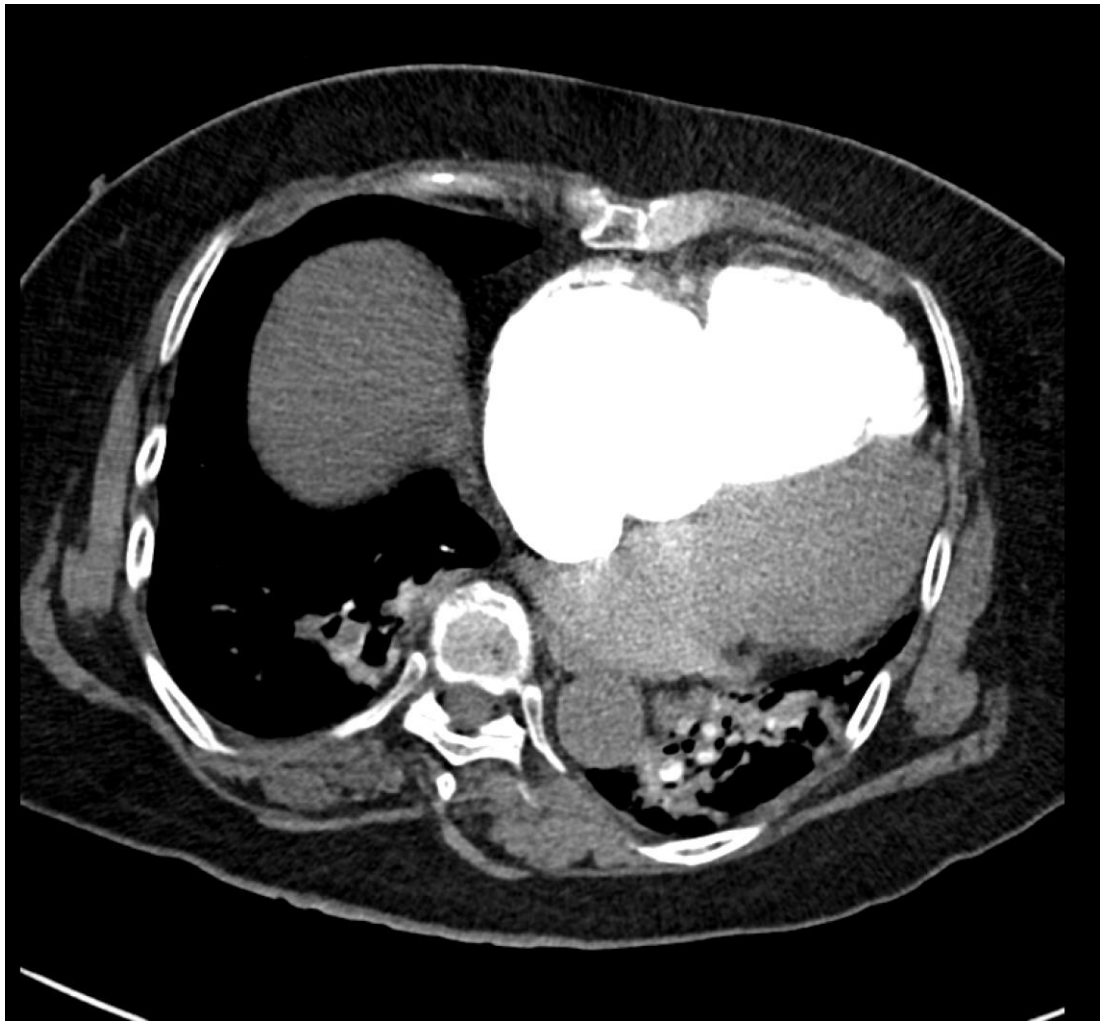
dyspnea

Brief Hx:

광양에서 구리시 집까지 쉬지 않고 4시간 가량 운전해서 왔다고 함. 이후 호흡곤란, 의식 저하, 119 신고, ER 도착 후 arrest로 CPR


GE
Venue


GE
Venue



Hospital Course

응급실에서 반복적인 arrest, CPR, ROSC 반복됨.

POCUS: RV dilatation 보여 촬영한 chest CT에서 massive pulmonary embolism 확인되어 tPA 50 mg 2차례 IV

ROSC 되었으나 심한 저혈압, 혼수상태 보이면서 중환자실 입실함.

중환자실에서 anoxic brain damage 소견

Norepinephrine, dobutamine, epinephrine으로도 혈압 유지되지 않아 다음 날 사망

증례 3 Review

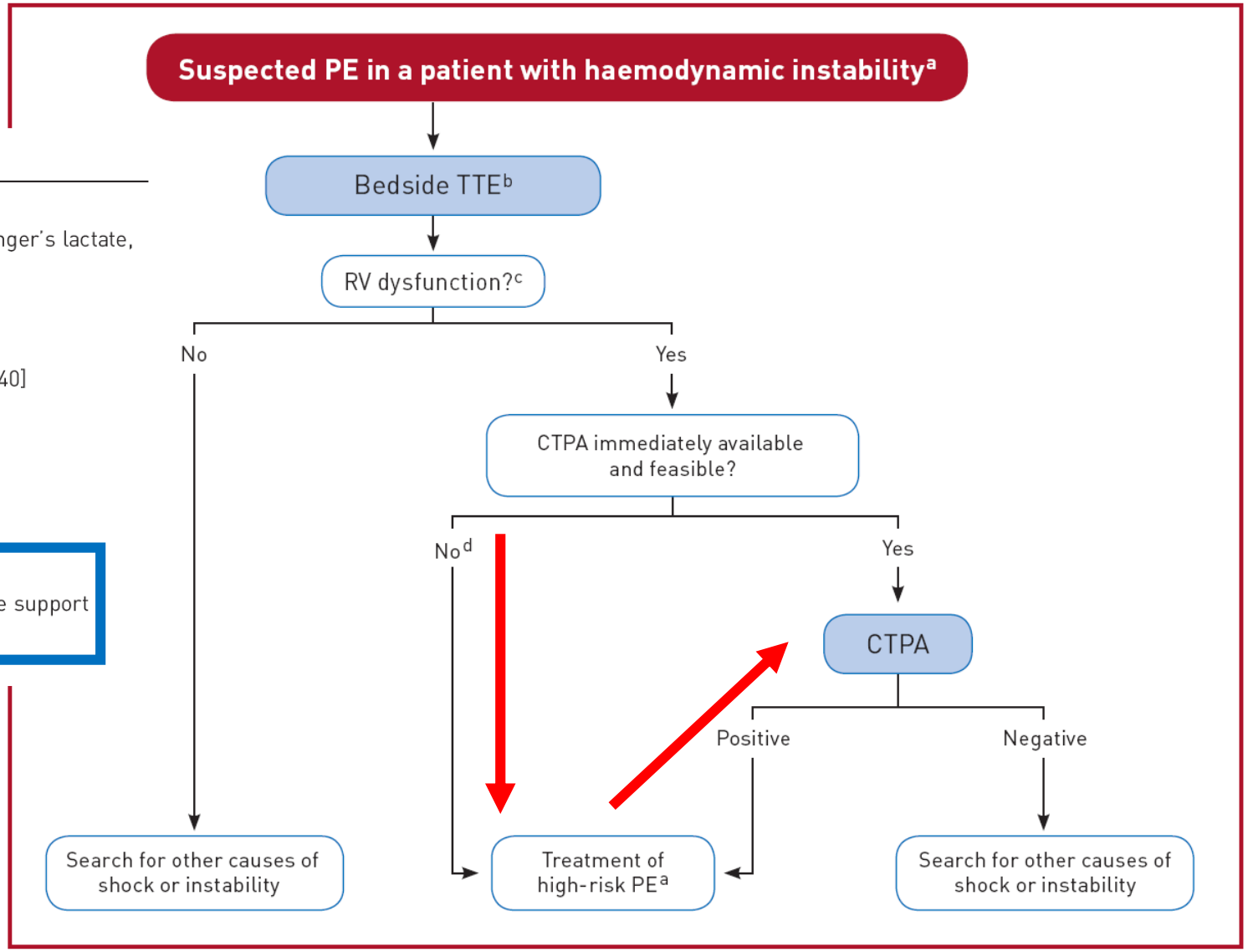
Strategy

Volume optimization
Cautious volume loading, saline, or Ringer's lactate, ⩽500 mL over 15–30 min

Vasopressors and inotropes
Norepinephrine, 0.2–1.0 μg/kg/min[a] [240]

Dobutamine, 2–20 μg/kg/min [241]

Mechanical circulatory support
Veno–arterial ECMO/extracorporeal life support [251, 252, 258]



2019 ESC Guidelines

증례 4

F/41

C/C:

■ 수술 기본정보

수술일 : 2024-01-03

집도의 :

보조의 :

마취방법 : General

■ 수술전 진단명

Adenomyosis

■ 수술후 진단명

Adenomyosis

■ 수술명

단일공자궁절제술

■ 수술중 특이사항

없음

■ 수술소견

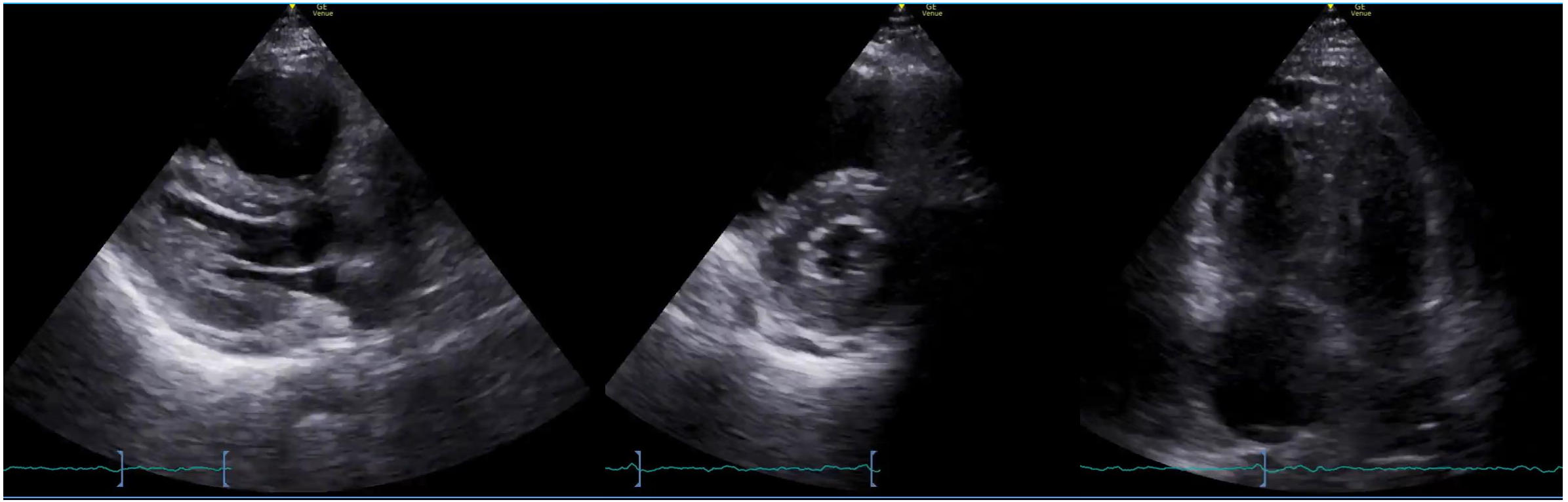
Uterus: 14 weeks sized enlarged,
2 cm sized myoma visible on anterior portion
Adnexa : both free
Adhesion: between left adenxa and sigmoid colon
between uterus serosa and bladder
No Ascites was seen.

