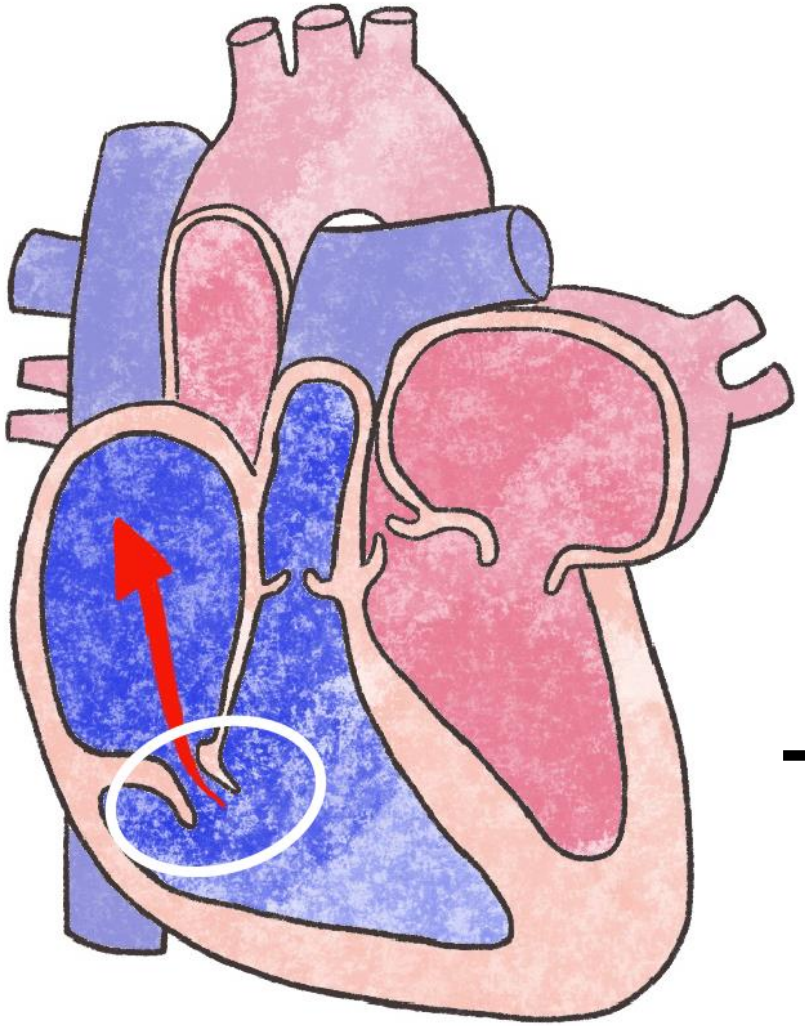
Why not TRPG?



