Heart failure and vascular access flow – What are the options?

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Hemodynamic changes after AV access creation

AV access creation

Decrease of peripheral vascular resistance

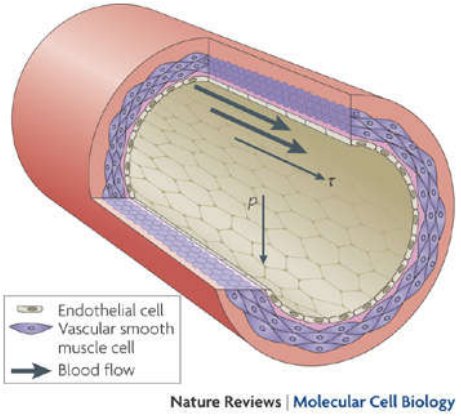
Flow increase

Increase of wall shear stress

Endothelium

↑NO

Feeding artery dilatation



WSS(τ) = (velocity*viscosity)/diameter

Normal brachial artery flow volume: 80-150ml/min

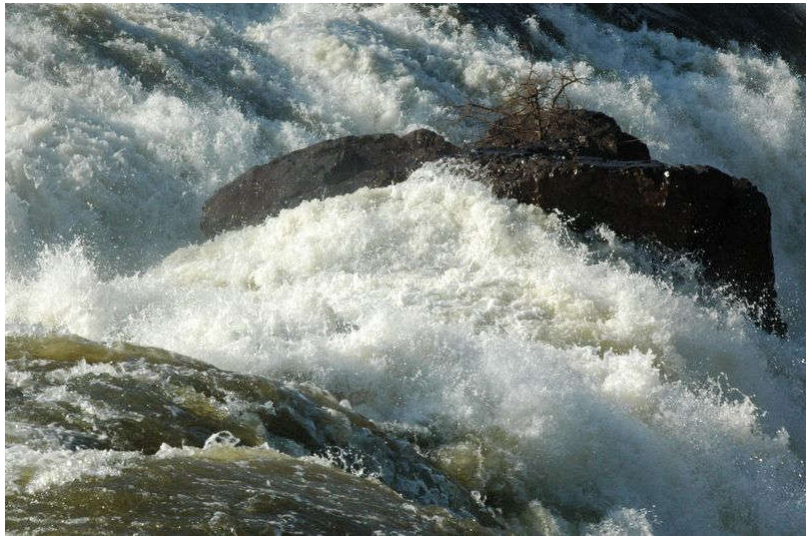
Brachial artery flow volume: ESRD pts. 60-120 ml/min

Usual flow volume via an AV-access (Qa):