산부인과 교수님 → 아침 일찍 다급한 전화 (혈압이 떨어진다)

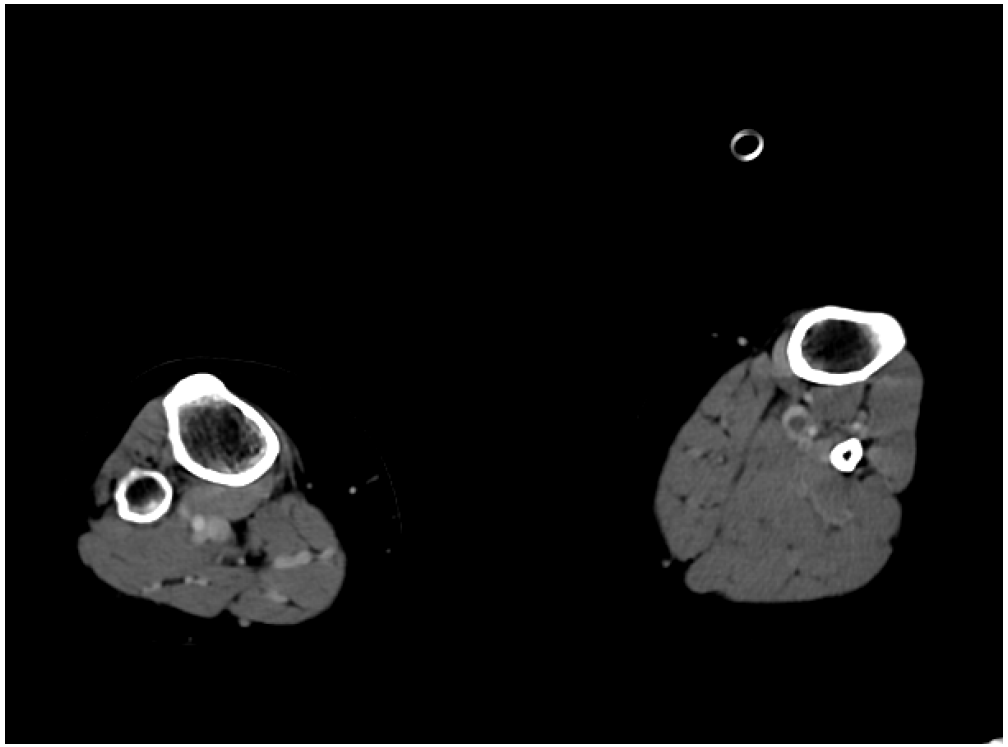
01-04 02:00	SR	숙면중임
01-04 06:00	SR	잘잠
01-04 06:34	SR	Total I/O 1700/970(+730) checked Dr고재연 알림 (rec"Foley remove 해주세요")
01-04 06:45	SR	Foley remove 시행함 I/O check 계속해야과 CIC 해야됨을 교육함, 11AM까지 Self voiding 보도록 하고 voiding 시 알리도록 함
01-04 07:10	SR	응급 콜벨 울려 자리 가보니 환자 lip cyanosis 증상 진행 상태며 얼굴 fail한 모습 보임 Self voiding 위해 화장실 가려고 일어났다가 자리에 온후 갑자기 가슴
01-04 07:12	SR	Nasal O2 5L apply 상태나 SPO2상 80-81% checked 지속적인 chest discomport 호소함 dr[redacted] 알림 (rec"EKG portable 찍고 교수님 noti하겠습니다")
01-04 07:13	SR	spo2 89%, BP:60/40mmHg checked, 02 Reserve bag full inhalation 시작함 confuse 한 모습 보이며 계속 횡설수설함. EKG patient monitor apply함
01-04 07:14	SR	SPO2 88%, BP:60/42mmHg checked
01-04 07:17	SR	Spo2 89%, BP 67/46mmHg checked
01-04 07:25	SR	Prof[redacted] 환자상태봄
01-04 07:29	SR	Dr [redacted]환자상태봄

01-04 07:39	SR	처치실로 환자옮김 Bed EKG monitor apply 함 HR:135회/min, SPO2:98%, BP:50/40mmHg checked Dr박태선 exam함 5DW 큐프린 mix fluid 5cc/hr infusior
01-04 07:41	SR	RRT옴 intubation hold 하고 High flow MICU에서 빌려 100% 60L apply 함
01-04 07:48	SR	Portable ECHO 시행후 PTE 확인함
01-04 07:49	SR	Heparin 5000 iv 1cc shooting함
01-04 07:56	SR	Heparin mix fluid 20cc/hr infusion시작함
01-04 07:57	SR	BP:60/50mmHg SPO2:95% checked 큐프린 20cc mix된 fluid 20cc/hr change함
01-04 07:59	SR	Bivon 3a iv함
01-04 08:02	SR	Actilyse 50mg 10mg은 iv하고 40mg은 20cc/hr infusion시작함
		VPC 있다가 바로사라짐, cyanosis관찰됨
		High flow 100% 60L apply함 HR:160회/min, SPO2:96% checked

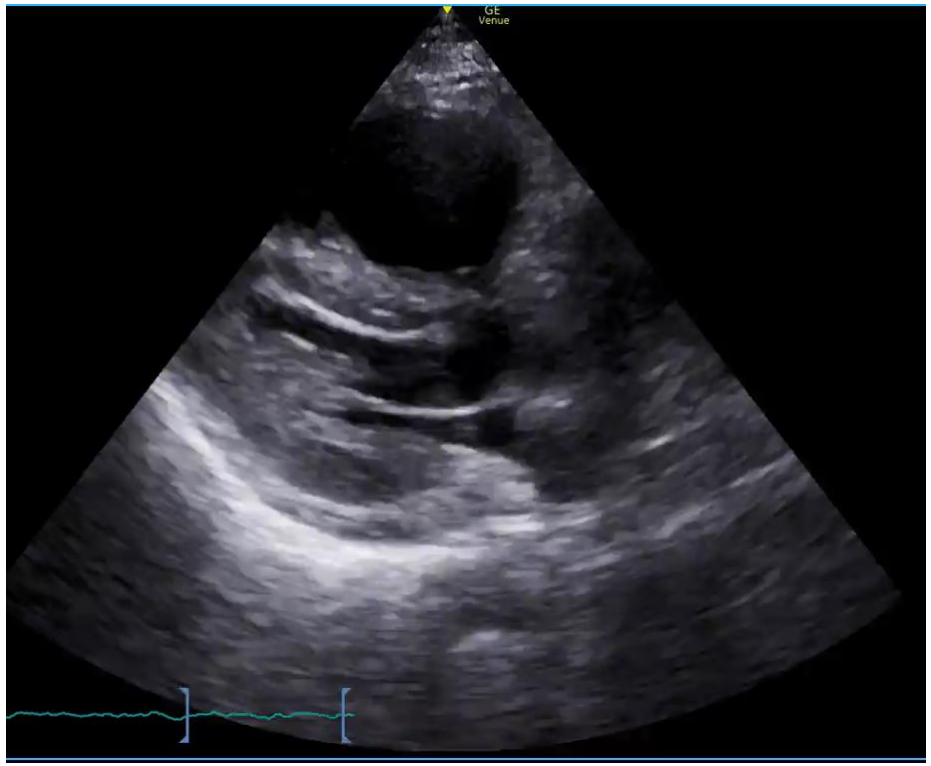
rtPA 50 mg
(half dose)

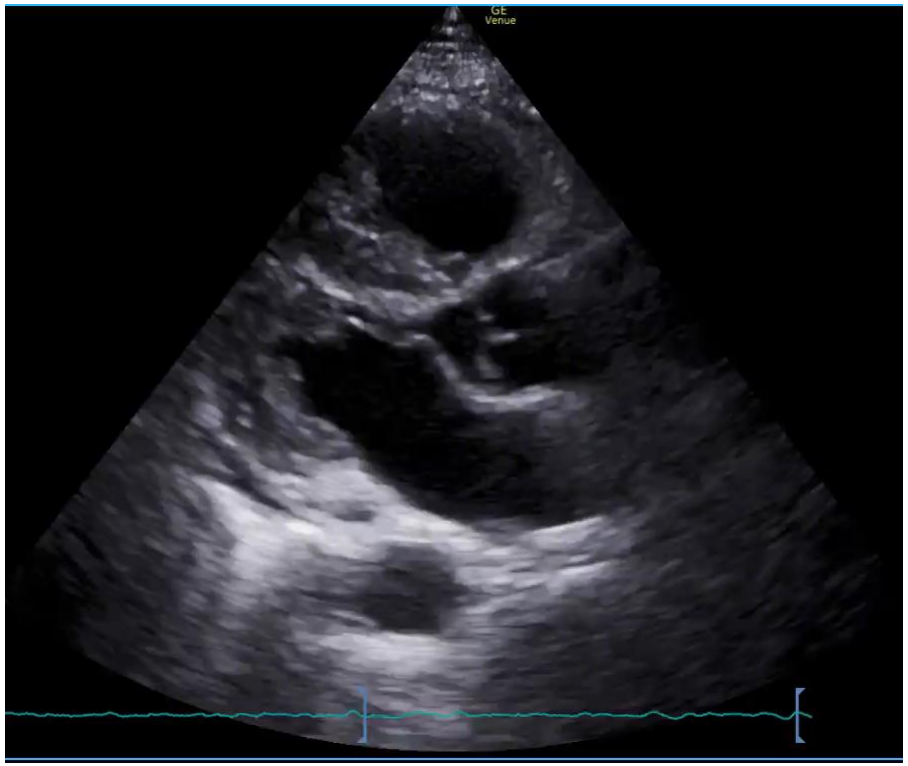


01-04 08:20	SR	Portable sono 확인하며 Rt Jugular catheter insertion함 by Dr 박태선 pressure로 리거지 되어 Plasma, NS 1L 20cc/hr로 kept 함 Rt arm 18G actilyse appl
01-04 08:25	SR	RBC 준비되었으나 지금당장은 hold 하자함
01-04 08:43	SR	Foley catheter 16fr insertion함
01-04 08:45	SR	Lt dorsal A-line insertion후 heparin mix fluid _pressure bag apply함
01-04 08:54	SR	prof 류기영 중환자실 입실 동의서, CT angiography CE, CT angiography CE PTE/DVT동시받음
01-04 09:06	SR	Actilyse 40mg 20cc/hr, Q-phrine 20cc/hr pump로 유지, High flow대신 reserve full로 하여 CT 촬영 위해 1층 CT실 내려감 방문후 MICU 전동예정임

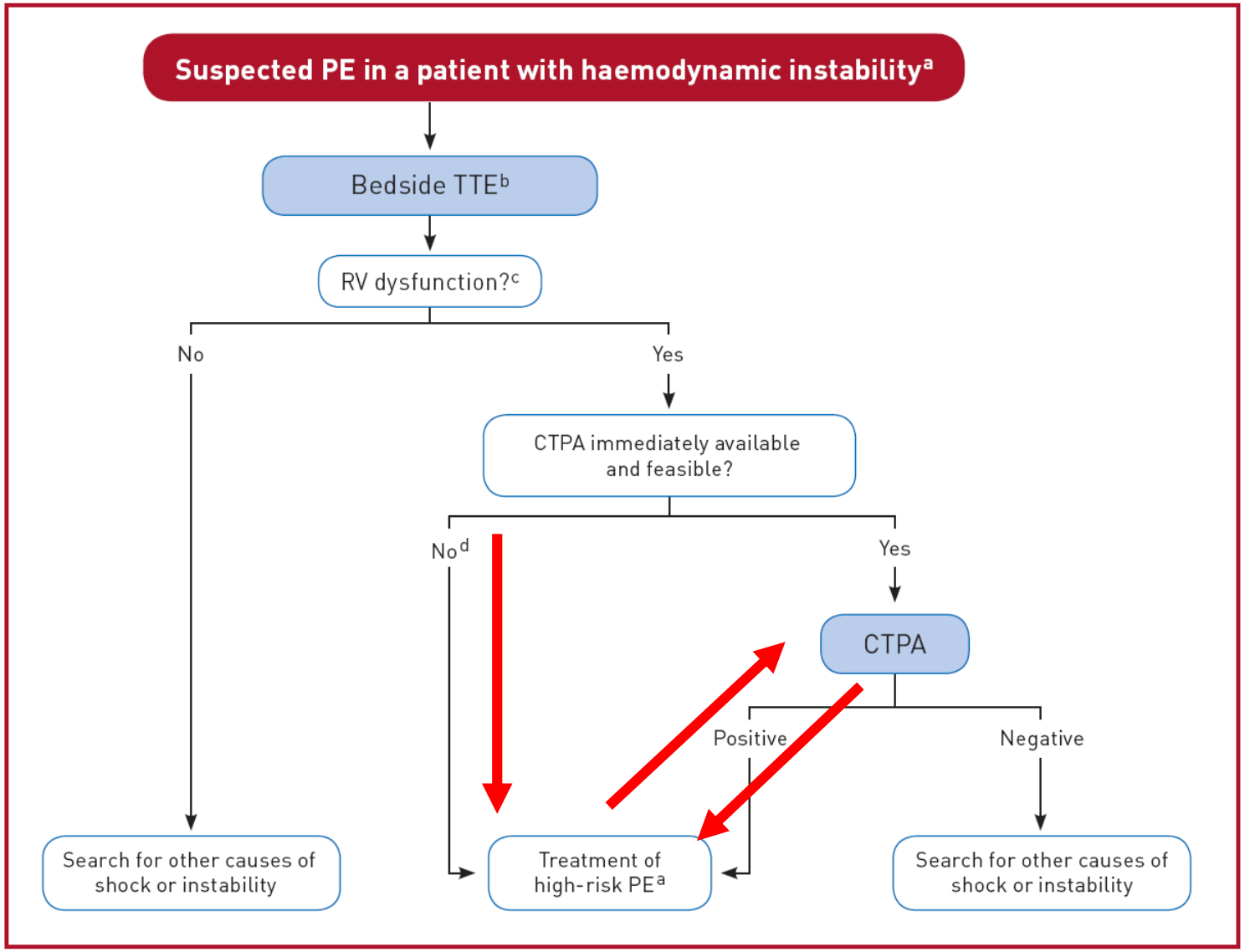


하루 지나고 나서...





