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Abstract

Hemodynamic effect of initially planned BPA sessions in elderly CTEPH patients

Kazutoshi Hirose[1]
Shun Minatsuki[1]
Minami Suzuki[1]
Tatsuhiko Ishihara[1]
Satoshi Ishii[1]
Hiroki Yagi[1]
Norihiko Takeda[1]

1. Department of Cardiovascular Medicine, The University of Tokyo, Tokyo, Japan

COI disclosure

Kazutoshi Hirose, Shun Minatsuki, Minami Suzuki, Tatsuhiko Ishihara, Satoshi Ishii, Hiroki Yagi, Norihiko Takeda

The authors have no financial conflicts of interest to disclose concerning the presentation.

Introduction

- Balloon pulmonary angioplasty (BPA) has beneficial effects on hemodynamics, exercise capacity, and further reduction in mortality in patients with inoperable chronic thromboembolic pulmonary hypertension (CTEPH).

- Given recent advancements in BPA strategies, BPA can be safely performed even in older patients.

EuroIntervention. 2022;17:1104-1111. JACC Asia. 2024;4:577–589. J Am Coll Cardiol. 2025;85:2270–2284.
IJC Heart & Vasculature 2025;60:101751. JACC Asia. 2026. in Press

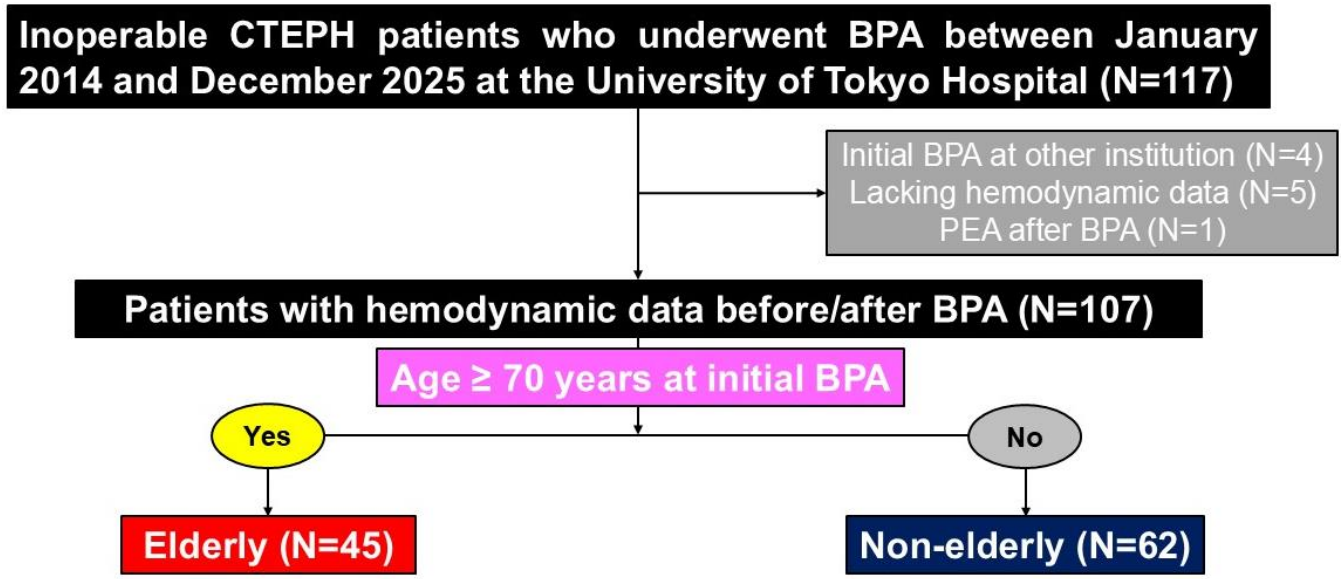
Introduction

- However, due to their frailty or comorbidities, elderly patients may have difficulty in receiving repeated BPA to achieve hemodynamic goals compared with non-elderly patients.

