

Sirkulasjonssvikt

Fagdager høst Intensiv St Olav

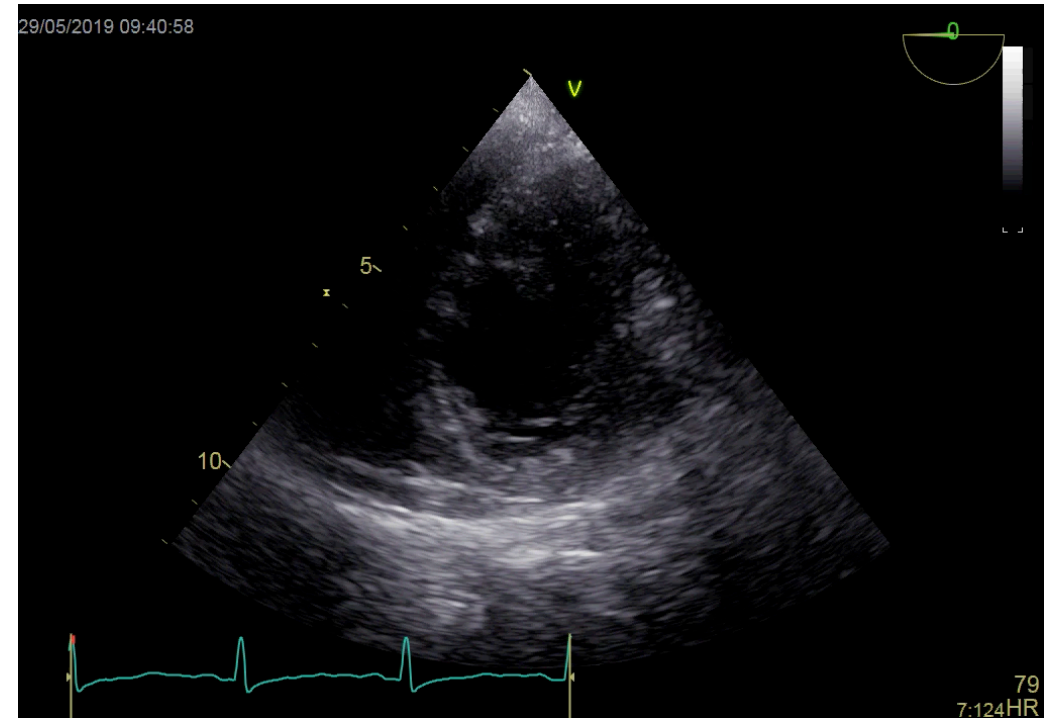
22.10 – 05.11 – 19.11 – 03.02

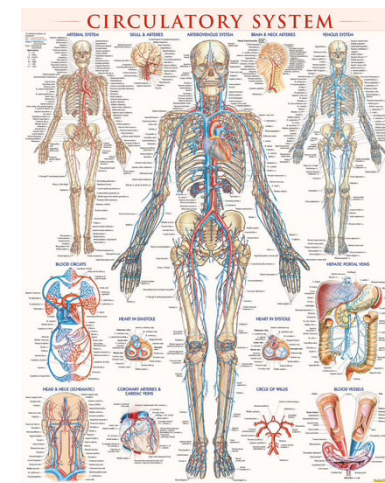
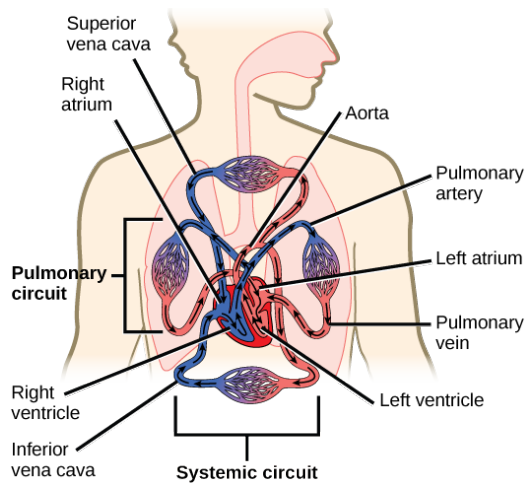
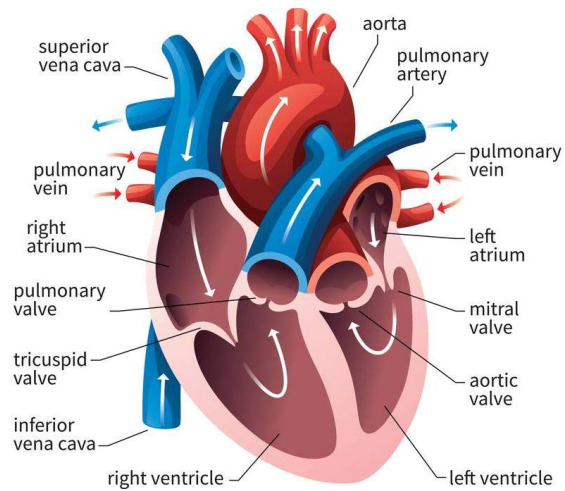
Nils Kristian Skjærvold

Overlege/forsker St Olavs/NTNU

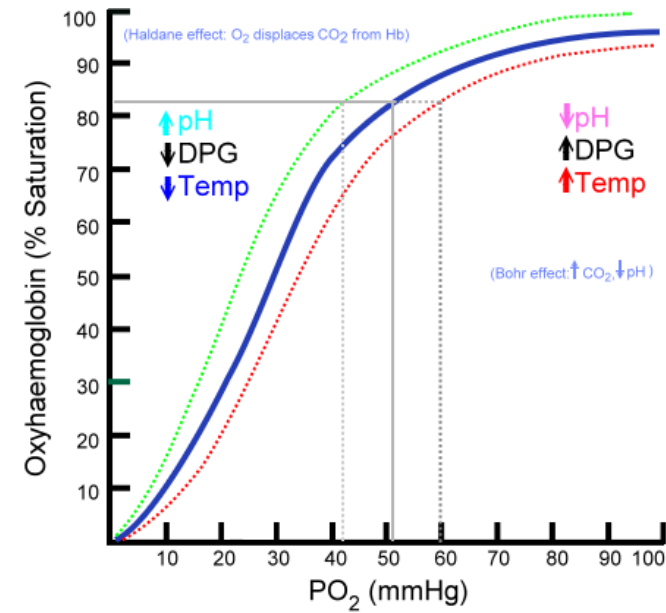
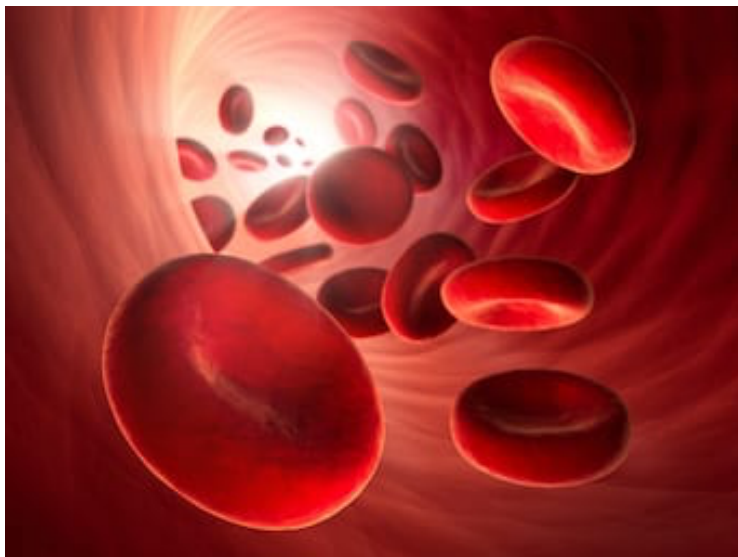
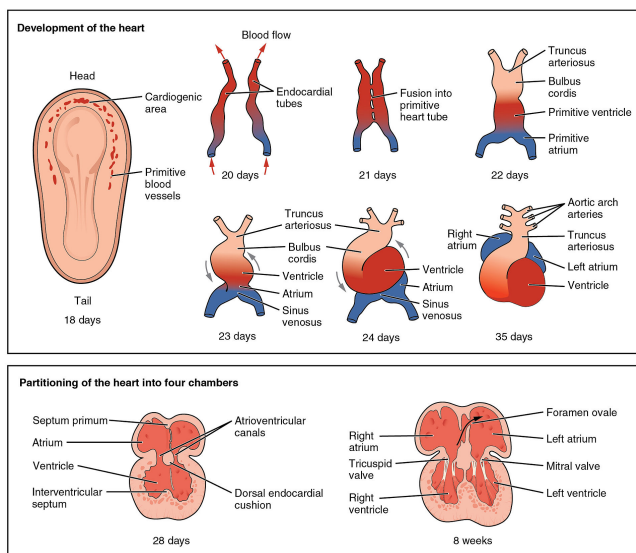
Kasuistikk 1

