

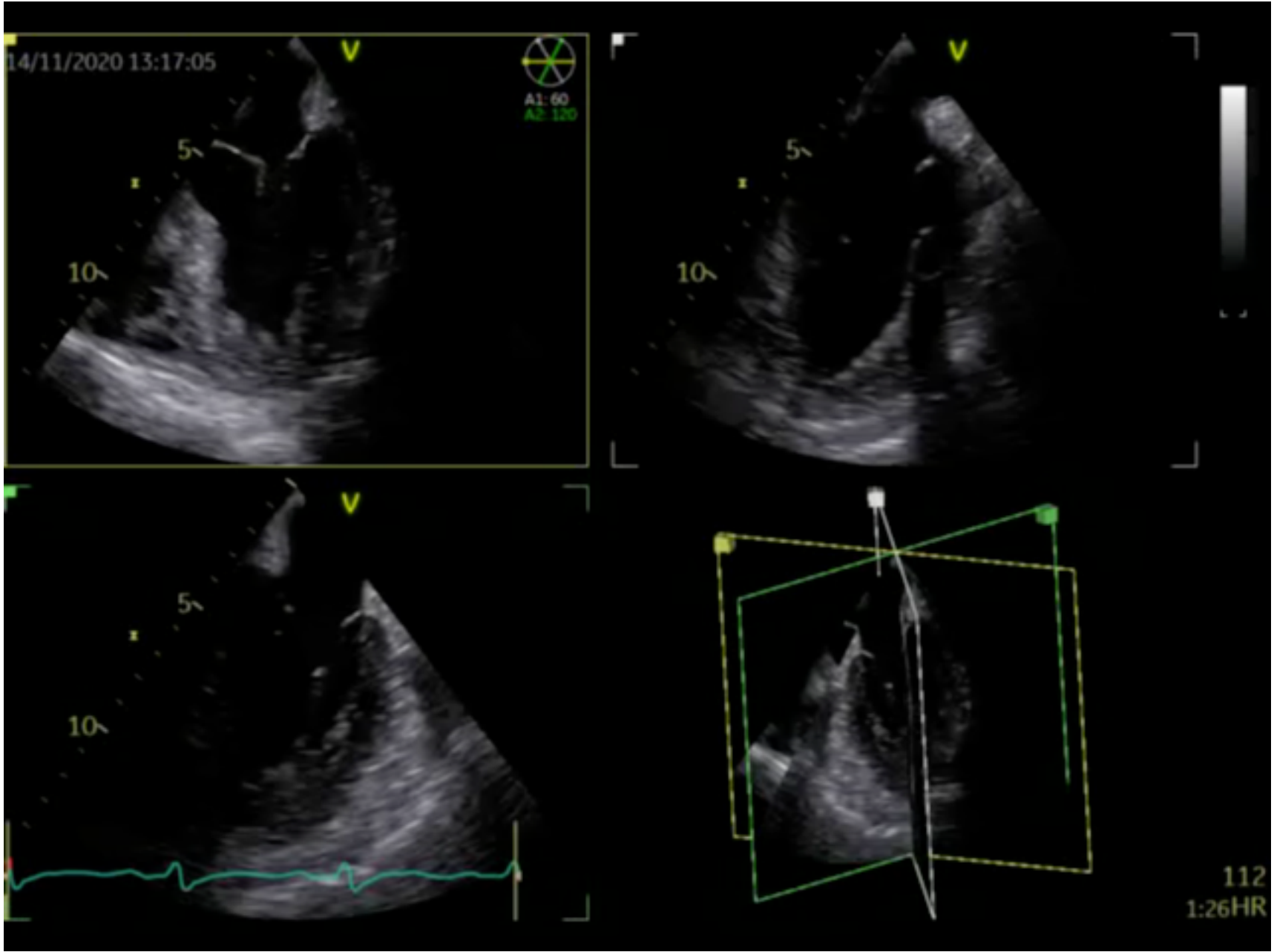
Swan Ganz kateter

Fagdag Anestesisykepleiere Thorax

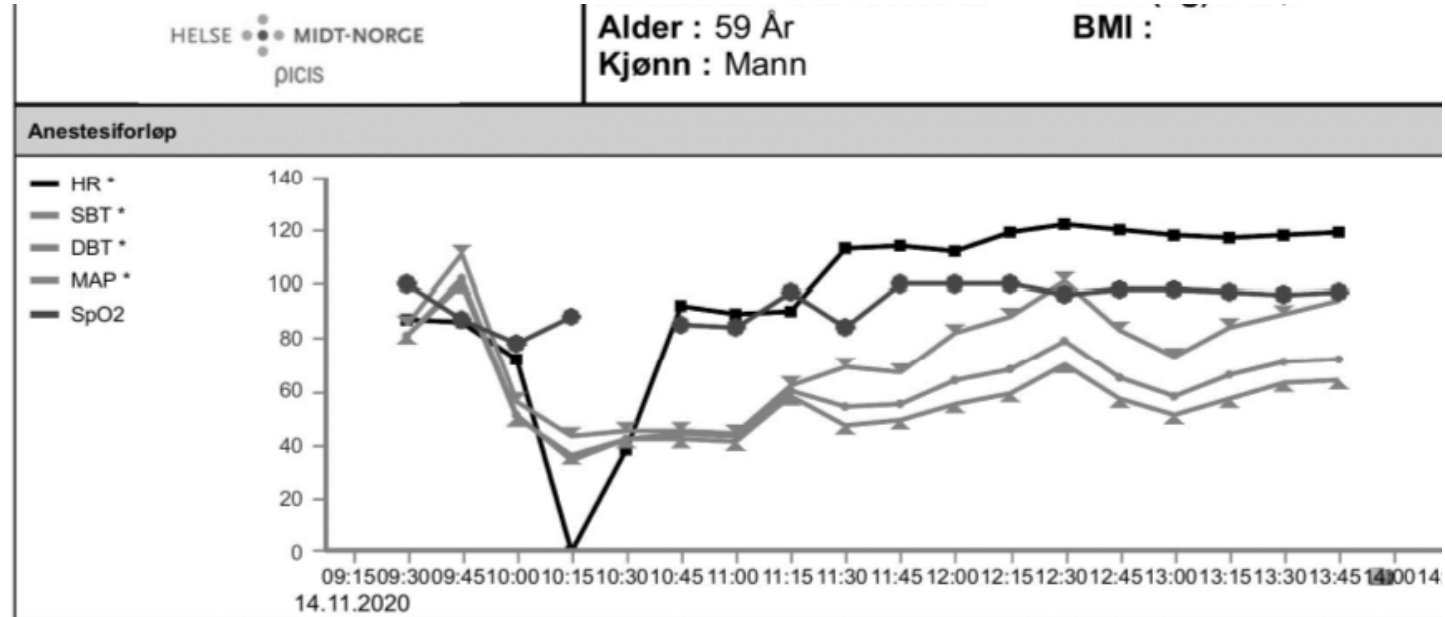
27. november 2020

Nils Kristian Skjærvold

- 59 år gammel mann
- Røyker, astma, gastritt
- Hjertestans med ROSC
- Angiolab - totalokkludert LAD
- Ecmo til op-stue; CABG
- Ved avgang overraskende god hjertefunksjon på TEE



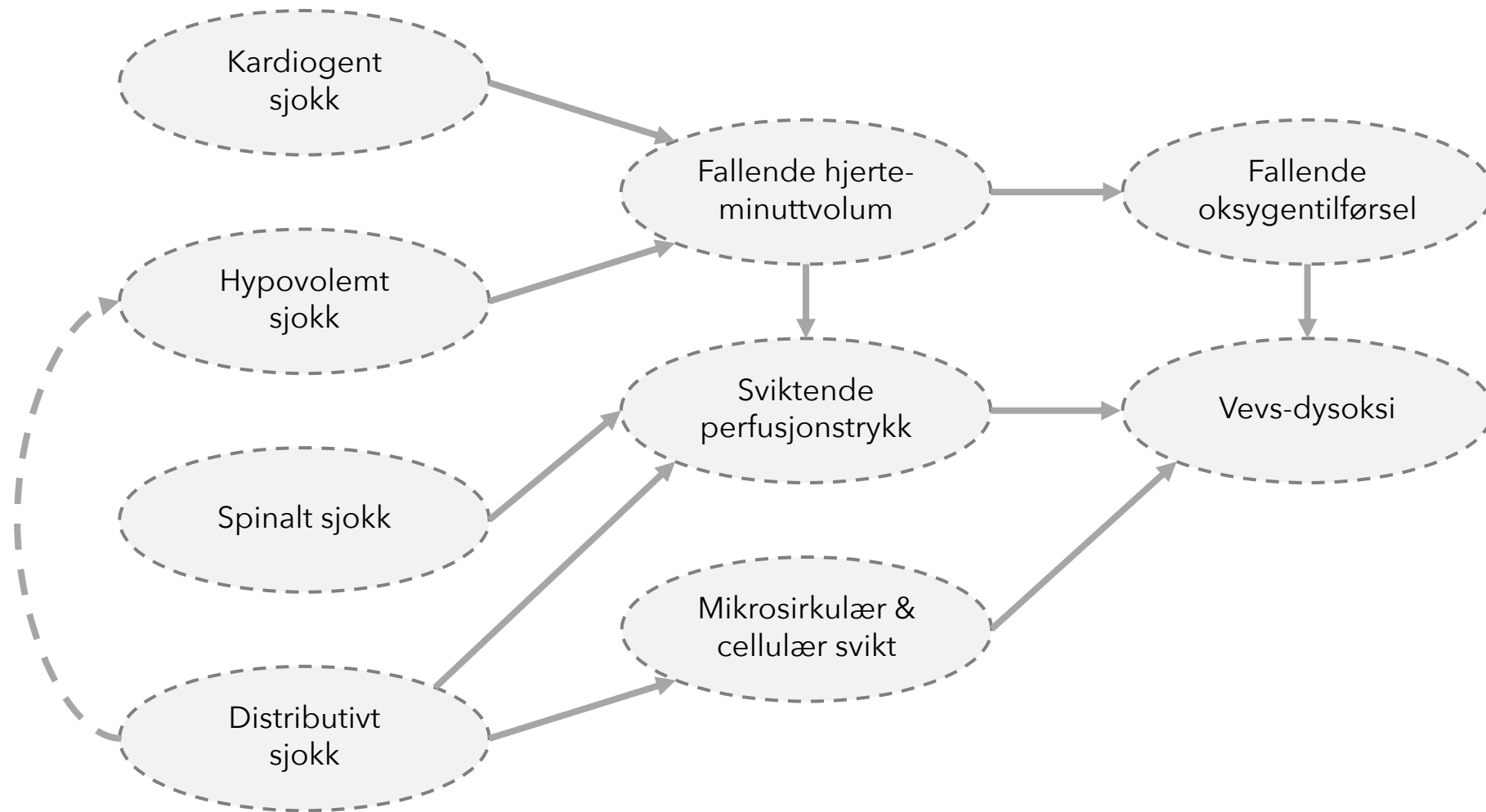
- ... men blodtrykket er lavt...



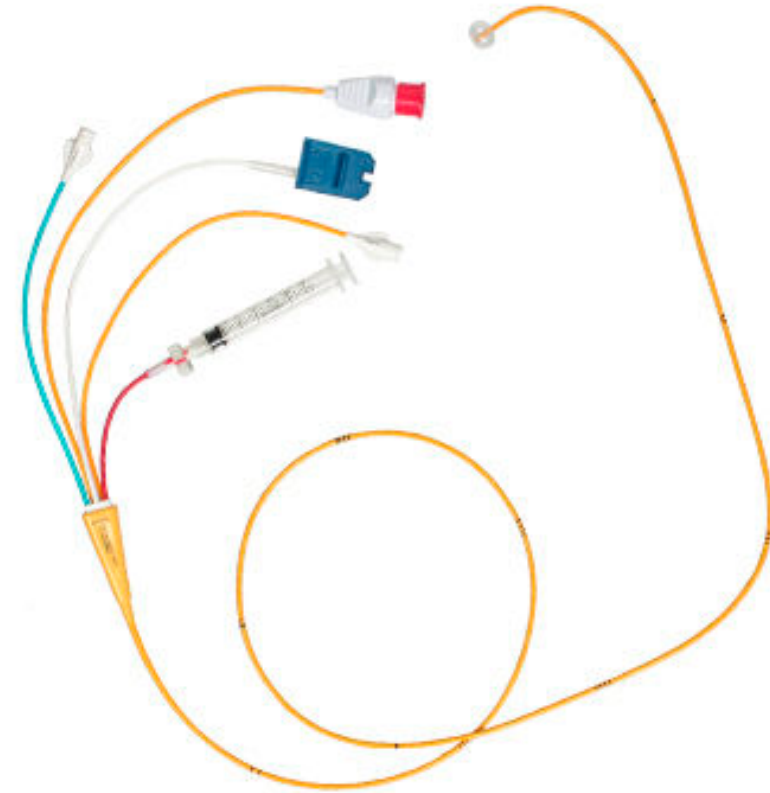
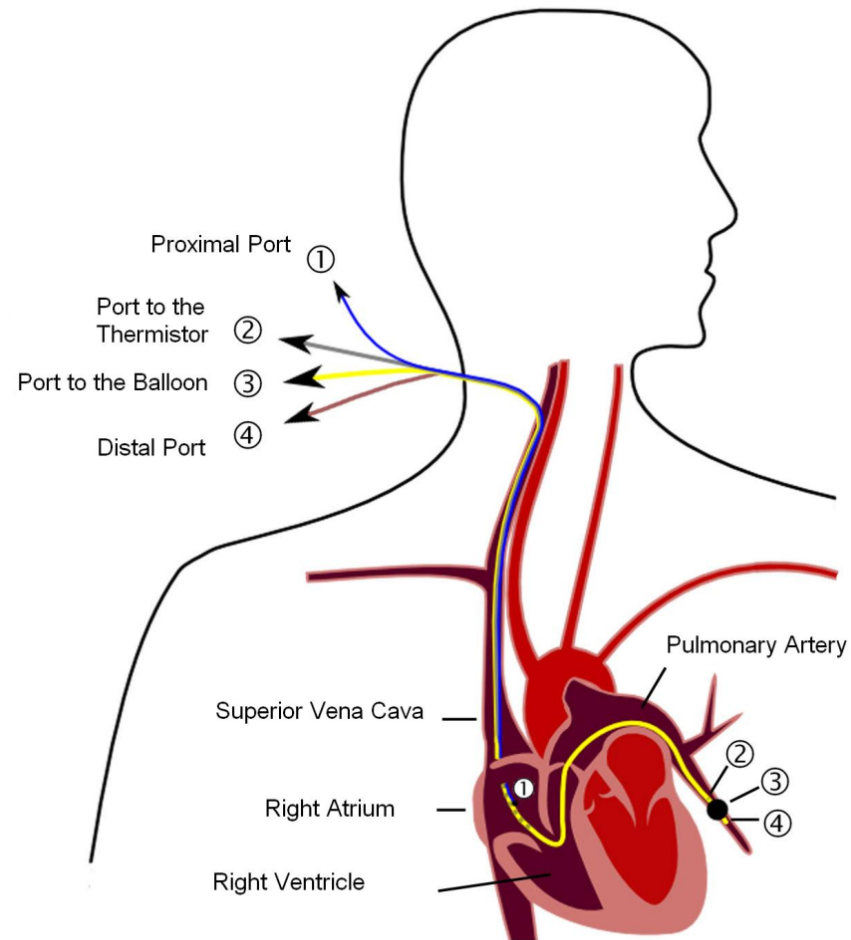
Propofol 10 mg/ml mg/kg/h Intravenøs		1	3	3	1	3	1	1	1	2
Noradrenalin 100 µg/ml µg/kg/min Intravenøs		0.34	0.11	0.23	0.34	0.45	0.57	0.57	0.57	0.47
Insulin 1 U/ml IE/t Intravenøs					4	3	1	↑	↑	↑