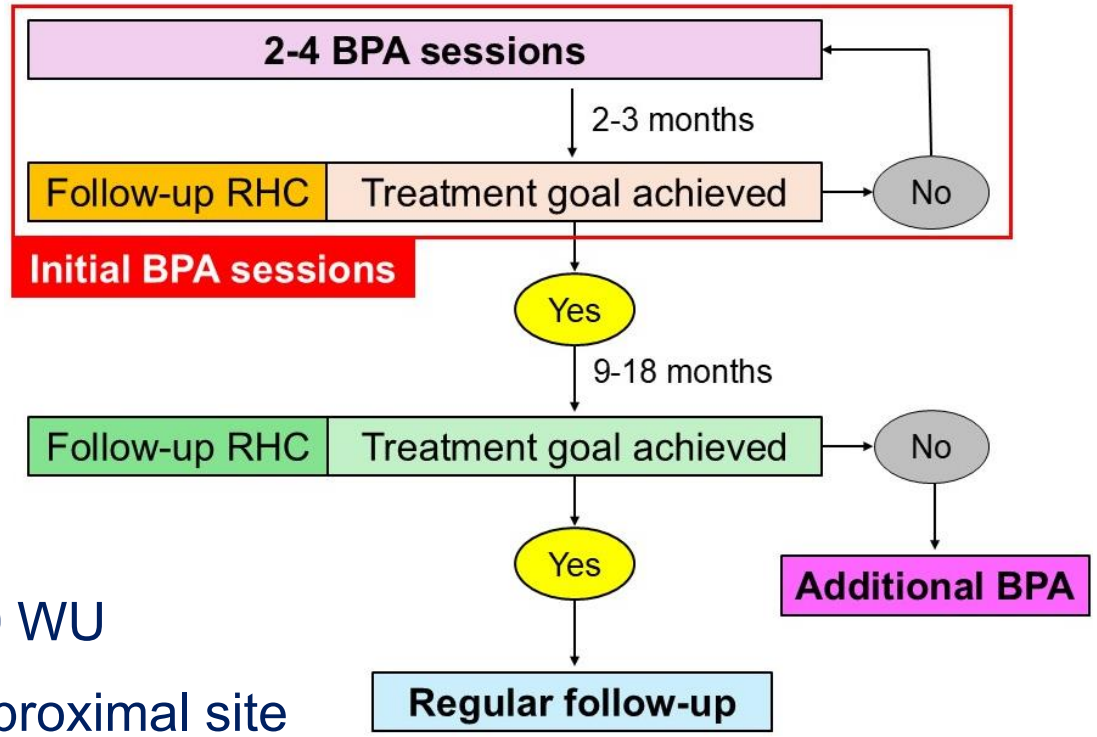
- The aim of the present study was to investigate whether elderly patients with CTEPH can achieve hemodynamic goal after initially planned BPA sessions, and its impact on mid-term survival.

Methods

Study population



BPA protocol



- PH: mean PAP >20 mmHg, PAWP ≤15 mmHg, PVR >2.0 WU
- BPA: unilaterally treated, 1st session: small size balloon, proximal site