증례 4 Review



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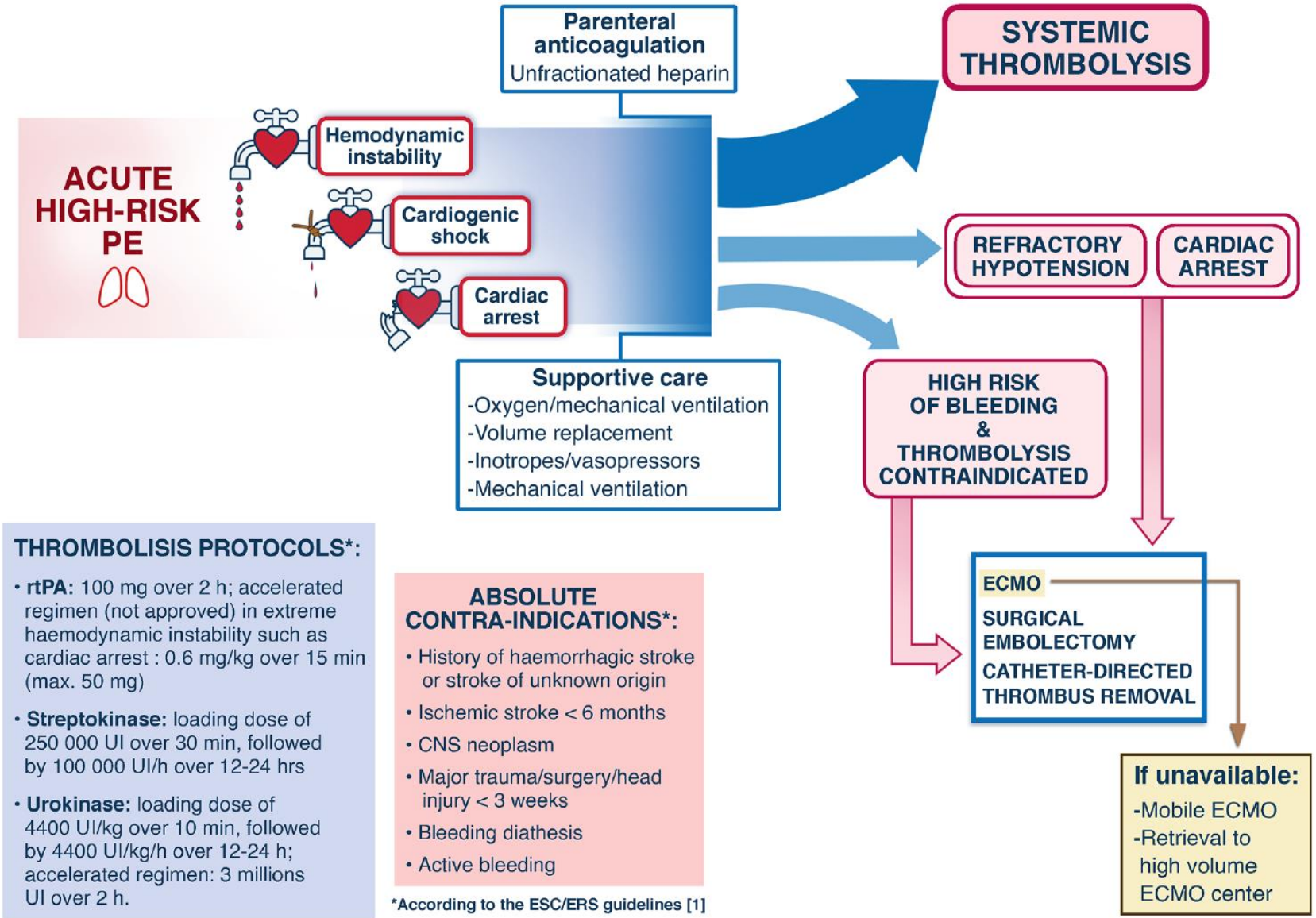
Molecule	Regimen	Contraindications to fibrinolysis
rtPA	100 mg over 2 h 0.6 mg/kg over 15 min (maximum dose 50 mg)[a]	**Absolute** History of haemorrhagic stroke or stroke of unknown origin Ischaemic stroke in previous 6 months Central nervous system neoplasm Major trauma, surgery, or head injury in previous 3 weeks Bleeding diathesis Active bleeding **Relative** Transient ischaemic attack in previous 6 months Oral anticoagulation Pregnancy or first post-partum week Non-compressible puncture sites Traumatic resuscitation Refractory hypertension (systolic BP >180 mmHg) Advanced liver disease Infective endocarditis Active peptic ulcer
Streptokinase	250 000 IU as a loading dose over 30 min, followed by 100 000 IU/h over 12–24 h Accelerated regimen: 1.5 million IU over 2 h	
Urokinase	4400 IU/kg as a loading dose over 10 min, followed by 4400 IU/kg/h over 12–24 h Accelerated regimen: 3 million IU over 2 h	

BP: blood pressure; IU: international units; rtPA, recombinant tissue-type plasminogen activator. [a]This is the accelerated regimen for rtPA in pulmonary embolism; it is not officially approved, but it is sometimes used in extreme haemodynamic instability such as cardiac arrest.



High-risk pulmonary embolism in the intensive care unit. Intensive Care Med (2023)

Management of Intermediate-High Risk PE

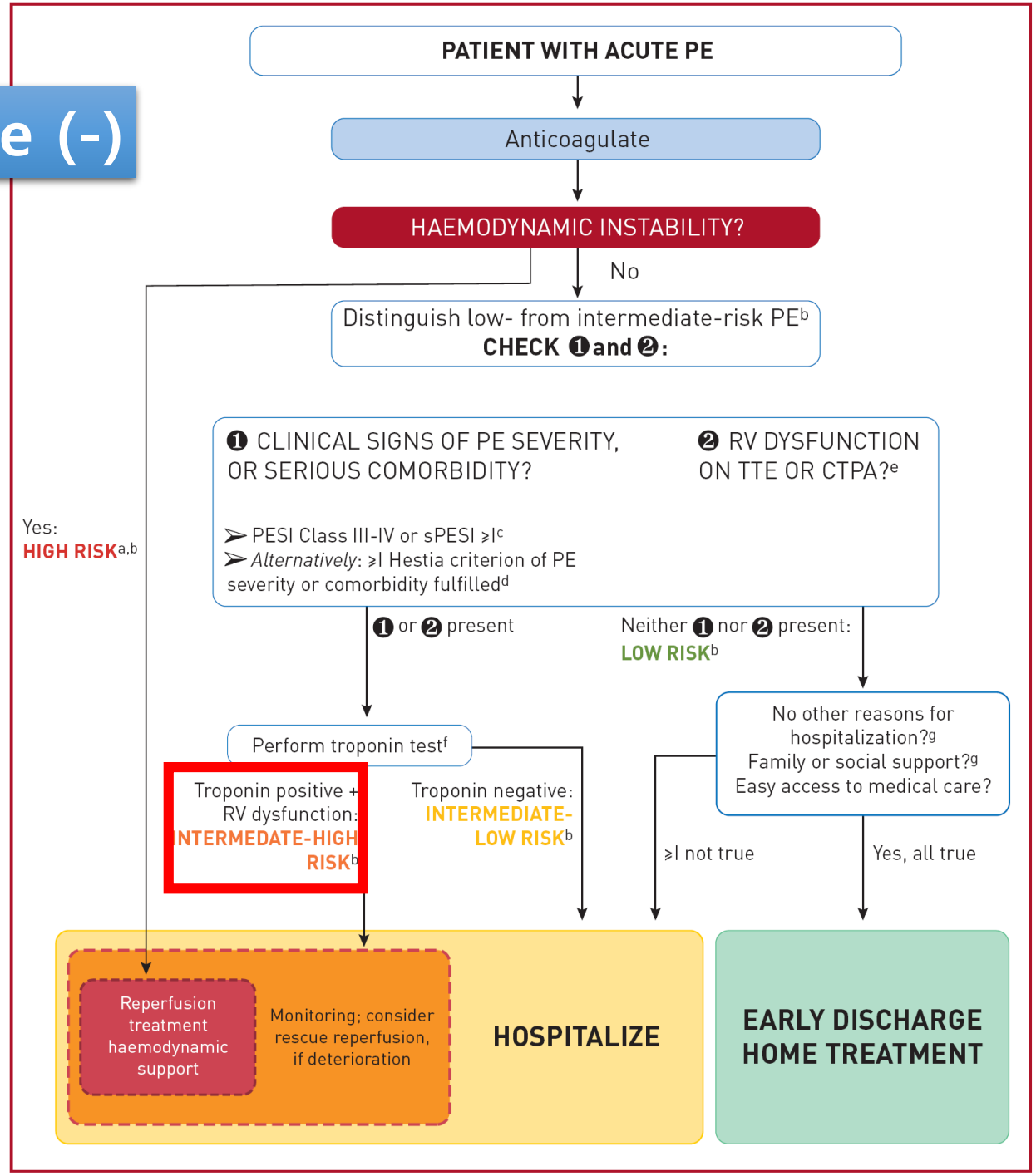
Hemodynamic collapse (-)

RV dysfunction (+)
Troponin (+)

