VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE

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Pulmonary perfusion in long-term survivors of COVID-19 treated by ECMO

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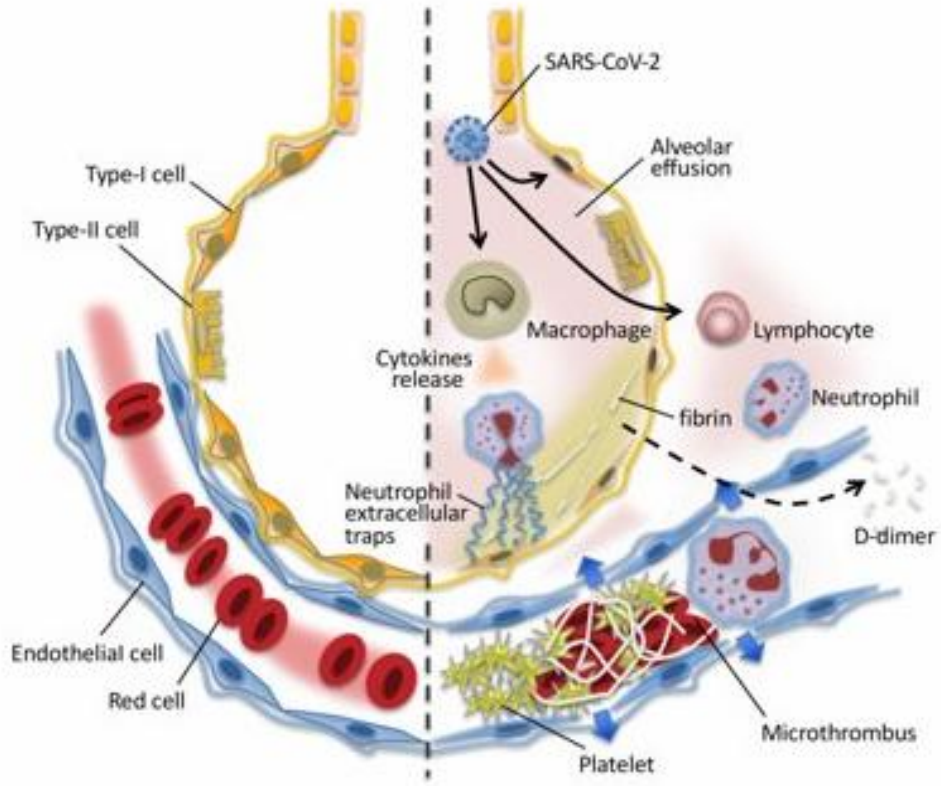
Thromboembolic events in COVID-19 infection

- Increased risk of VTE in the **acute** phase of the infection

- COVID-19-induced coagulopathy and prothrombogenic state [1]
  - **Endothelial dysfunction**
  - Immune-inflamatory reaction
  - **Microthrombosis**

- COVID-19 vasculopathy - pulmonary vascular walls thickening in deceased COVID-19 patients [2]