Tomoaki NATSUKAWA

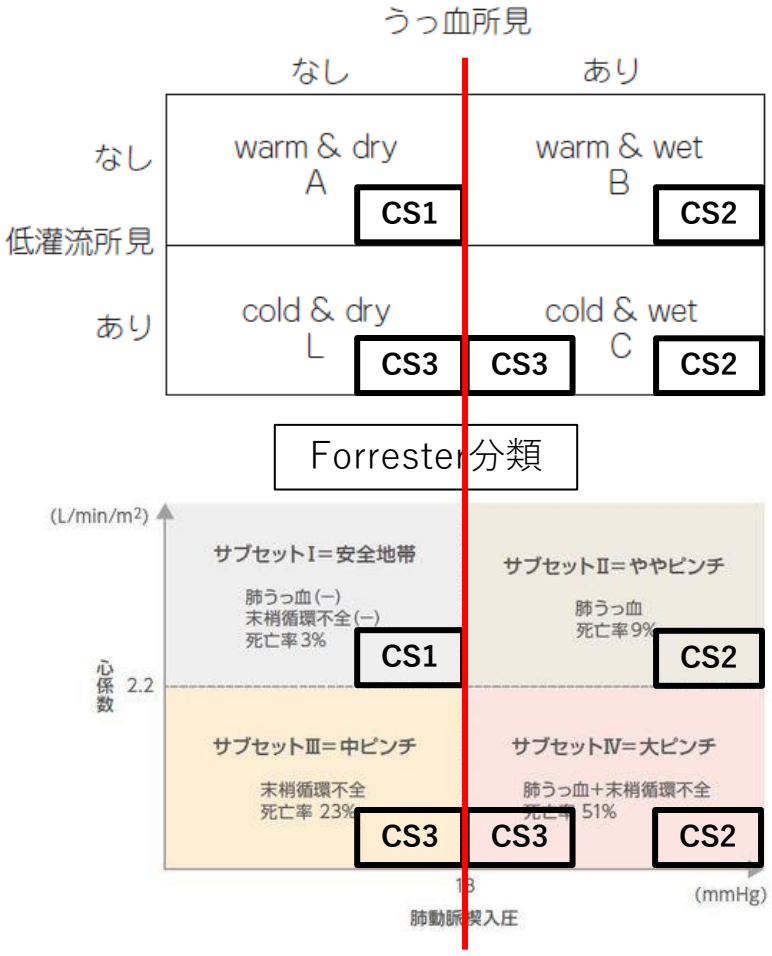
夏川知輝のオレ流チャンネル

エビデンスはいつもオレの後ろ

初めに…

心不全の分類

Nohria-Stevenson分類



Forrester分類

臨床的指標は？

Clinical Scenario

分類	収縮期血圧	(予想される)病態	治療
CS1	＞140mmHg	びまん性肺水腫 全身性浮腫は軽度のことが多い	硝酸薬などの血管拡張薬、NPPV 利尿薬の適応はほとんどない
CS2	100~140mmHg	全身性浮腫	利尿薬、血管拡張薬、NPPV
CS3	＜100mmHg	低灌流性心不全	容量負荷、カテコールアミン
CS4	—	急性冠症候群	再灌流療法など、ACSガイドラインに準じて実施
CS5	—	右心不全	SBP＞90mmHgと全身性浮腫あれば利尿薬、SBP＜90mmHgならカテコールアミン

循環血液量の指標は？

機能的指標

- 少 FCT
- 少 PLRT
- 少 多 GEDI
- 少 多 Hb・Hctの推移

動的指標

- 少 多 IVCの呼吸性変動
- 少 SVV
- 少 動脈圧の呼吸性変動

静的指標

- 少 多 IVC径
- 少 多 CVP
- 少 LVDd
- 多 PCWP
- 多 **TRPG**

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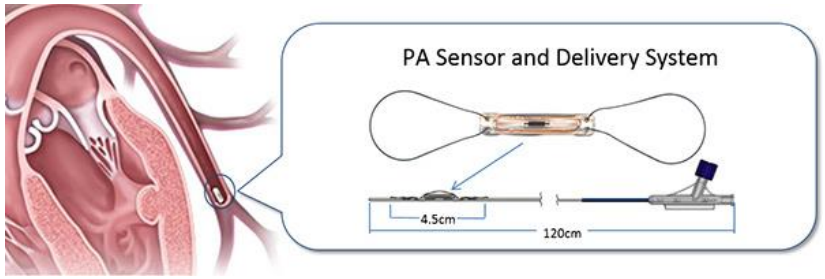
Long-term Prognostic Significance of Admission Tricuspid Regurgitation Pressure Gradient in Hospitalized Patients With Heart Failure With Preserved Ejection Fraction: A Report From the Japanese Real-World Multicenter Registry

Kazunori Omote [1], Toshiyuki Nagai [1] ✉, Kiwamu Kamiya [1], Tadao Aikawa [1], Shingo Tsujinaga [1], Yoshiya Kato [1], Hirokazu Komoriyama [1], Hiroyuki Iwano [1], Kazuhiro Yamamoto [2], Tsutomu Yoshikawa [3], Yoshihiko Saito [4], Toshihisa Anzai [1]

Introduction



- ワイヤレス肺動脈圧モニタリングのガイド付き管理により、HFpEF患者のHF悪化による入院が減少
- PHの正確で非侵襲的な推定は、HFpEFの管理にとって重要
- TRPGは、肺動脈収縮期圧を評価するための代表的な非侵襲的心エコー検査パラメーター
- HFpEF患者の長期転帰に関連したHFの急性非代償性期の入院時のTRPGの予後への影響は不明
- この研究の目的は、入院時のTRPGがHFpEF患者のその後の有害事象と関連しているかどうかを調査すること

Method

- 2012年11月から2015年3月の間に取得されたJASPER（日本のHFpEFレジストリ）からのデータを後方視的に分析
- JASPERは急性非代償性心不全の診断で入院となった高齢の患者を含む多施設、観察、前向きコホート
- 535人の患者のうち、入院時にアクセス可能なTRPGデータがない患者は除外し、469人の患者が対象

Method

- 心エコー検査は入院から6時間以内に実施
- TRPGは、収縮期の右心室から右心房への逆流速度から、ベルヌーイ方程式 ($\Delta P = 4 \times V^2$) を使用して計算
- 肺毛細血管楔入圧(PCWP)は、心室中隔で測定されたLV流入Eとeの比率を使用して推定

  $PCWP = 11.96 + 0.596 \times E/e$ (心室中隔)

Results

Table 1. Baseline Patient Characteristics at Admission and During In-hospital Treatment