forearm 600-1200 ml/min

brachial 800-1500 ml/min

Normal resting cardiac output (CO): 4-6 l/min



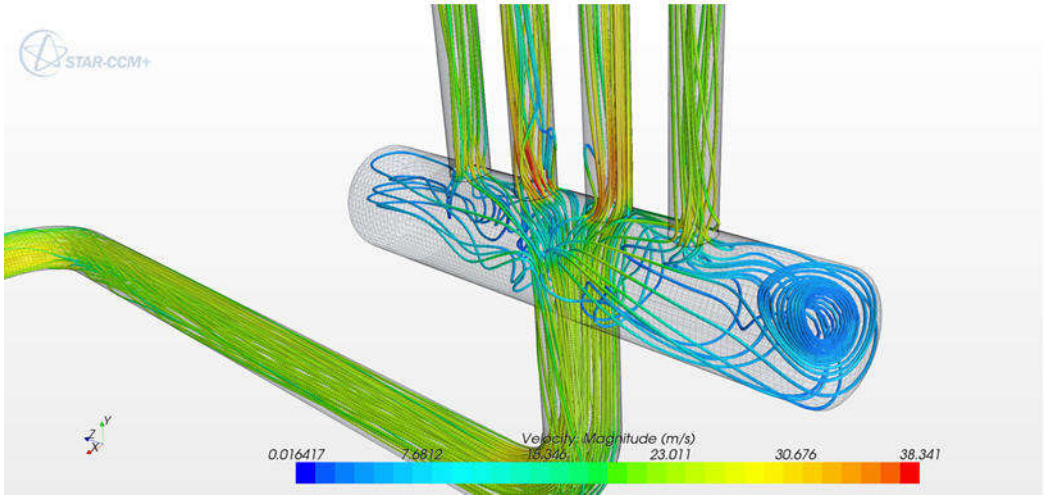
Consequences of AV-access creation

- Flow competition (hand ischemia, AVF-CABG competition...)
- Heart failure (de-compensation)
  - High-output (hyperkinetic) HF
  - Congestive HF
- Pulmonary hypertension

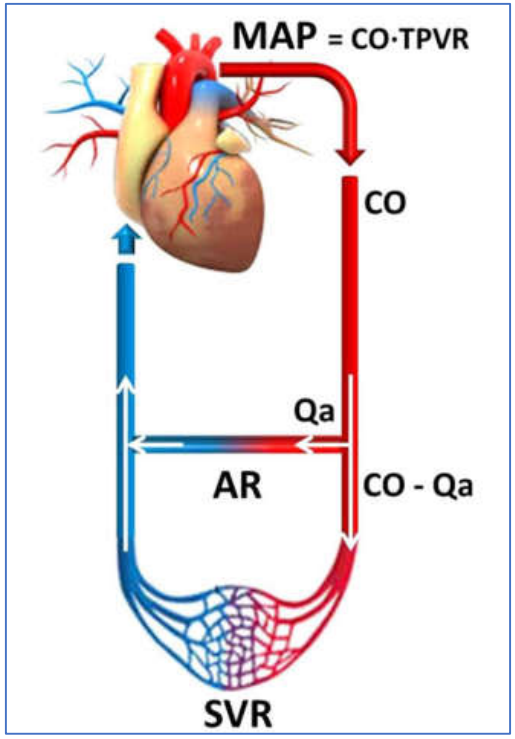
Flow competition

The flow is driven by:

- perfusion pressure (mean arterial-central venous pressure)↑ ~ cardiac output
- vascular resistance↓



Cardiac output and access flow (Qa)



Basile C, Lomonte C. Semin Dial 2018

- Effective CO = total CO-Qa
- High-flow AVF:
  - >1500-2000 ml/min
  - Qa > 1/3 of CO

Heart failure types

- Classic, congestive HF
  - Relatively or absolutely low CO (COef.) at reast or excercise
  - Very frequent

- High-output HF
  - Very high CO
  - Rare

High-output (hyperkinetic) heart failure

- Symptoms of heart failure (dyspnoe, fatique)
- Signs: BNP, ↑ congestion on X-ray, ↑ left atrial pressure
- High cardiac output indexed to body surface area (CI)

- Cut-off values: CI 3.5-3.9 l/min/m^2

- Qa usually > 2000 ml/min

- Resolves after banding or other flow reducing procedure

Chemla E et al. Semin Dial. 2007;20(1):68-72
Reddy YNV et al. J Am Coll Cardiol 2016;68(5): 473-482