→2nd session: larger size balloon or more distal site

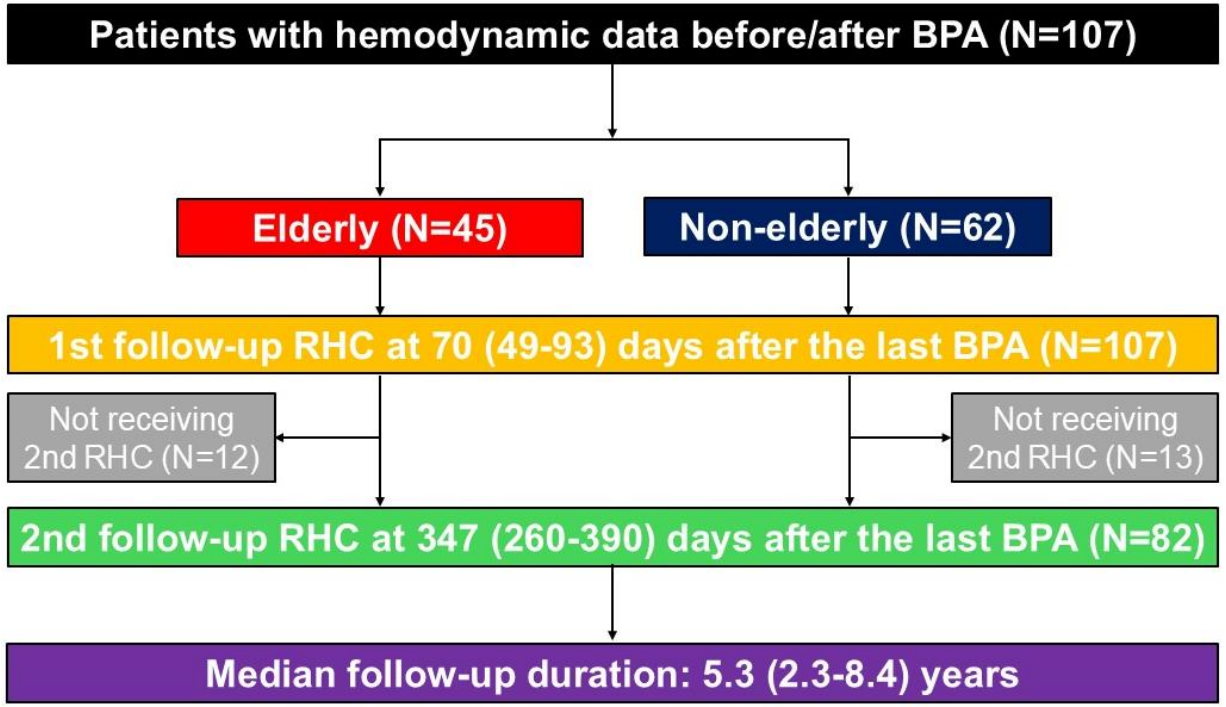
- Treatment goal: mean PAP <30 mmHg or <25 mmHg (if available)

Outcome: 5-year mortality

J Cardiol. 2020;75:182–8. Eur Heart J. 2022;43:3618–3731. IJC Heart & Vasculature. 2025;60:101751. JACC Asia 2026 in press.

Results-study flowchart and baseline characteristics

Study Flowchart



Baseline characteristics

	Elderly (n=45)	Non-elderly (n=62)	P value
Age, years	76±4	54±10	<0.001
Women, n (%)	33 (73.3)	37 (59.7)	0.143
BMI, kg/m^2	21.9±4.6	24.8±4.4	<0.001
Acute PE, n (%)	24 (53.3)	32 (51.6)	0.860
DVT, n (%)	23 (51.1)	26 (41.9)	0.347
Atrial fibrillation, n (%)	3 (6.7)	1 (1.6)	0.307
Hypertension, n (%)	24 (53.3)	18 (29.0)	0.011
Diabetes, n (%)	5 (11.1)	6 (9.7)	0.810
Dyslipidemia, n (%)	18 (40.0)	16 (25.8)	0.120
CKD, n (%)	15 (33.3)	11 (17.7)	0.063
Smoking, n (%)	15 (33.3)	29 (46.8)	0.163
PH medication, n (%)	16 (35.6)	29 (46.8)	0.246
Diuretics, n (%)	21 (46.7)	17 (27.4)	0.040
HOT, n (%)	21 (46.7)	20 (32.3)	0.130
History of PEA, n (%)	1 (2.2)	1 (1.6)	1.000

BMI = body mass index, CKD = chronic kidney disease, DVT = deep vein thrombosis, HOT = home oxygen therapy, PE = pulmonary embolism, PEA = pulmonary endarterectomy, PH = pulmonary hypertension, WHO-FC = World Health Organization functional class