Systolisk blodtrykk (Art.)	74	86	90	80	84	77
Diastolisk blodtrykk (Art.)	54	60	63	56	58	55
Mean blodtrykk (Art.)	61	68	72	63	67	63
Pulmonaltrykk systolisk	15	39	39	38	38	34
Pulmonaltrykk diastolisk	8	18	18	19	23	21
Pulmonaltrykk mean	11	28	28	27	29	26
Sentralt venetrykk	7	10	10	8	12	12
Hjertefrekvens *	113	110	109	106	102	94
Systolisk BT *	74	86	90	80	84	77
Diastolisk BT *	54	60	63	56	58	55
Mean BT *	61	68	72	63	67	63
Temperatur *	37,1	37,2	37,3	37,5	37,6	37,6
Blandet venøs metning	57	59	60	46	22	59
Blood Temperature	37,0	37,0	37,1	37,3	37,3	37,4
Kiletrykk	12			17		
Continuous Cardiac Output	5	5	7	5	6	6

Sirkulasjonssjokk (Skjærvolds klassifikasjon...)

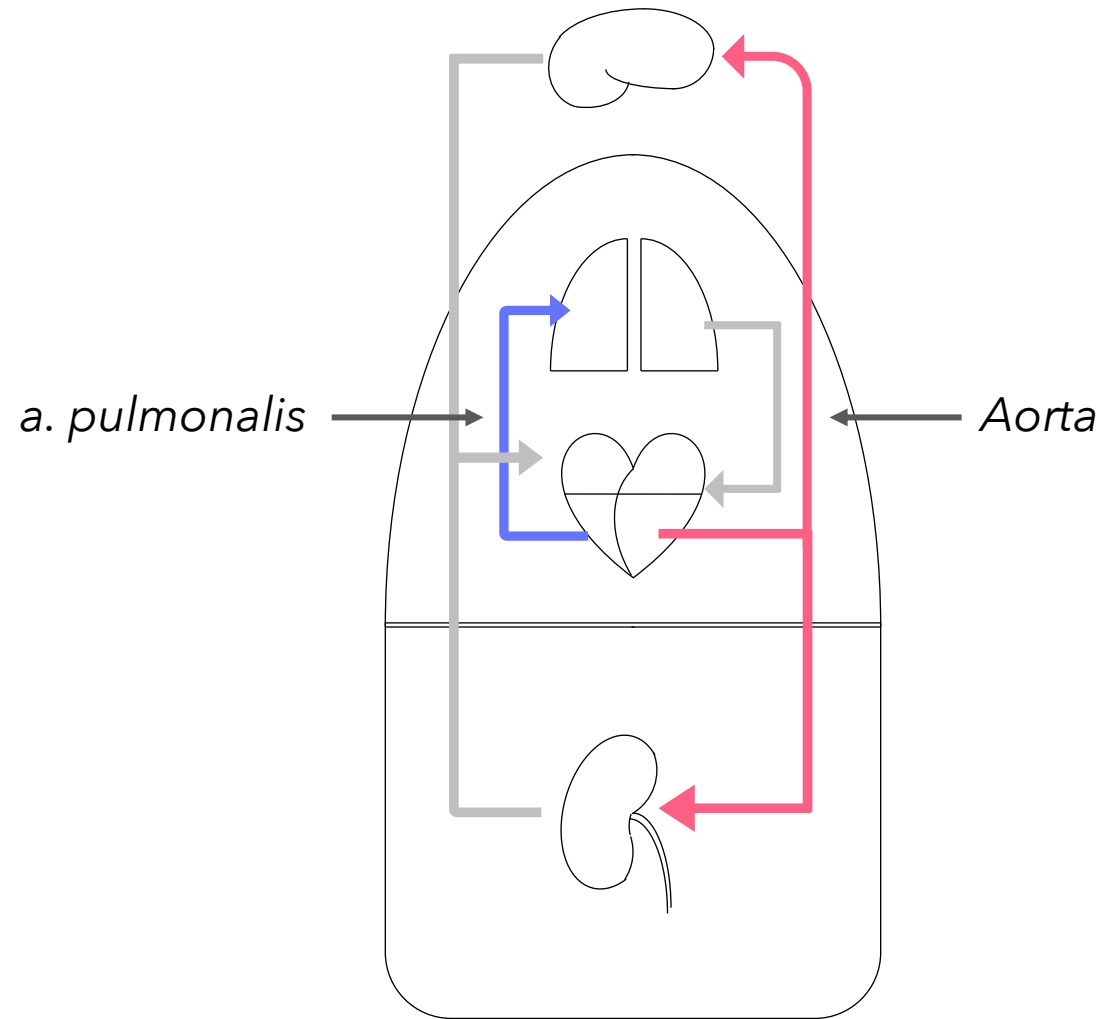


PAC = Pulmonalarteriekateter = Swan Ganz kateter

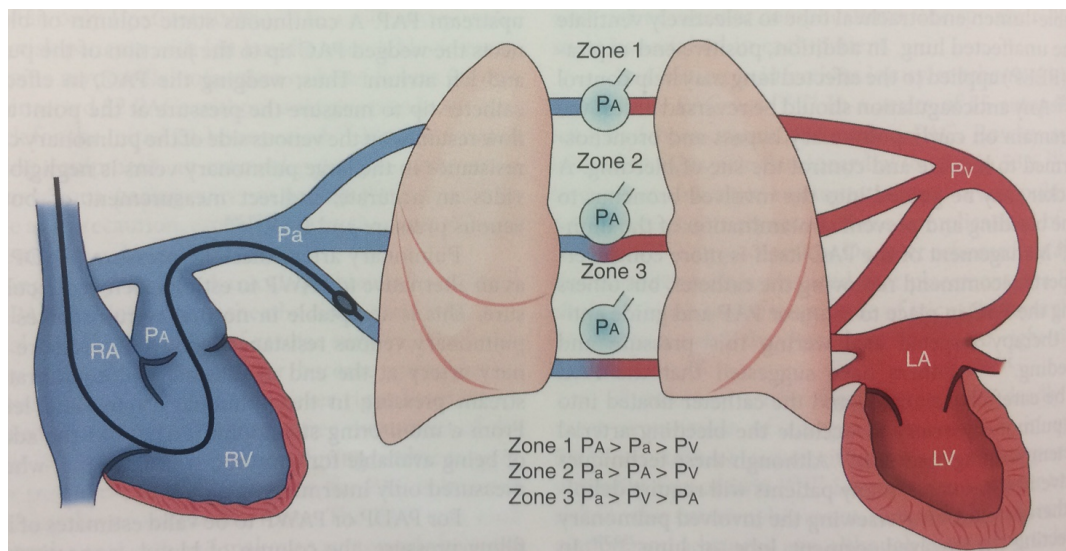


[Video](#)

Samme volum gjennom venstre og høyre hjerte



Hva måler Swan Ganz kateteret?



The Stewart- Hamilton Equation:

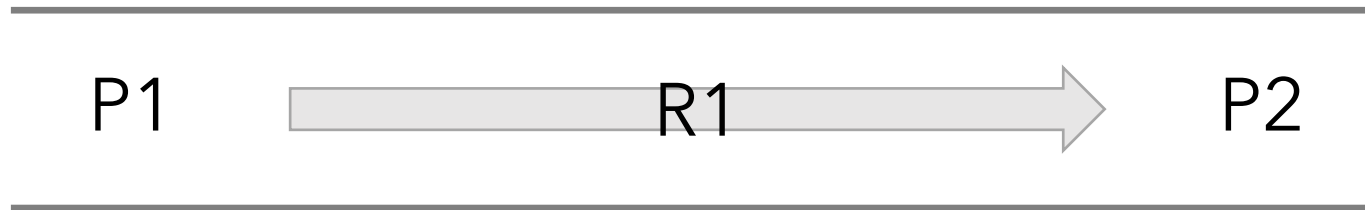
$$Q = \frac{V \times (T_b - T_i) K_1 \times K_2}{T_b(t) dt}$$

Q = cardiac output
V = injected volume
T_b = blood temperature
T_i = injectate temperature
K₁ and K₂ = corrections for specific heat and density of the injectate and for blood and dead space volume
T_b(t)dt = change in blood temperature as a function of time

- Pulmonaltrykk
 - Pulmonal hypertensjon
 - Høyre ventrikkelsvikt
- Kiletrykk
 - VV fylningstrykk
 - Beregning av PVR
- CO
 - Hjertets samlede pumpeevne
 - Global oksygenforsyning
- SvO₂
 - Oksygentilbud - oksygenforbruk

Sammenheng trykk, flow og motstand

- flow forutsetter trykk $P1 > P2$
- jo større trykkforskjell jo større flow
- jo større motstand jo mindre flow



Motstand kan regnes ut i enkle systemer
I sirkulasjonen må motstand beregnes fra flow og trykk



Jean Léonard Marie
Poiseuille 1779 - 1869

Poiseuilles lov -> Ohms lov
$$Q = (\Delta P * \pi * r^4) / 8 * \mu * L = \Delta P / R$$



Georg Simon Ohm
1789 - 1854

Sammenheng trykk, flow og motstand

Systemkretsløpet:

$$CO = (MAP - CVP) / SVR$$

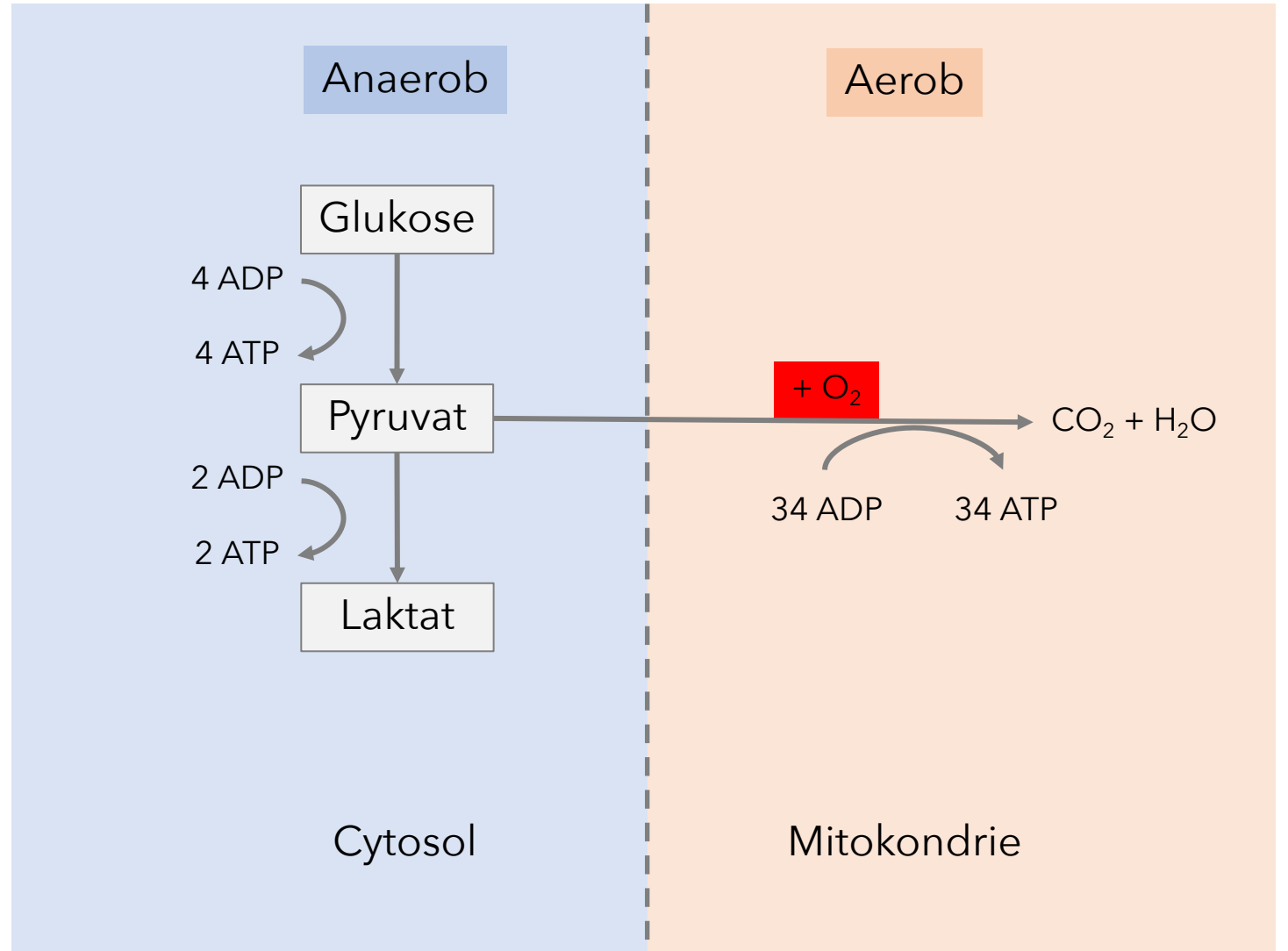
$$SVR = (MAP - CVP) / CO$$

Pulmonalkretsløpet:

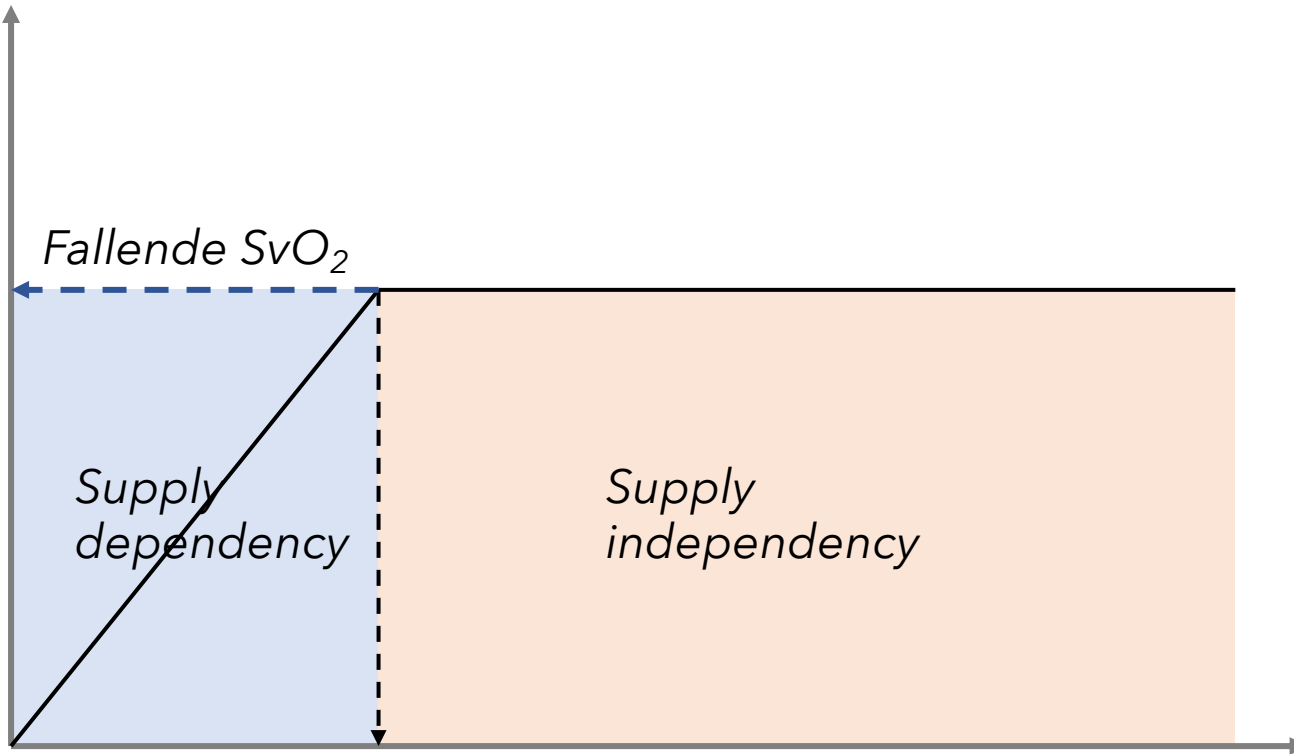
$$CO = (MPAP - PCWP) / PVR$$

$$PVR = (MPAP - PCWP) / CO$$

→ neste time

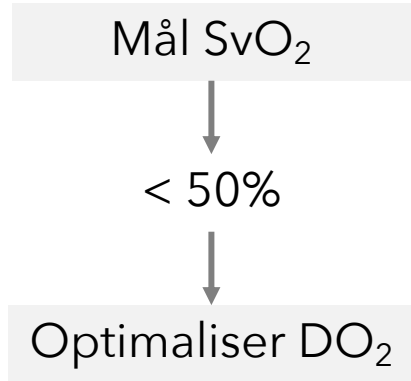


$$VO_2 = Hb \times SV \times HR \times (sO_2 - S_vO_2)$$

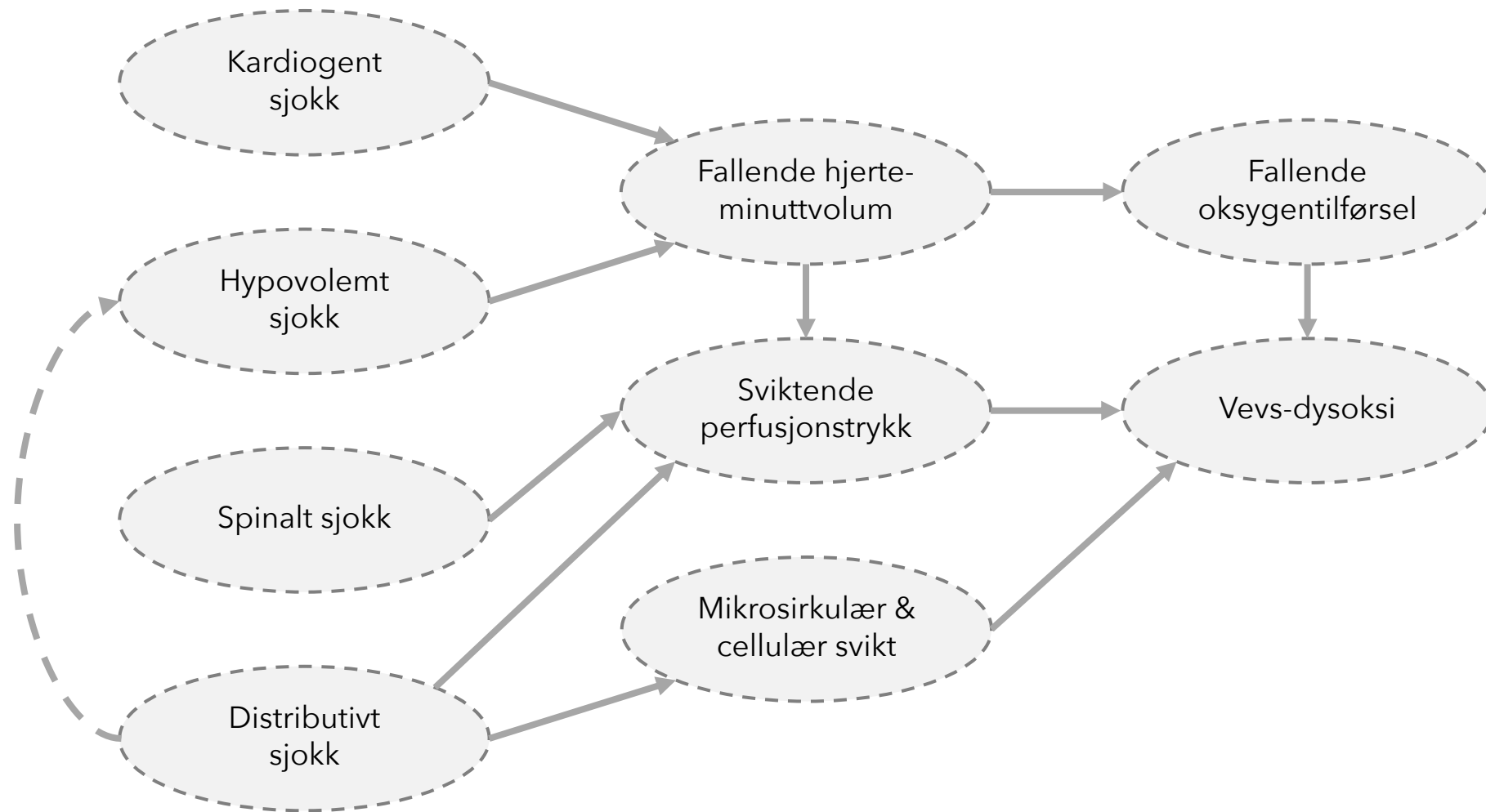


Critical
oxygen
delivery

$$DO_2 = Hb \times SV \times HR \times sO_2$$



Sirkulasjonssjokk (Skjærvolds klassifikasjon...)



Oppsummering Swan Ganz kateter

- Relativt enkelt å legge med få komplikasjoner
- Flow proporsjonalt med trykk, invers proporsjonalt med motstand
- Global oksygenforsyning avhengig av Hb, CO og sO_2
- Indikasjon 1: Hjertesvikt med behov for inotropi
- Indikasjon 2: Pulmonal hypertensjon med risiko for høyre ventrikkelsvikt
- Generelt: Muliggjør identifisering og differensiering av ulike typer sirkulasjonssjokk

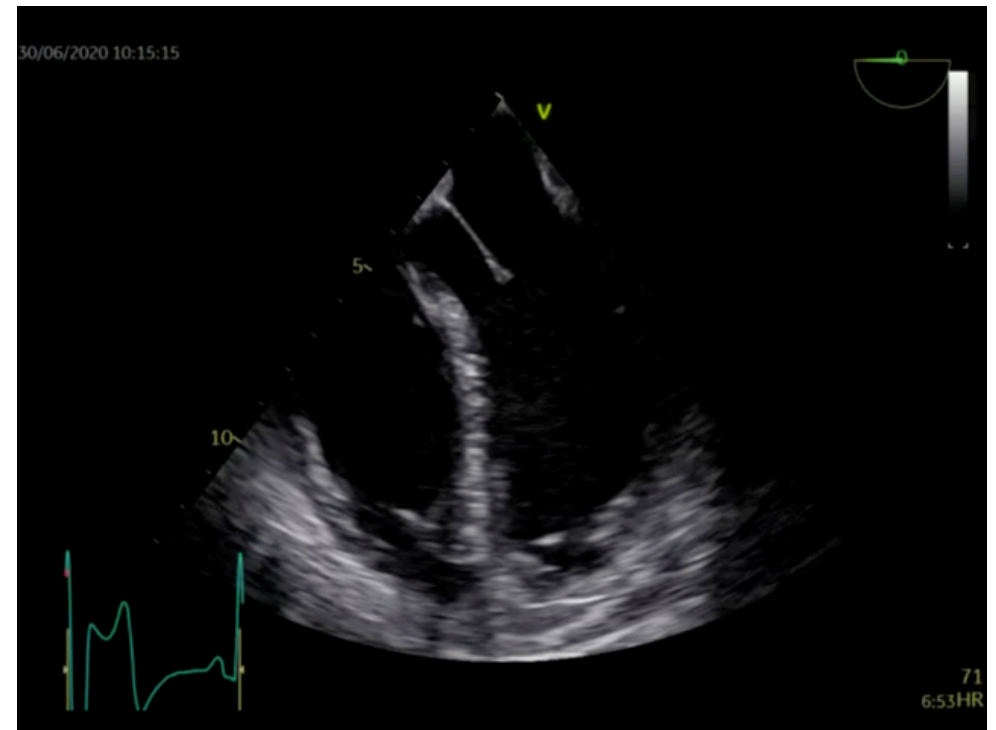
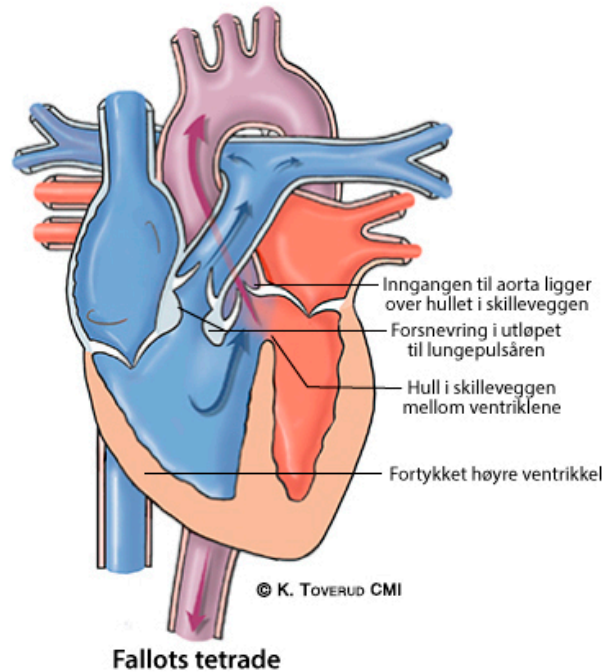
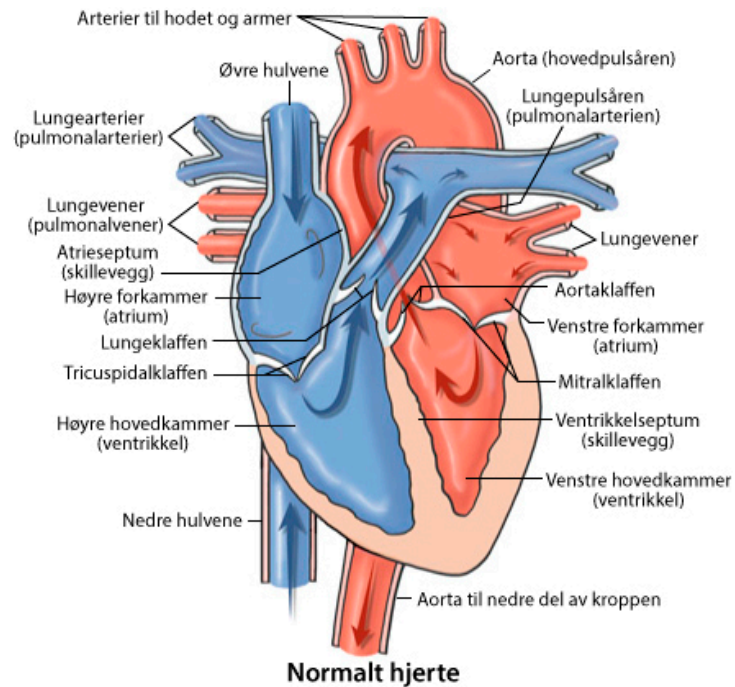
Akutt høyre ventrikkelsvikt og pulmonal hypertensjon