Iba et al., *J.Thrombosis and Haemostasis*, 2020 Jun 18: 10.1111

VTE = venous thromboembolic events

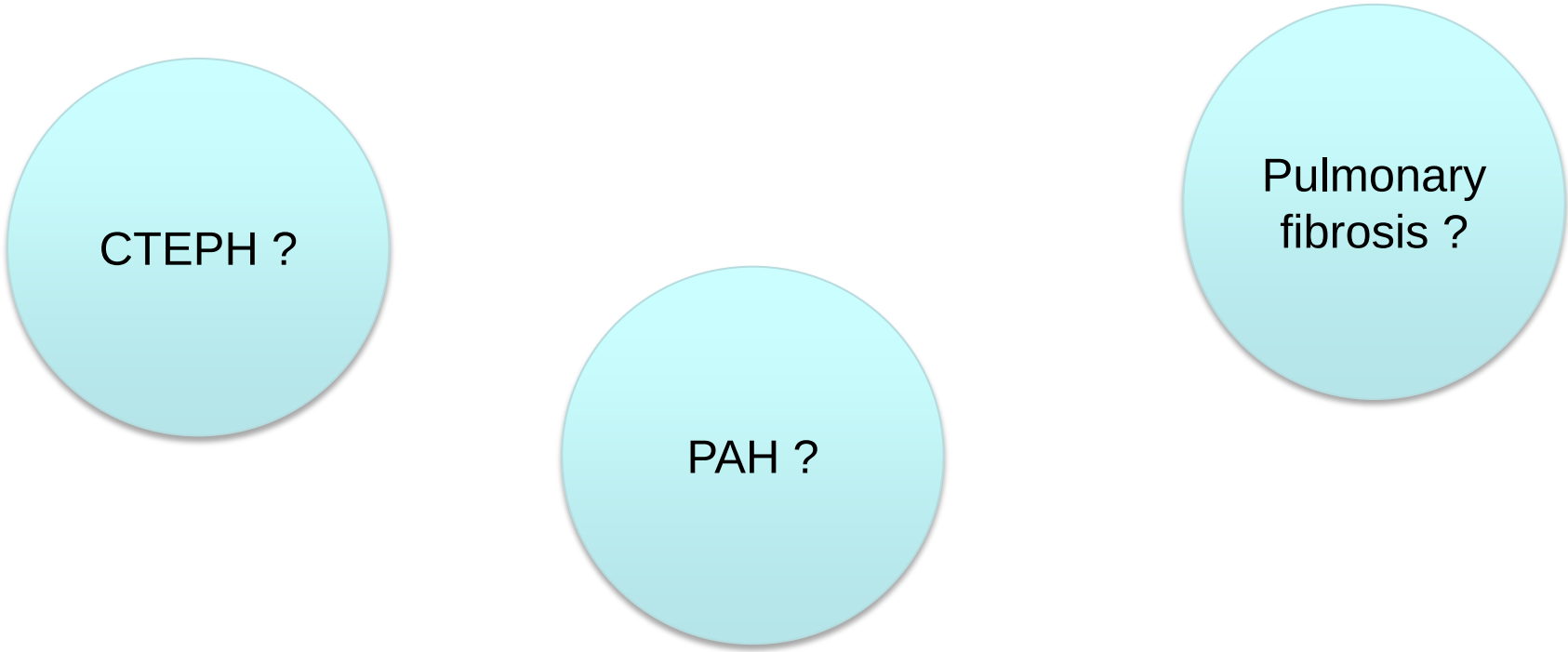
1. T.C.Hanff et al., 2020, *Am J Hematol.,* Thrombosis in COVID-19
2. Y.J.Suzuki et al., *Med Hypotheses*, 2021 Feb; 147: 110483

COVID-19 and pulmonary embolism

- Incidence of PE in hospitalized patients with COVID-19 is 14,7 % [1], in patients on ECMO almost 37 % [2]
- Peripheral vessels (segmental) [3]
- Microvascular damage (potentially underdiagnosed) [4]