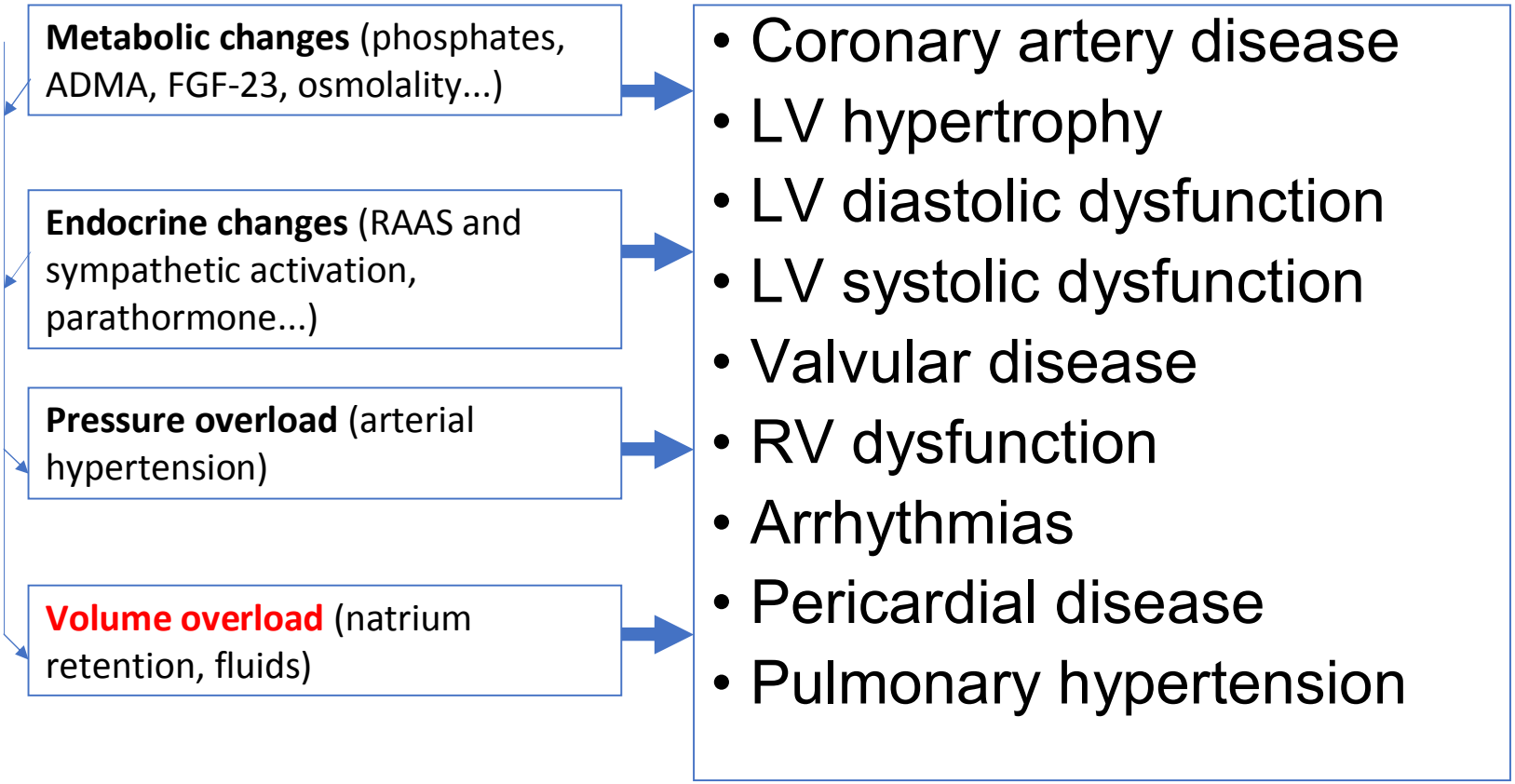
Congestive heart failure

- CO (COef.) relatively/absolutely low
- Signs: BNP, ↑ congestion on X-ray, ↓LV EF, valvular disease....

- Very frequent and associated with ↑↑ mortality

- Qa: any value („last drop effect“)

Heart failure: mechanisms at CKD



Malik J. J Vasc Access 2018

Volume overload

- CKD→ impaired Na+H_2O excretion
- Fluid retention between HD (associated w. blood pressure disease)
- Anemia
- AV access flow

Increase of cardiac output (CO)

Temporary „luxurious“ tissue perfusion

Later CO decrease

Brod J. Ulster Med J. 1975

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Volume overload:consequences