Fagdag Anestesisykepleiere Thorax

27. november 2020

Nils Kristian Skjærvold

- 37 år gammel mann
- operert Fallot tetrade som barn, nå lett høyresvikt og lettgradig pulmonal stenose
- ca pulm med planlagt bilobectomi høyre side

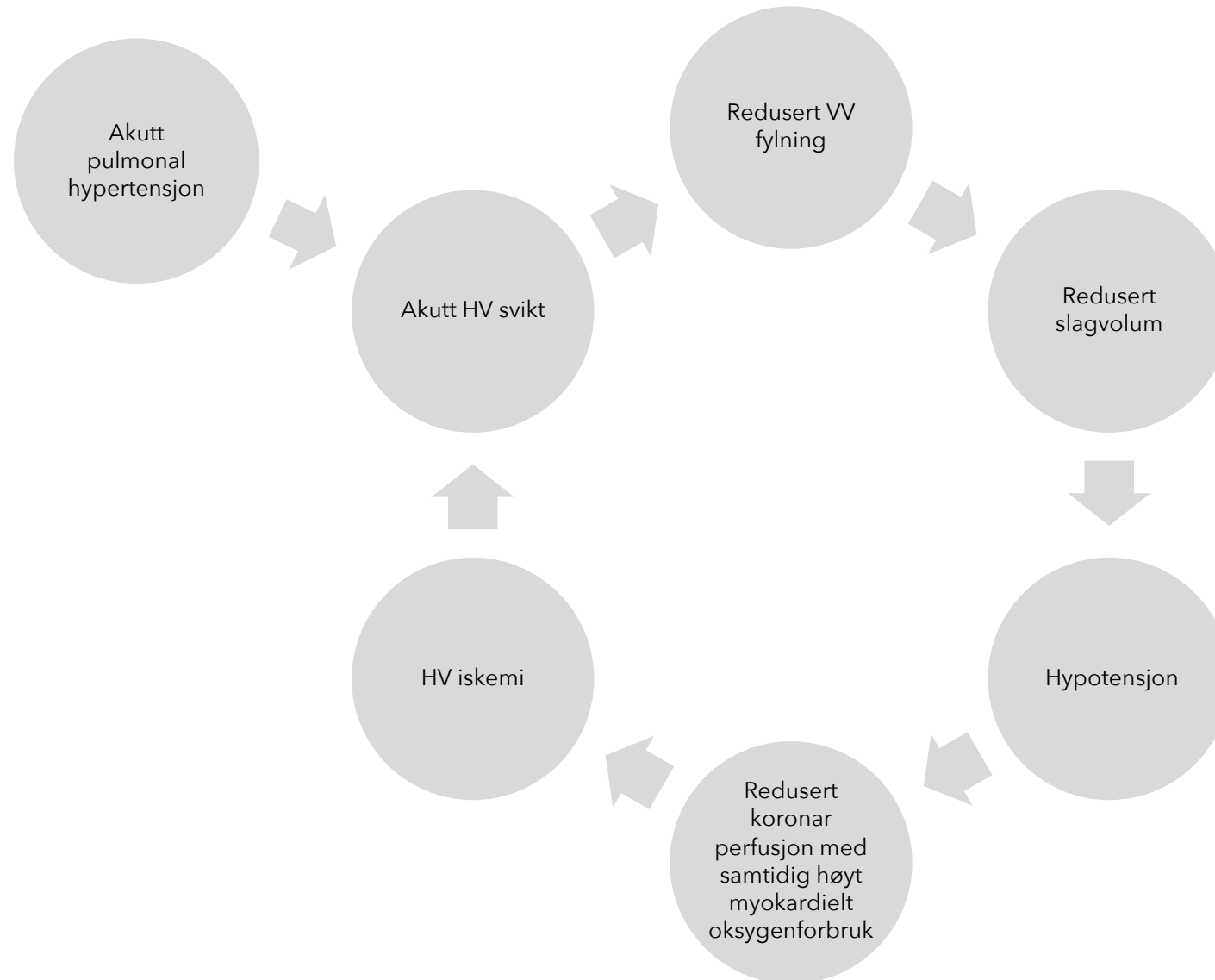


- prosedyre lar seg godt gjennomføre etter god planlegging (uten bronkodilatator)
- postop komplisert med respirasjonssvikt, høyre hjertesvikt og perioder med NO-behandling
- etter hvert sendt hjem til Ålesund - nå halvt år etter inngrepet ennå ikke bra...

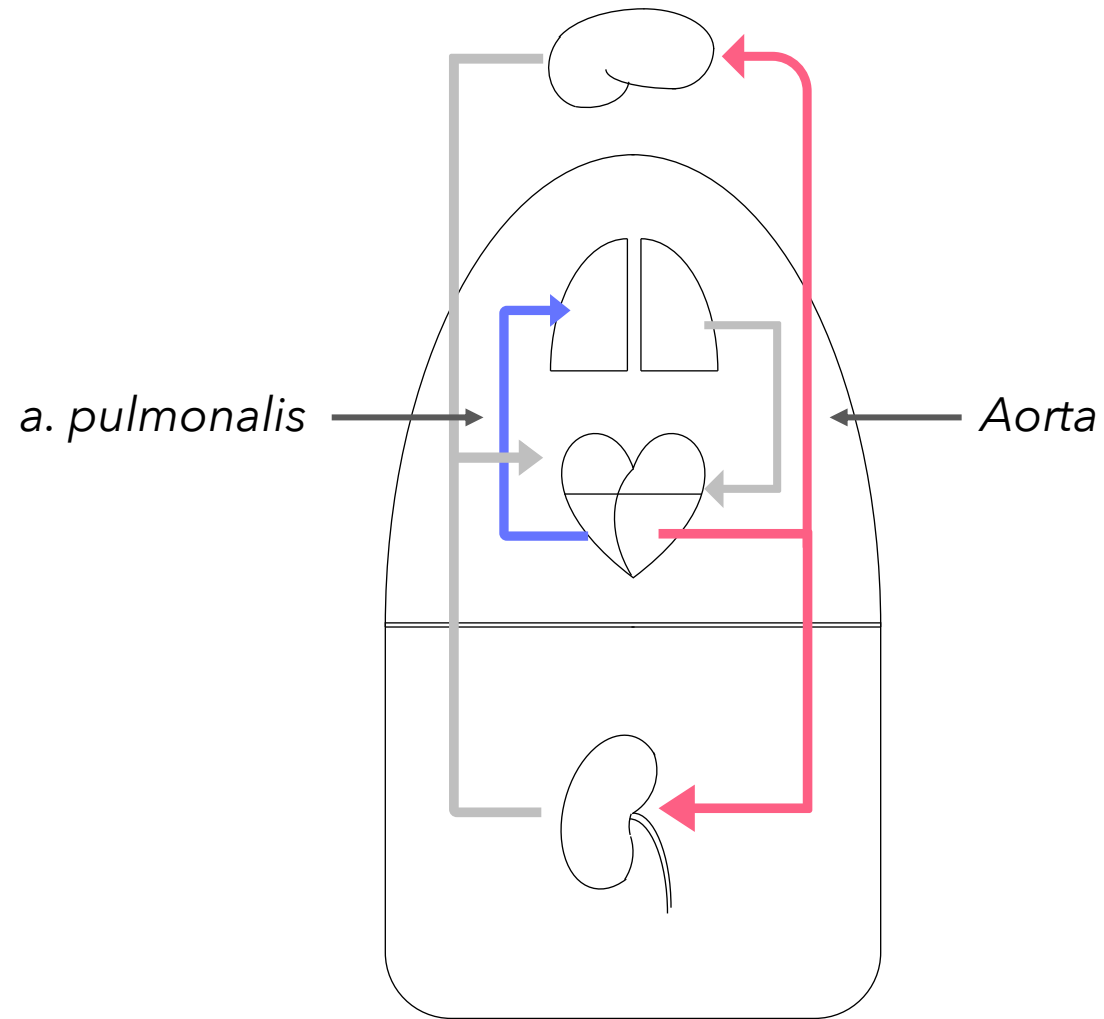
Hvor farlig er pulmonal hypertensjon ved hjertekirurgi?

- «overalt» beskrevet som en viktig kompliserende faktor
- ... men veldig vanskelig å finne tall på hvor farlig det er
- Som oftest ser vi dette pga luft i høyre koronarkar etter klaffekirurgi - lar seg greit løse med forlenget CPB-tid

Pulmonal hypertensjon og sirkulasjonssvikt



Samme volum gjennom venstre og høyre hjerte



Sammenheng trykk, flow og motstand

Systemkretsløpet:

$$CO = (MAP - CVP) / SVR$$

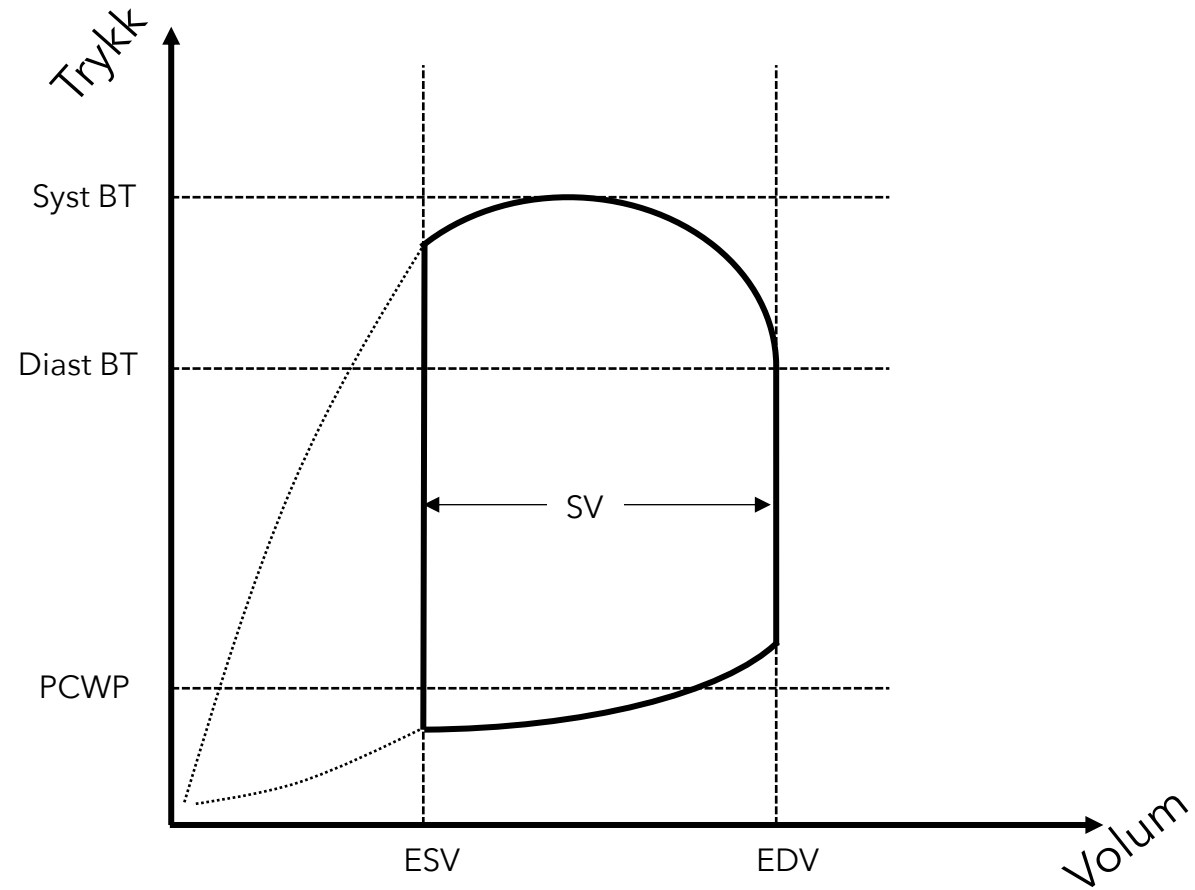
$$SVR = (MAP - CVP) / CO$$

Pulmonalkretsløpet:

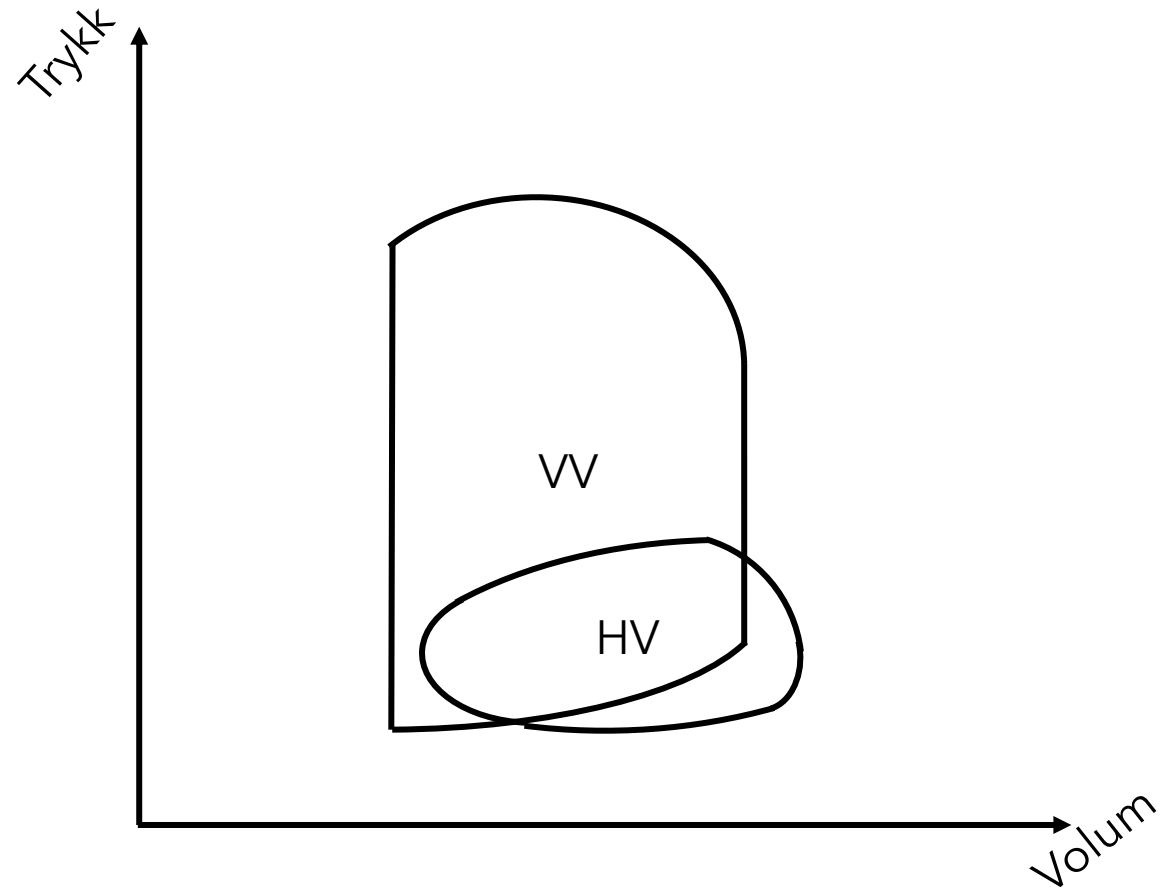
$$CO = (MPAP - PCWP) / PVR$$

$$PVR = (MPAP - PCWP) / CO$$

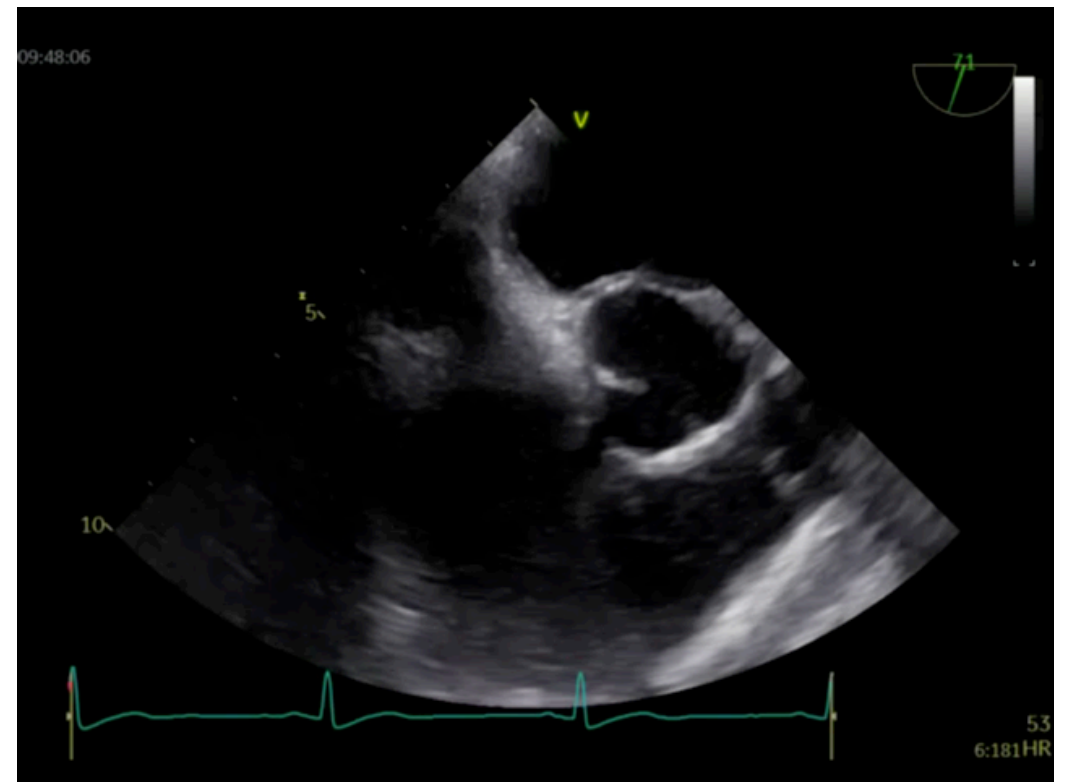
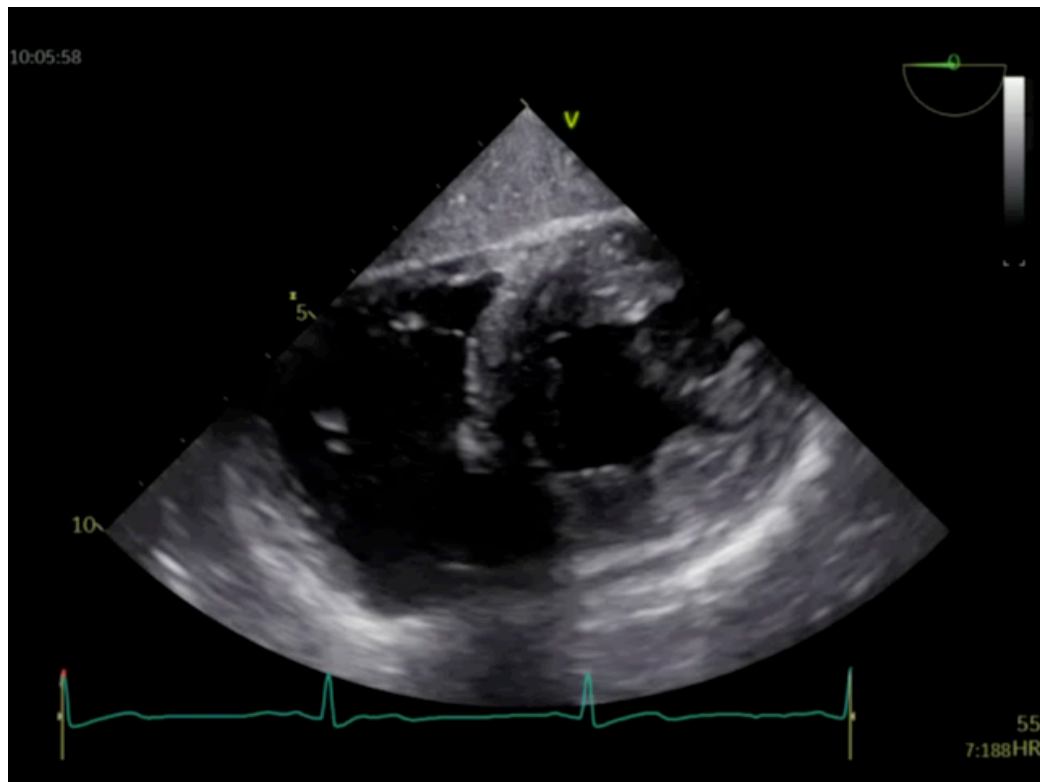
Trykk-volum sløyfa viser dynamikk i venstre ventrikkel, energi tilført sirkulasjonen og energi forbrukt



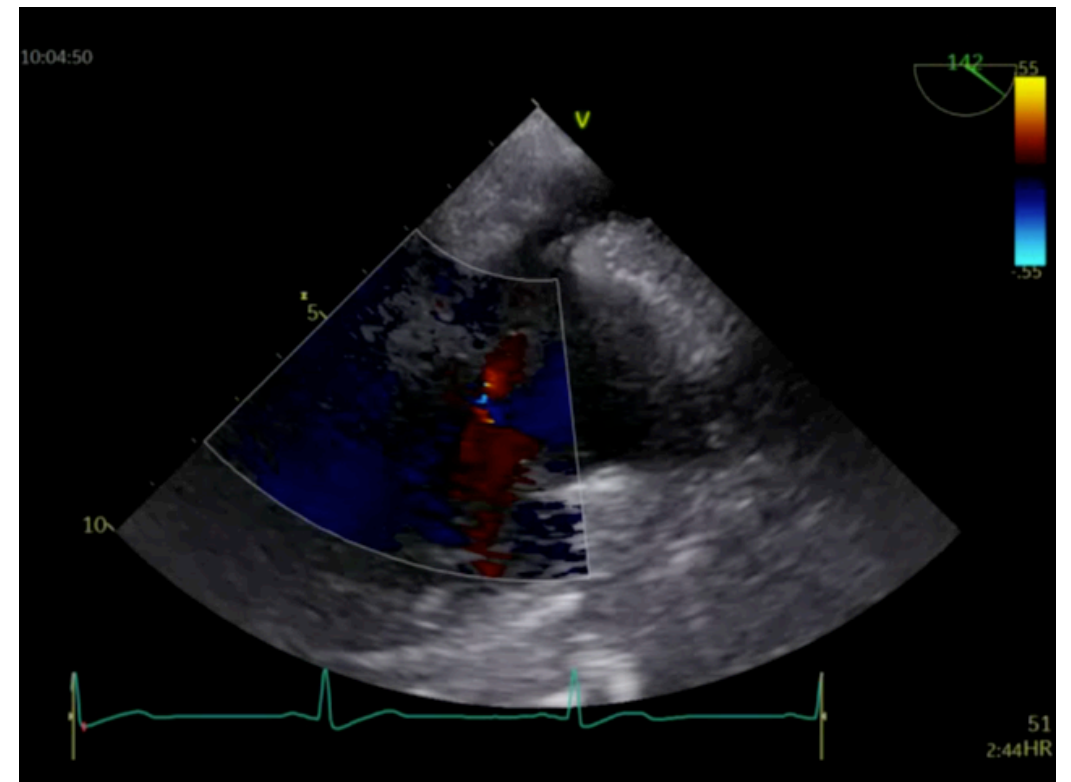
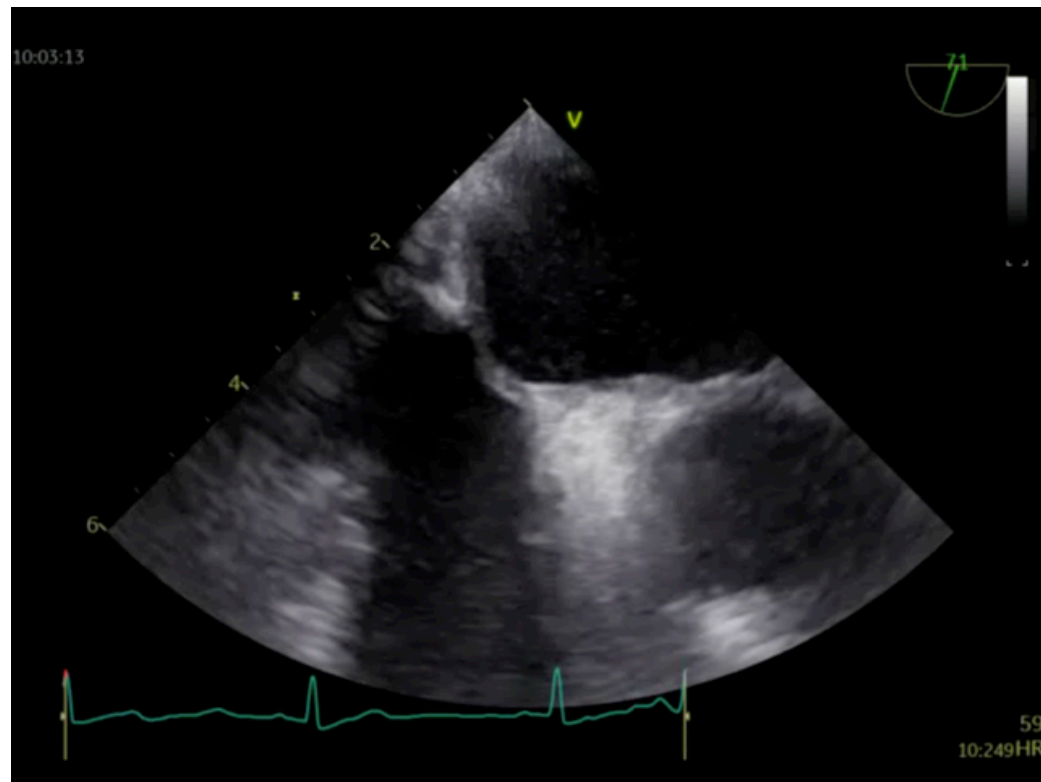
System sirkulasjonen er et høytrykkssystem og pulmonalsirkulasjonen er et lavtrykkssystem



VV er tykkvegget, utfører et stort arbeid og genererer høyt trykk – motsatt for HV