Results-baseline hemodynamic and functional characteristics

	Elderly (n=45)	Non-elderly (n=62)	P value
WHO-FC, 1/2/3/4	0/18/26/1	1/22/37/2	0.960
6-minute walk distance, m (96)	330 (274-386)	401 (338-463)	<0.001
eGFR, ml/min/1.73m^2	56.5±14.5	65.8±15.5	0.006
BNP, pg/ml	104 (57-363)	58 (18-192)	0.004
LV ejection fraction, % (105)	70.4±8.6	67.6±10.7	0.294
%DLCO, % (103)	86.8±22.1	82.2±14.9	0.533
A-a DO_2, mmHg (101)	43.7±9.7	41.5±10.4	0.258
Heart rate, bpm	73±11	77±14	0.172
RAP, mmHg	6±3	7±3	0.086
PAWP, mmHg	9±3	9±3	0.670
Mean PAP, mmHg	39±7	40±9	0.707
Cardiac output, ml/min	4.0±1.0	4.9±1.4	0.002
Cardiac index, ml/min/1.73m^2	2.6±0.7	2.8±0.8	0.283
PVR, dyne・s・cm^{-5}	626 (472-818)	520 (341-734)	0.054
Mean blood pressure, mmHg	87±19	89±15	0.638
SaO_2, %	89.7±4.0	91.3±5.0	0.006
SvO_2, %	62.3±8.9	66.4±7.2	0.021

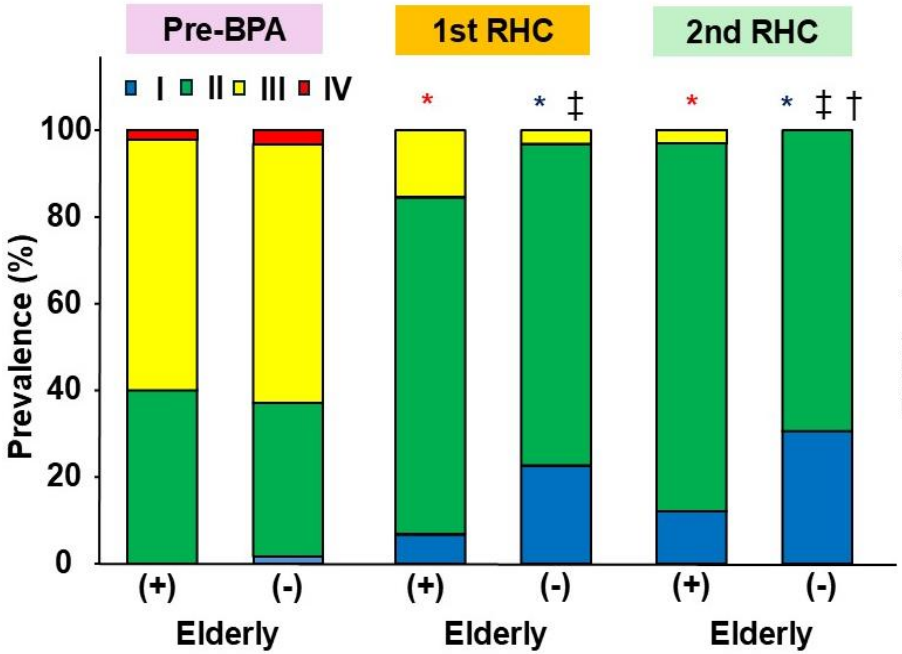
$A\text{-}aDO_2$ = alveolar-arterial oxygen gradient, BNP = brain natriuretic peptide, %DLCO = diffusing capacity for carbon monoxide, eGFR = estimated glomerular filtration rate, LV = left ventricle, PAP = pulmonary artery pressure, PAWP = pulmonary artery wedge pressure, PVR = pulmonary vascular resistance, RAP = right atrial pressure, SaO_2= arterial oxygen saturation, SvO_2 = mixed venous oxygen saturation, WHO-FC = World Health Organization functional class