Pulmonary and systemic venous congestion

↓

Dyspnoea, edema, impaired organ perfusion

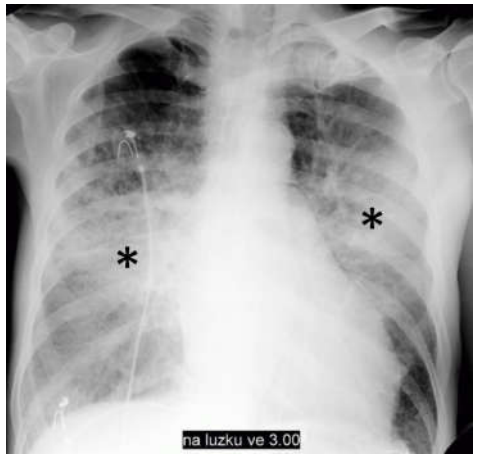
↓

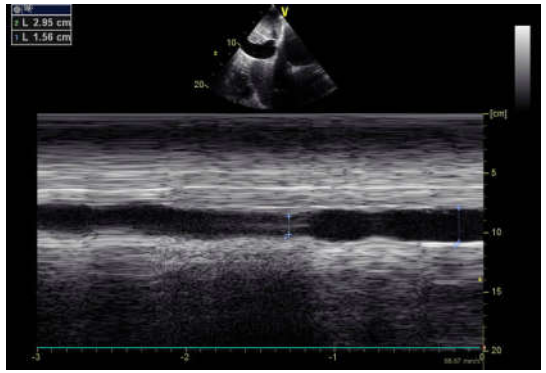
Development of LV systolic dysfunction

↓

↓

Increased mortality





AVF (Qa) effects on the heart

- Cavities enlargement (atria and ventricles)
- Increase of filling pressures (diastolic dysfunction)
- Hypertrophy
- ↑BNP levels
- ↑sympathetic aktivity

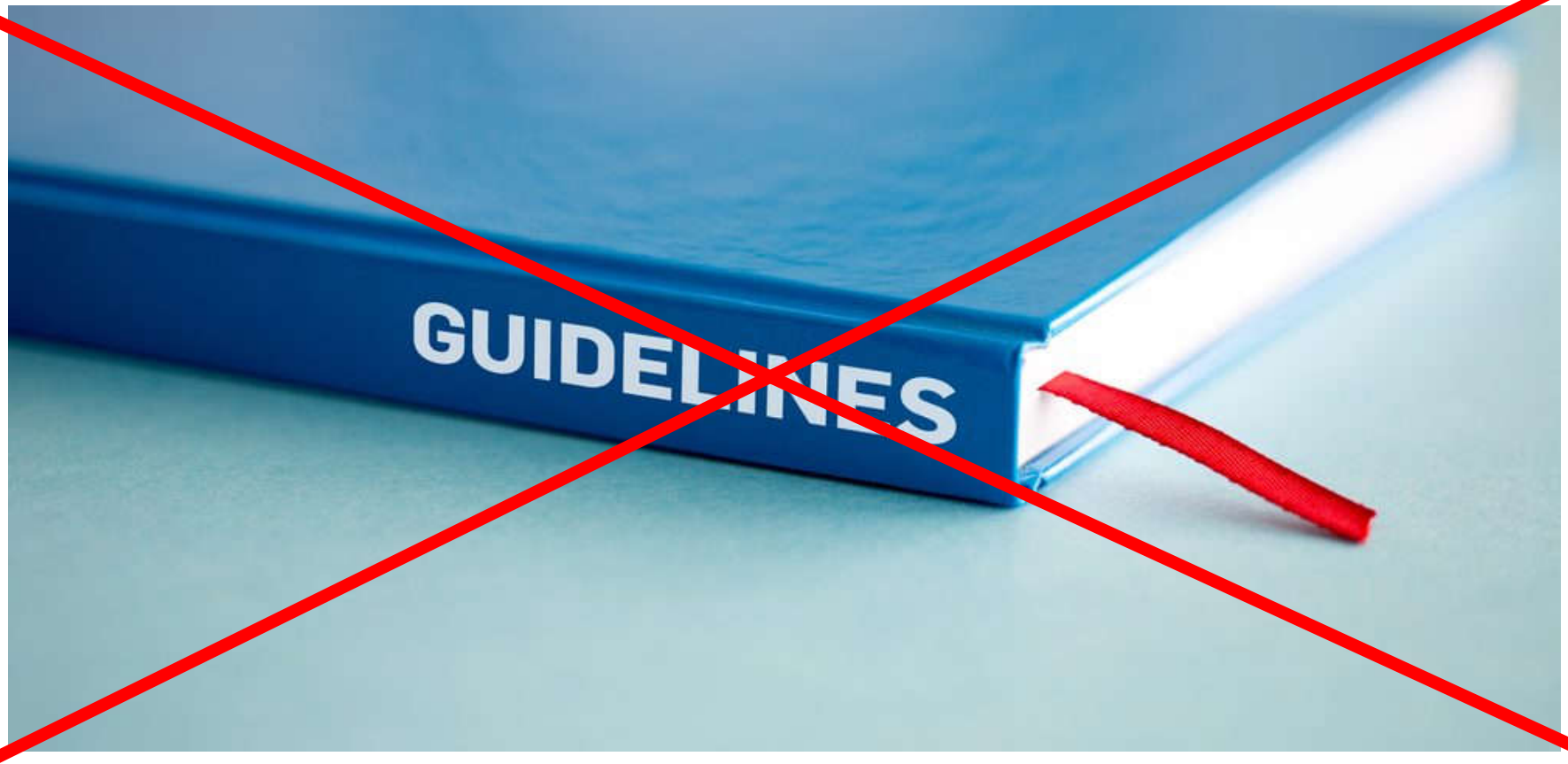
- ↓aortic/arterial stiffness
- ↓ frequency of dialysis-induced regional LV stunning
- ↓ of systemic blood pressure
- ↓ decline of renal function

