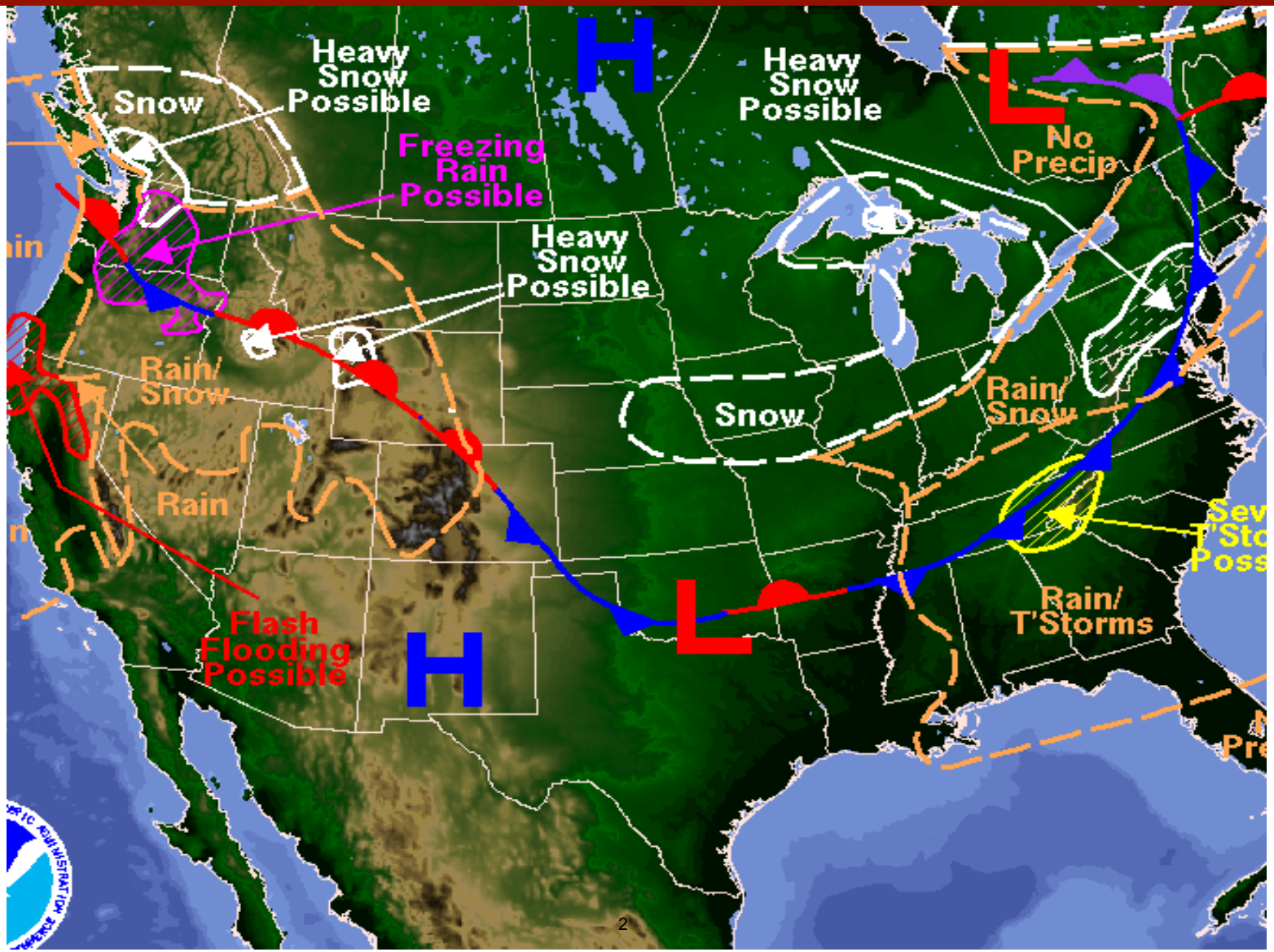
6.011: Signals, Systems & Inference

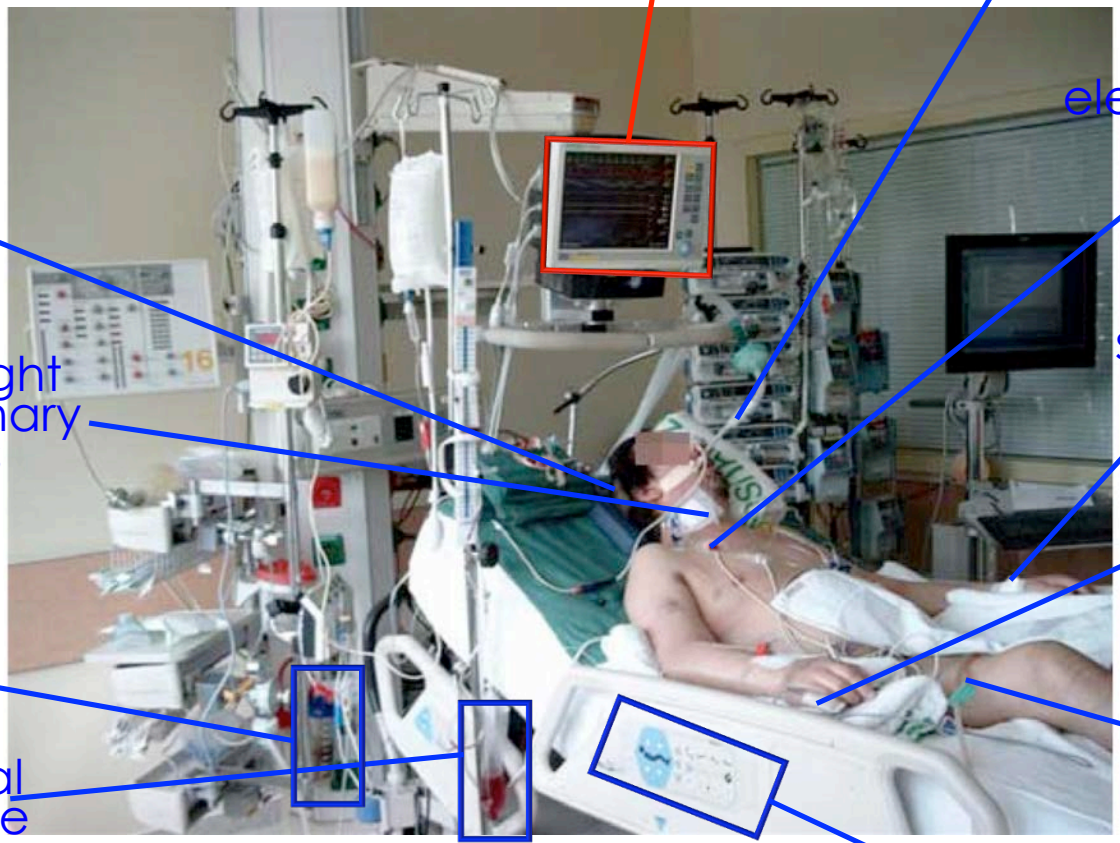