Variables	All patients	TRPG				*P* value
		First quartile ≤ 26 mmHg	Second quartile 27–34 mmHg	Third quartile 35–43 mmHg	Fourth quartile ≥ 44 mmHg	
Number	469	106	120	121	122	
Age, years	78.3 ± 10.0	76.3 ± 11.3	78.0 ± 9.6	79.1 ± 9.3	79.5 ± 9.9	0.076
Female	232 (49.5)	45 (42.5)	67 (55.8)	56 (46.3)	64 (52.5)	0.175
BMI, kg/m^2	23.6 ± 5.0	23.5 ± 5.4	24.3 ± 5.1	23.7 ± 4.7	23.0 ± 4.9	0.22
NYHA functional class, n (%)						
I	3 (0.7)	0 (0)	2 (1.7)	0 (0)	1 (0.9)	0.75
II	105 (23.3)	27 (27.0)	27 (22.9)	28 (24.6)	23 (19.5)	
III	191 (42.4)	43 (43.0)	51 (43.2)	45 (39.5)	52 (44.1)	
IV	151 (33.6)	30 (30.0)	38 (32.2)	41 (36.0)	42 (35.6)	
Vital signs						
Heart rate, beats/min	78 (65–100)	80 (70–104)	81 (66–107)	75 (64–93)	77 (62–99)	0.073
Systolic BP, mmHg	149.2 ± 36.0	143.3 ± 39.6	145.9 ± 35.8	158.3 ± 35.7	148.5 ± 31.6	0.009
Diastolic BP, mmHg	78.7 ± 22.9	78.3 ± 21.4	78.6 ± 24.2	82.0 ± 24.4	75.9 ± 21.2	0.23
Past history, n (%)						
Smoking	41 (10.5)	12 (13.3)	6 (6.5)	14 (13.5)	9 (8.8)	0.30
Prior HF admission	177 (39.1)	34 (33.0)	42 (35.9)	42 (36.2)	59 (50.4)	0.032
Prior myocardial infraction	59 (12.7)	15 (14.4)	14 (11.8)	17 (14.2)	13 (10.7)	0.79
Coronary artery disease	94 (20.3)	19 (18.3)	22 (18.5)	26 (21.7)	27 (22.5)	0.80
Atrial fibrillation	302 (65.1)	64 (61.0)	81 (68.4)	76 (63.9)	81 (66.4)	0.66
Diabetes mellitus	173 (37.0)	32 (30.5)	45 (37.5)	47 (39.2)	49 (40.2)	0.44
Dyslipidemia	186 (39.9)	43 (40.6)	52 (43.3)	46 (39.0)	45 (36.9)	0.77
Cerebrovascular disease	109 (23.6)	20 (19.1)	29 (24.6)	32 (26.7)	28 (23.5)	0.59
Chronic kidney disease	245 (52.5)	43 (41.0)	61 (50.8)	73 (60.8)	68 (55.7)	0.022
COPD/asthma	52 (11.3)	7 (6.7)	18 (15.1)	12 (10.4)	15 (12.4)	0.24
Clinical signs, n (%)						
Breathlessness	412 (90.4)	93 (90.3)	103 (89.6)	110 (92.4)	106 (89.1)	0.82
Elevated JVD	211 (51.1)	41 (43.2)	54 (51.9)	54 (52.4)	62 (55.9)	0.32
Lower extremity edema	345 (74.0)	71 (67.6)	90 (75.6)	95 (78.5)	89 (73.6)	0.30
Laboratory data at admission						
Sodium, mEq/L	139.9 ± 4.2	139.4 ± 4.5	139.8 ± 4.7	140.2 ± 3.7	140.1 ± 3.9	0.51
BUN, mg/dL	22 (16–32)	19 (16–27)	22 (15–30)	23 (17–35)	25 (17–36)	0.005
Creatinine, mg/dL	1.1 (0.8–1.5)	1.0 (0.8–1.3)	1.0 (0.7–1.4)	1.1 (0.8–1.8)	1.1 (0.8–1.8)	0.038
Hemoglobin, g/dL	11.2 ± 2.2	11.7 ± 2.2	11.3 ± 2.3	10.9 ± 2.2	10.7 ± 1.9	0.002
BNP, pg/mL	423 (233–691)	338 (188–595)	395 (224–629)	438 (274–726)	488 (265–834)	0.006
C-reactive protein, mg/dL	0.4 (0.1–1.4)	0.4 (0.2–1.1)	0.3 (0.1–1.4)	0.5 (0.1–2.1)	0.4 (0.1–1.5)	0.43
Albumin, g/dL	3.6 ± 0.5	3.6 ± 0.5	3.6 ± 0.5	3.6 ± 0.5	3.7 ± 0.4	0.73
Total cholesterol, mg/dL	156.2 ± 38.4	156.1 ± 38.1	161.9 ± 42.9	156.4±32.0	150.9 ± 39.0	0.23
Total bilirubin, mg/dL	0.8 (0.6–1.1)	0.8 (0.6–1.1)	0.7 (0.6–1.1)	0.8 (0.5–1.0)	0.8 (0.6–1.1)	0.57
Medications before admission, n (%)						
ACEIs/ARBs	274 (58.4)	52 (49.1)	73 (60.8)	76 (62.8))	73 (59.8)	0.160
β-blockers	207 (44.1)	41 (38.7)	50 (41.7)	58 (47.9)	58 (47.5)	0.41
Loop diuretics	252 (53.7)	48 (45.3)	63 (52.5)	62 (51.2)	79 (64.8)	0.025
MRAs	100 (21.3)	23 (21.7)	27 (22.5)	24 (19.8)	26 (21.3)	0.97
Digitalis	54 (11.5)	6 (5.7)	16 (13.3)	17 (14.1)	15 (12.3)	0.188
Anticoagulants	224 (47.8)	43 (40.6)	61 (50.8)	59 (48.8)	61 (50.0)	0.40
Initial treatment, n (%)						
Intravenous diuretics	380 (81.0)	80 (75.5)	99 (82.5)	100 (82.6)	101 (82.8)	0.43
Vasodilators	275 (58.6)	49 (46.2)	63 (52.5)	85 (70.3)	78 (63.9)	< 0.001
Length of hospital stay, days	16 (11–23)	16 (11–22)	15 (11–21)	16 (11–23)	18 (12–24)	0.27

ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; BMI, body mass index; BNP, plasma brain-type natriuretic peptide; BP, blood pressure; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; HF, heart failure; JVD, jugular venous distention; MRA, mineralocorticoid receptor antagonists; NYHA, New York Heart Association; TRPG, tricuspid regurgitation pressure gradient.