Frequency of high-flow AVF induced changes

- Higher risk of high-flow AVF development: upper-arm AVF, males, previous access surgery, young
- The incidence of HF associated w. high-flow AVF requiring surgical correction: 3.7%
- Qa>2000 ml/min have a greater tendency to LV dilatation than Qa <1000 ml/min

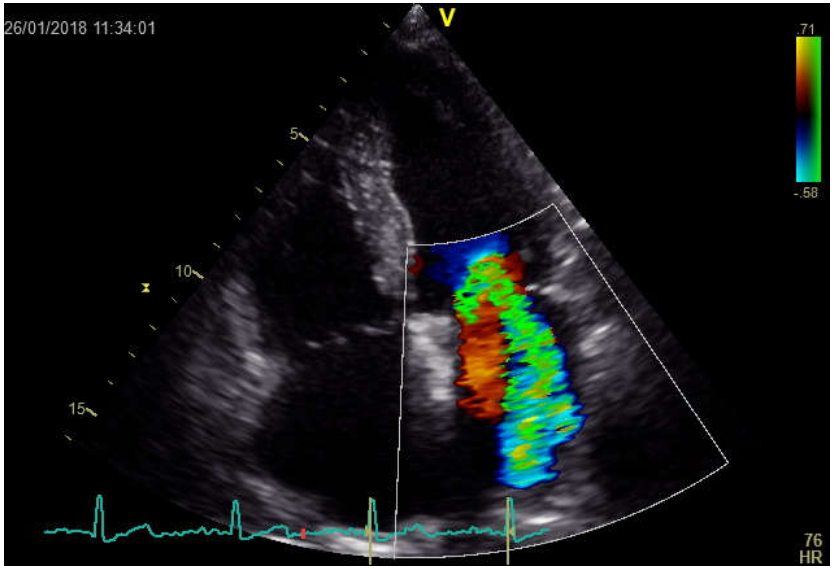
Wijnen E et al. Artif Organs 2005;29:960-964
Chemla ES et al. Semin Dial 2007;20:68-72
MacRae JM et al. J Am Soc Nephrol 2004;15:396A