MIT, Spring 2018

Weather prediction



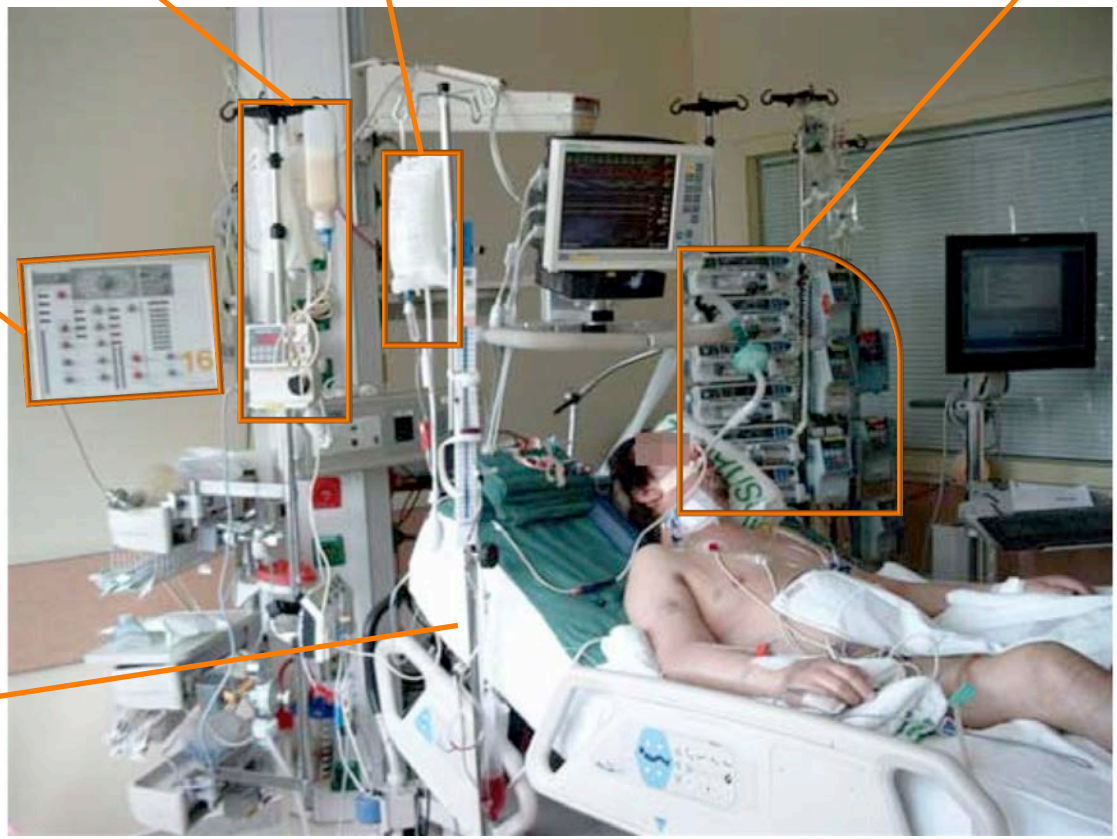
Courtesy of NOAA. This image is in the public domain.