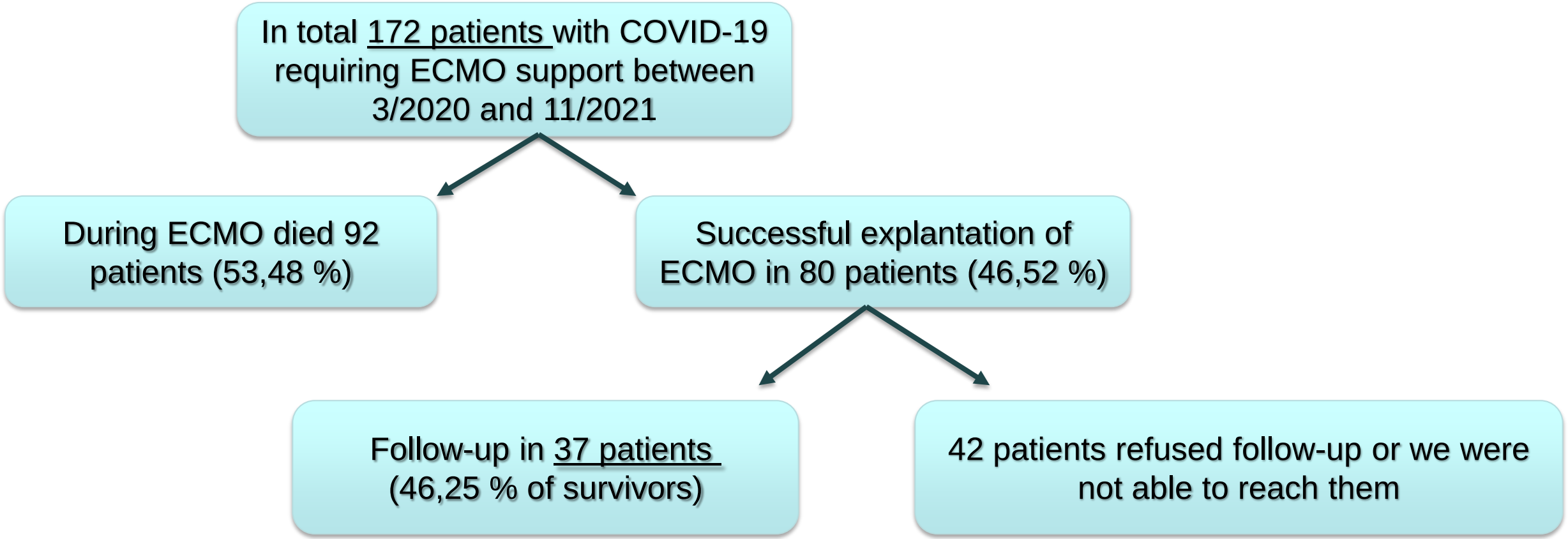
1. L. Rancon et al., 2020, *Eur J Intern Med*., Incidence of acute pulmonary embolism in COVID-19 patients: Systematic review and meta-analysis
2. A.J.Doyle, 2021, *Citical Care Med*, A Comparison of Thrombosis and Hemorrhage rates in Patients With Severe Respiratory Failure Due to Coronavirus Disease 2019 and Influenza Requiring Extracorporeal Membrane Oxygenation
3. R. M. Kwee et al., 2021, *Eur Radiol*, Pulmonary embolism in patients with COVID-19 and value of D-dimer assessment: a meta-analysis
4. S.Halawa et al., 2021, *Natural Reviews Cardiology*, Potential long-term effect od SARS-CoV-2 infection on the pulmonary vasculature: a global perspective

Long-term cardio-pulmonary sequelae after COVID-19 infection remain uncertain



Chronic pulmonary perfusion abnormalities in long-term survivors of severe COVID-19 ARDS treated by ECMO

Overview


In total 172 patients with COVID-19 requiring ECMO support between 3/2020 and 11/2021
During ECMO died 92 patients (53,48 %)
Successful explantation of ECMO in 80 patients (46,52 %)
Follow-up in 37 patients (46,25 % of survivors)
42 patients refused follow-up or we were not able to reach them