Close monitoring

If "deterioration",
→ reperfusion

시점 결정이 쉽지 않음



2019 ESC Guidelines

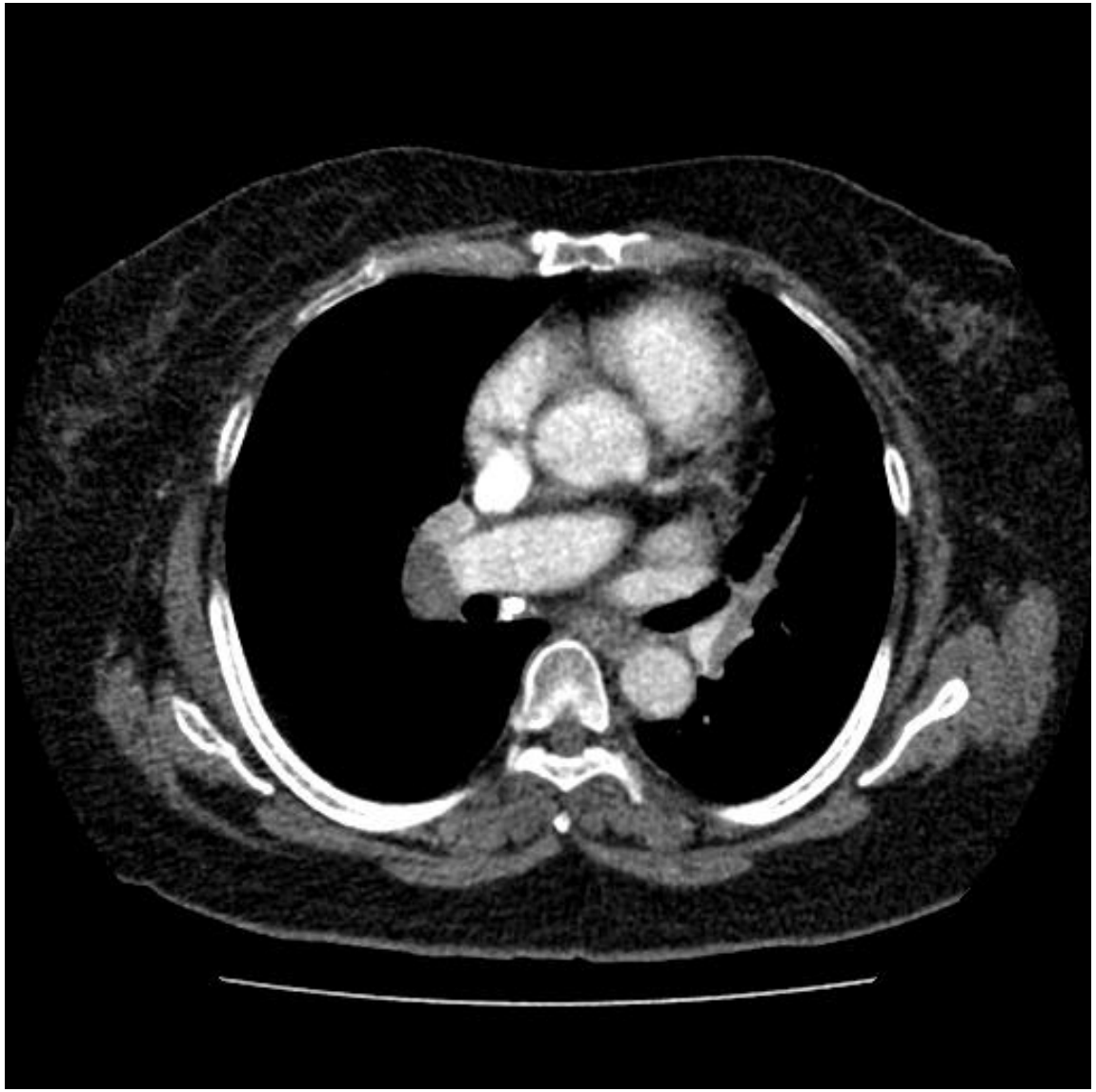
증례 5

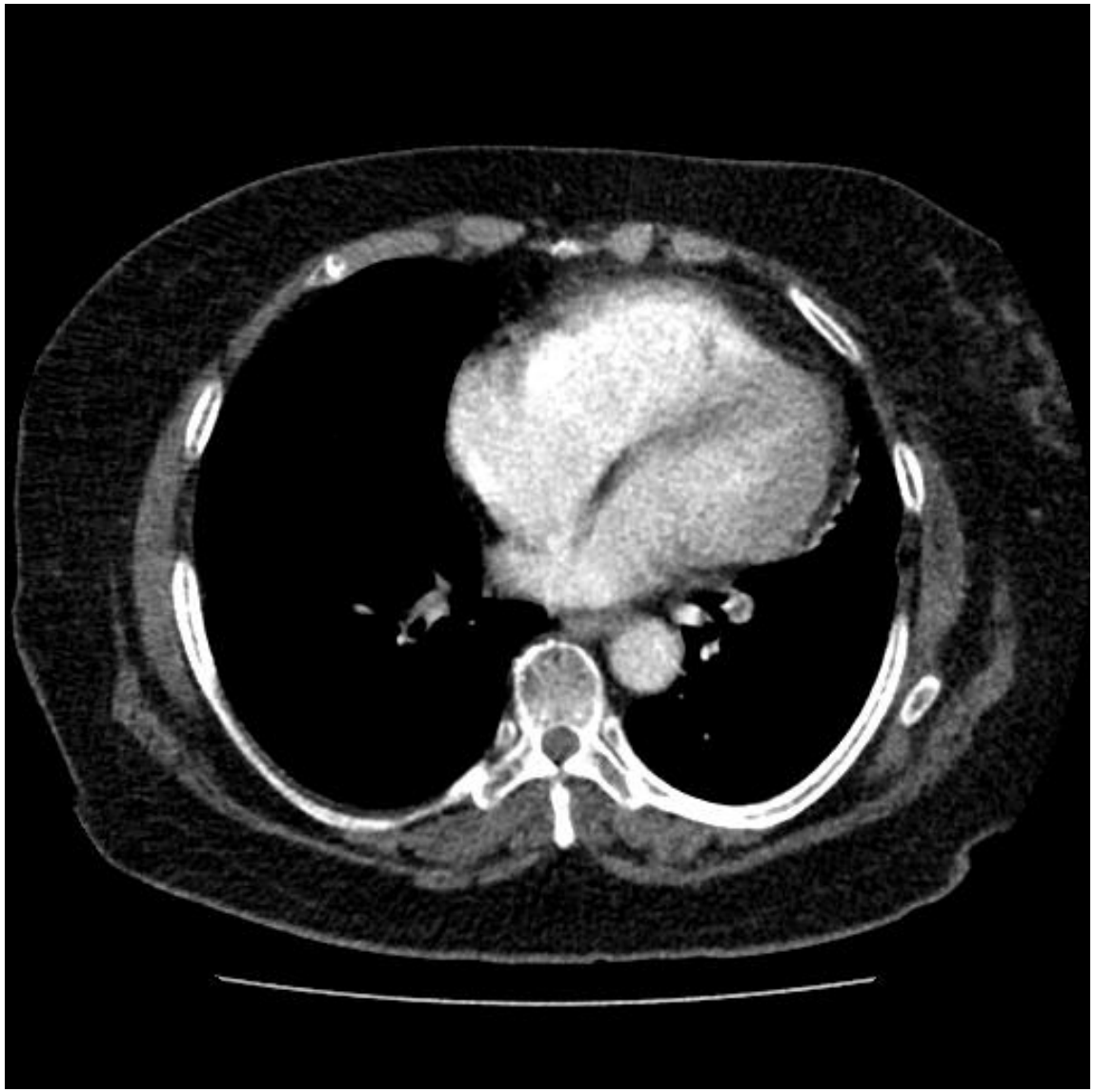
F/73

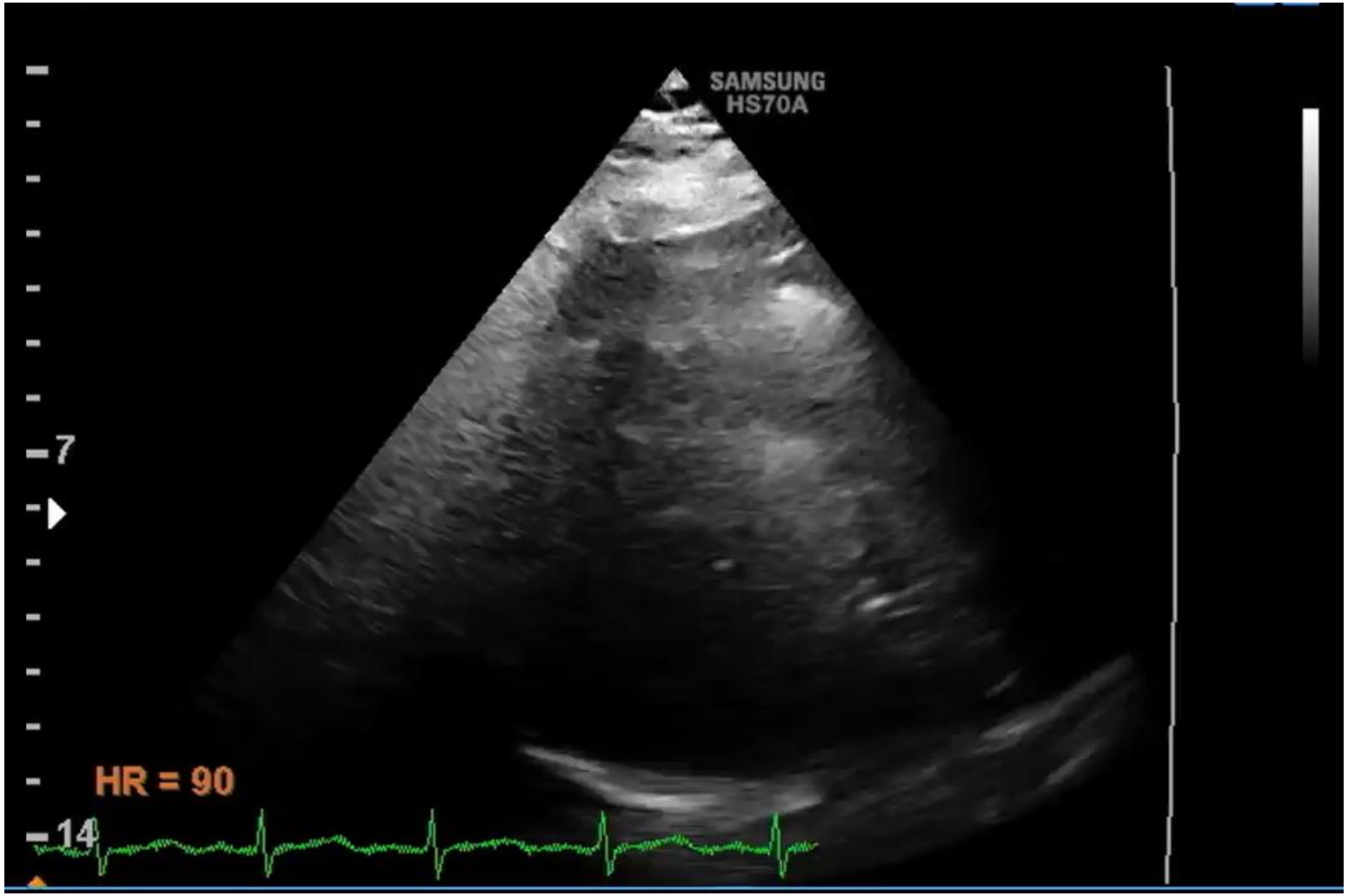
C/C: dyspnea

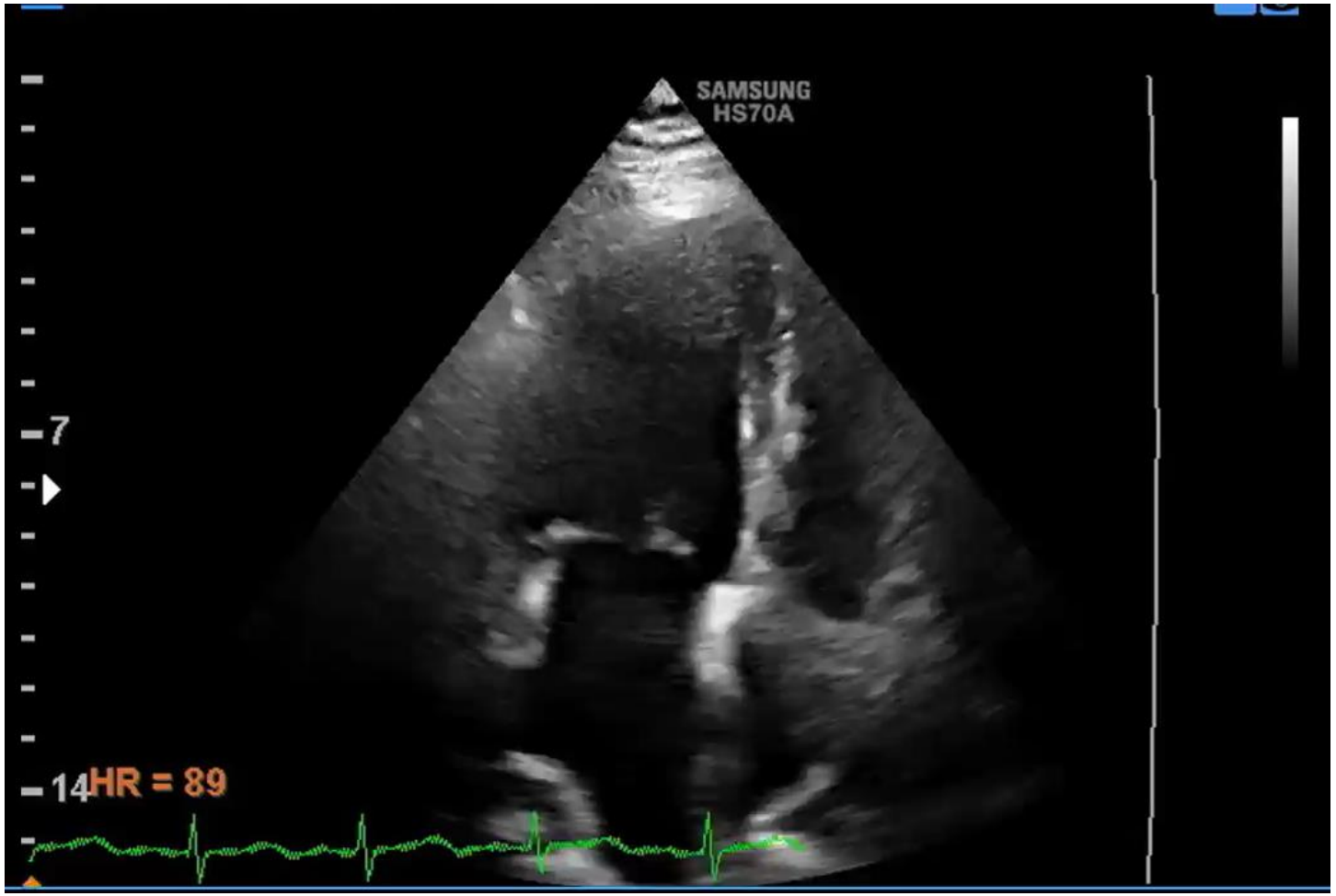
Brief Hx: 집에서 4륜 오토바이 타고 가다 넘어져서 요즘 많이 누워지내던 중 호흡곤란 발생하여 응급실 통해 입원