Cases: our atttempt

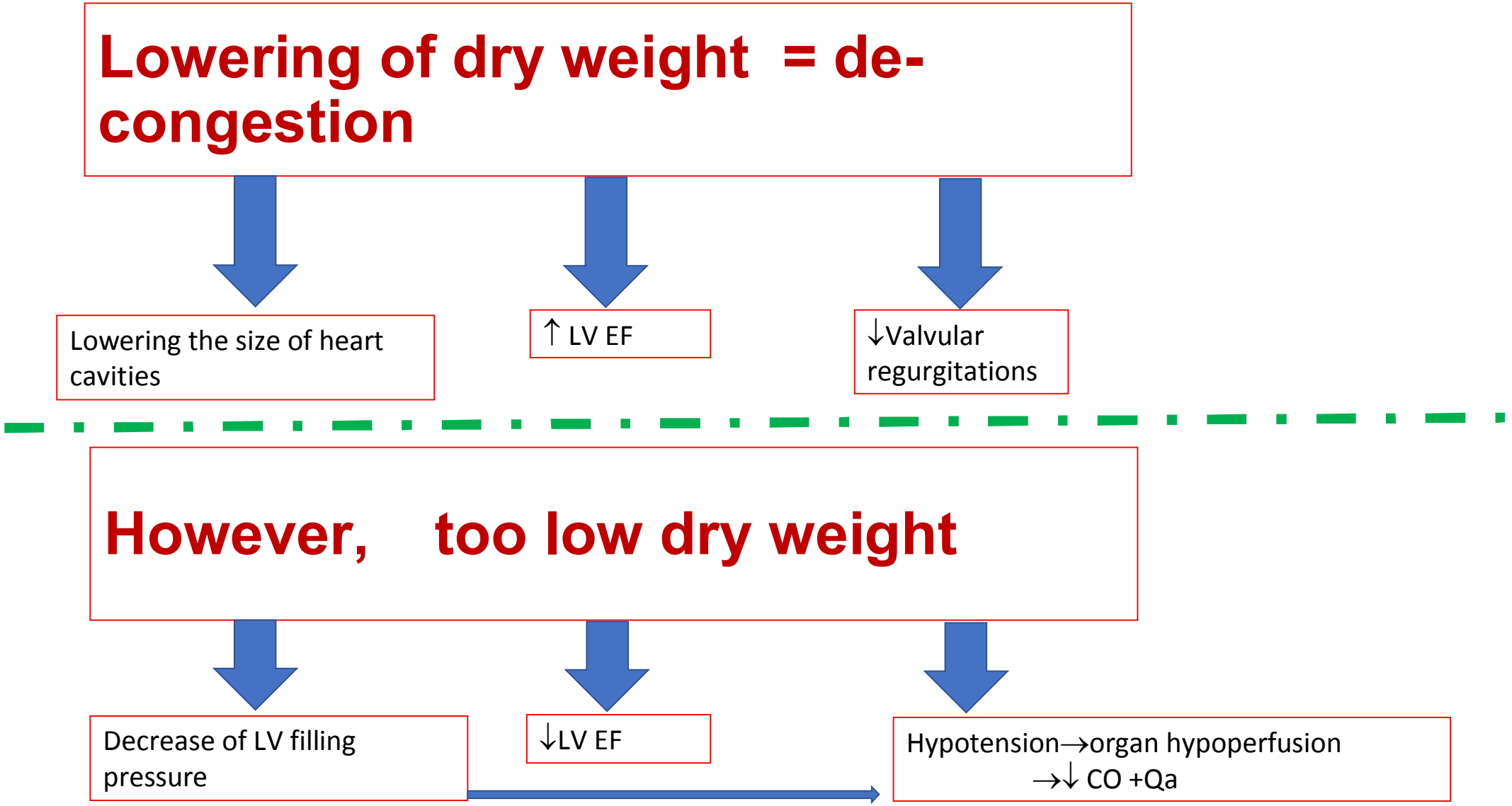


Case 1

- 72-y.o.male, on dialysis, shortness of breath NYHA III
- Qa 1800 ml/min
- Echo: moderate-to severe mitral reg., EF 45%



Steps:
1.Dry weight adjustment
2.Anemia correction
3.??flow-reducing surgery??