- ✓ 70 år gammel kvinne
- ✓ Siste dager purulent hoste og feber; fallende AT
- ✓ Ved ankomst: somnolent, BT 70/40, HF 110, sO_2 88 % m/10 L O_2
- ✓ Blodgass: pH 7.2, pCO_2 8, pO_2 10, BE -7, laktat 6
- ✓ $ScvO_2$: 40 %
- ✓ Ekko: «Tomt hjerte», CO ~2.5 L/min
- ✓ 2 L plasmalyte
- ✓ HF 100, CO 4 L/min, BT 80/40
- ✓ Noradrenalin
- ✓ Bedring i BT
- ✓ SwanGanz: CO 10 L/min, SvO_2 80 %
- ✓ *Hva skjedde egentlig her...?*



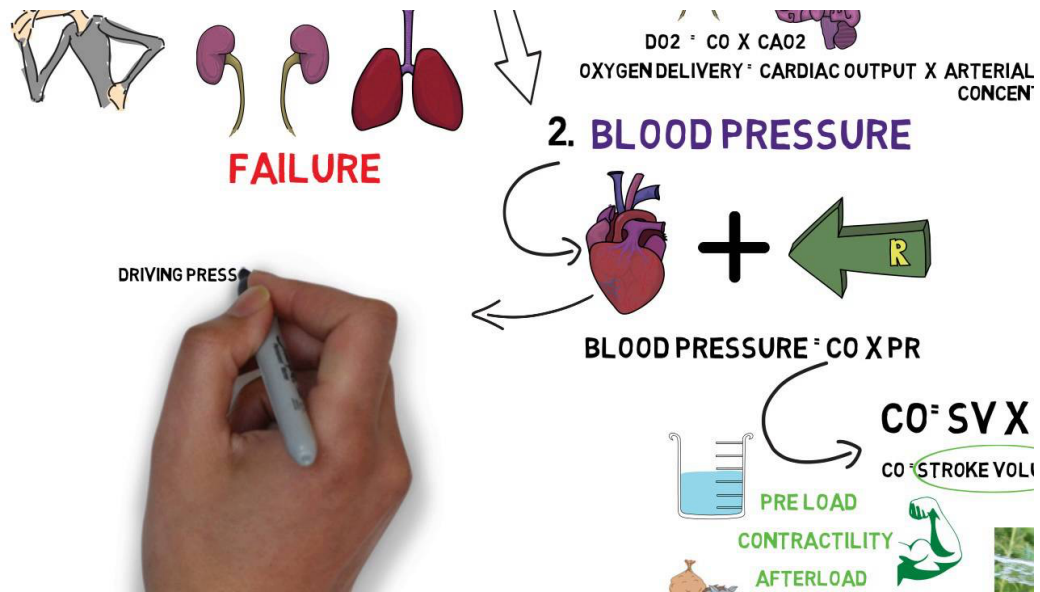


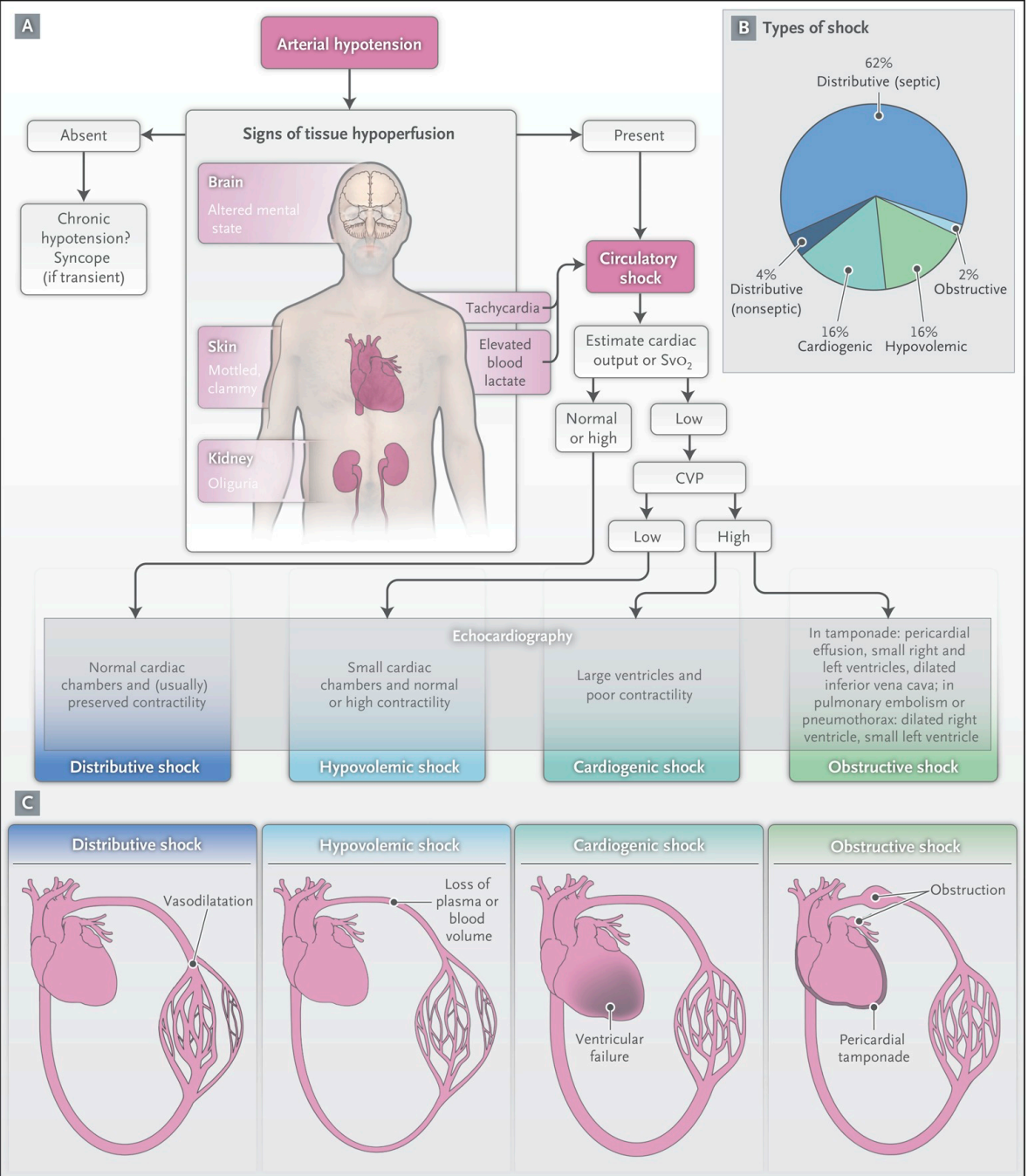
Hva er sirkulasjonssystem? Hvorfor et sirkulasjonssystem?





Hva betyr sirkulasjonssjokk?