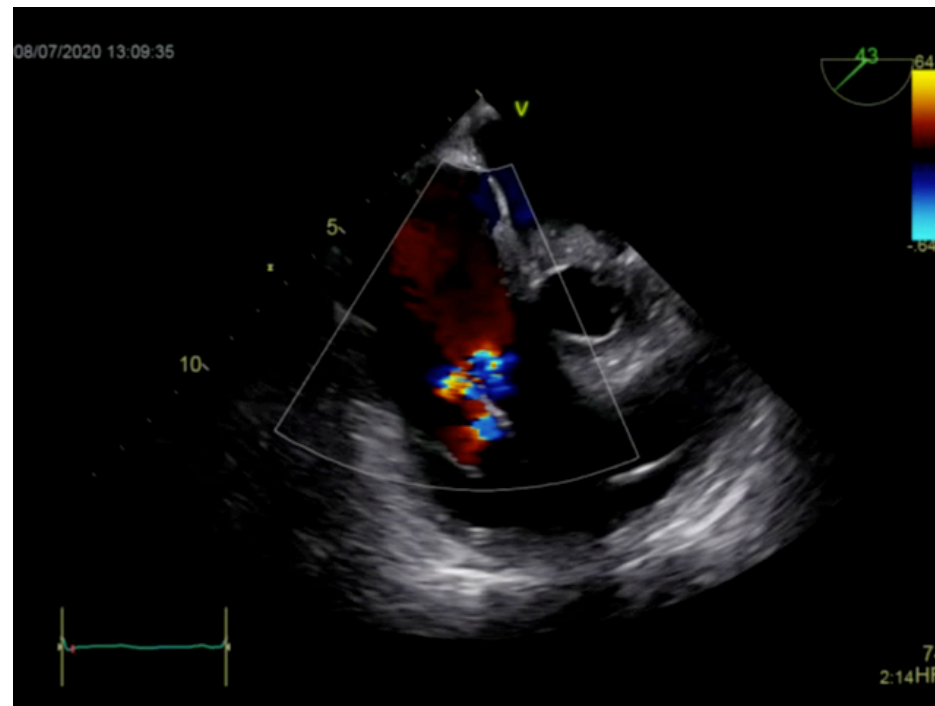


VV er tykkvegget, utfører et stort arbeid og genererer høyt trykk – motsatt for HV



Akutt høyre ventrikkelsvikt oppstår når høyre ventrikkel ikke
makter å kompensere for økt pulmonal motstand

Akutt vil vi kun forsøke senke pulmonal motstand hvis høyre ventrikkel ikke kompenserer



Sammenheng trykk, flow og motstand

Hva er egentlig pulmonal hypertensjon

Systemkretsløpet:

$$CO = (MAP - CVP) / SVR$$

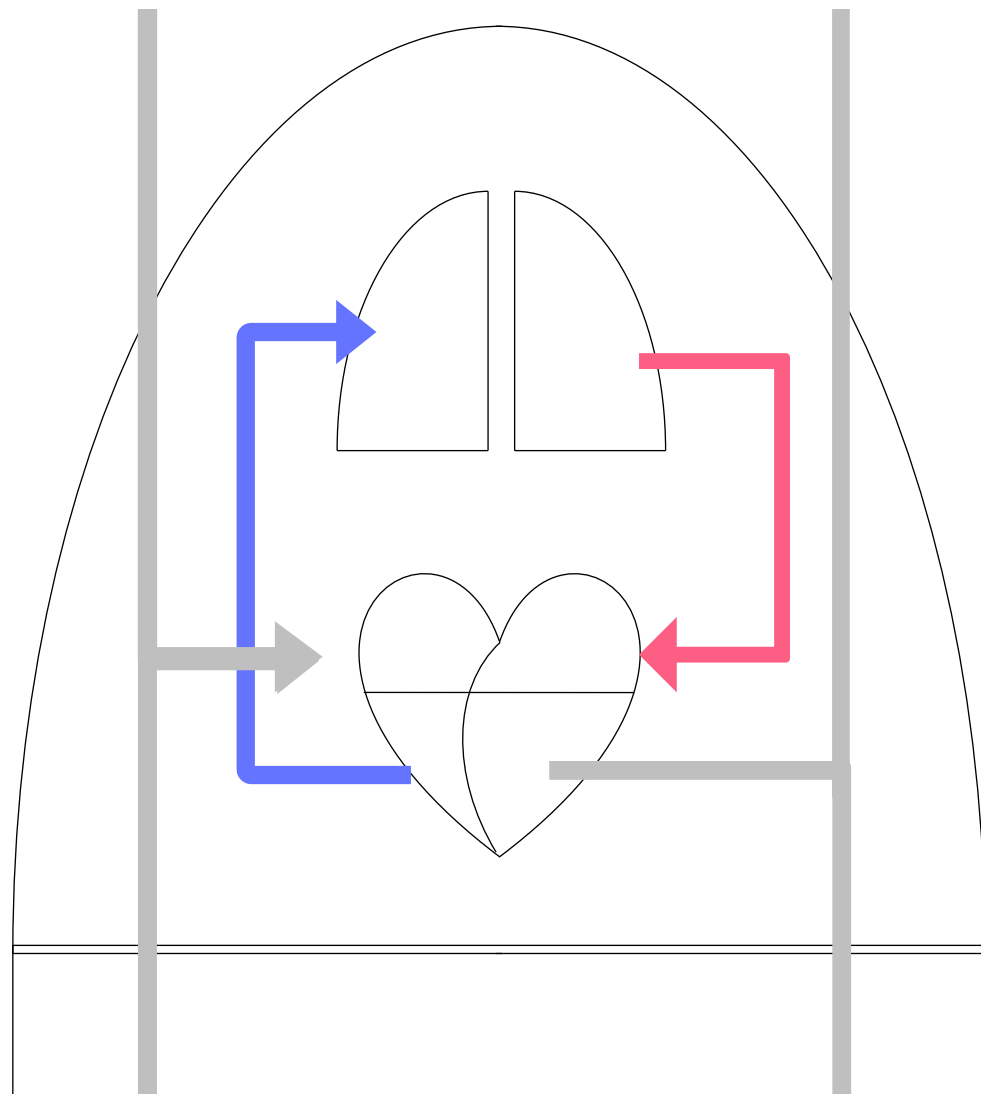
$$SVR = (MAP - CVP) / CO$$

Pulmonalkretsløpet:

$$CO = (MPAP - PCWP) / PVR$$

$$PVR = (MPAP - PCWP) / CO$$

$$MPAP = (CO \times PVR) + PCWP$$

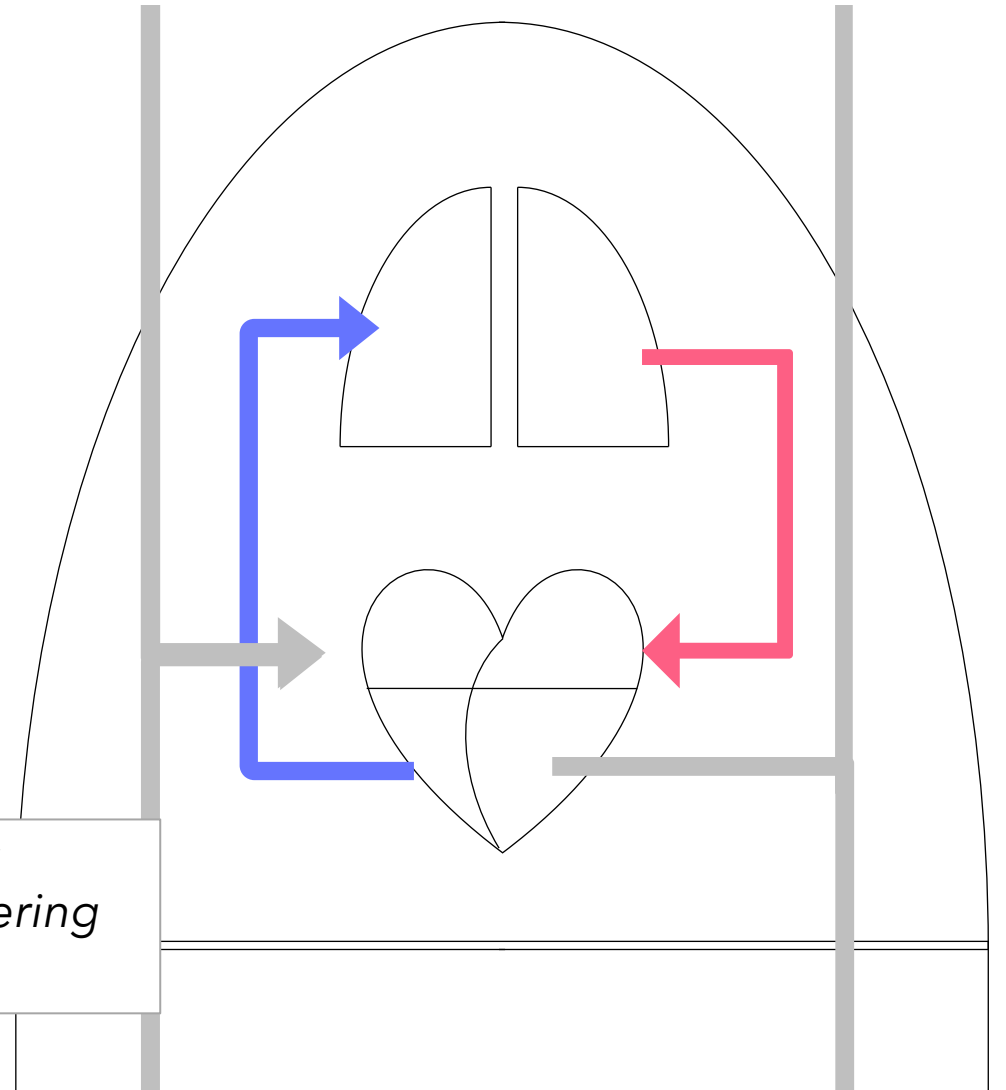


Pulmonal hypertensjon har ulike årsaker

$$\text{MPAP} = (\text{CO} \times \text{PVR}) + \text{PCWP}$$

1. PAH (primær, idiopatisk, «pre-kapillær»)
2. Sekundært til VV-svikt («backward-failure», «post-kapillær»)
3. Sekundært til lungesykdom
4. Sekundært til tromboembolisk sykdom
5. Uklare/multifaktorielle årsaker

Pasientene har ikke egentlig høyt pulmonalt trykk men høy pulmonal motstand eller høyt VV-fyllingstrykk - ved generering av en gitt CO gir dette høyt pulmonaltrykk



Behandling: 1) Lengre CPB tid 2) Stimulere Høyre ventrikkel 3) Senke pulmonalmotstand

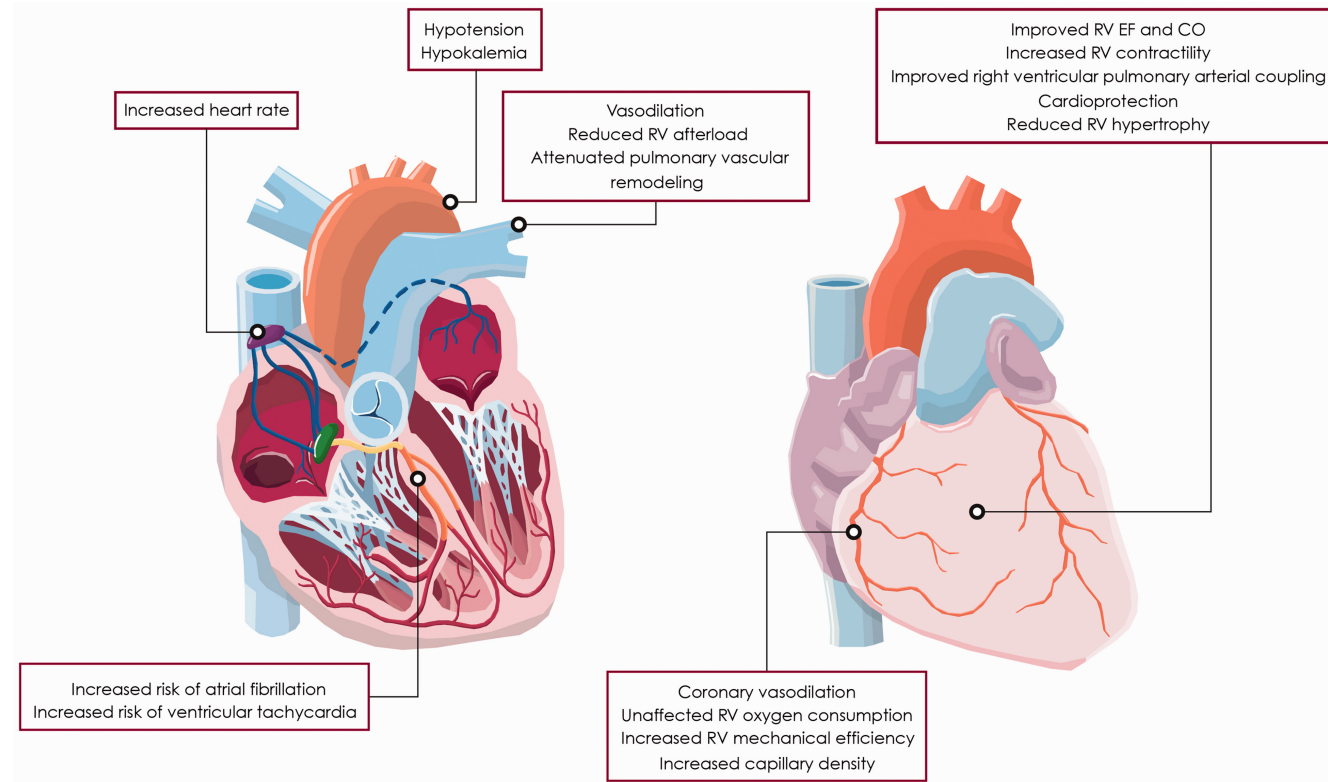
- Ekko-bilde luft venstre ventrikkel...
 - ... men jeg fant ikke igjen noen fine bilder...

Behandling: 1) Lengre CPB tid 2) Stimulere Høyre ventrikkel 3) Senke pulmonalmotstand

- Ordinære inotropika, dvs:
 - efedrin
 - dobutamin
 - Milrinon
- Med samtidig nøye titrert HV preload
 - CVP
 - TEE

Behandling: 1) Lengre CPB tid 2) Stimulere Høyre ventrikkel 3) Senke pulmonalmotstand

Levosimedan

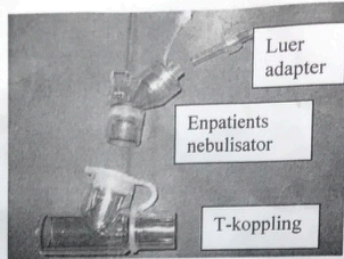
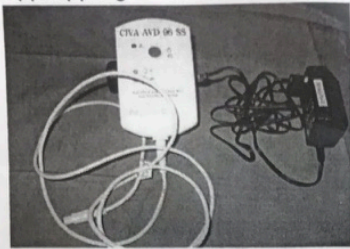


Hansen et al 2018: Levosimedan in pulmonary hypertension and right ventricular failure. Pulmonary Circulation.