CTEPH in patients after severe COVID-19 with ECMO support

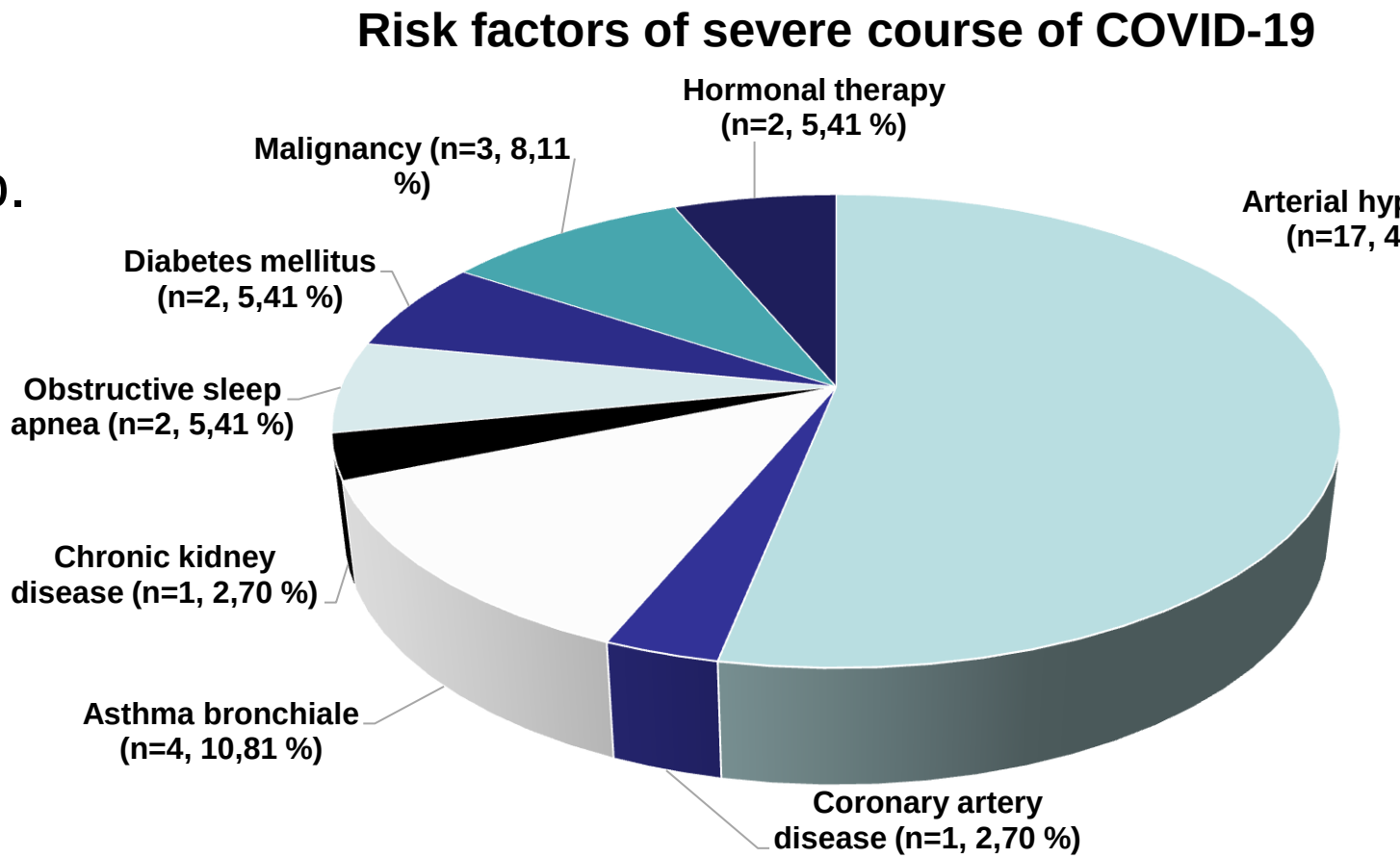
- Evaluation of pulmonary perfusion abnormalities, potentially leading to development of CTEPH, in long-term survivors severe COVID-19 infection treated by ECMO - **by V/Q SPECT** (at least 3 months after ECMO explantation and anticoagulation therapy)

- Evaluation of venous thromboembolic complication in the acute phase of the infection

- Evaluation of the clinical status (dyspnea), NT-proBNP, quality of life questionnaire during the check-up

Characteristics

- **37 patients**
- 10 women (27 %)
- Average age: 52,4 ± 9,3 y.o.
- Average BMI: 33 ± 6,7