Results-functional parameters before/after initial BPA sessions

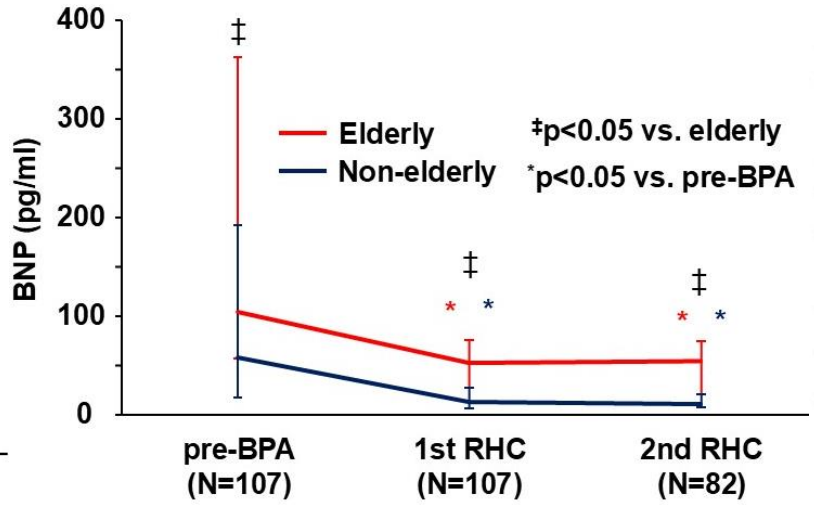
Median number of BPA sessions: elderly 4 (4-6) vs. non-elderly 5 (4-6), p=0.082

PH medications at follow-up RHC: elderly 27 (60.0%) vs. non-elderly 40 (64.5%), p=0.634