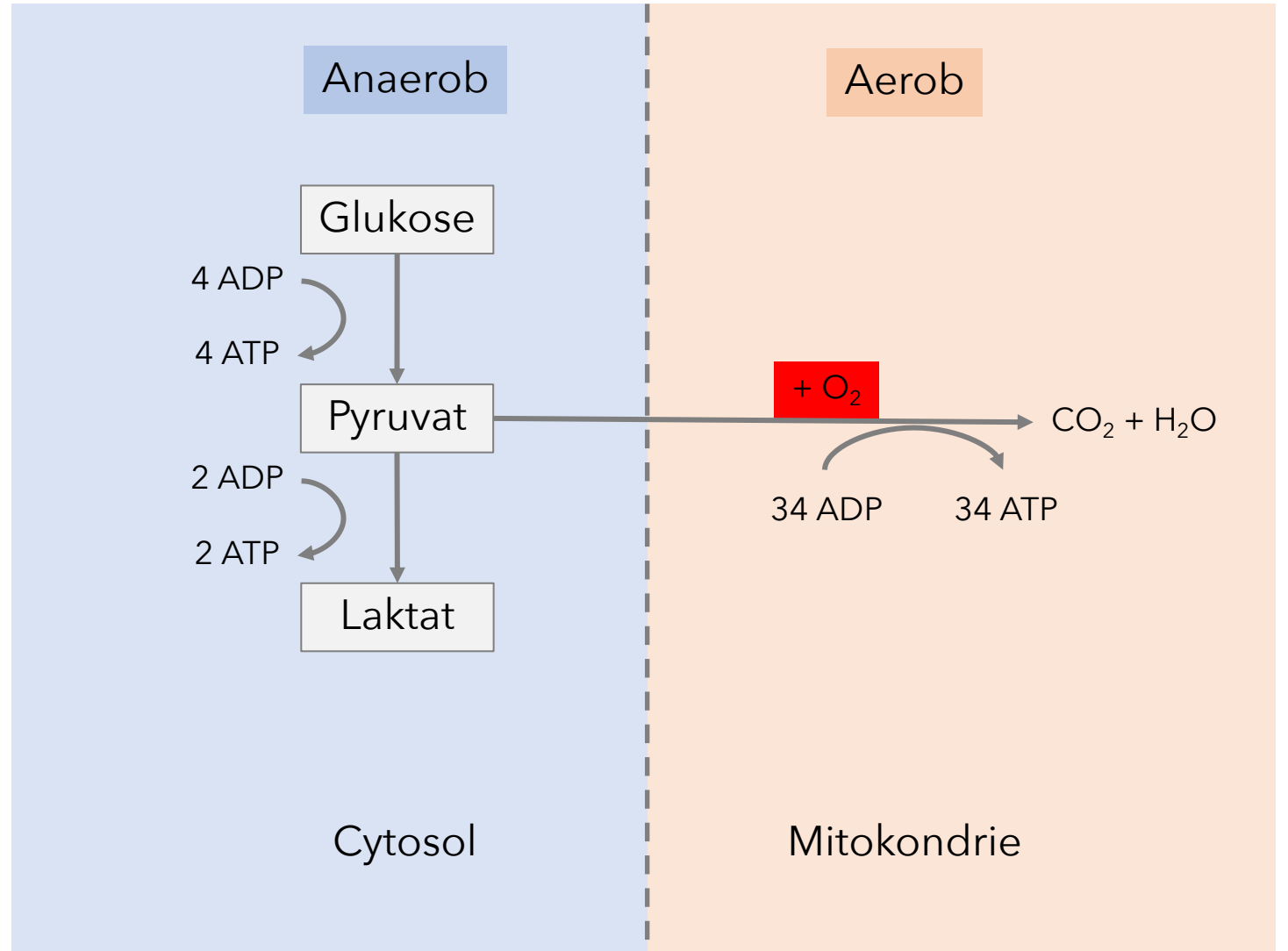




1. betraktning

Sirkulasjonssjokk: en tilstand hvor sirkulasjonssystemet leverer for lite oksygen til å tilfredsstille vevets behov

Gammelt jungelordtak

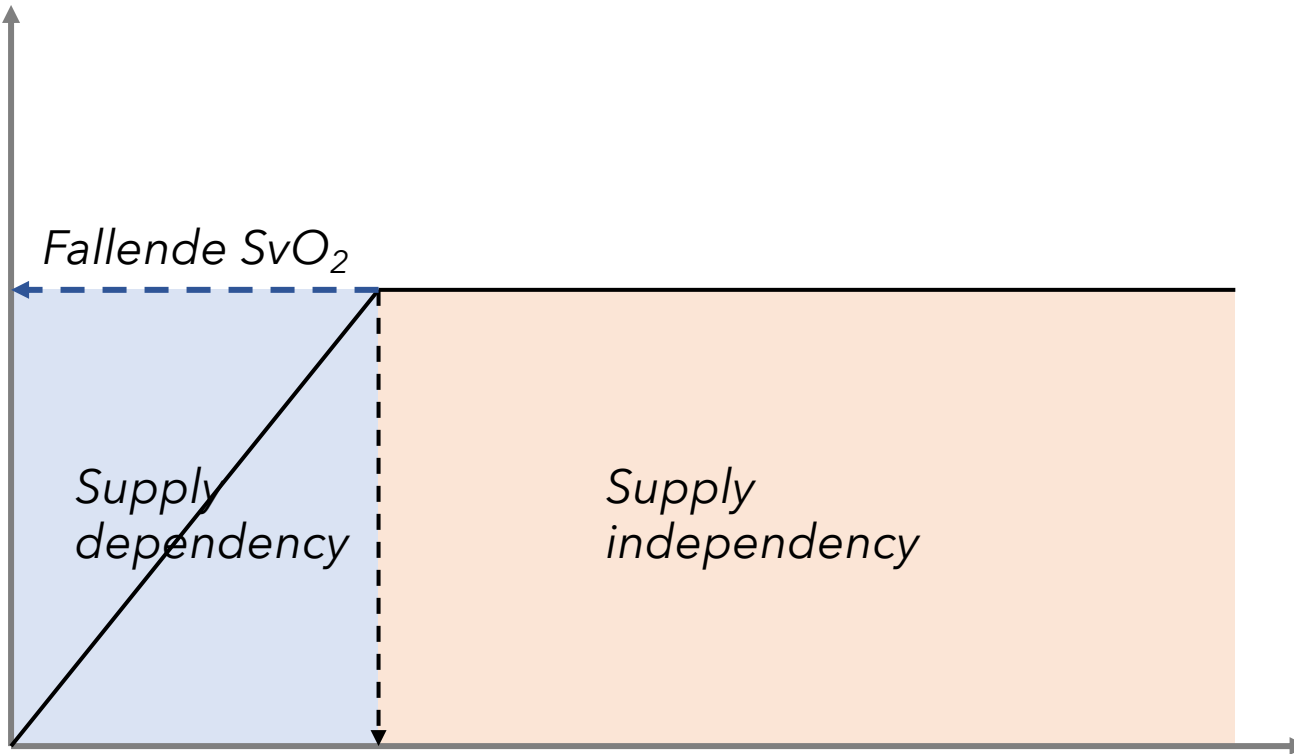


Hva bestemmer kroppens oksygenforsyning?

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

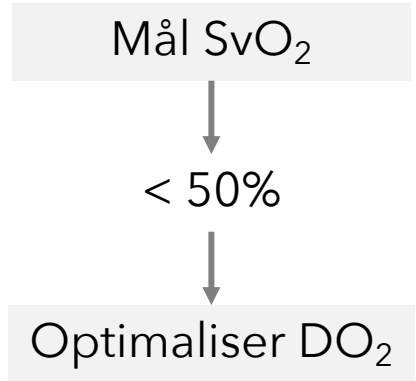
Eks: $(14 \times 0.08 \times 60 \times 1.00 \times 13.4) \text{ ml/min} = 900 \text{ ml/min}$

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



Critical
oxygen
delivery

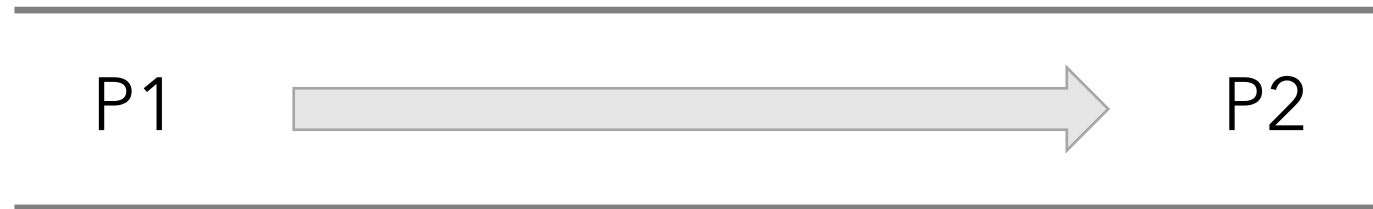
$$DO_2 = Hb \times SV \times HR \times sO_2$$



2. betraktning

- ✓ *En viss trykkgradient er nødvendig for bevegelse av blodet*
- ✓ *Trykket må være høyere enn organenes autoreguleringsterskell*

Flow er gitt hvis trykk $P1 > P2$, med størrelse inverst proporsjonalt med samlet motstand



Poiseuilles lov:

$$Q = (\Delta P \cdot \pi \cdot r^4) / (8 \cdot \mu \cdot L) = \Delta P / R$$



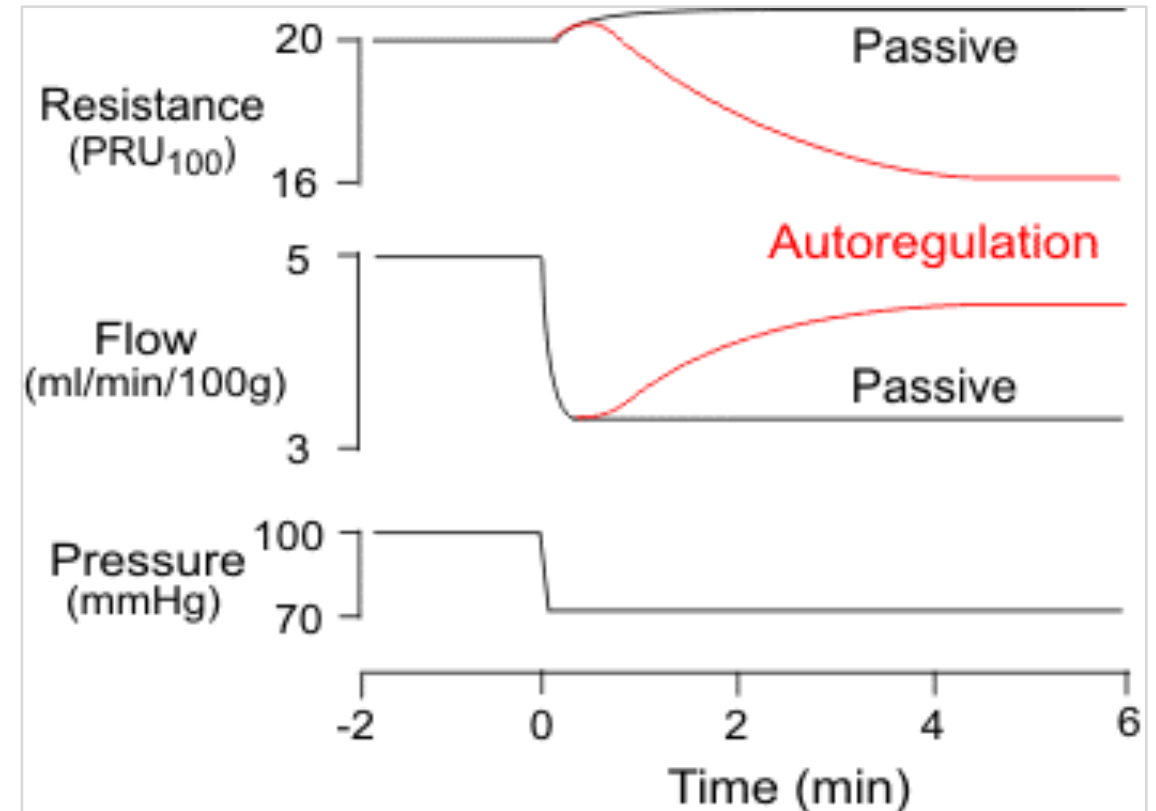
Lav R og høy flow

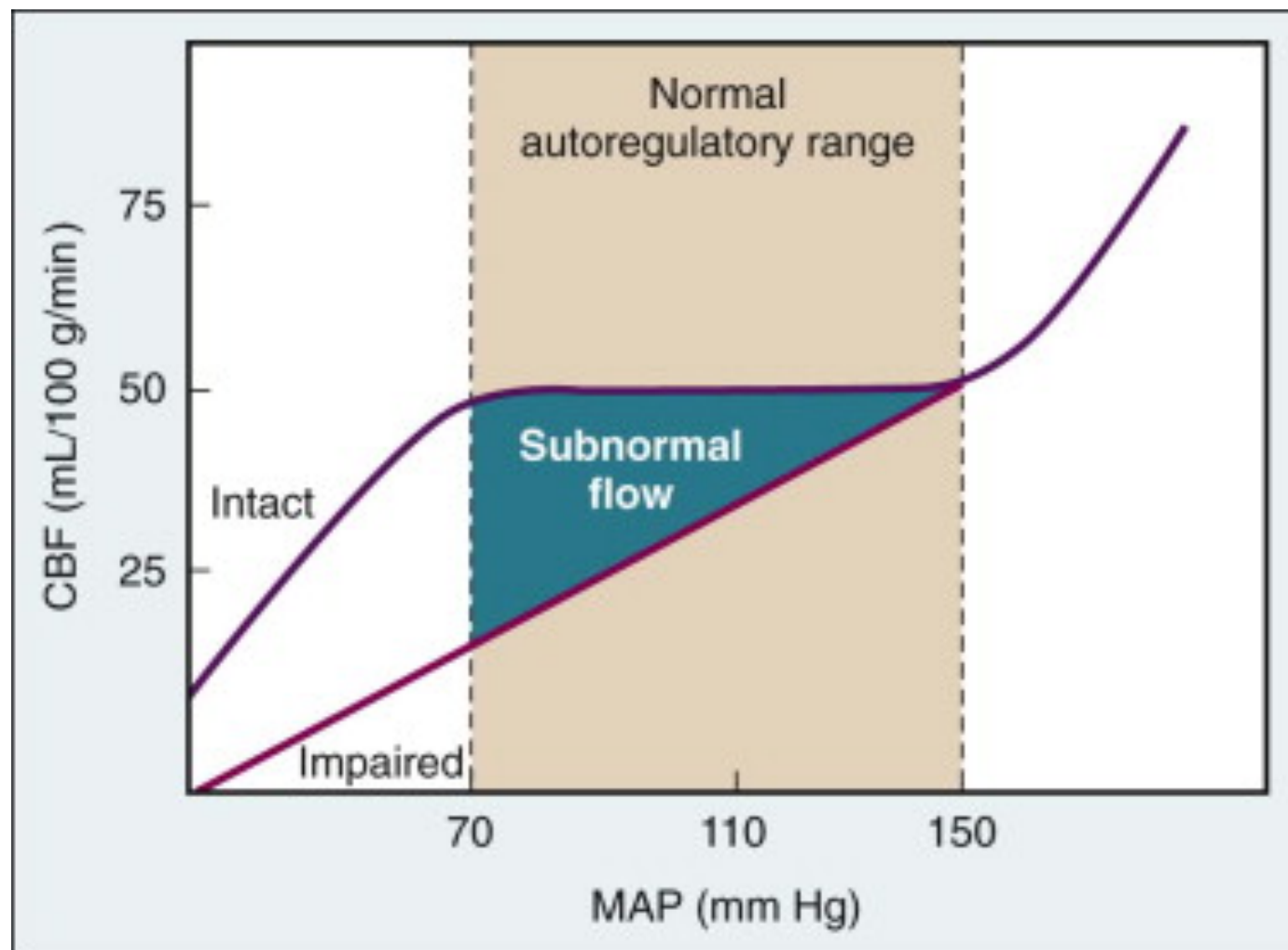
$$CO = (MAP - CVP) / SVR$$



Høy R og lav flow

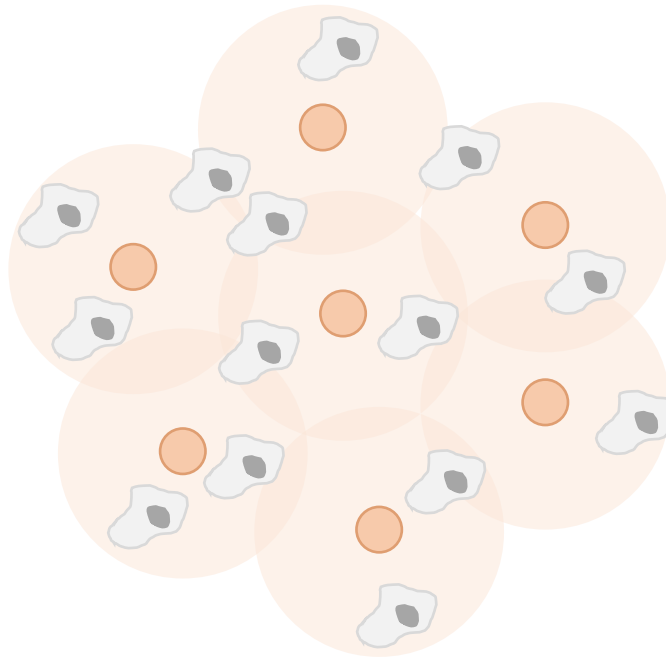
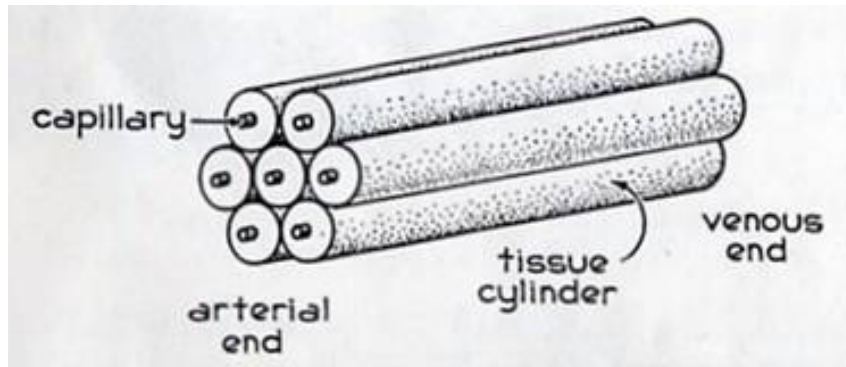
Autoregulering: et organs evne til å opprettholde konstant blodfløde tross endringer i perfusjons-trykk.