The measurements



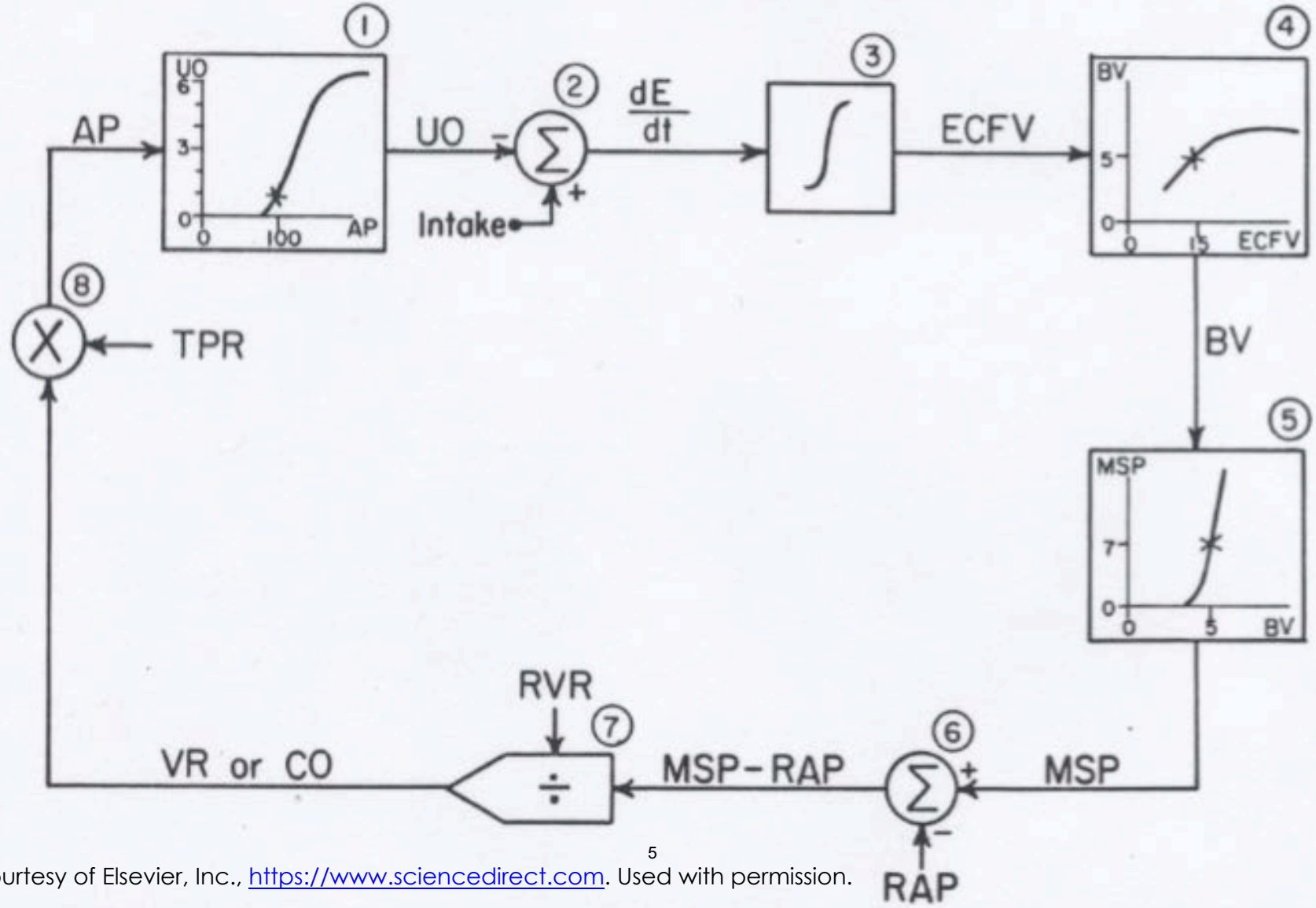
© source unknown. All rights reserved. This content is excluded from our Creative Commons license.
For more information, see https://ocw.mit.edu/help/faq-fair-use/