ECMO characteristics

- Time from ECMO explantation to V/Q SPECT (median): 420 days

Time from PCR test until ECMO implantation	11 days	
Type of ECMO (initially)	V-V	n=35, 94,6 %
	V-A	n=2, 5,4 %
Indication of ECMO (inicially)	Respiratory failure	n=35, 94,6 %
	RV failure	n=2, 5,4 %
Artificial pulmoary ventilation during ECMO	n=36, 97,3 %	
Lenght of ECMO therapy	12 days	

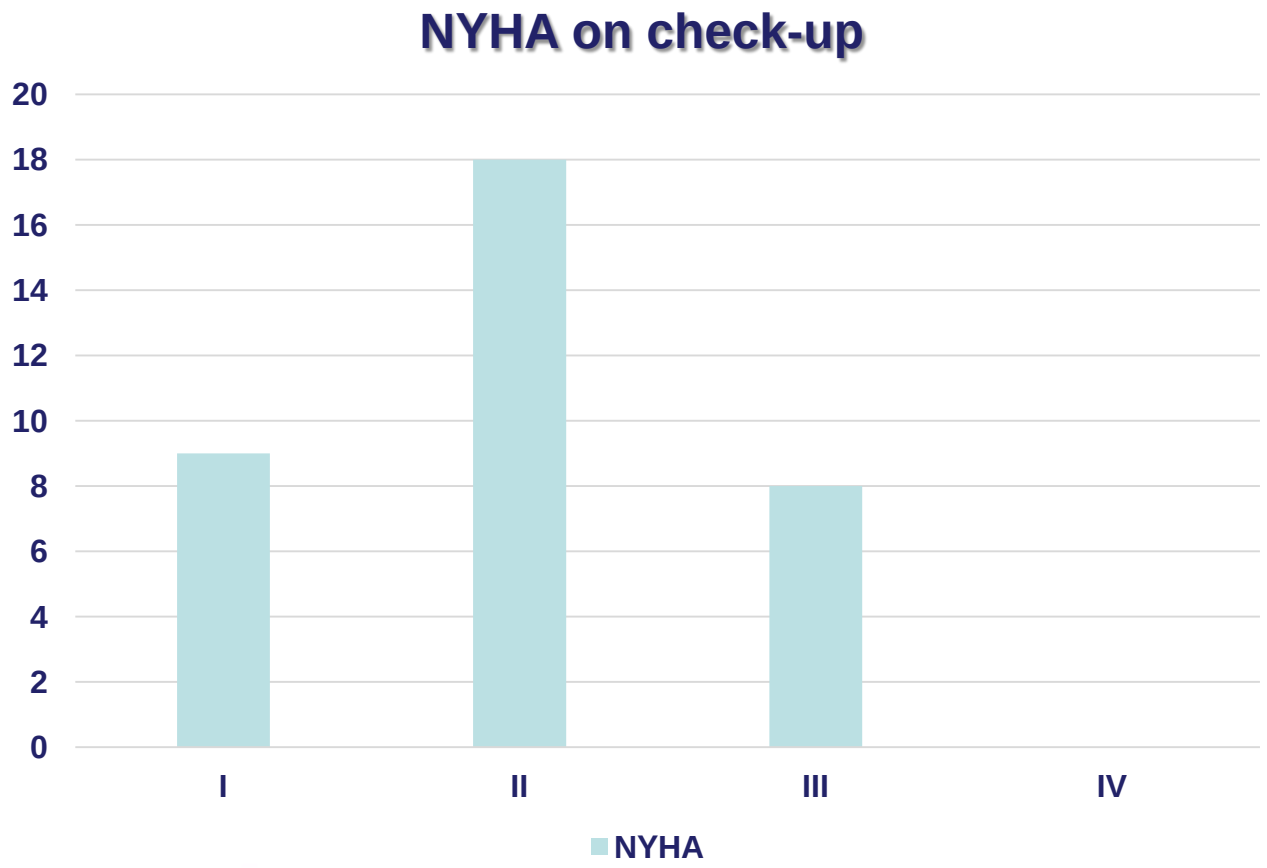
Venous thromboembolic event in acute phase of COVID-19