V/S: **135/73 mmHg** – 96 /min – 20 /min – 36.4 ℃






SAMSUNG
HS70A
7
HR = 90
14

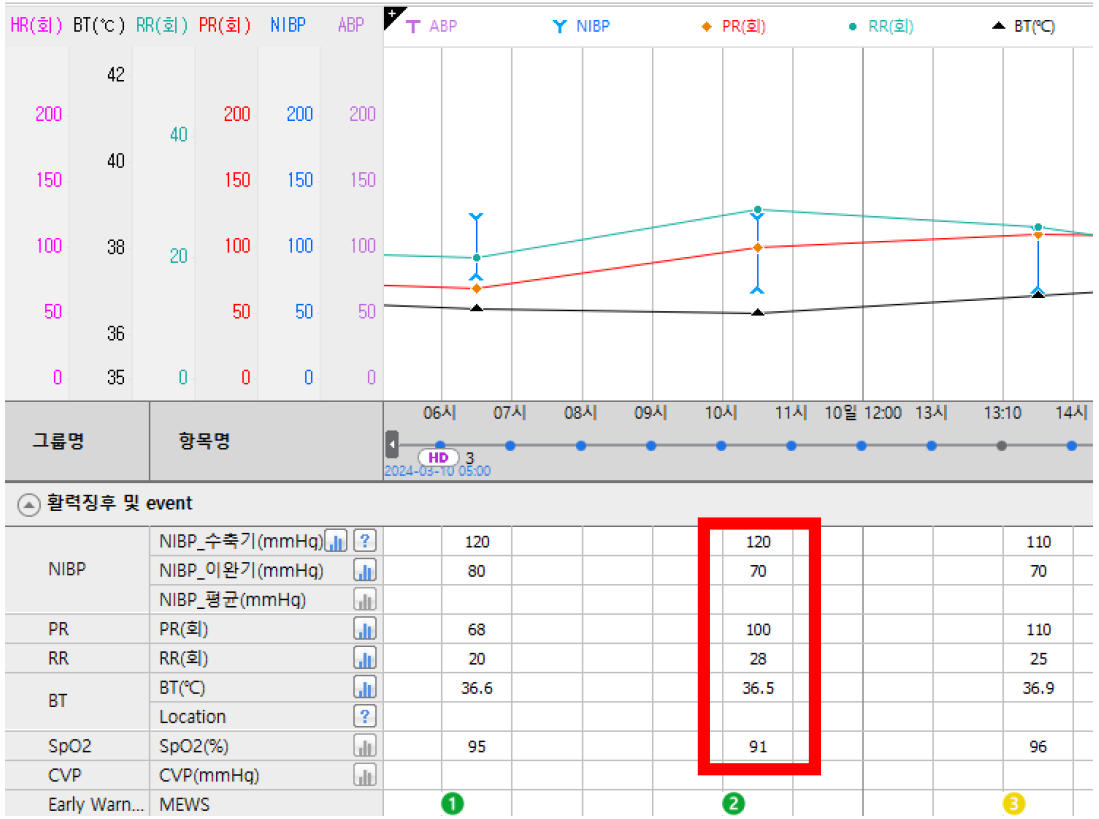


TnI 0.103 (+)

GW admission

LMWH

HD #2 – Aggravation of Dyspnea



rtPA 60 mg

증례 6

M/20

C/C: dyspnea

Brief Hx: 내원 당일 갑자기 숨 쉬기 힘들다고 하여 응급실 방문

V/S: **119/80 mmHg** – 117 /min– 18 /min – 36.2 ℃

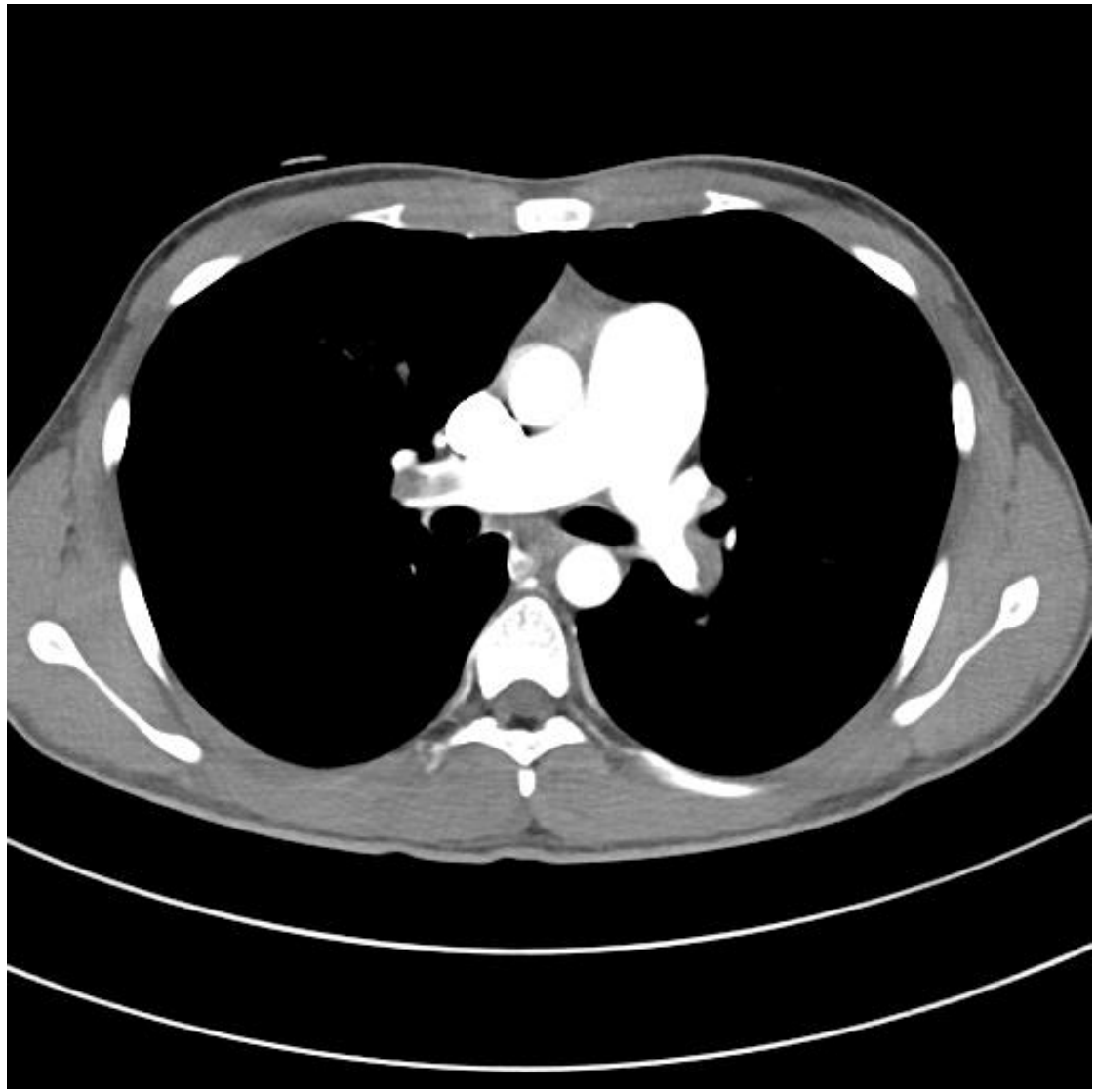
ER record

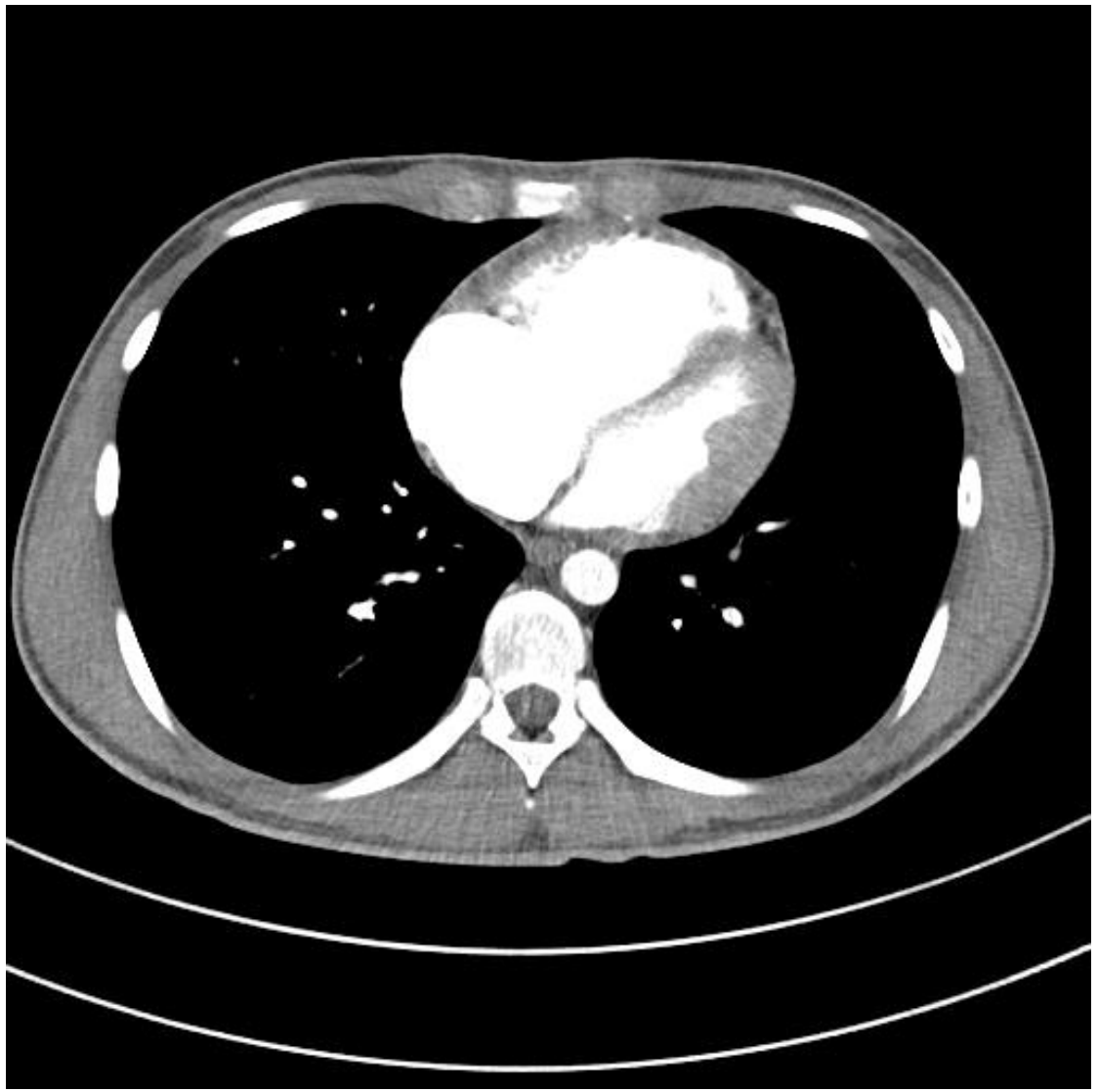
15:13 환자 응급의료센터 내원함

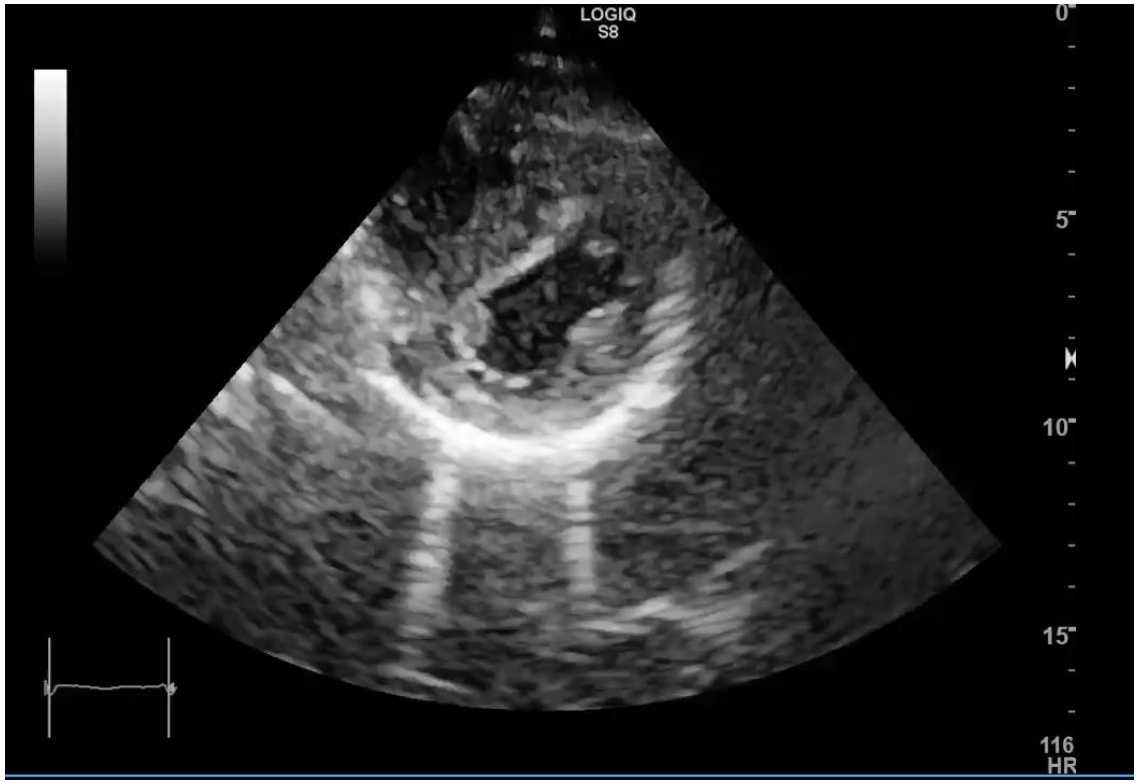
16:08 D-dimer 2864 [0 – 250]