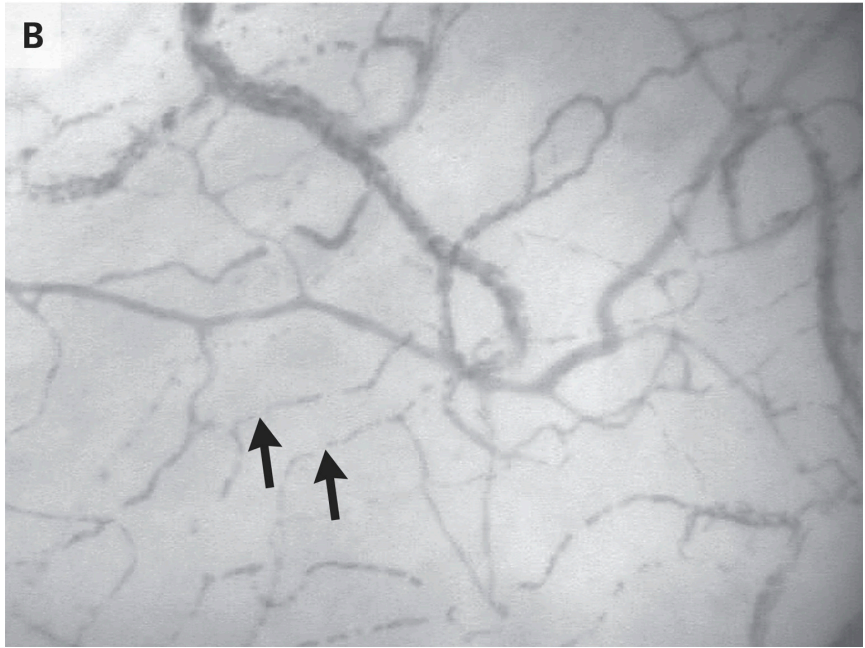
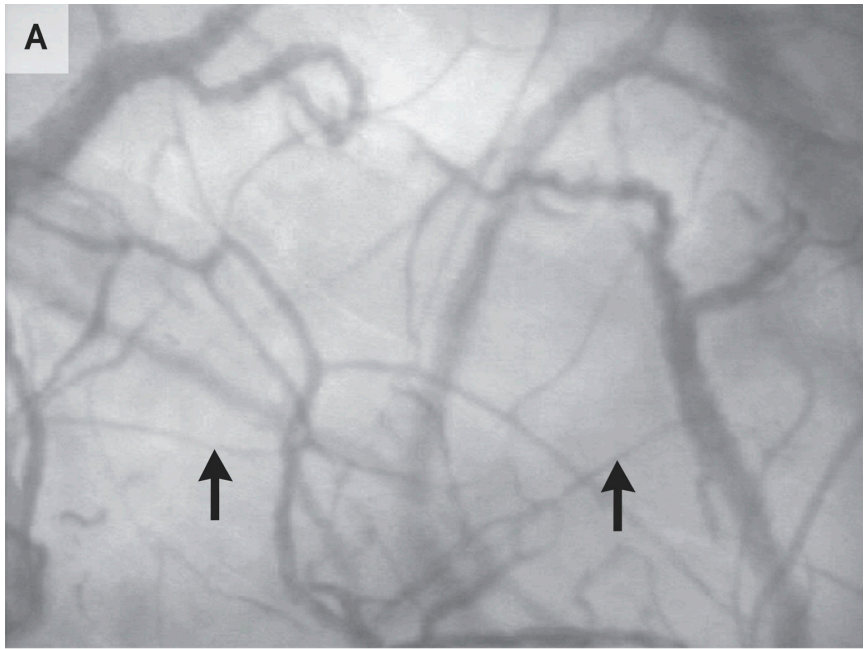


3. betraktning

- ✓ *I distributivt sjokk oppstår vevsdysoksi tross opprettholdt oksygenleveranse og blodtrykk pga mikrosirkulære forstyrrelser*
- ✓ *... og selv med dette intakt, kan man ha sviktende mitokondriefunksjon og derfor manglende evne til aerob forbrenning*



August Krogh Nobelprisen 1920



ORIGINAL RESEARCH

The coherence of macrocirculation, microcirculation, and tissue metabolic response during nontraumatic hemorrhagic shock in swine

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Keywords

Hemorrhagic shock, microcirculation, microdialysis, microspheres, pig, swine.

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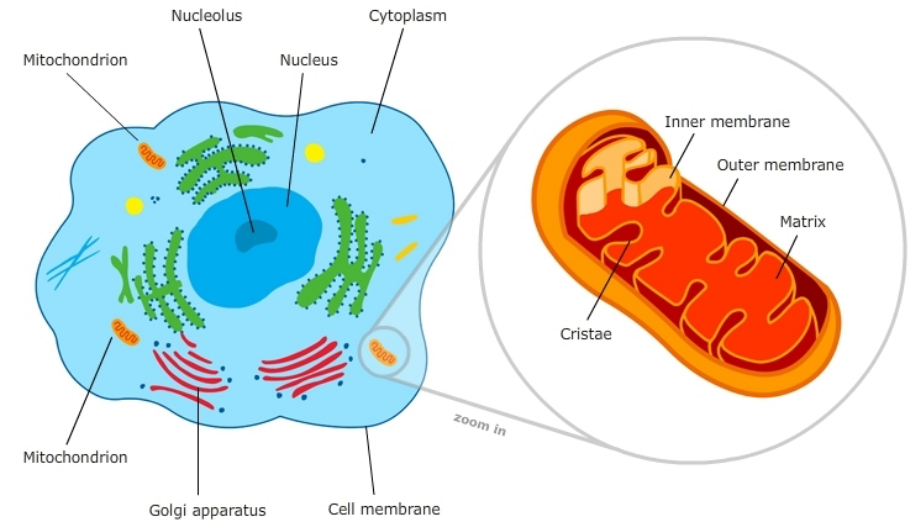
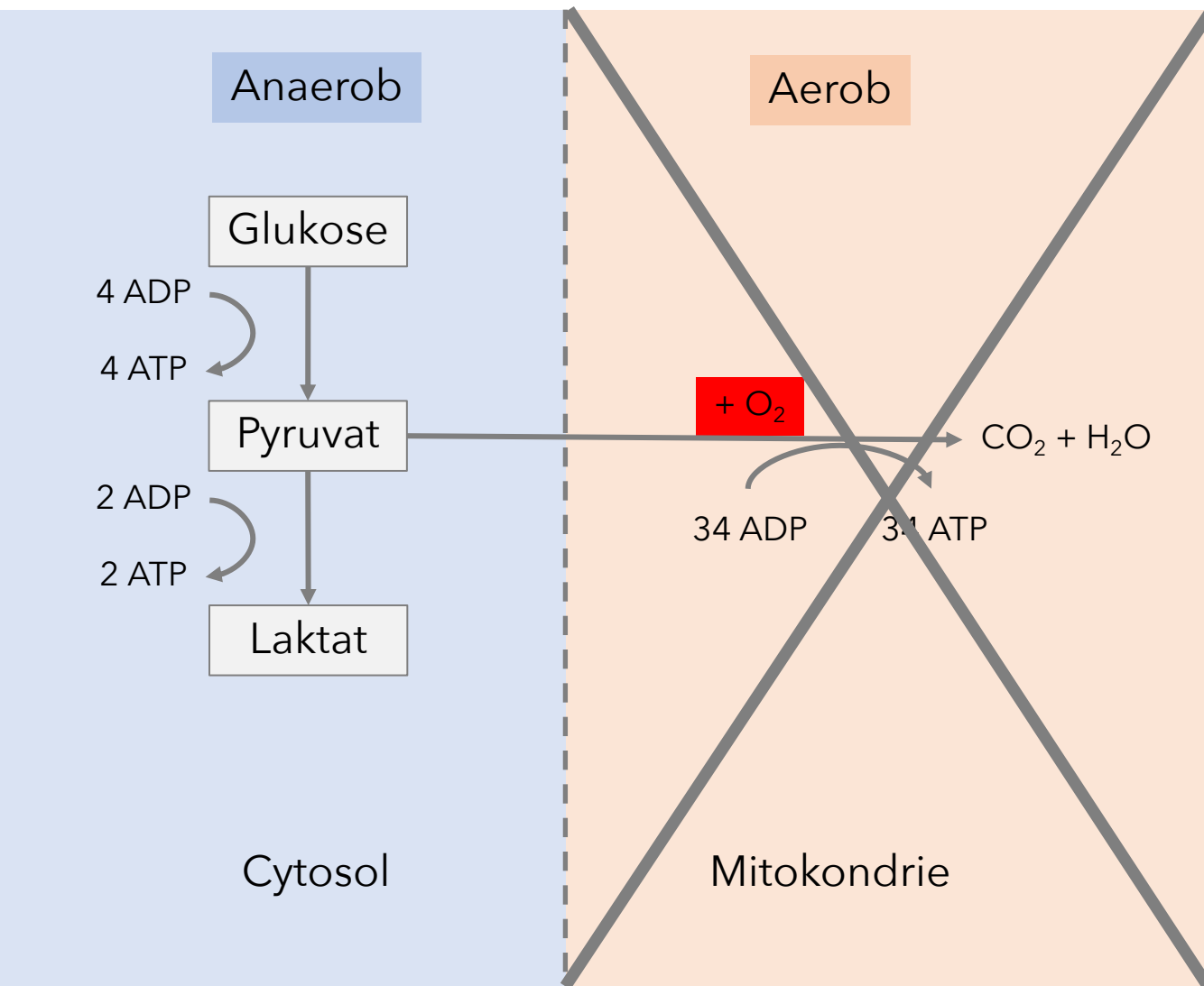
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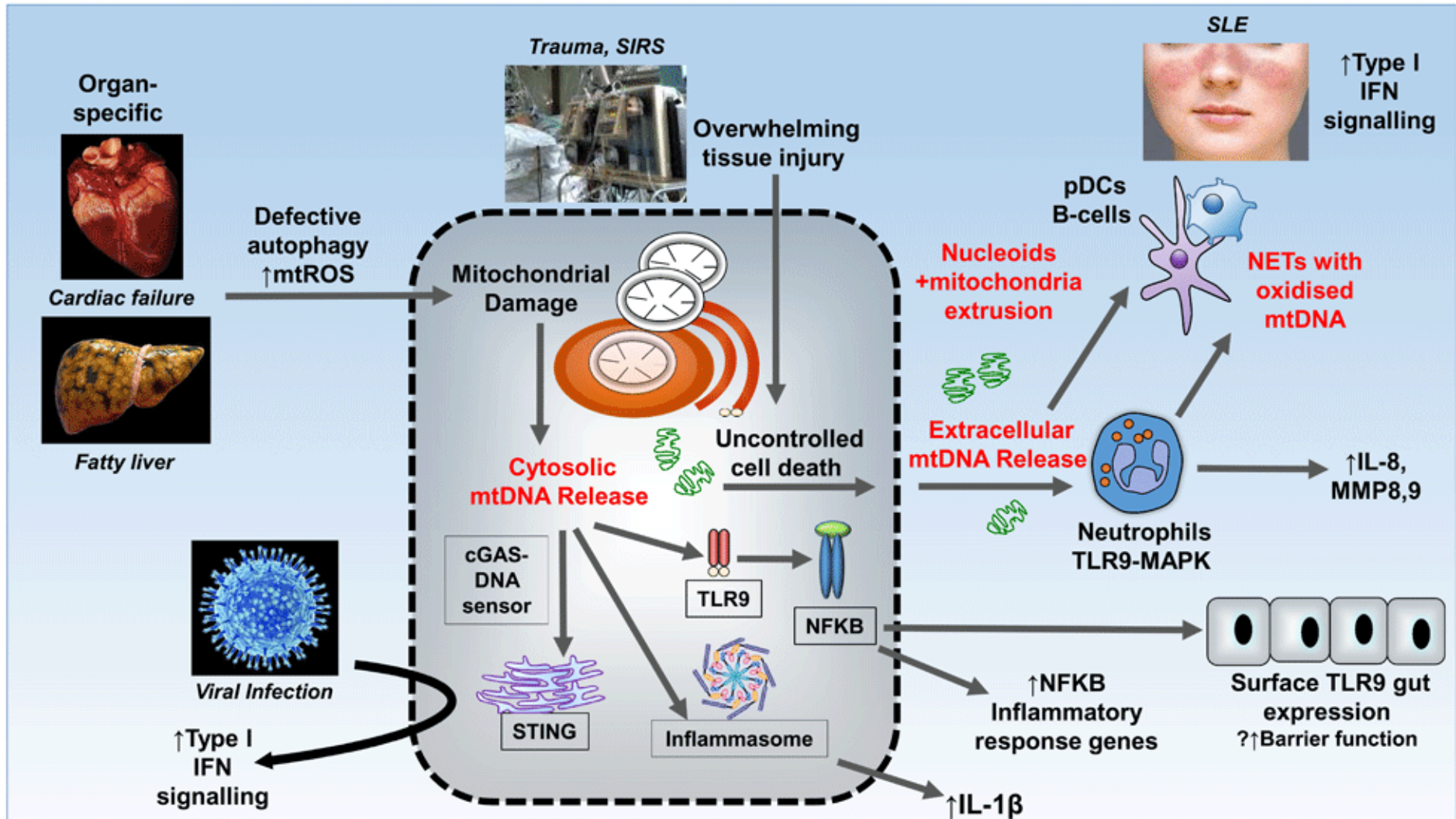
Funding Information