Lowering of dry weight = de-congestion
Lowering the size of heart cavities
↑ LV EF
↓Valvular regurgitations
However, too low dry weight
Decrease of LV filling pressure
↓LV EF
Hypotension→organ hypoperfusion
→↓ CO +Qa

Case 2

- 68y.o. lady, NYHA III, fatigueness
- Qa 1500 ml/min
- BP 130/65mmHg, HR 130/min irreg.
- Echo: sligthly dilated, diffusely hypokinetic LV, EF 30%

Steps:
1.Arrhythmia control
2.Dry weight adjustment?
3.??flow-reducing surgery??

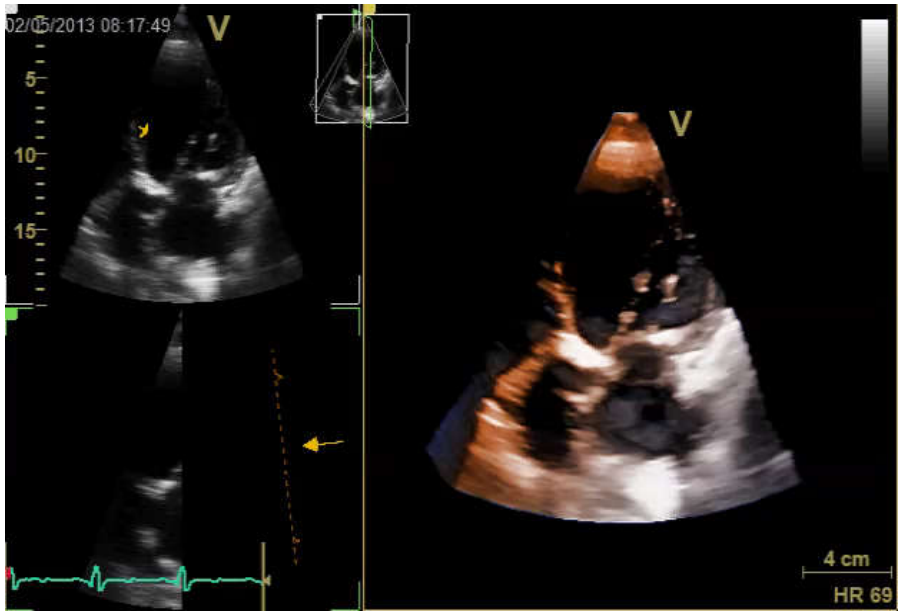
ad Case 2

- The most frequent arrhythmia is atrial fibrillation
- If longer lasting - „tachycardia-induced cardiomyopathy“

LV dilatation, systolic dysfunction

Case 3

- 57y.o. lady
- NYHA III, no help of dry weight adjustments
- Qa 500 ml/min
- ECHO: C0 2.6 l/min, CI 1.8 l/min/m^2



Steps:
1.Revascularization?
2.Resynchronization?
3.AVF ligation, catheter insertion

Case 4

- 54y.o. man practically symptomless
- Qa 6200 ml/min
- Echo: EF 67%, concentric hypertrophy, dilated left atrium

What to do?

Final remarks 1: Indication to flow-reduction:

- HF high-output: with CI > 3.5-3.9 l/min/m^2
- HF congestive: symptomatic patients after correction of dry weight, anemia
- Always consider Qa in relation to other patient´s characteristics

Final remarks 2: AVF

- Is generally the safest dialysis access
- Its impact on the circulation is both positive and negative
- Individualized approach is a must

General University Hospital in Prague