TnI 0.055 [0 – 0.029]

16:33 CT 촬영함






LOGIQ
S8
0"
5"
10"
15"
116
HR


LOGIQ
S8
0"
5"
10"
15"
116
HR

ER record

15:13 환자 응급의료센터 내원함
16:08 D-dimer 2864 [0 – 250]
TnI 0.055 [0 – 0.029]
16:33 CT 촬영함
17:27 Enoxaparin 60 mg SC
19:57 ICU 입원 대기 중 cardiac arrest
20:24 rtPA 100 mg
20:48 ROSC – Arrest 반복, ROSC 유지되기 시작
21:42 V/S: 82/60 mmHg – 128 /min, ICU adm 후 VA ECMO

증례 6의 교훈

DTD 이론

Down Team is Down

RV **D**ysfunction **to** **D**eterioration

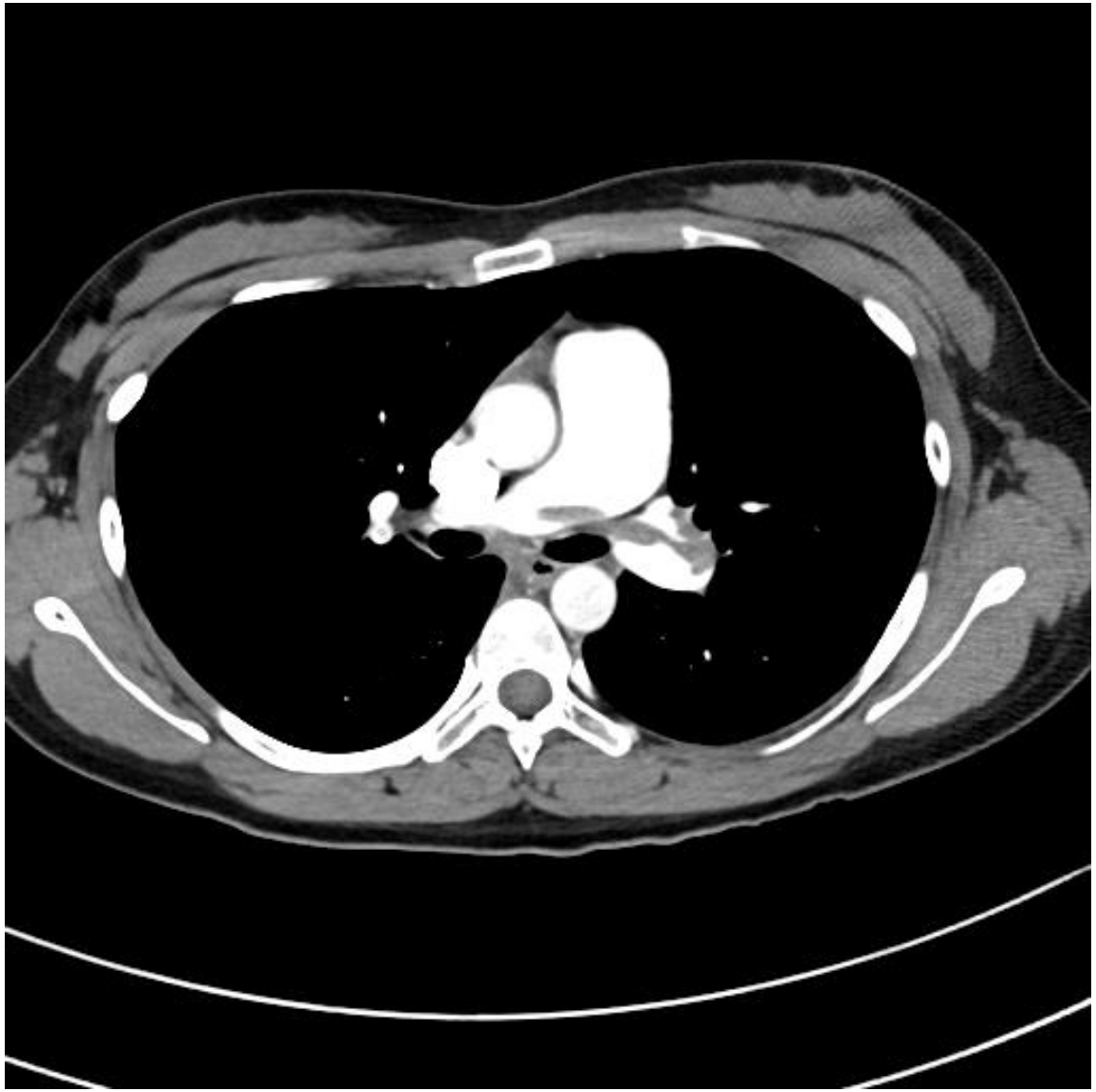
증례 7

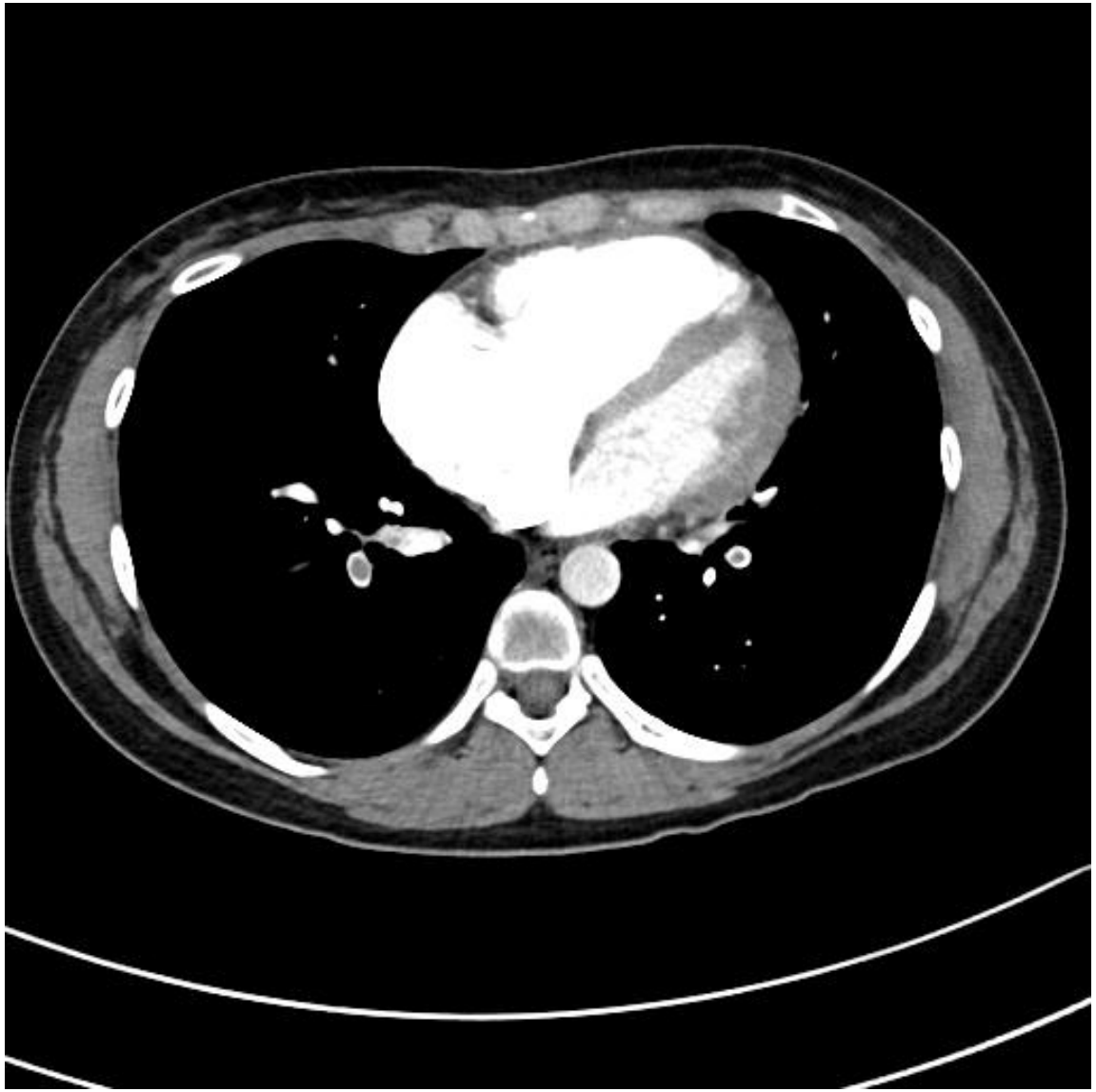
F/22

C/C: syncope

Hx: 하지 인대 파열, splint

119 SBP 70 mmHg → ER BP **108/88 mmHg, Alert**





증례 7

Body weight: 55 kg

	▶ 기본처방 ◀
1	Message
	※ Actilyse dose: 50 kg - 10 mg IVS, 이후 2시간 동안 60 mg 주입 (총 70 mg)

01-29 01:25	Actilyse 60mg/ml 를 30cc/hr 로 2시간동안 주입 start 함. plasma fluid 20cc/hr 로 조절함.
01-29 01:24	BP; 94/65mmHg HR: 97회/분 SPO2: 100% mental: alert 전신 피부상태 확인함. 이상없음. Dr. [redacted] Actilyse 10mg iv 함. 환자 보호자(모)에게 보호자 1인 상주 필요성, 출혈, 의식상태 변화 등 이상 있을 경우 의료진
01-29 01:16	중환자실 입실동의서 받음.
01-29 01:15	rTPA 동의서 받음.