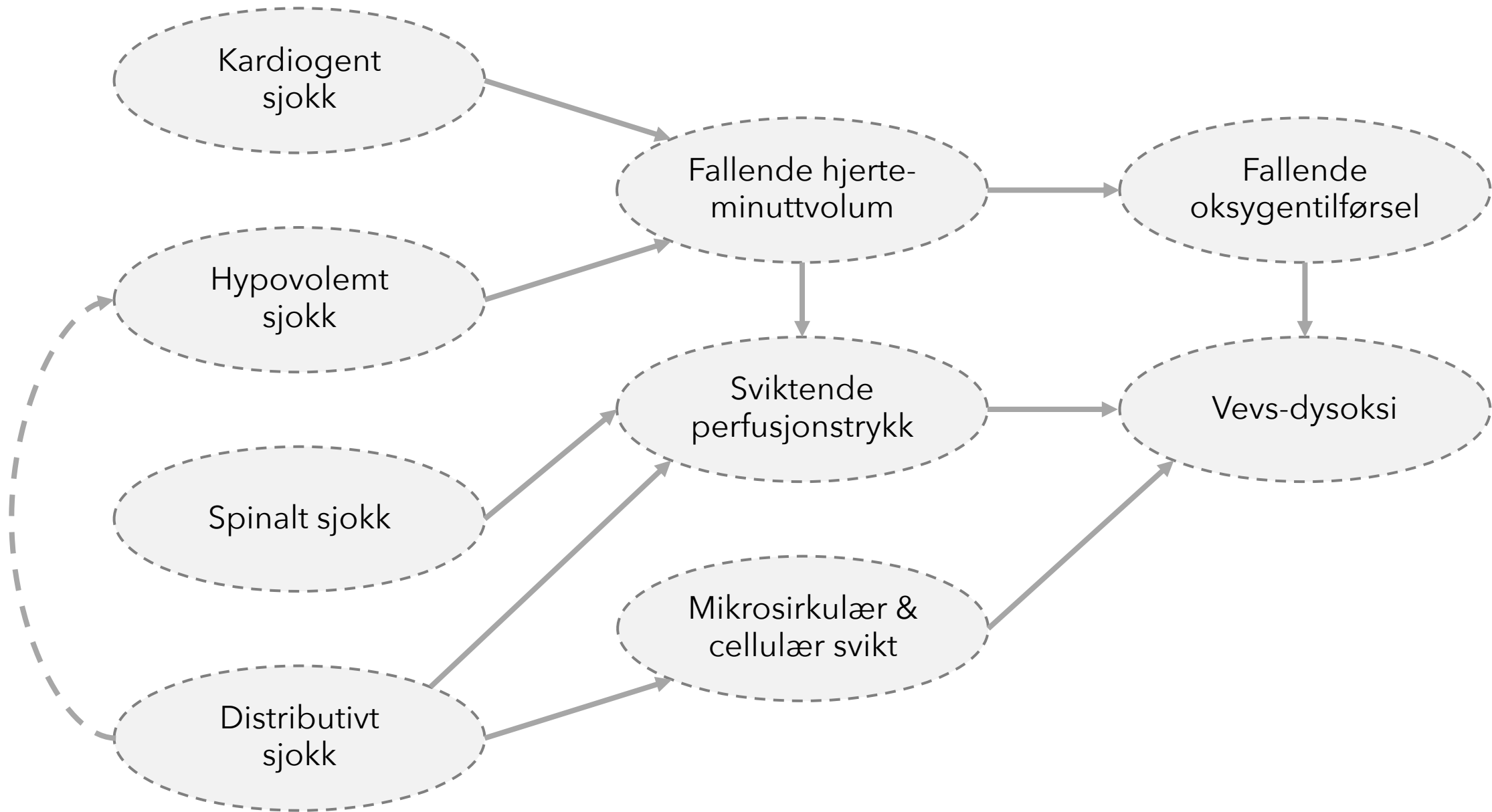
We thank the Department of Anesthesiology and Intensive Care Medicine, Trondheim University Hospital, Trondheim, Norway, for funding this project.

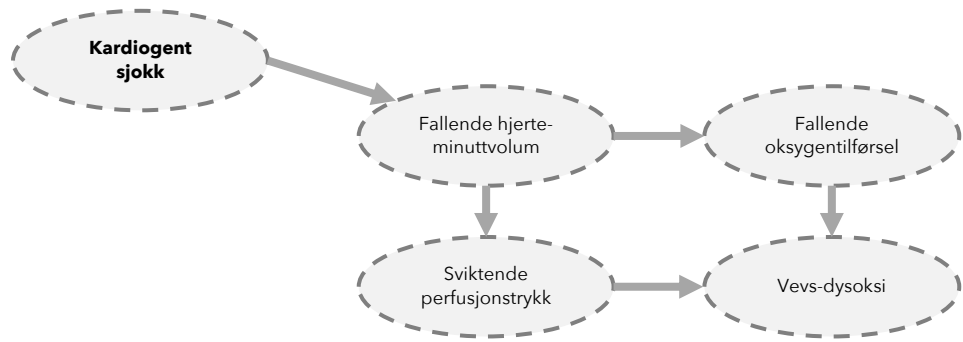
Abstract

Hemorrhagic shock is clinically observed as changes in macrocirculatory indices, while its main pathological constituent is cellular asphyxia due to microcirculatory alterations. The coherence between macro- and microcirculatory changes in different shock states has been questioned. This also applies to the hemorrhagic shock. Most studies, as well as clinical situations, of hemorrhagic shock include a “second hit” by tissue trauma. It is therefore unclear to what extent the hemorrhage itself contributes to this lack of circulatory coherence. Nine pigs in general anesthesia were exposed to a controlled withdrawal of 50% of their blood volume over 30 min, and then retransfusion over 20 min after 70 min of hypovolemia. We collected macrocirculatory variables, microcirculatory blood flow measurement by the fluorescent microspheres technique, as well as global microcirculatory patency by calculation of Pv-aCO₂, and tissue metabolism measurement by the use of microdialysis. The hemorrhage led to anticipated changes in macrocirculatory variables with