The interventions



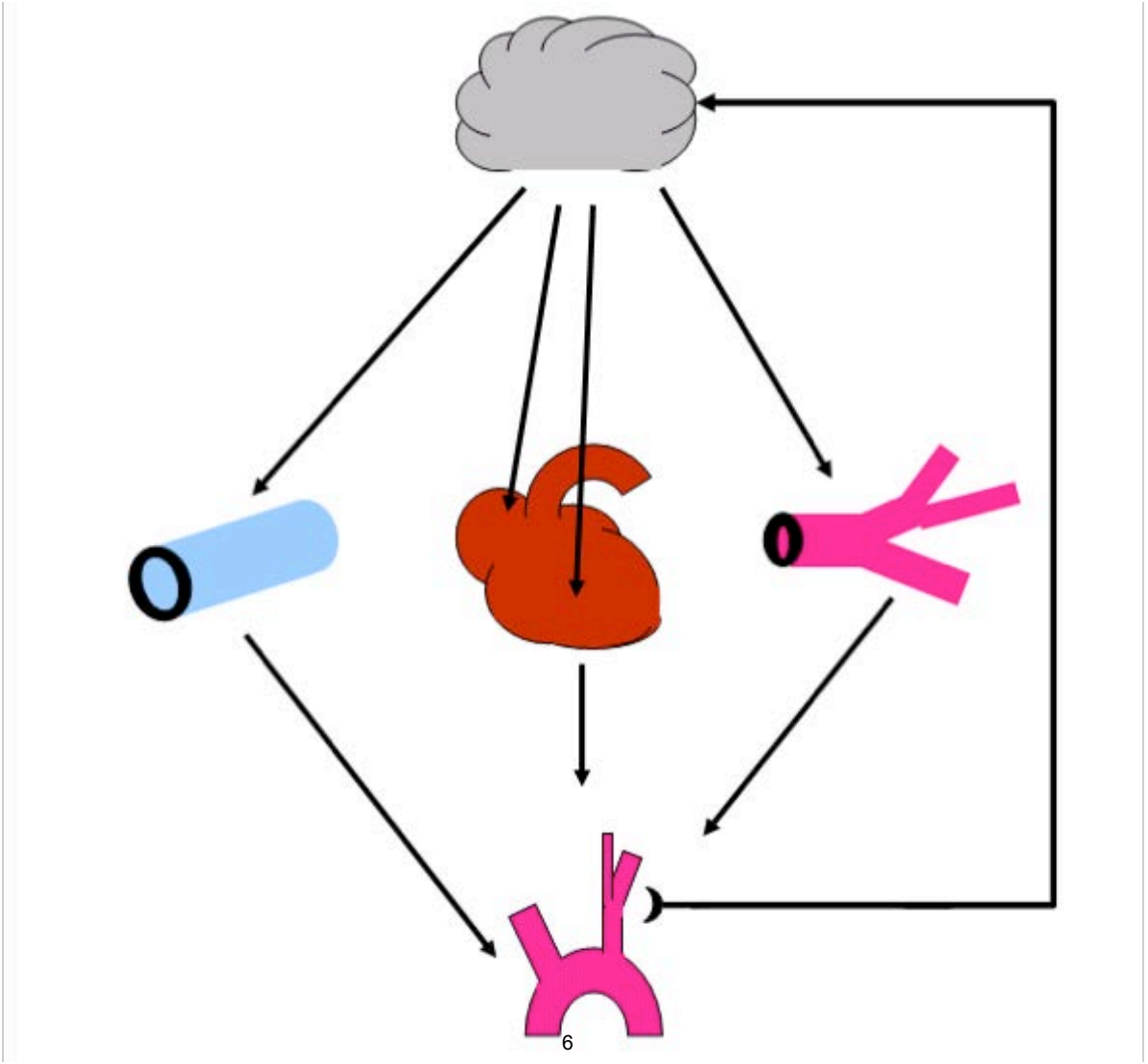
© source unknown. All rights reserved. This content is excluded from our Creative Commons license.
For more information, see https://ocw.mit.edu/help/faq-fair-use/