Note: Continuous variables are presented as mean ± SD if normally distributed and as median (interquartile range) if not normally distributed. Categorical variables are presented as number of patients (%).

Table 2. Echocardiographic Parameters at Admission

Variable	All patients	TRPG				*P* value
		First quartile (≤ 26 mmHg)	Second quartile (27–34 mmHg)	Third quartile (35–43 mmHg)	Fourth quartile (≥ 44 mmHg)	
Number	469	106	120	121	122	
LVEF, %	60 ± 8	58 ± 8	60 ± 8	61 ± 8	60 ± 9	0.058
LAD, mm	46 ± 9	43 ± 10	45 ± 7	46 ± 10	48 ± 9	0.002
LAVI, mL/m^2	60 (43–80)	48 (37–74)	54 (40–73)	60 (44–81)	73 (53-93)	0.015
LVDD, mm	46 ± 7	46 ± 6	47 ± 7	47 ± 7	47 ± 7	0.24
LVPWD, mm	11 ± 2	11 ± 2	10 ± 2	11 ± 2	11 ± 2	0.20
LVIVSD, mm	11 ± 3	11 ± 3	11 ± 2	11 ± 3	11 ± 3	0.55
LVMI, g/m^2	118 ± 35	110 ± 37	115 ± 31	123 ± 37	123 ± 32	0.012
E wave, cm/s	102 ± 34	86 ± 29	99 ± 28	104 ± 33	118 ± 40	<0.001
A wave, cm/s	78 ± 32	73 ± 29	78 ± 33	82 ± 27	79 ± 40	0.51
E/A	1.3 (0.8–1.7)	1.0 (0.7–1.6)	1.1 (0.8–1.7)	1.1 (0.9–1.5)	1.4 (0.8–2.0)	0.24
DcT, ms	193 ± 67	193 ± 74	191 ± 57	193 ± 59	196 ± 77	0.95
E/e′ (septum), cm/s	17 (13–22)	15 (12–20)	16 (13–22)	18 (13–23)	19 (16–26)	0.001
E/e′ (lateral), cm/s	12 (9–16)	10 (8–15)	12 (9–18)	11 (9–15)	15 (10–18)	0.077
E/e′ (average), cm/s	14 (11–18)	12 (10–16)	14 (10–19)	13 (11–17)	16 (12–21)	0.047
PCWP, mmHg	23 ± 6	22 ± 5	23 ± 5	24 ± 6	25 ± 7	0.002
TRPG, mmHg	37 ± 13	21 ± 5	31 ± 2	39 ± 3	53 ± 8	<0.001
IVCD, mm	20 ± 6	19 ± 6	19 ± 6	20 ± 6	20 ± 6	0.82

DcT, deceleration time of early-diastolic flow; IVCD, inferior vena cava diameter; LA, left atrial; LAD, left atrial dimension; LAVI, left atrial volume index; LVDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; LVIVSD, left ventricular interventricular septum diameter; LVMI, left ventricular mass index; LVPWD, left ventricular posterior wall diameter; PCWP, post capillary wedge pressure; TRPG, tricuspid regurgitation pressure gradient.

Note: Continuous variables are presented as mean ± SD if normally distributed.