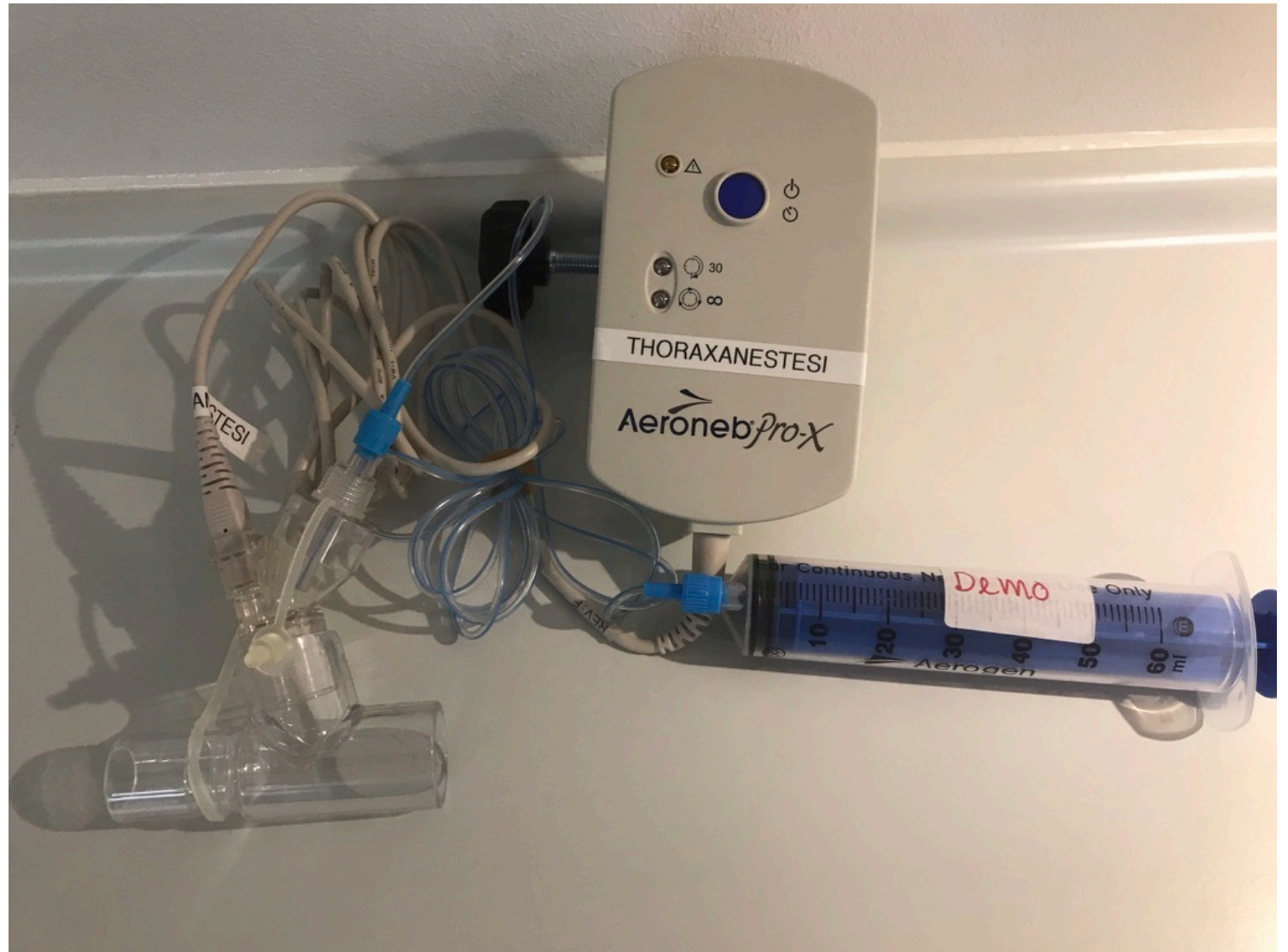
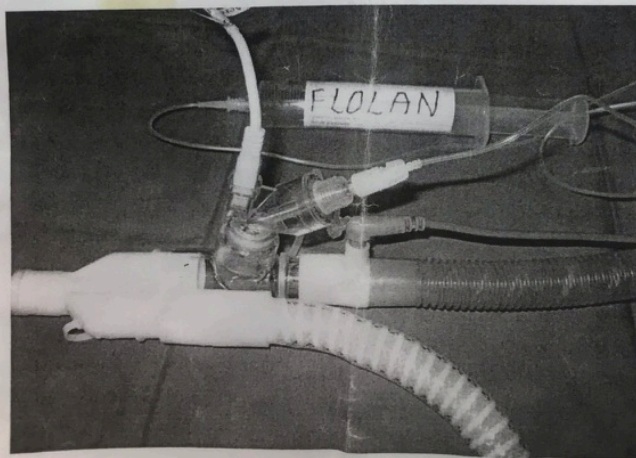
Behandling: 1) Lengre CPB tid 2) Stimulere Høyre ventrikkel 3) Senke pulmonalmotstand

- Inhalasjonsbehandling - 3 etablerte metoder
 - NO
 - Dyrt, komplisert, bra på intensiv, kanskje best...?
 - epoprostenol (Flolan)
 - Enkelt, rimelig...
 - Milrinon
 - Enda enklere..?, enda rimeligere..?

Uppkoppling



Vid kontinuerlig nebulisering behöver Aeroneb Pro-x vara kopplad med sin nätadapter till eluttag. Ta fram T-koppling, enpatientsnebulisator samt lueradapt. Koppla enligt bild nedan. Kabeln från styrenheten ansluts i kontakten på nebulisatorn. Inhalationerna kopplas på inspirationslangen. Flolan kopplas via sprutpump, infusionsadapter och lueradapter till nebulisatorn.



Aerosolized Vasodilators for the Treatment of Pulmonary Hypertension in Cardiac Surgical Patients: A Systematic Review and Meta-analysis

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Hosham Ased, MSc A, CPC,* François Haddad, MD,‡ Yoan Lamarche, MD,§
Louis P. Perrault, MD, PhD,§ Jean Lambert, PhD,|| Alexis F. Turgeon, MD, MSc,¶# and
André Y. Denault, MD, PhD***

BACKGROUND: In cardiac surgery, pulmonary hypertension is an important prognostic factor for which several treatments have been suggested over time. In this systematic review and meta-analysis, we compared the efficacy of inhaled aerosolized vasodilators to intravenously administered agents and to placebo in the treatment of pulmonary hypertension during cardiac surgery. We searched MEDLINE, CENTRAL, EMBASE, Web of Science, and clinicaltrials.gov databases from inception to October 2015. The incidence of mortality was assessed as the primary outcome. Secondary outcomes included length of stay in hospital and in the intensive care unit, and evaluation of the hemodynamic profile.

METHODS: Of the 2897 citations identified, 10 studies were included comprising a total of 434 patients.

RESULTS: Inhaled aerosolized agents were associated with a significant decrease in pulmonary vascular resistance (-41.36 dyne·s/cm⁵, $P = .03$) and a significant increase in mean arterial pressure (8.24 mm Hg, $P = .02$) and right ventricular ejection fraction (7.29%, $P < .0001$) when compared to intravenously administered agents. No significant hemodynamically meaningful differences were observed between inhaled agents and placebo; however, an increase in length of stay in the intensive care unit was shown with the use of inhaled aerosolized agents (0.66 days, $P = .01$). No other differences were observed for either comparison.

CONCLUSIONS: The administration of inhaled aerosolized vasodilators for the treatment of pulmonary hypertension during cardiac surgery is associated with improved right ventricular performance when compared to intravenously administered agents. This review does not support any benefit compared to placebo on major outcomes. Further investigation is warranted in this area of research and should focus on clinically significant outcomes. (Anesth Analg 2017;125:393–402)

Hva bringer framtida...?



Luftveishåndtering

Fagdag Anestesisykepleiere Thorax

27. november 2020

Nils Kristian Skjærvold

Betydning av god luftveishåndtering

1. Dødsfall og alvorlig morbiditet
2. Larynx-traume
3. God stil



Respiration and Sleep Medicine

■ SYSTEMATIC REVIEW ARTICLE

Laryngeal Injury and Upper Airway Symptoms After Endotracheal Intubation During Surgery: A Systematic Review and Meta-analysis

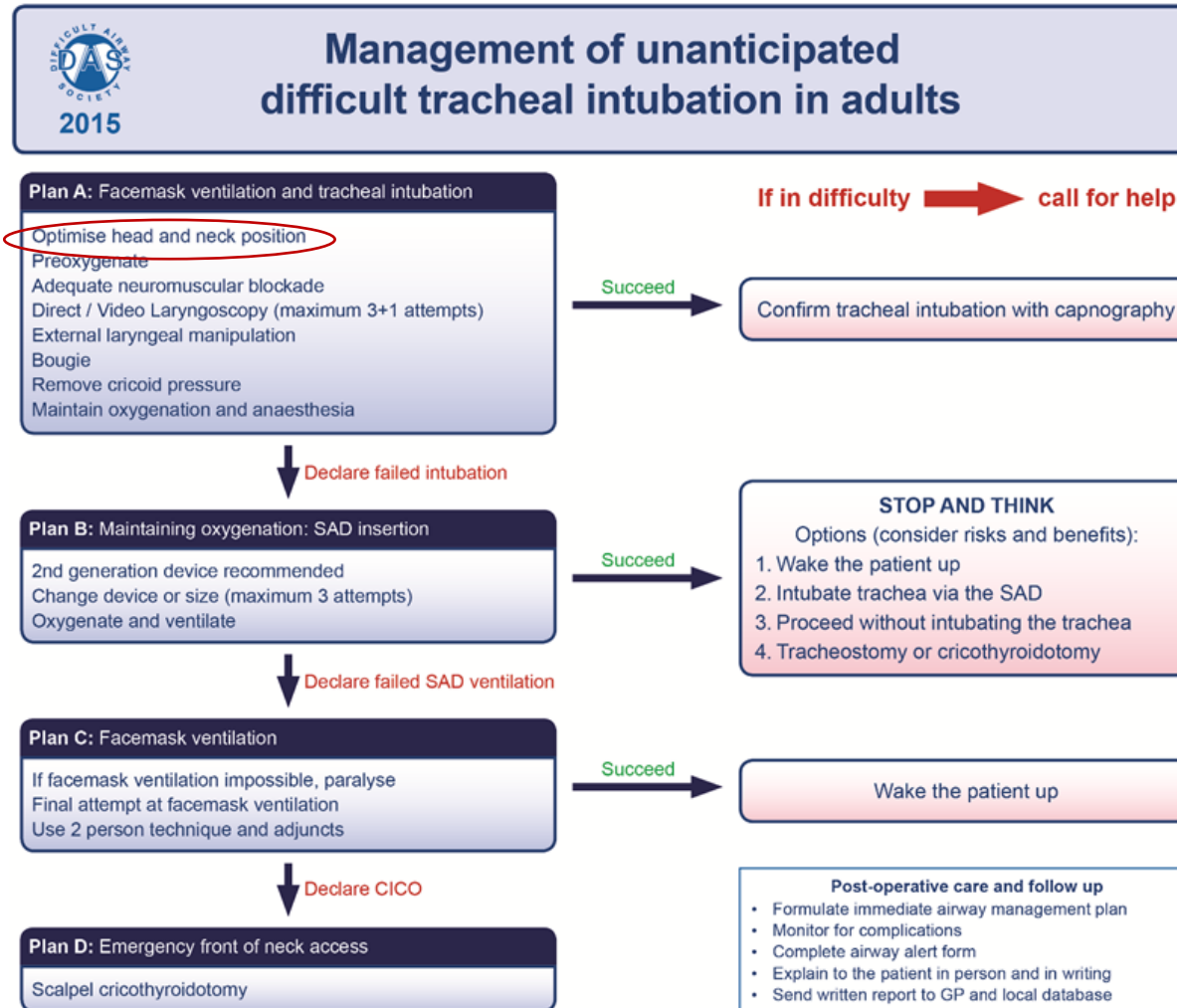
Martin B. Brodsky, PhD, ScM, CCC-SLP,*†† Lee M. Aket, MD,§ Erin Jedlonek, MS,||
Yinciya Pandian, PhD, MBA, MSN,††† Brendan Blackford, MHS,§ Carrie Price, MLS,**
Gai Cole, DrPH, MBA, MHA,†† Pedro A. Mendez-Tellez, MD,†,‡,§§ Alexander T. Hillel, MD,§
Simon R. Best, MD,§ and Matthew J. Levy, DO, MS†††