Blood pressure regulation (Guyton 1972)

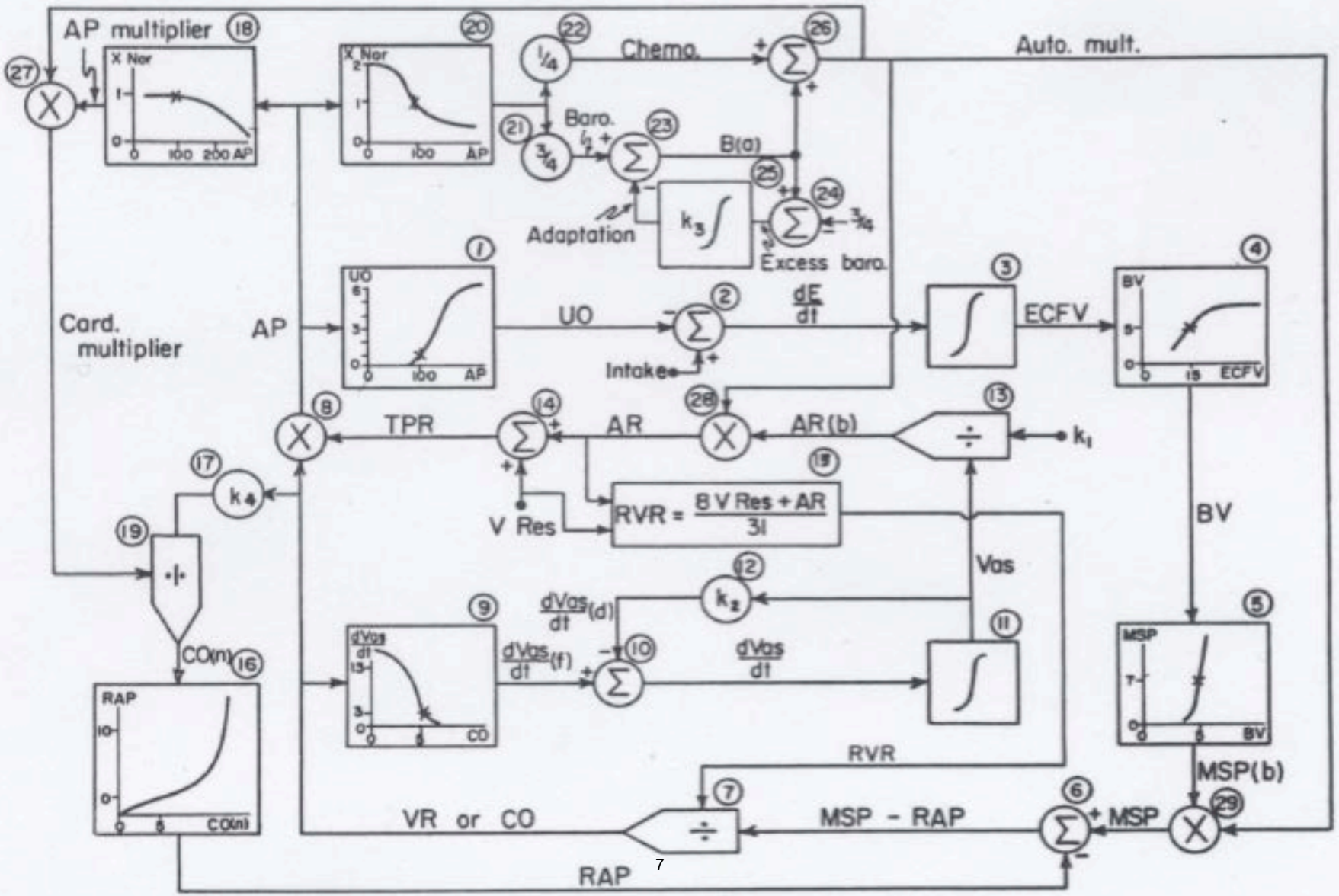


Courtesy of Elsevier, Inc., https://www.sciencedirect.com. Used with permission.