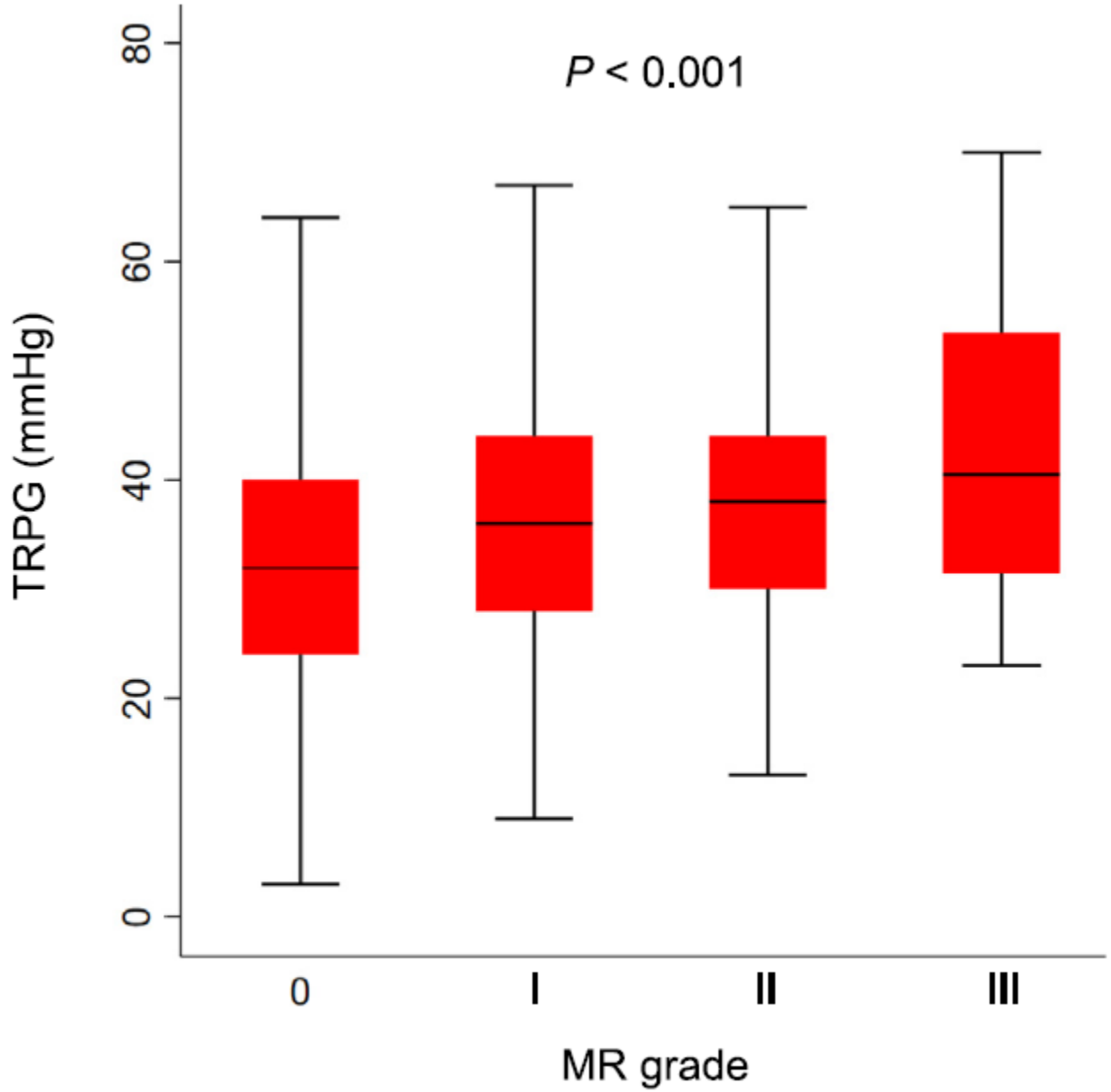


Fig. 1. Levels of TRPG at admission according to MR grade. MR, mitral regurgitation; TRPG, tricuspid regurgitation pressure gradient.