- 24 patients **(64,86 %) VTE** – 23 cannula-associated DVT caused by ECMO cannulas, 1 thrombus in VCI before implantation of ECMO
- 2 patients with cannula-associated DVT had thrombosis in other location at the same time
- 5 patients **(13,51 %) had PE** (2 before ECMO, 2 during ECMO a 1 after ECMO), all these patients had cannula-associated DVT

- PE in acute phase could be underdiagnosed – only 7 patients assessed by pulmonary artery CTAG
- All of them had anticoagulation therapy during ECMO

Clinical follow-up

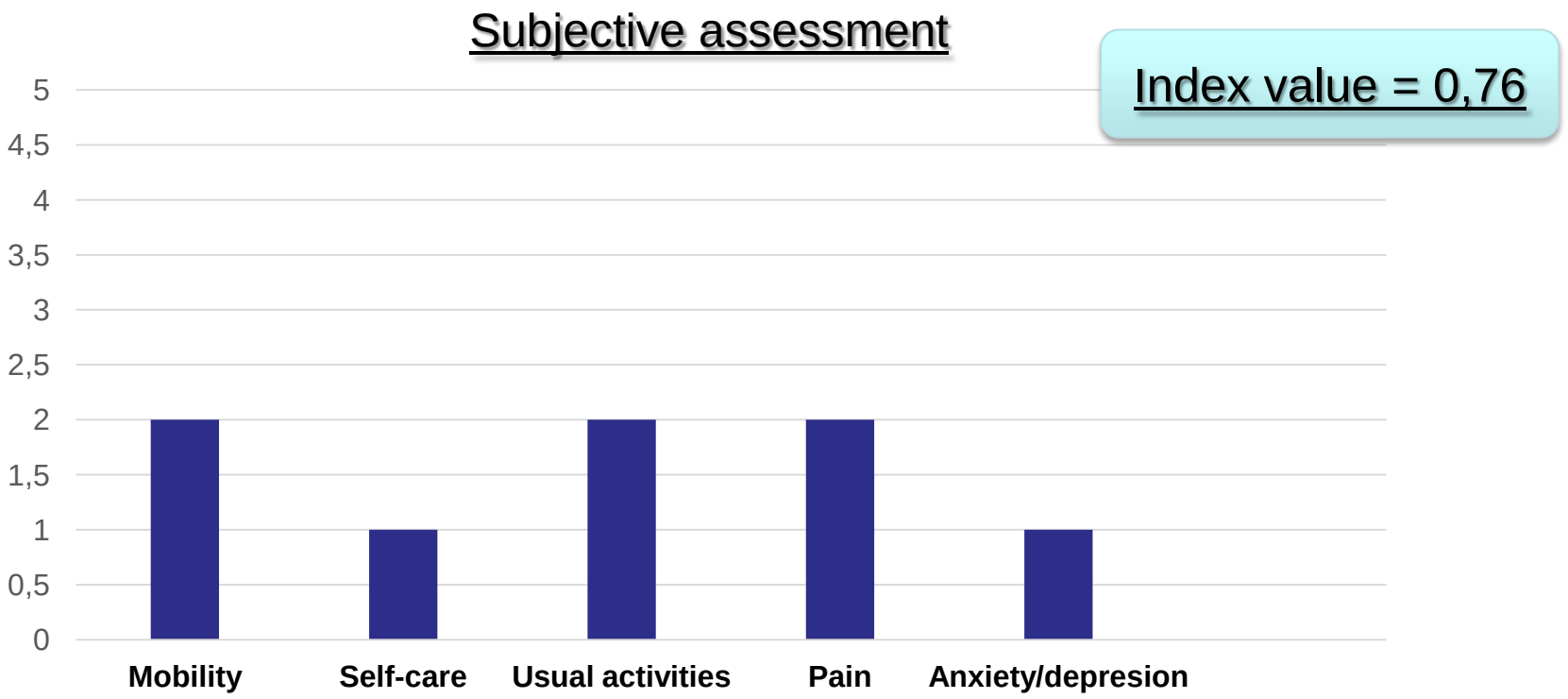
- Average NT-proBNP: 115,29 ±122,04 ng/l (n=35)