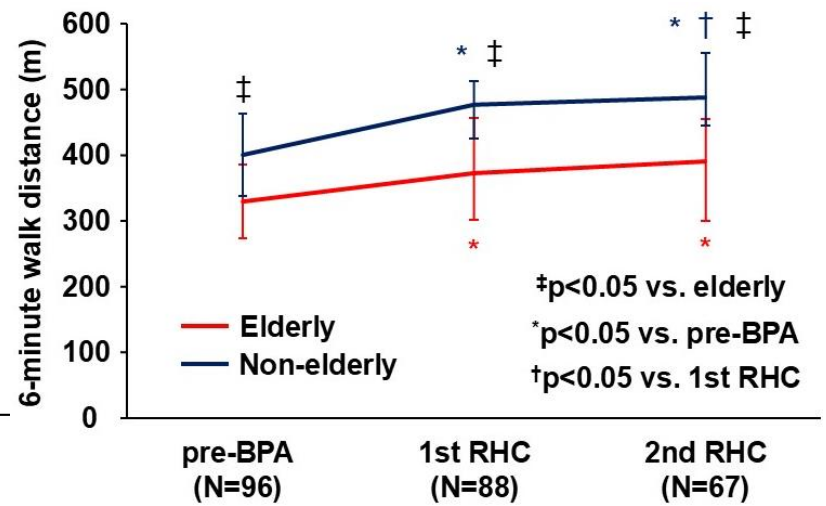
WHO-FC



BNP



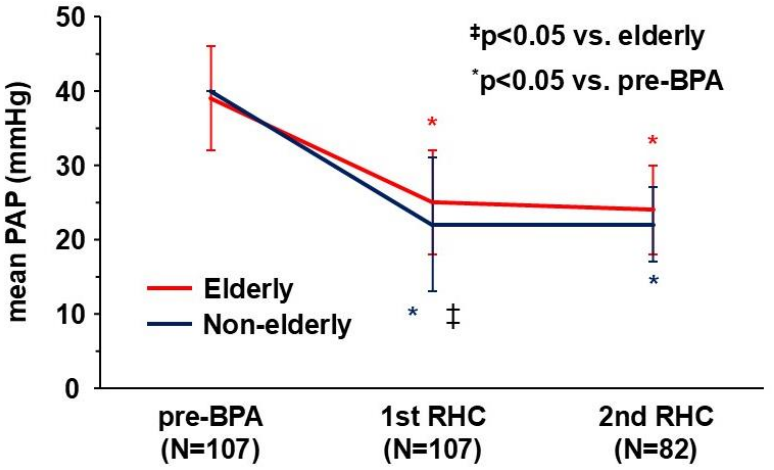
6-minute walk distance



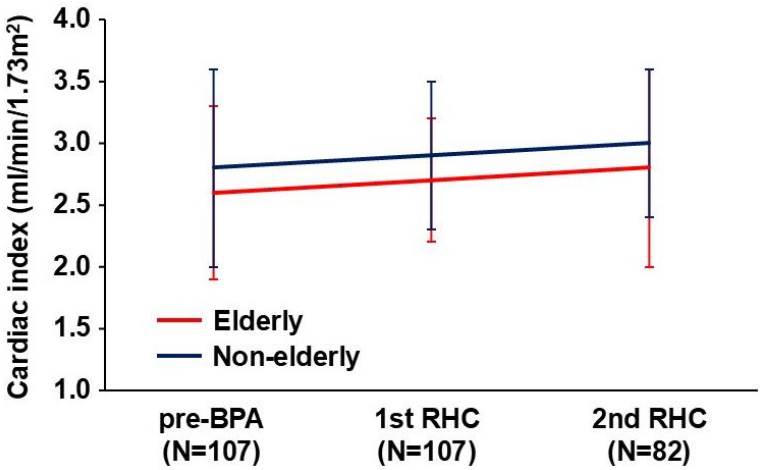
- The non-elderly group experienced greater functional improvement after initial BPA sessions.
- BNP significantly decreased in both groups, but remained higher in the elderly group.