Molecule	Regimen
rtPA	100 mg over 2 h 0.6 mg/kg over 15 min (maximum dose 50 mg)[a]

Concern major bleeding (eg. ICH)

<65 yr, 1.4 mg/kg (Min. 50 mg ~ Max. 100mg)

≥65 yr, 1.0 mg/kg (Max: 70 mg)

Actilyse dose: > 65 kg - 10 mg IVS, 이후 2시간 동안 90 mg 주입 (총 100 mg)
Actilyse dose: 60~65 kg - 10 mg IVS, 이후 2시간 동안 80 mg 주입 (총 90 mg)
Actilyse dose: 55~60 kg - 10 mg IVS, 이후 2시간 동안 70 mg 주입 (총 80 mg)
Actilyse dose: 50~55 kg - 10 mg IVS, 이후 2시간 동안 65 mg 주입 (총 75 mg)
Actilyse dose: 45~50 kg - 10 mg IVS, 이후 2시간 동안 55 mg 주입 (총 65 mg)
Actilyse dose: < 45 kg - 10 mg IVS, 이후 2시간 동안 50 mg 주입 (총 60 mg)

Role of Thrombolysis in Intermediate-Risk PE

- To prevent clinical decline in patients whom treated with anticoagulation alone (impending hemodynamic compromise)
- **PEITHO trial** (tenecteplase vs. tenecteplase + anticoagulation)
  - Less hemodynamic collapse, but more frequent bleeding
- **MOPETT trial**
  - Low dose rtPA: no difference for death

J. Clin. Med. 2024, 13, 257

6.7. Recommendations for acute-phase treatment of intermediate- or low-risk pulmonary embolism

Recommendations	Class[a]	Level[b]
Reperfusion treatment		
Rescue thrombolytic therapy is recommended for patients with haemodynamic deterioration on anticoagulation treatment [282].	I	B
As an alternative to rescue thrombolytic therapy, surgical embolectomy[e] or percutaneous catheter-directed treatment[e] should be considered for patients with haemodynamic deterioration on anticoagulation treatment.	IIa	C
Routine use of primary systemic thrombolysis is not recommended in patients with intermediate- or low-risk PE[c,f] [179].	III	B

2019 ESC Guidelines

Intermediate-risk PE

- Still representative of a large and diverse patient group
- Heterogeous nature
- Serologic biomarkers and imaging modalities
- Debate on the optimal care

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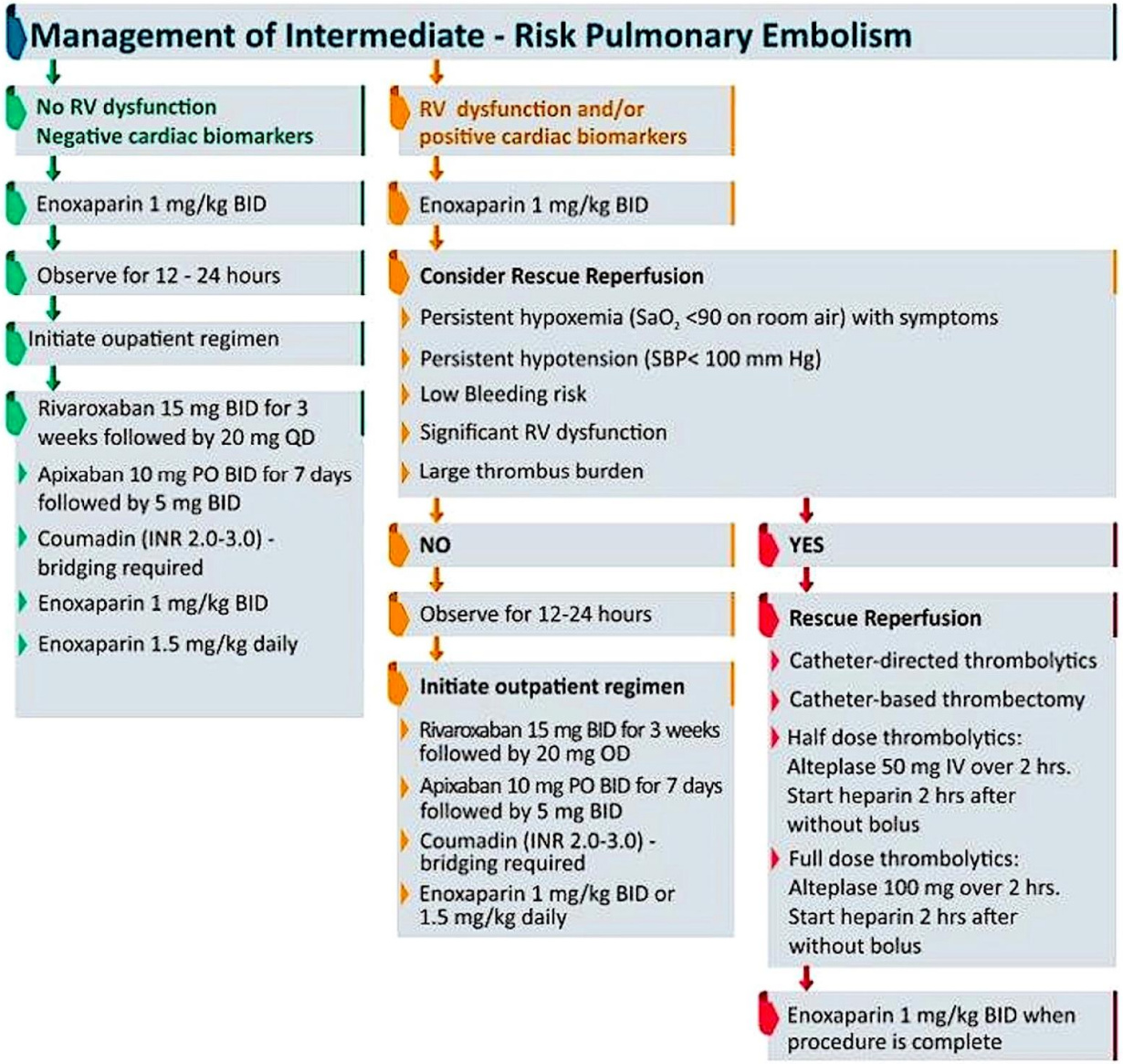
Proposed Management of Intermediate-Risk Pulmonary Embolism (PE)

Intermediate Risk = Acute PE without systemic hypotension (SBP > 90 mm Hg) and sPESI >0



J. Clin. Med. 2024, 13, 257

Multidisciplinary Teams: the PERTs

Pulmonary Embolism Response Teams

The high complexity, mortality risk, and evolving nature of available therapies with intermediate-risk PE

6.8. Recommendations for multidisciplinary pulmonary embolism teams

Recommendations	Class[a]	Level[b]
Set-up of a multidisciplinary team and a programme for the management of high- and (in selected cases) intermediate-risk PE should be considered, depending on the resources and expertise available in each hospital.	IIa	C

2019 ESC Guidelines

PERT

- Pulmonary critical care
- Interventional cardiology
- Cardiac surgery
- Interventional radiology
- Catheter-directed therapies

PERT

- Short time-to-therapeutic anticoagulation
- Decrease in ICU length of stay
- Reduced bleeding rates
- Decreased utilization of IVC filter
- May reduced PE-related mortality

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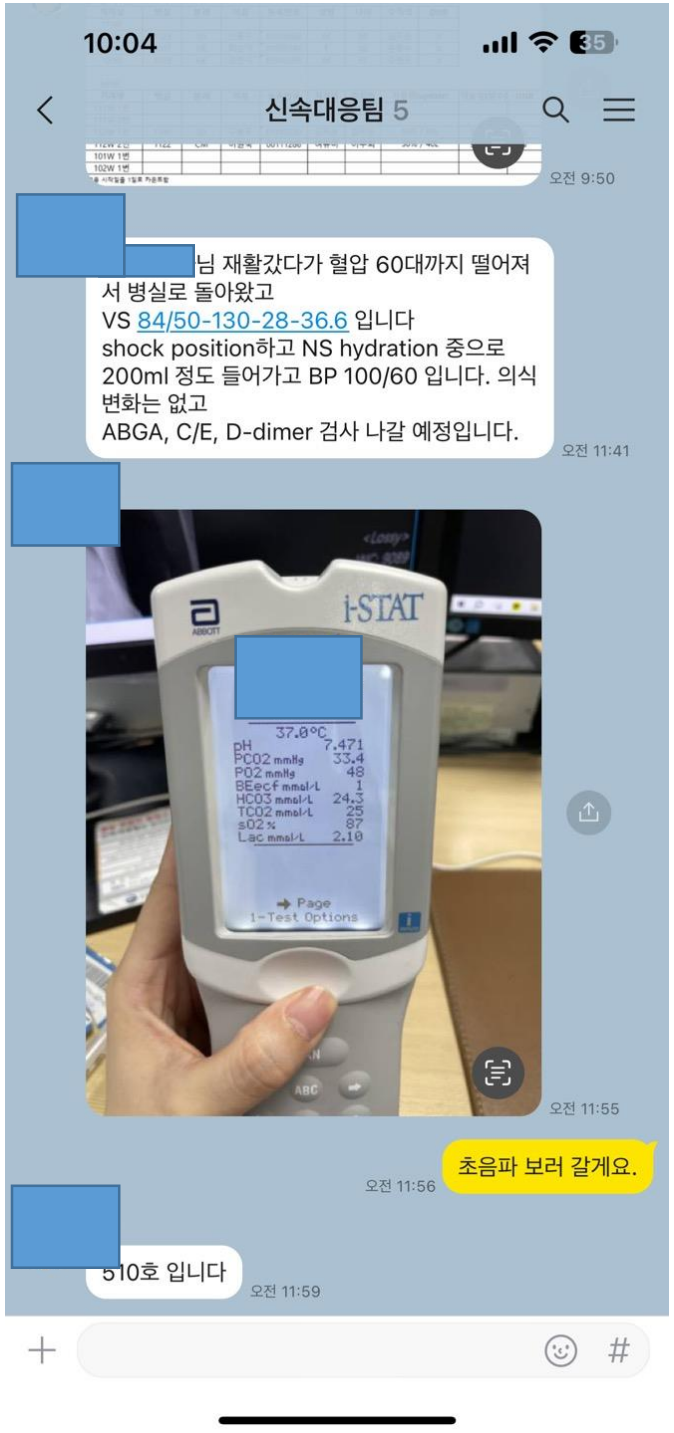
증례 8