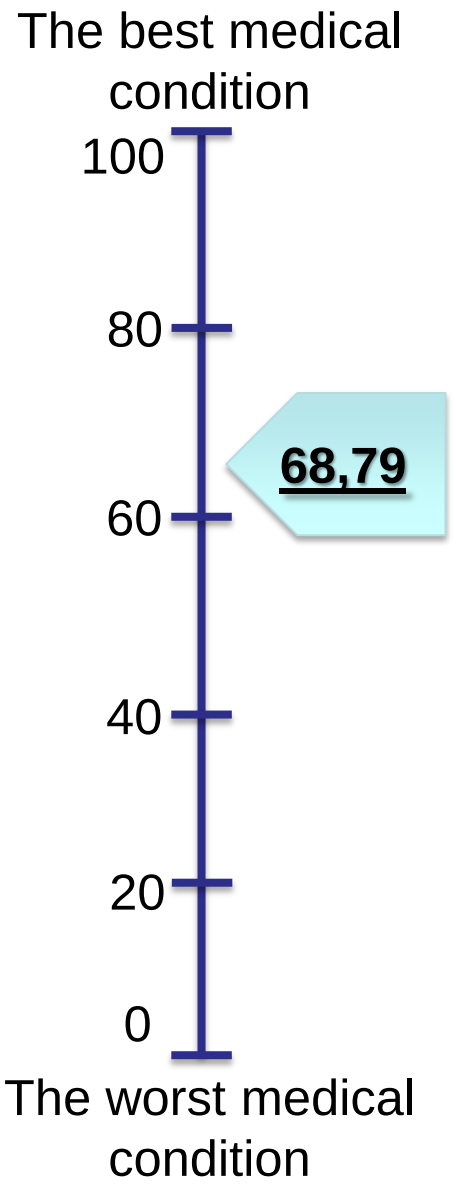


	patients (n)
• NYHA I	9
• NYHA II	18
• NYHA III	8
• NYHA IV	0

Quality of Life

- EQ-5D-5L questionnaire





V/Q SPECT results

- 36 V/Q SPECT and 1 V/Q scan
- Positive result = mismatched perfusion defects in 1 or more segmental arteries
- **All examinations were negative**

	N	%
Subsegmental perfusion defect	2	5,41
Segmental perfusion defect	0	0
No perfusion defect	28	75,68
Defects in correlated localities	7	18,92

Chronic thromboembolic pulmonary hypertension and clot resolution after COVID-19-associated pulmonary embolism