Results -age-specific hemodynamic impact of initial BPA sessions

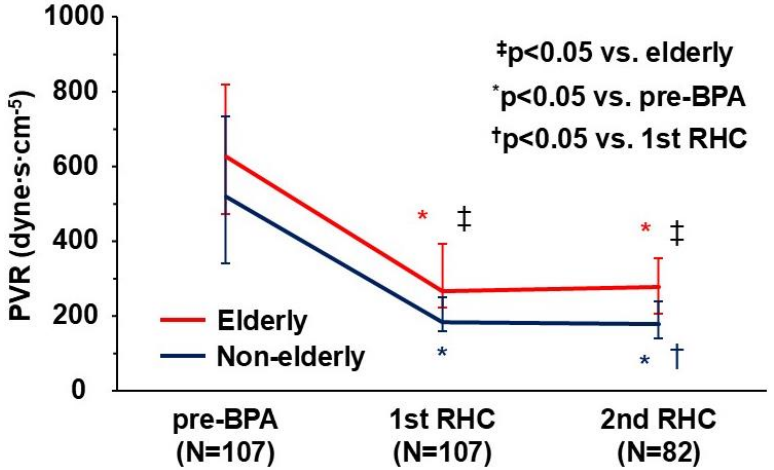
mean PAP



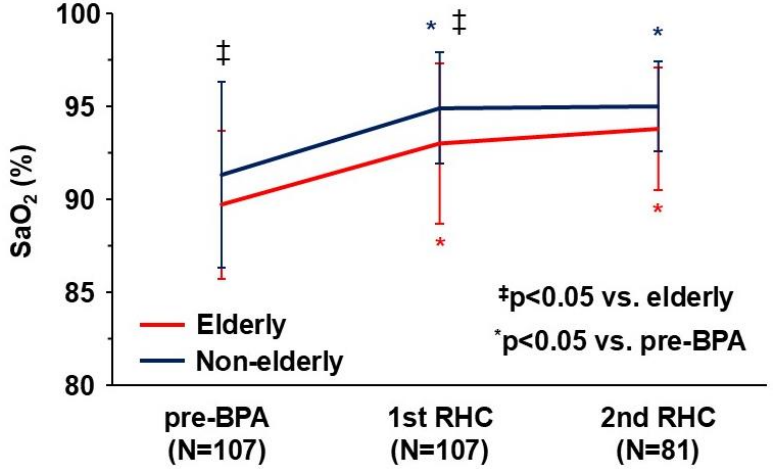
Cardiac index



PVR



SaO_2

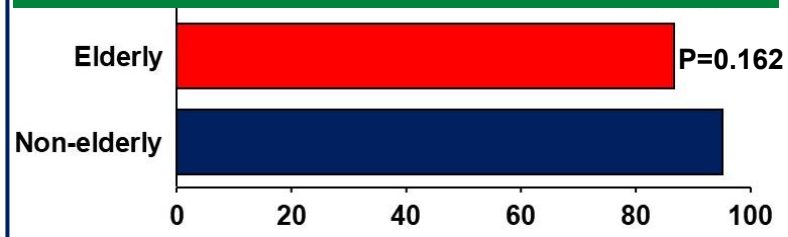


- Mean PAP improved to similar levels between elderly and non-elderly groups, while PVR was higher in the elderly group.
- Cardiac output was lower through initial BPA sessions in the elderly group, but these differences were attenuated for cardiac index.
- In the elderly group, SaO_2 did not reach levels comparable to those in the non-elderly group after initial BPA sessions.

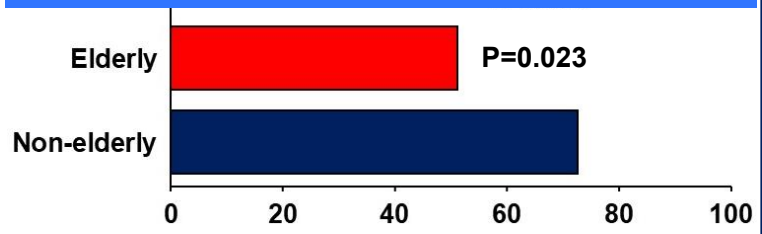
Results -achievement of initial goal and outcome