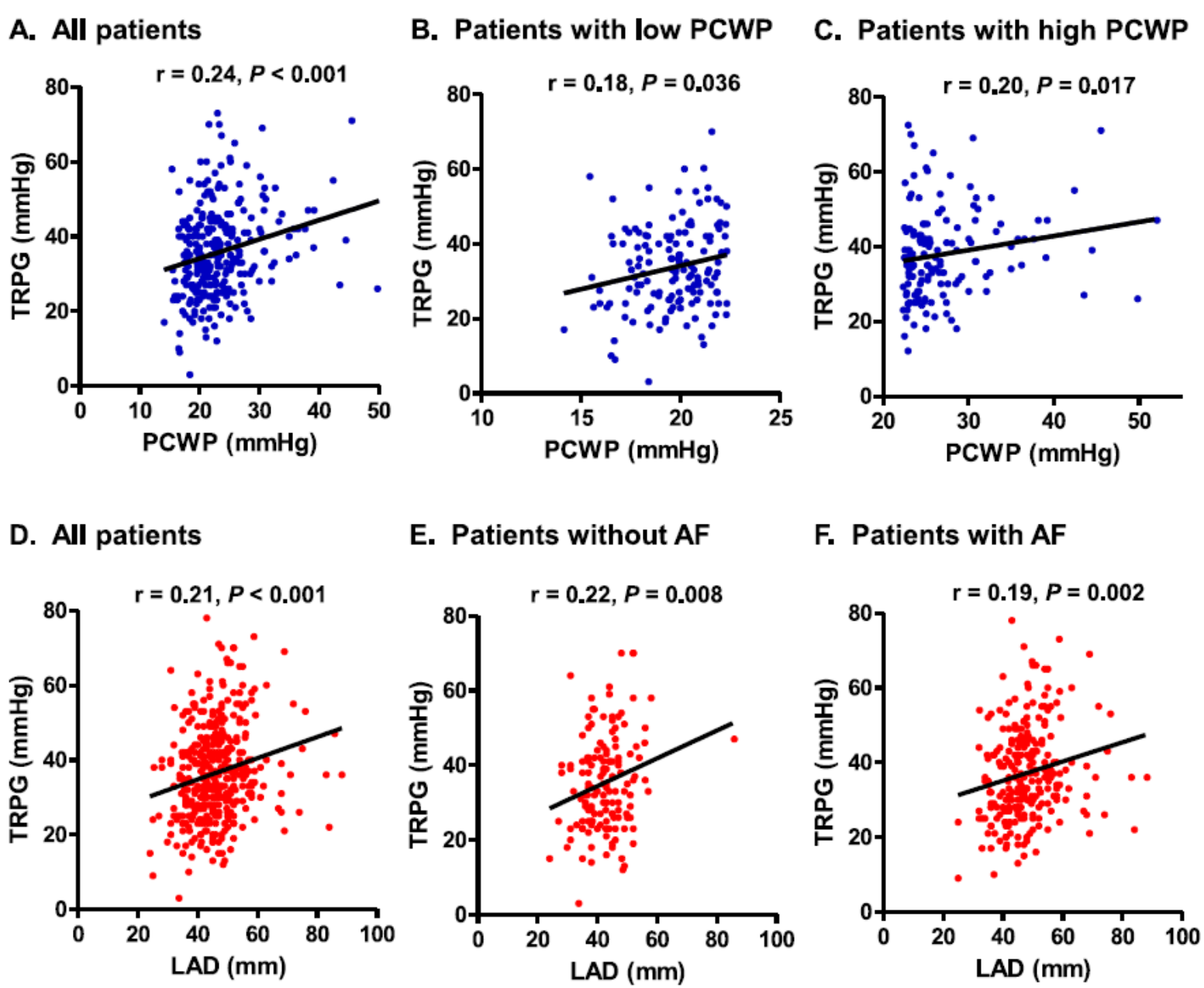
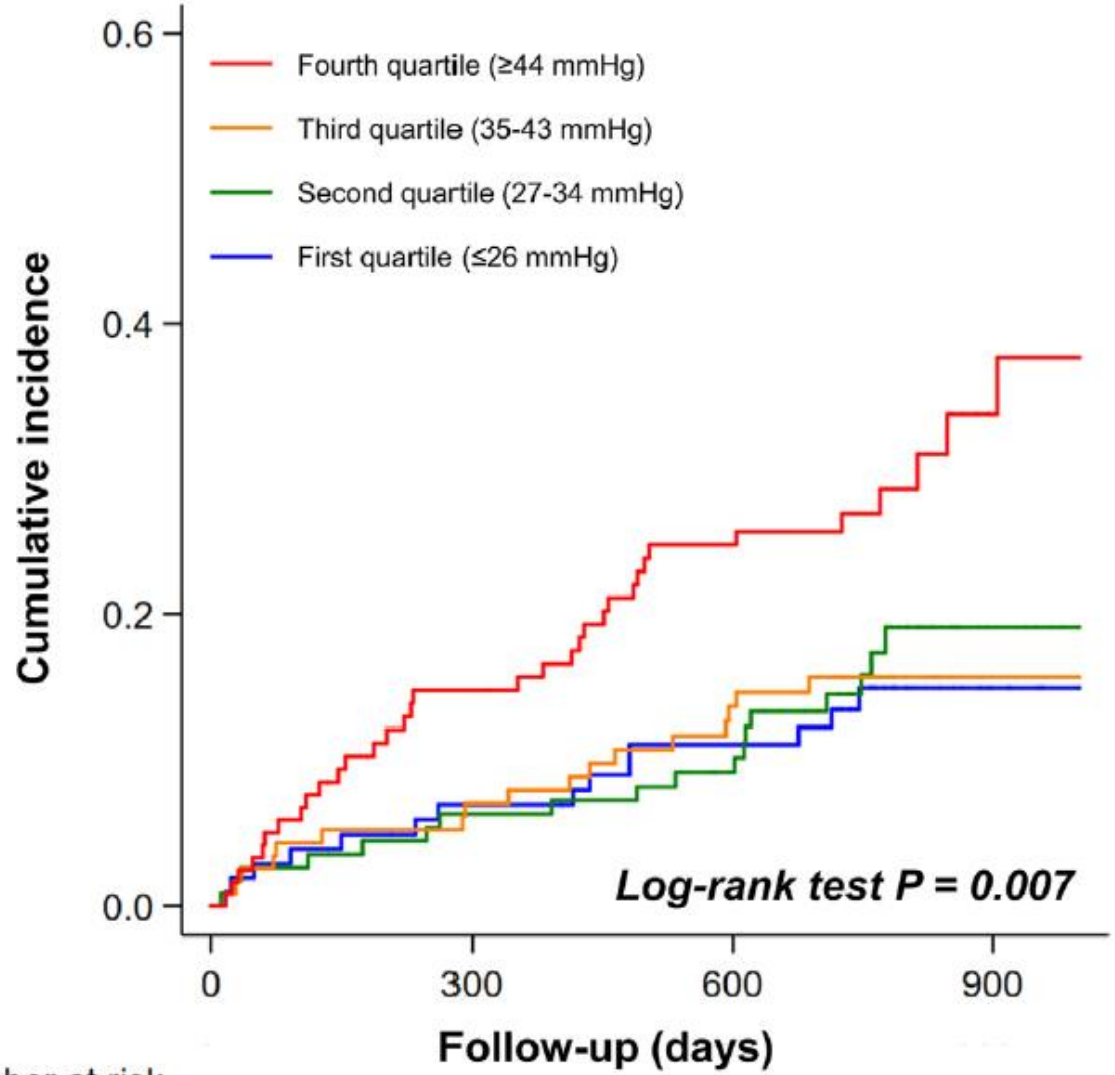


Fig. 2. A, Relationship between TRPG and PCWP. B, PCWP in patients with low PCWP. C, PCWP in patients with high PCWP. D, Relationship between TRPG and LAD. E, LAD in patients without AF. F, LAD in patients with AF. AF, atrial fibrillation; LAD, left atrial diameter; PCWP, pulmonary wedge pressure; TRPG, tricuspid regurgitation pressure gradient.



Number at risk				
Fourth quartile	122	96	82	17
Third quartile	121	102	89	13
Second quartile	120	100	88	10
First quartile	106	91	82	19

Fig. 3. Kaplan-Meier analysis of all-cause death categorized by TRPG. TRPG, tricuspid regurgitation pressure gradient.