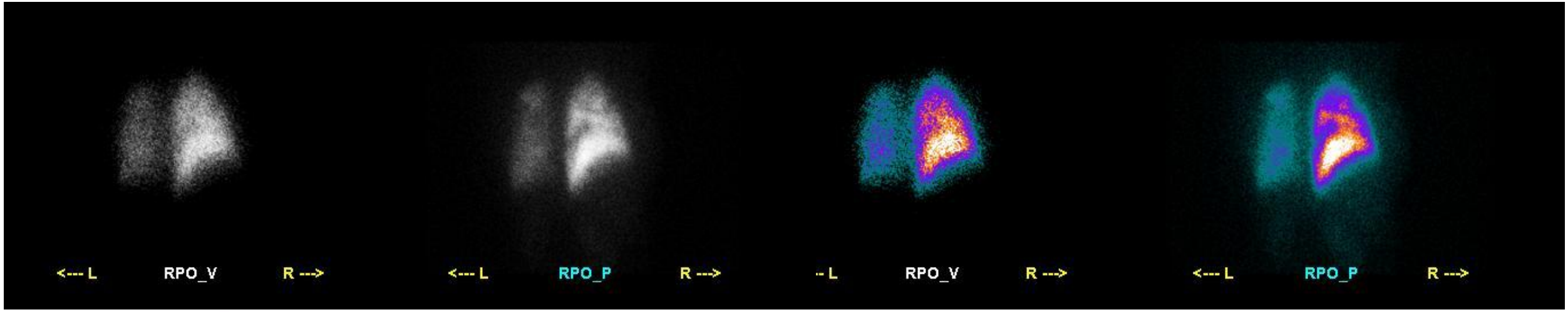
Cindy M.M. de Jong[1], Chantal Visser[2], Remy H.H. Bemelmans[3], Wim G. Boersma[4], Bram van den Borst[5], J. Louise I. Burggraaf[6], Suzanne C. Cannegieter[1,6], Arina J. ten Cate-Hoek[7,8], F. Nanne Croles[9], Harald J. Faber[10], Laura M. Faber[11], Merel E. Hellemons[12,13], Lisa M. Hessels[4], Menno V. Huisman[1], Pieter W. Kamphuisen[14,15], Stephanie C.E. Koster[16], Lucia J.M. Kroft[17], Ivo van der Lee[18], Jenneke Leentjens[19], Karina Meijer[20], Maarten K. Ninaber[21], Brigitte M. Sondermeijer[18], Susanne Stads[22], Anton Vonk Noordegraaf[23], Kristien Winckers[7,8], Marieke J.H.A. Kruip[2] and Frederikus A. Klok[1] on behalf of the Dutch COVID & Thrombosis Coalition investigators

In conclusion, CTEPH was absent in our study population of COVID-19-associated PE survivors, suggesting that CTEPH is not a more common long-term complication after COVID-19-associated PE than after non-COVID-19-associated PE. None of the patients had recurrent symptomatic VTE during median follow-up of 19 months, and thrombus resolution did not seem to be different than after non-COVID-19-associated PE. Hence, typical long-term PE sequelae may not be important determinants of long COVID in COVID-19-associated PE survivors.

Case report

- Female, 53 y.o.
- 3/2021 COVID-19 bilat. pneumonia, **V-V ECMO 10.-21.3.2021** (11 days), artificial pulmonary ventilation, tracheostomy
- check-up 2/2022: dyspnea **NYHA III**, native saturation O2: 92 %

- **V/Q SPECT 2/2022**: nonhomogeneous distribution of pulmonary perfusion and ventilation in correlating locations - **matching defects**



Case report

- **Echocardiography 4/2022:** EF LK 61%, borderline enlargement of the RV and RA, estimated **PASP 72mmHg**, tricuspid regurgitation 2+

- **Pulmonary artery CTAG 4/2022**: no evidence of CTEPH, severe damage of pulmonary parenchyma

- **Bodypletysmography 7/2022**: severe restrictive respiratory disorder, moderate obstructive respiratory disorder, severly reduced DLCO (VC 36%, FVC 37%, FEV1 42%)

Case report

- RHC 7/2022: **PA** 69/24/**40**, PCW 2, TPG 38, CO 4,5, CI 2,44,
  PVR 8,44 WU **- precapillary PH**

- **Pulmonary arterial hypertension (PAH), idiopathic, with a share of pulmonary disease after COVID-19 pneumonia**

- **7/2022** specific therapy by sildenafil
- **1/2023** specific therapy by ambrisentan

- RHC 10/2023: **PA 33/12/19, PCW 9, TPG 10, CO 5,6, CI 2,99, PVR 1,8 WU**

Conclusion

- Increased incidence of VTE in the acute phase of COVID-19
- **Long-term cardio-pulmonary sequelae of COVID-19 is still not completely clear**

- So far, the incidence of CTEPH after COVID-19 infection does not seem to be increased
  - No chronic mismatched pulmonary perfusion defects on V/Q SPECT in patients after severe COVID-19 pneumonia treated by ECMO

- The association between pulmonary hypertension and COVID-19 infection is questionable, but possible

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Thank you

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