F/78

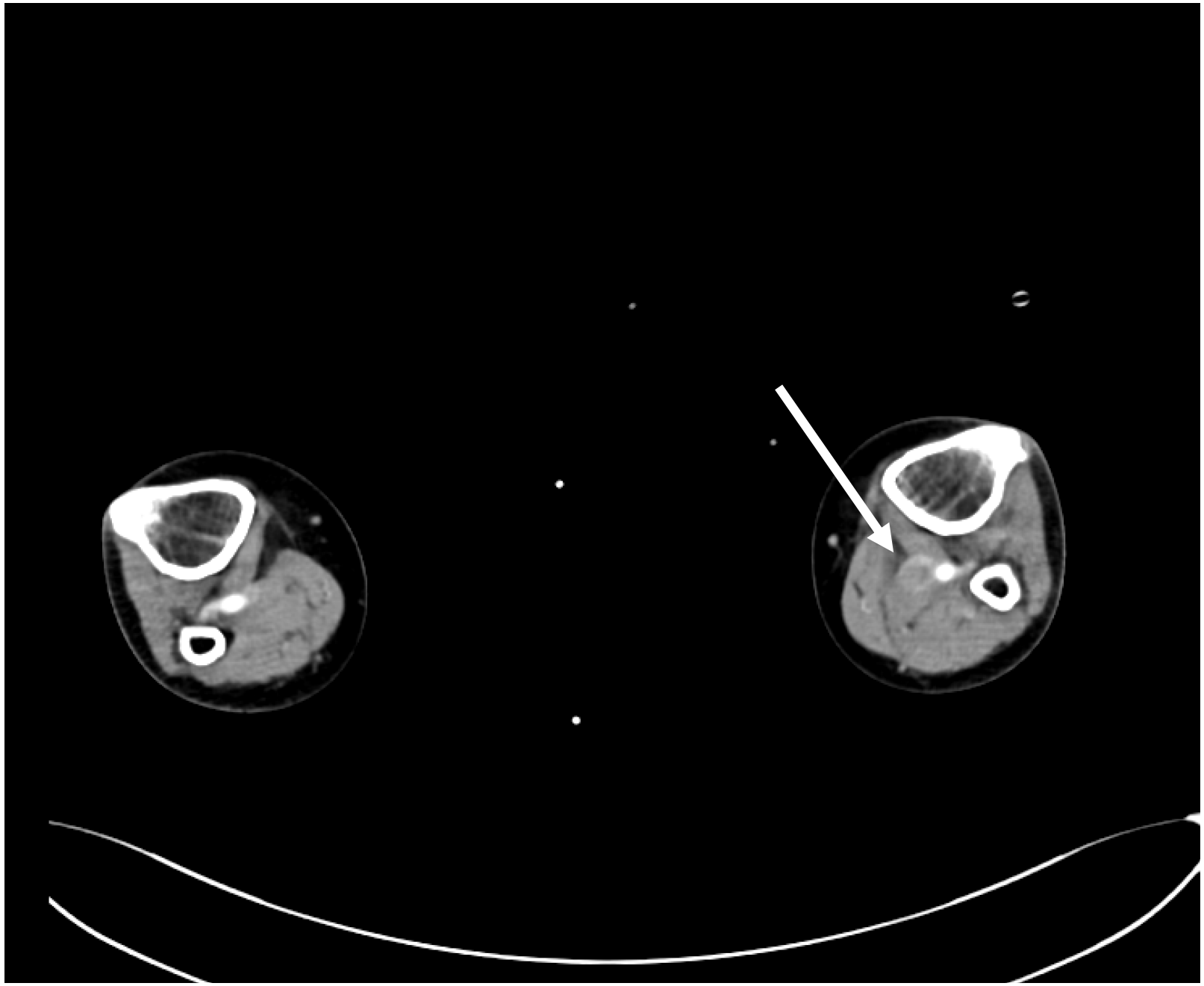
ICH

NS → RE

HD #25

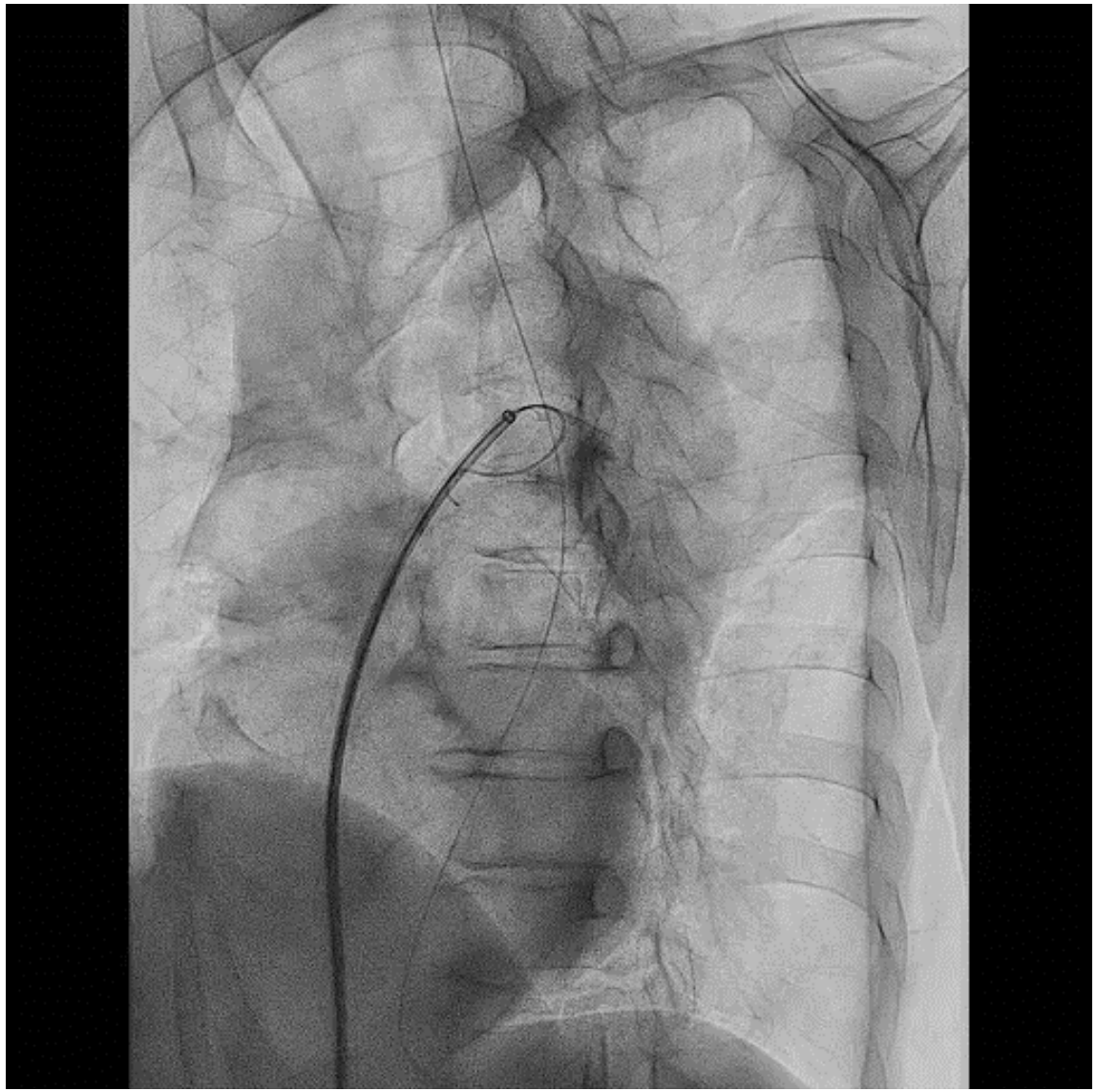


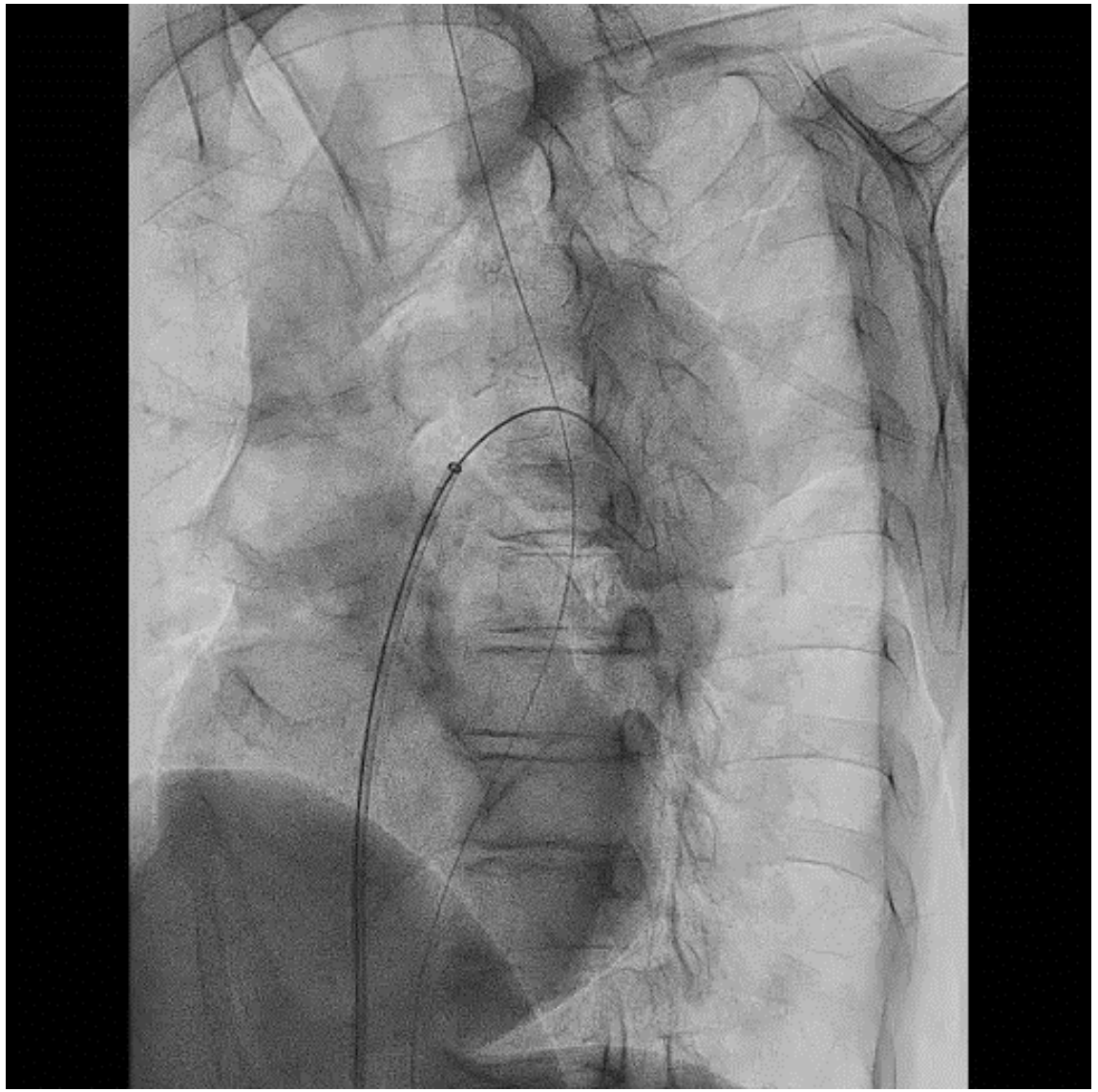

GE
Venue

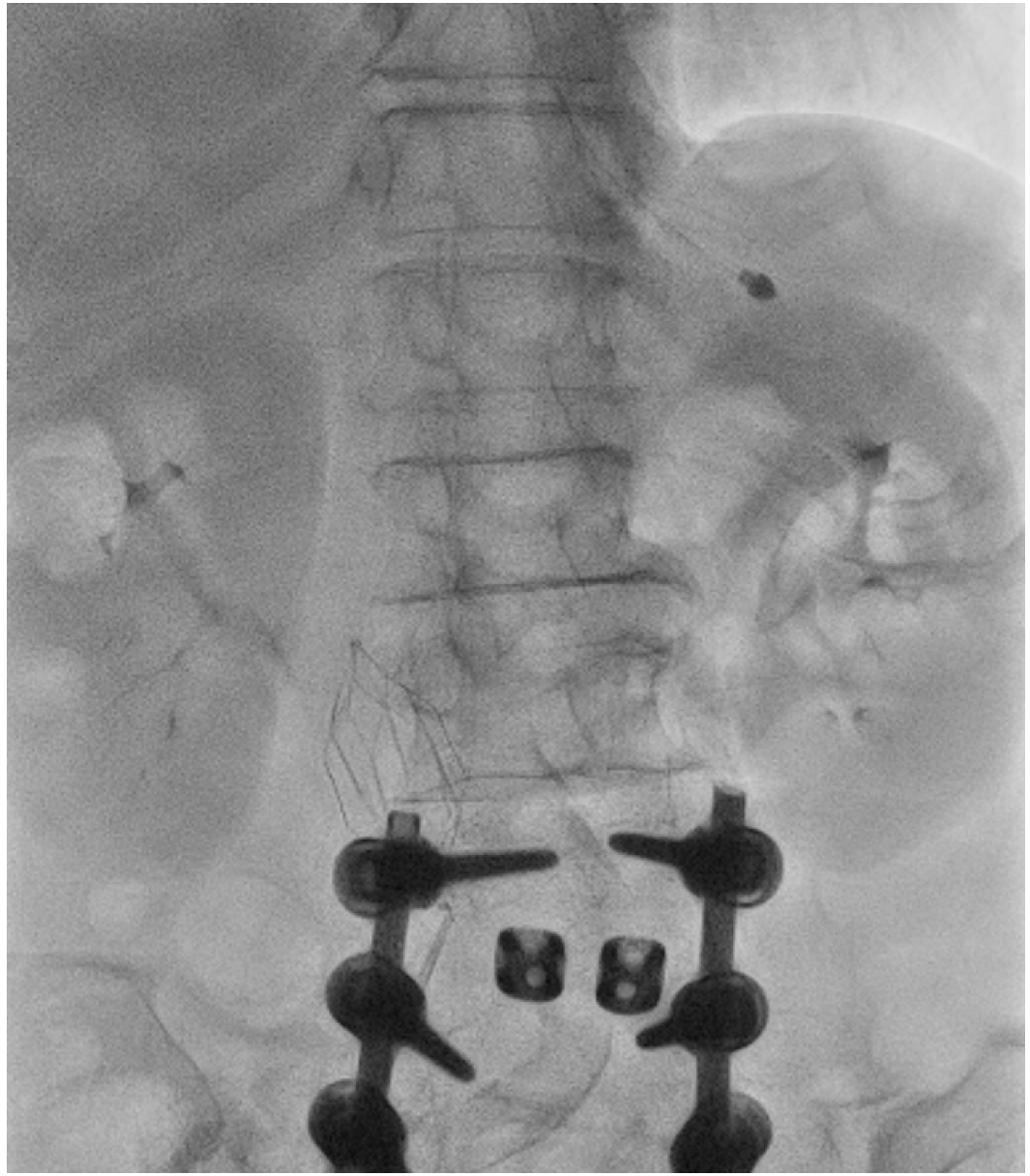


PERT (?)

- Intensivist, RRT: LMWH, consult to CV, ICU 자리 준비
- NS: contraindication of thrombolysis
- CV: catheter-based therapy (thrombectomy), prn IVC filter







마무리

- **High-risk PE**
  - Hemodynamic instability 환자: **POCUS**로 PE 여부를 감별
  - **Hemodynamic support**로 가능하다면 CTPA
    - Fluid optimization, Norpeinephrine, VA ECMO
  - **Reperfusion therapy**
    - Thrombolysis (half ~ standard), Catheter-base therapies, Surgery

마무리

- **Intermediate high-risk PE**
  - Risk stratification: **Hemodynamic, RV dysfunction, Troponin,** PESI
  - **환자의 hemodynamic collapse는 종종 급격히 진행된다!**
  - **RV dysfunction**은 정량화하기 어려우나 high risk PE로 전환될 가능성이 매우 높다.
  - **PERT, catheter-directed therapies**가 항상 가능하면 좋겠으나 나이/체중/기저질환을 고려한 thrombolysis도 괜찮은 선택이다.