Table 3. Cox Proportional Hazard Models for All-Cause Death

	TRPG (per 1 mmHg increase)		
	HR	95% CI	*P* value
Model 1	1.02	1.01–1.04	0.004
Model 2	1.02	1.01–1.04	0.009
Model 3	1.02	1.01–1.04	0.008
Model 4	1.04	1.001–1.07	0.043

Model 1 was unadjusted. Model 2 was adjusted by age and gender. Model 3 was adjusted by age, gender, systolic blood pressure, serum sodium, log brain natriuretic peptide, serum albumin, and blood urea nitrogen. Model 4 was adjusted by age, gender, systolic blood pressure, serum sodium, log brain natriuretic peptide, pulmonary capillary wedge pressure, and left atrial volume index. Harrell C-indexes of Models 3 and 4 are 0.77 and 0.72, respectively. CI, confidence interval; HR, hazard ratio.

Discussion

- TRPGと推定PCWPやLADとの間に有意な相関関係のメカニズムは、左心室充満圧の上昇が左心房高血圧を引き起こし、左心房の拡張と硬化を引き起こし、その結果、肺静脈うっ血と肺高血圧症を引き起こしていると考えられる
- 以前の研究では、TRPGと右心カテーテル法で測定されたPASPとの間に非常に強い相関関係があることが示されており(r = 0.97、推定の標準誤差= 4.9mmHg)、IVC径及び呼吸変動は右心房圧の半定量的評価のみで、特に中間値(5-10 mmHg) の患者では誤った推論につながる可能性があることを示していた

Conclusion

- 入院時の高いTRPGは、HFpEFの入院患者におけるより悪い臨床転帰の独立した決定要因
- 入院時のTRPGが非代償性HFpEFの患者のリスク層別化に有用であることを示唆

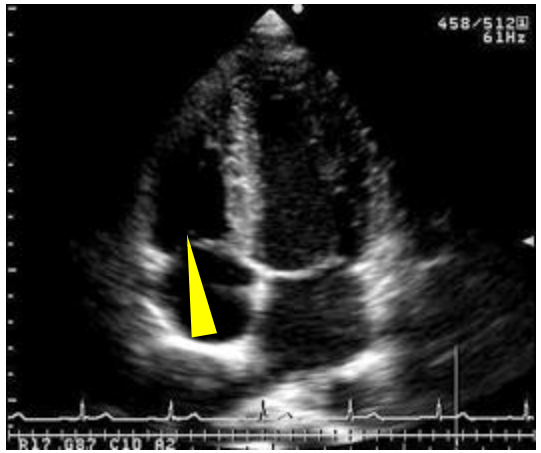
My interpretation

- TRPGは**循環血液量が多いかどうか**に有用
- 循環血液量が多い≒**TRPG≧25mmHg**
  - クリニカルシナリオ2の心不全か否か
  - fluid challenge後の除水
- TRPGを循環血液量の指標として使えないのは
  - PE
  - 慢性肺高血圧症
  - 肺動脈狭窄症

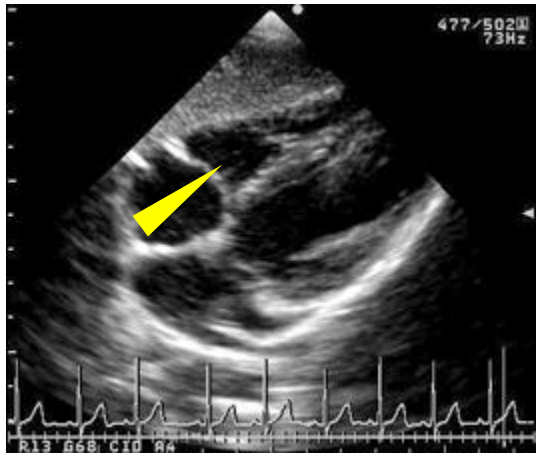
How to evaluate TRPG

1. How to approach TR

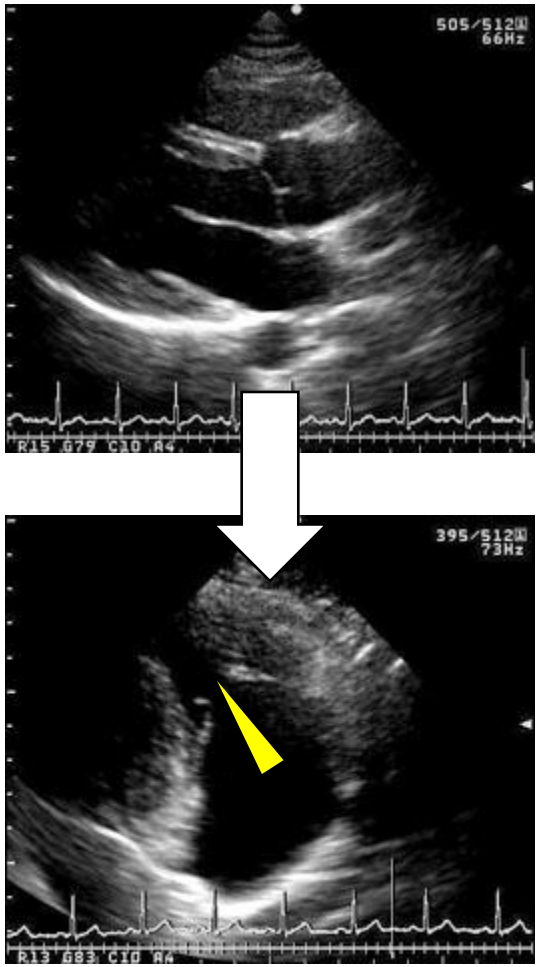
心尖部 (4チャンバー)