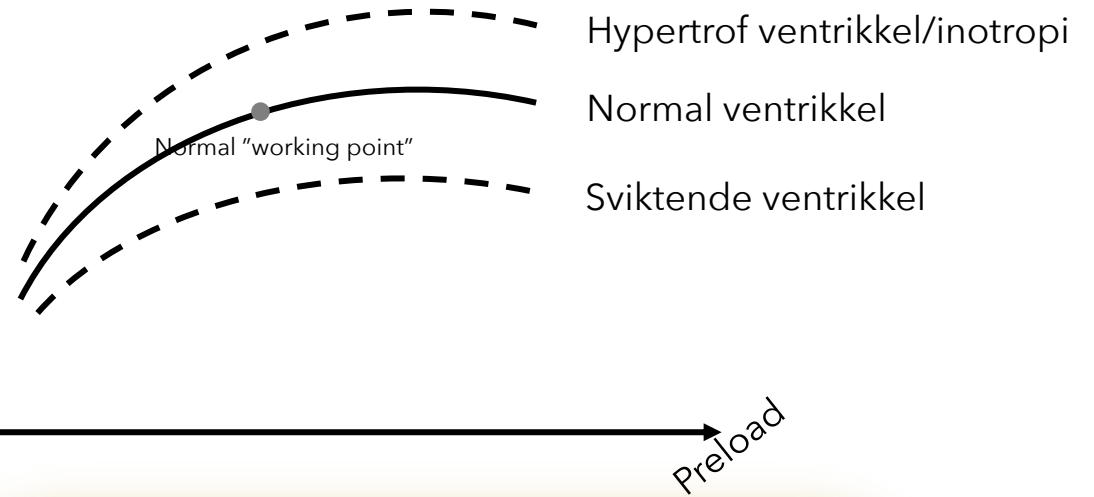






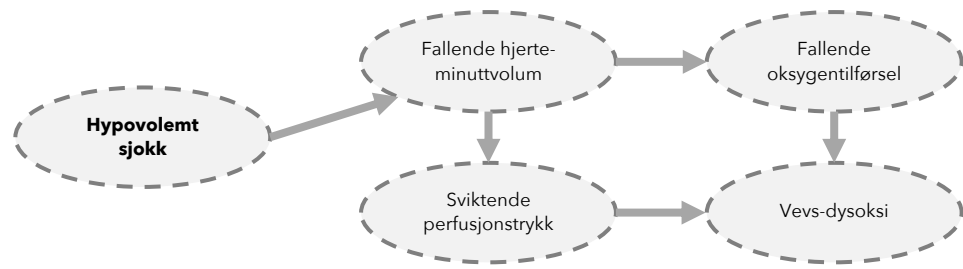
Kontraktilitet

Frank-Starling mekanismen



- ✓ Inotropi - øker kontraktilitet men også oksygenforbruket
- ✓ Noradrenalin - heve perfusjonstrykk men øker afterload
- ✓ Nitroprussid - senker afterload men også perfusjonstrykk





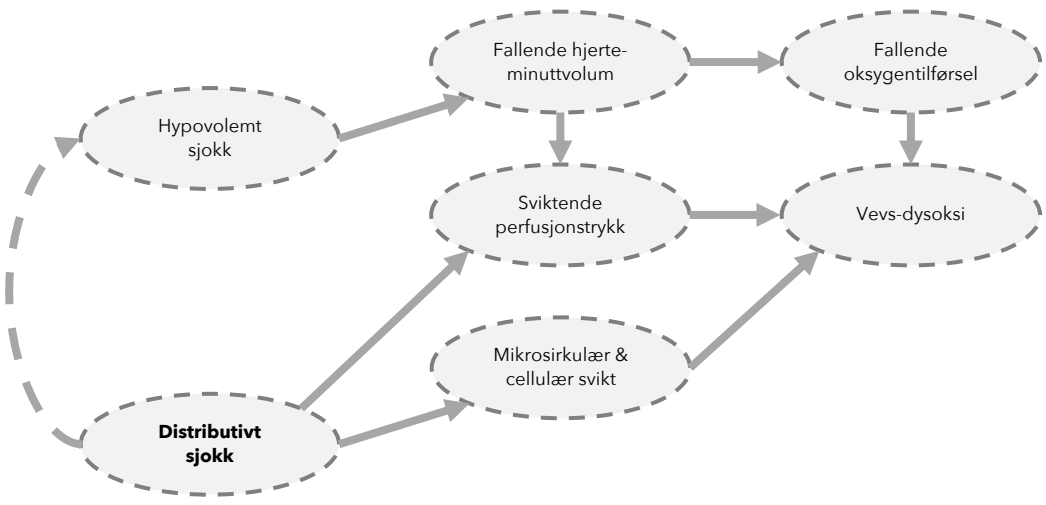
Traumepakke



Blødning - behandling

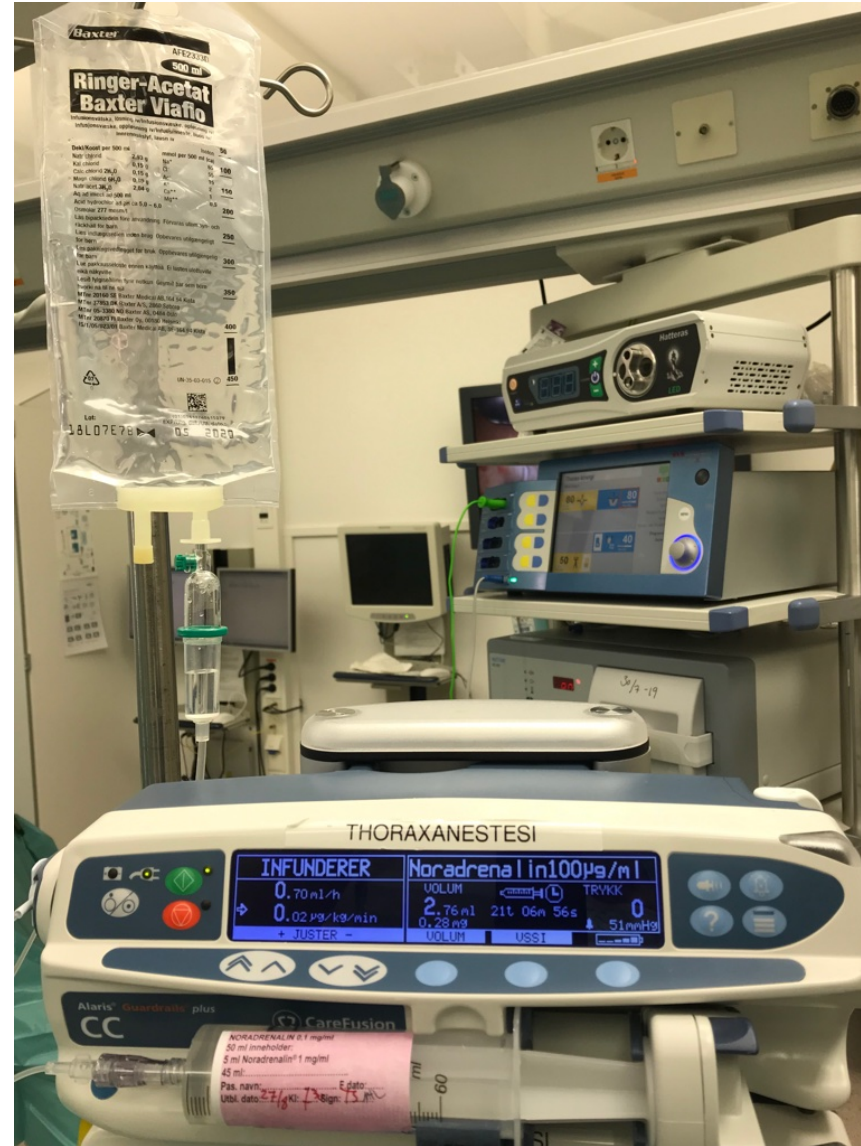
- Blanke væsker: fortynder koagulasjonsfaktorer, forstyrrer pH balansen, reduserer oksygenbærende kapasitet i blodet
- «Dødens triangel»: acidose, hypotermi, koagulopati
- Gi blod
- Transfunder 3:3:1