Achievement of initial treatment goal at 1st f/u RHC

mean PAP <30 mmHg

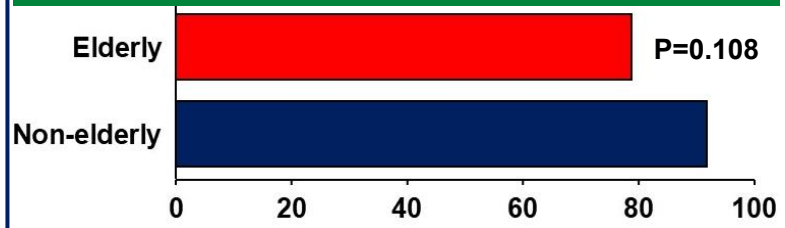


mean PAP <25 mmHg

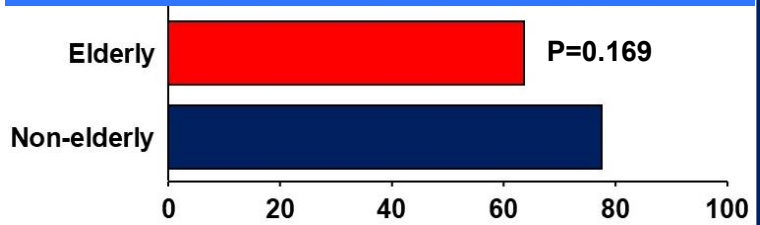


Achievement of initial treatment goal at 2nd f/u RHC

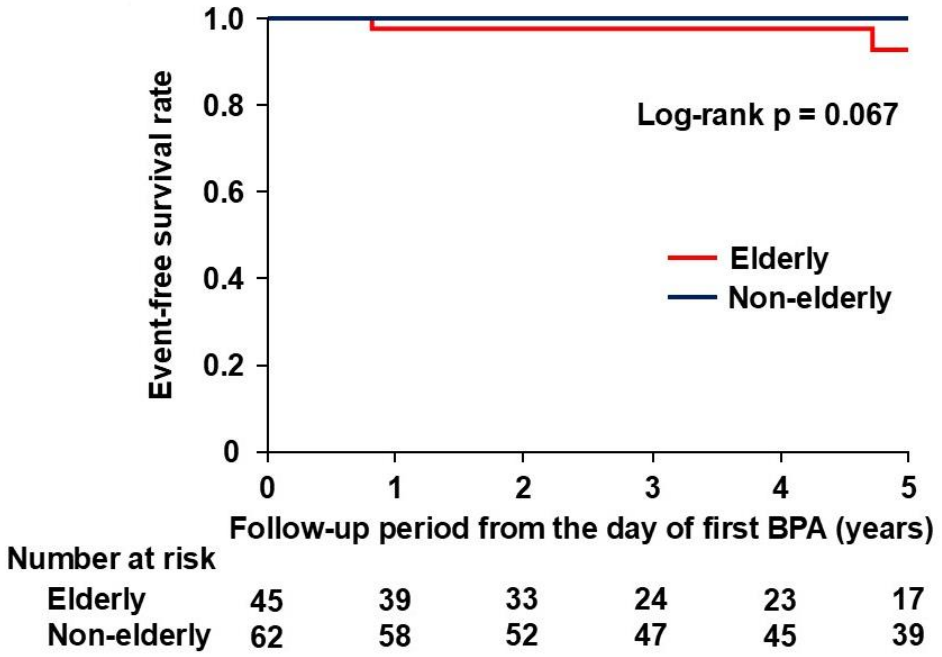
mean PAP <30 mmHg



mean PAP <25 mmHg



5-year mortality



Additional BPA: 21 (19.6%) patients (9 in the elderly group)
Time from initial sessions to additional BPA: 644 (350-1092) days

2 deaths: Heart failure
1: mPAP<30 mmHg at f/u RHC
1: mPAP≥30 mmHg at f/u RHC

Discussion

- As compared with the non-elderly group, the elderly group represented a similar improvement in PAP, but higher BNP/PVR and lower SaO_2 after initial BPA sessions.
- Elevated BNP may reflect latent left-side cardiac dysfunction (e.g., LV diastolic dysfunction) in the elderly group.
- Higher PVR in the elderly group could be explained by lower cardiac output.
- Lower SaO_2 in the elderly group might be attributed to impaired alveolar diffusion capacity (e.g., microvasculopathy or residual V/Q mismatch) and impaired skeletal muscle oxygen utilization (e.g., reduced muscle mass), requiring further investigation.

Front. Physiol. 2020;11:964. Circ Heart Fail. 2025;18:e012912.

Discussion

- Although the elderly group demonstrated smaller hemodynamic and functional improvements after the initial BPA sessions compared with the non-elderly group, the mid-term prognosis after BPA remained acceptable.

- Recent studies have demonstrated beneficial hemodynamic and functional effects of PH-targeted medications beyond BPA. In our cohort, 60% of elderly patients received PH medications after the initial BPA sessions, which may have contributed to maintaining hemodynamic stability and preventing PH-related mortality.

Lancet Respir Med. 2025;13:789-799. J Heart Lung Transplant. 2024;43:1642-1651.

Discussion-limitations

- Due to the small sample size of a single-center study, the association between age and hemodynamic or functional changes after BPA remains unclear.
- Additional BPA performed after initial BPA sessions may affect event-free survival.
- We could not evaluate long-term impact of the initial BPA procedures on hemodynamic and functional parameters because of lacking data on long-term follow-up RHC.
- An effect of learning curve for BPA on hemodynamic improvement was not considered in the present study.

Conclusion

- Although the elderly CTEPH patients demonstrated smaller hemodynamic and functional improvements and were less likely to achieve hemodynamic goal after initial BPA sessions, the elderly group represented acceptable mid-term survival compared with the non-elderly group.