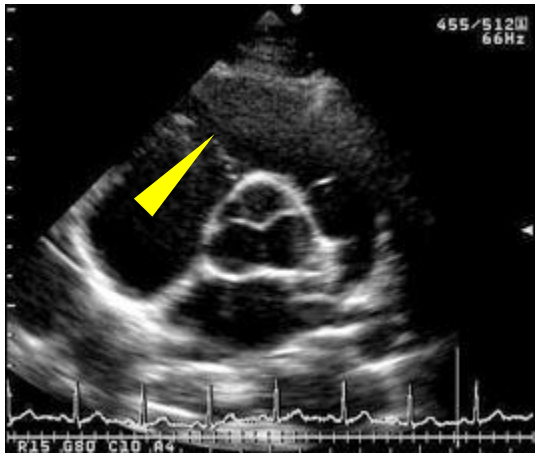
心窩部 (肺疾患のPt)



傍胸骨長軸 (やや足側に向ける)

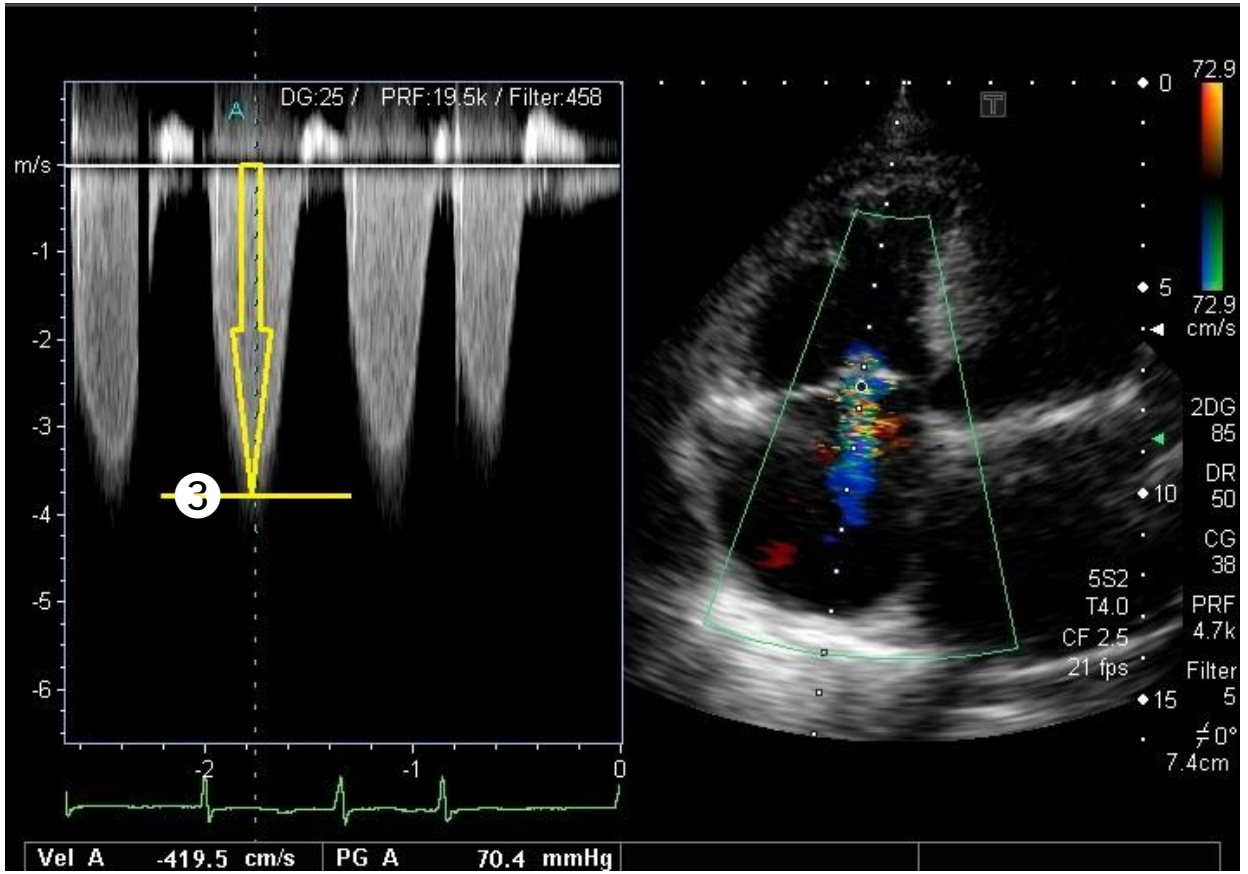


傍胸骨短軸 (大動脈弁レベル)



2. How to measure TRPG

① CDI (カラードップラー)
② CW (連続波ドップラー)
③ 計測



My Message

TRPG≧25mmHg
≒循環血液量が多い