Laryngeal injury from intubation can substantially impact airway, voice, and swallowing, thus necessitating multidisciplinary interventions. The goals of this systematic review were (1) to review the types of laryngeal injuries and their patient-reported symptoms and clinical signs resulting from endotracheal intubation in patients intubated for surgeries and (2) to better understand the overall frequency at which these injuries occur. We conducted a search of 4 online bibliographic databases (ie, PubMed, Embase, Cumulative Index of Nursing and Allied Health Literature [CINAHL], and The Cochrane Library) and ProQuest and Open Access Thesis Dissertations (OPTD) from database inception to September 2019 without restrictions for language. Studies that completed postextubation laryngeal examinations with visualization in adult patients who were endotracheally intubated for surgeries were included. We excluded (1) retrospective studies, (2) case studies, (3) preexisting laryngeal injury/disease, (4) patients with histories of or surgical interventions that risk injury to the recurrent laryngeal nerve, (5) conference abstracts, and (6) patient populations with nonfocal, neurological impairments that may impact voice and swallowing function, thus making it difficult to identify isolated postextubation laryngeal injury. Independent, double-data extraction, and risk of bias assessment followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the Cochrane Collaboration's criteria. Twenty-one articles (1 cross-sectional, 3 cohort, 5 case series, 12 randomized controlled trials) representing 21 surgical studies containing 6140 patients met eligibility criteria. The mean patient age across studies reporting age was 49 (95% confidence interval [CI], 45-53) years with a mean intubation duration of 132 (95% CI, 106-159) minutes. Studies reported no injuries in 80% (95% CI, 69-88) of patients. All 21 studies presented on type of injury. Edema was the most frequently reported mild injury, with a prevalence of 9%-84%. Vocal fold hematomas were the most frequently reported moderate injury, with a prevalence of 4% (95% CI, 2-10). Severe injuries that include subluxation of the arytenoids and vocal fold paralysis are rare (<1%) outcomes. The most prevalent patient complaints postextubation were dysphagia (43%), pain (36%), coughing (32%), a sore throat (27%), and hoarseness (27%). Overall, laryngeal injury from short-duration surgical intubation is common and is most often mild. No uniform guidelines for laryngeal assessment postextubation from surgery are available and hoarseness is neither a good indicator of laryngeal injury or dysphagia. Protocolized screening for dysphonia and dysphagia postextubation may lead to improved identification of injury and, therefore, improved patient outcomes and reduced health

Table 3. Prevalence^a of Signs/Symptoms Reported After Extubation

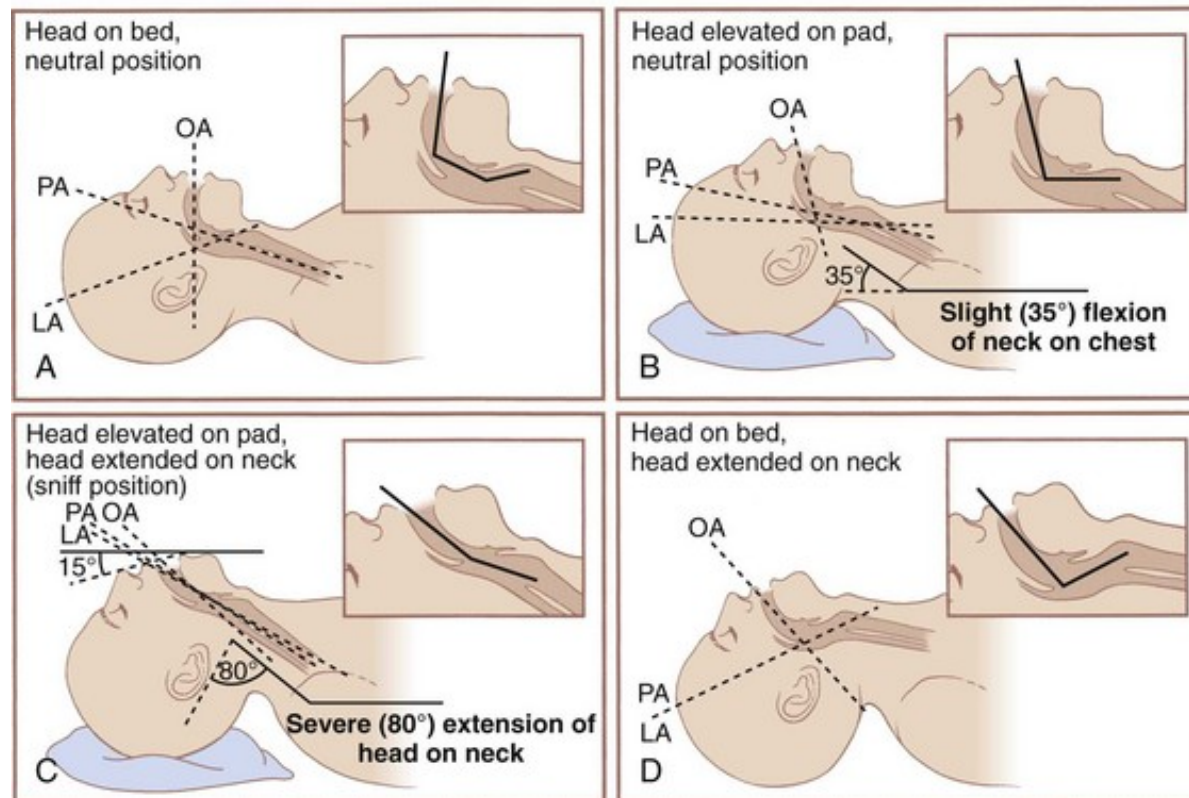
Sign/symptom	Studies reporting: Prevalence %			
	Patients	Study no.	count (%)	(95% CI)
Dysphagia	41	95	3 (14)	43 (21-68)
Pain	91	670	4 (19)	38 (0.5-99)
Cough	39	123	2 (10)	32
Sore throat	363	1427	10 (48)	27 (16-42)
Hoarseness	1173	4297	14 (67)	27 (12-50)
Dysphonia	31	491	3 (14)	17 (0.0-99)
Laryngeal dyspnea	15	123	2 (10)	12
Aphonia	2	55	1 (5)	4

Luftveisalgorithmen



De tre aksene!

Head and neck position and the axes of the head and neck upper airway



Ear-Sternal Notch line & Scale-Ampulle Assembly

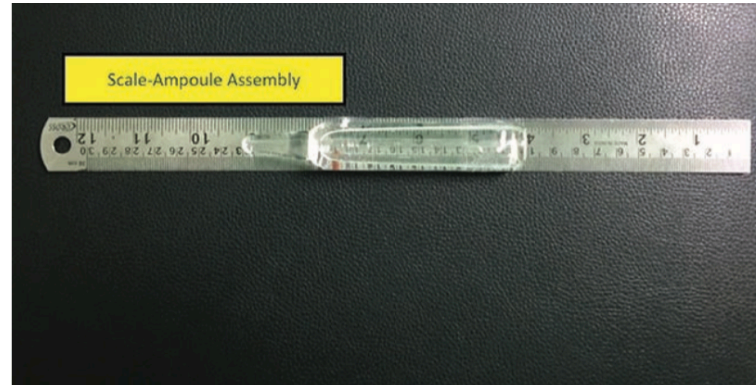


Figure 1. Ampule-Scale Assembly—a readily available glass ampule is fixed to a scale with help of a transparent adhesive tape.

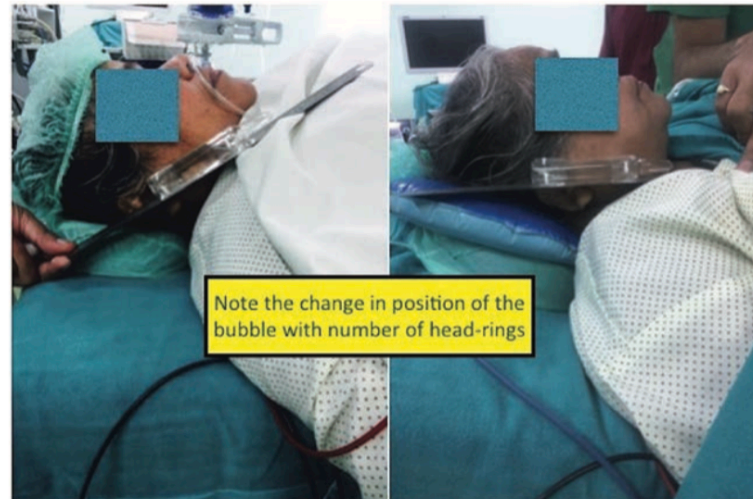
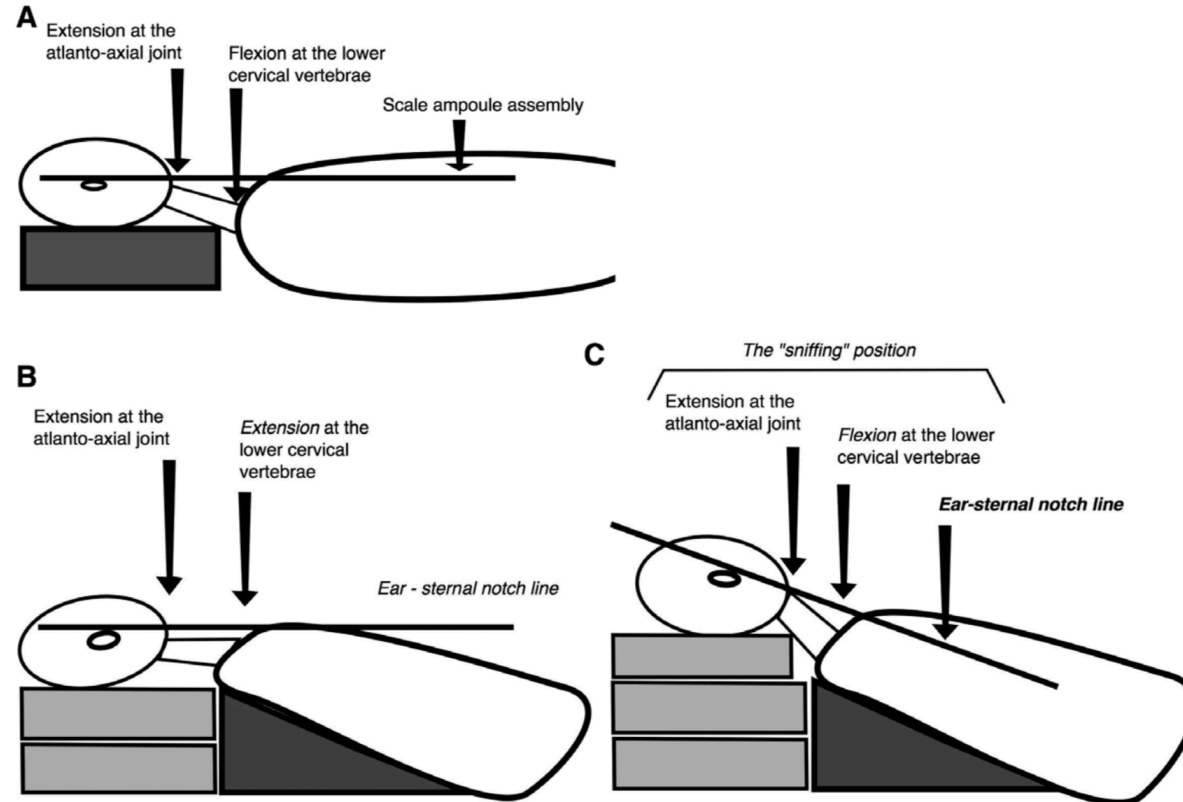


Figure 2. The position of the air-bubble is indicative of the height of the ramp. The number of sheets can be adjusted to bring the bubble to the center.

Sinha, Aparna, Lakshmi Jayaraman, and Dinesh Punhani. "Scale-Ampule Assembly to Assess Ramp Position for Airway Management:" *Anesthesia & Analgesia* 124, no. 6 (June 2017): 2087

Øre-sternum, flektert lavt cervikalt og ekstendert atlanto-axialt



Rahiman, Sarfaraz Navaz, and Michael Keane. "The 'Ear-Sternal Notch' Line—How Should You Lie?:" *Anesthesia & Analgesia* 125, no. 6 (December 2017): 2162-64.

Leiring 1



Ser en del av dette, her er ørene langt under sternum noe som kan medføre vanskelig intubasjon ved at man får en vinkel mellom farynx og larynx.

Leiring 2



Bedre leiring, men når torso er hevet må hodet oppbygges («rampes») for å få fleksjon lavt cervikalt

Leiring 3



Mange hjertekir-pasienter har tønneformet thorax, da havner fort ørene under sternum

Leiring 4



Dette ser ganske bra ut (selv om ørene også her ligger litt lavt ifh til sternum...)

Leiring 5



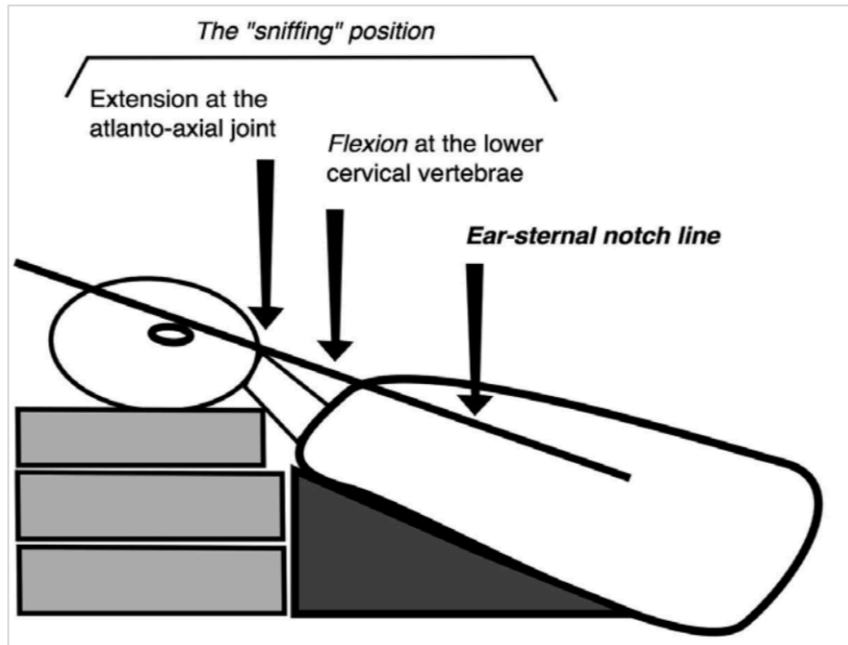
God leiring...

Leiring 6



Pasient med potensielt vanskelig luftvei - beste leiring vi fikk til - godt innsyn ved intubasjon

God leiring – hvordan?



- Hvis nødvendig sett opp ryggen for å løfte ørene over sternum
- Alltid pute/step/«ramping» for fleksjon lavt cervikalt
 - Obs - mange sklir ned fra puta
- Hvis nødvendig bøy hodet noe bakover for ekstensjon atlanto-axialt