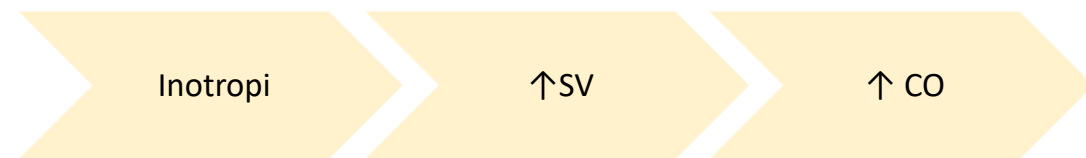
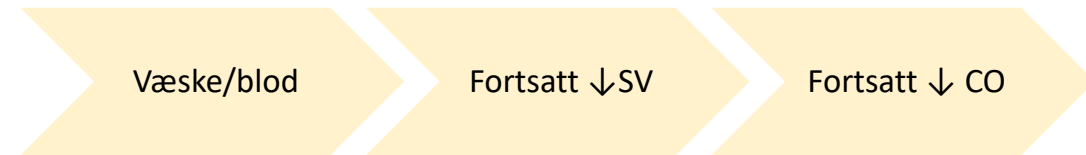
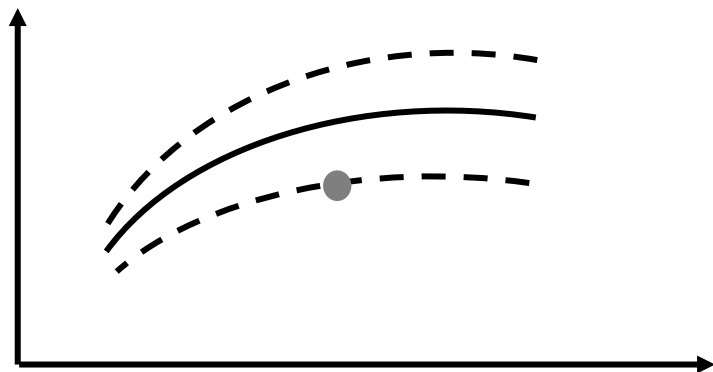


Distributivt sjokk - patofysiologi

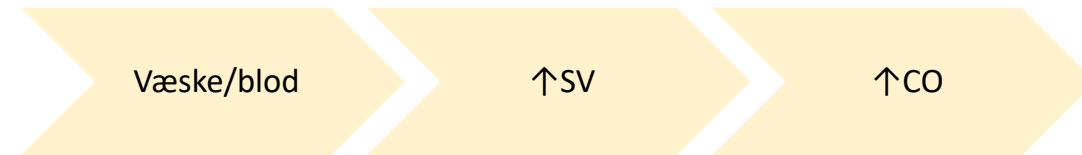
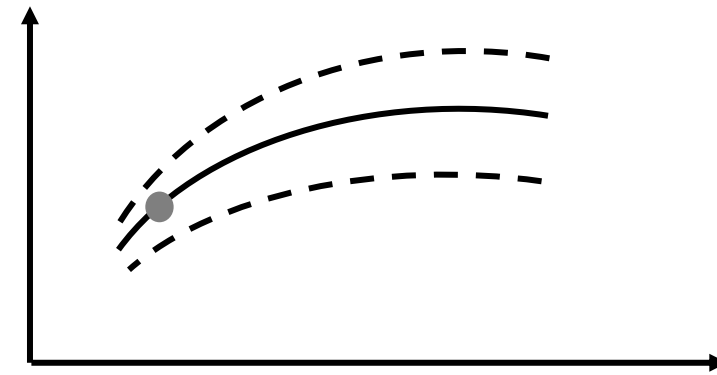
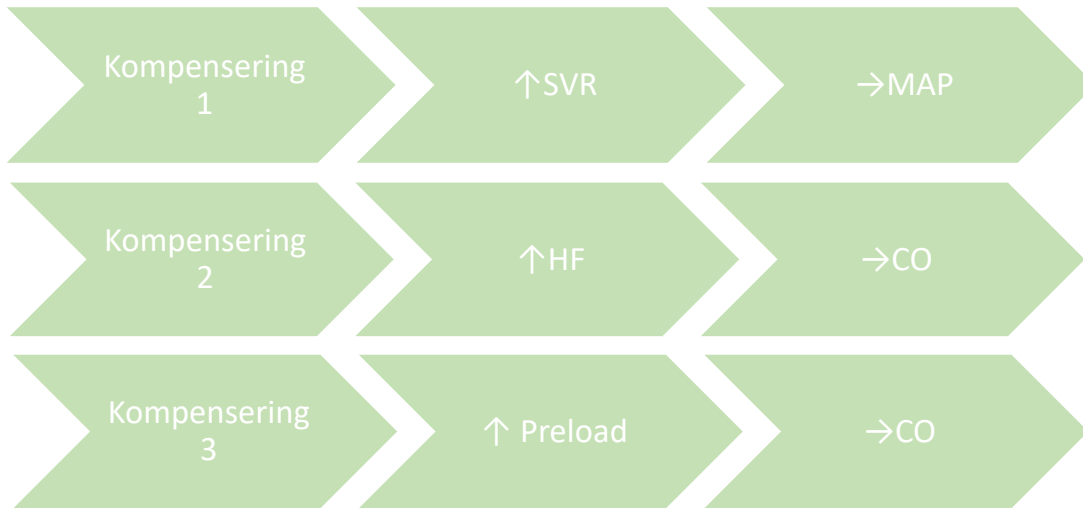
- ✓ Kapillærlekkasje med hypovolemi og fallende hjerte-minuttvolum
- ✓ Dilatasjon av arterioler med lav SVR og fallende blodtrykk
- ✓ Mikrosirkulær og cellulær svikt



Kardiogent sjokk (venstre ventrikkel-svikt)



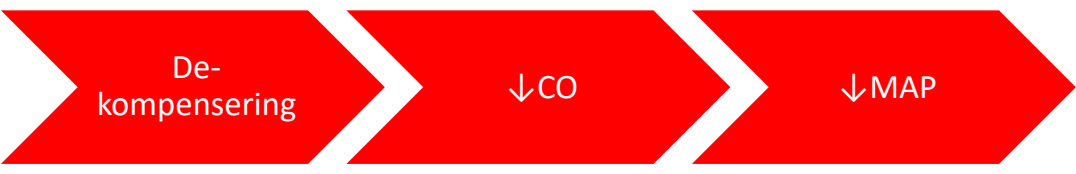
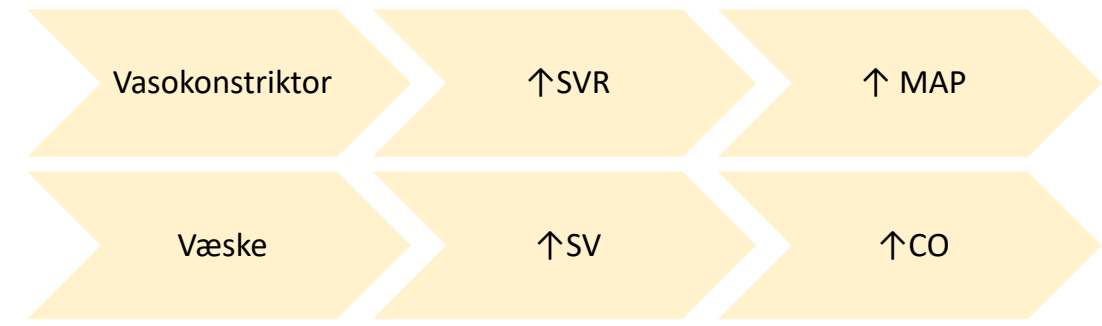
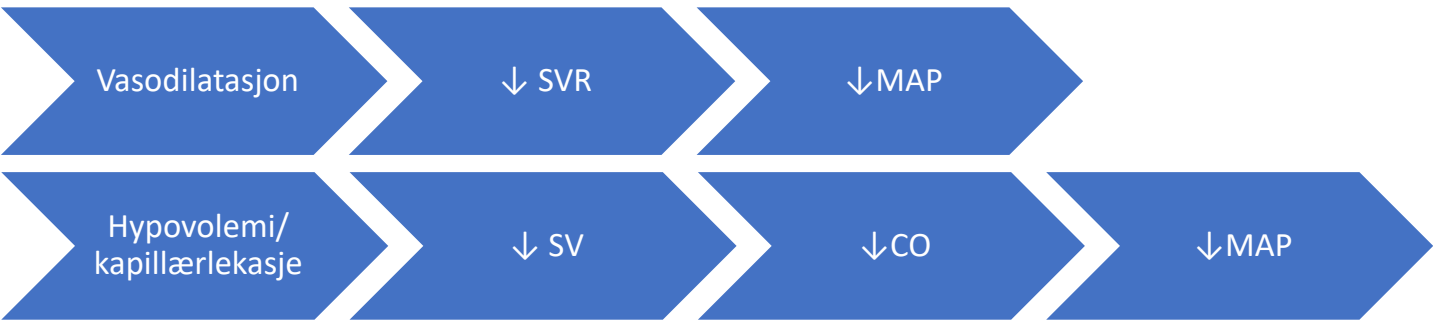
Hypovolemt sjokk (blødning)



Ved blødning er tachykardi tegn på kompensering mens blodtryksfall er tegn på dekompensering!



Distributivt sjokk



Take home message!

<i>Foreligger truet sirkulasjon?</i>	Bevissthet Blodtrykk Laktaacidose SvO ₂			
<i>Hva slags sirkulasjonssvikt?</i>	Sykehistorie Ekko cor Ev. SwanGanz- kateter	Blødning	Distributivt	Kardiogent
<i>Hvilken behandling?</i>		Blod	Væske og vasopresor	Vanskelig...
<i>Hvilke behandlingsmål?</i>	Oksygentransport til SvO ₂ > 50% MAP til normalisering av laktaacidose og diurese			