Baroreflex

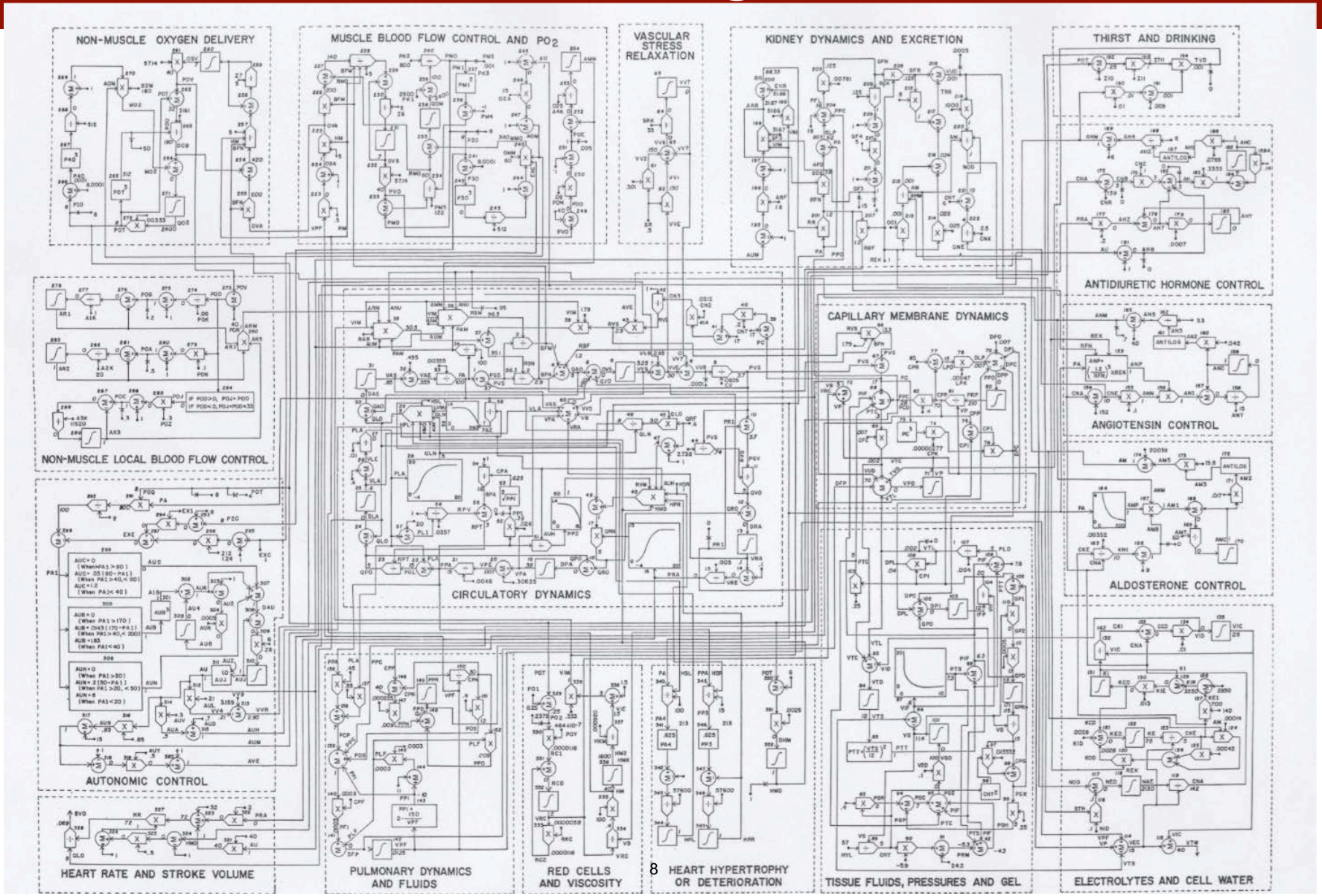


Blood pressure regulation +



Courtesy of Elsevier, Inc., https://www.sciencedirect.com. Used with permission.

Blood pressure regulation +++



Courtesy of Elsevier, Inc., https://www.sciencedirect.com. Used with permission.

Time-based capnography

Exhaled CO_2 partial pressure ($PeCO_2$) vs. time

Non-invasive

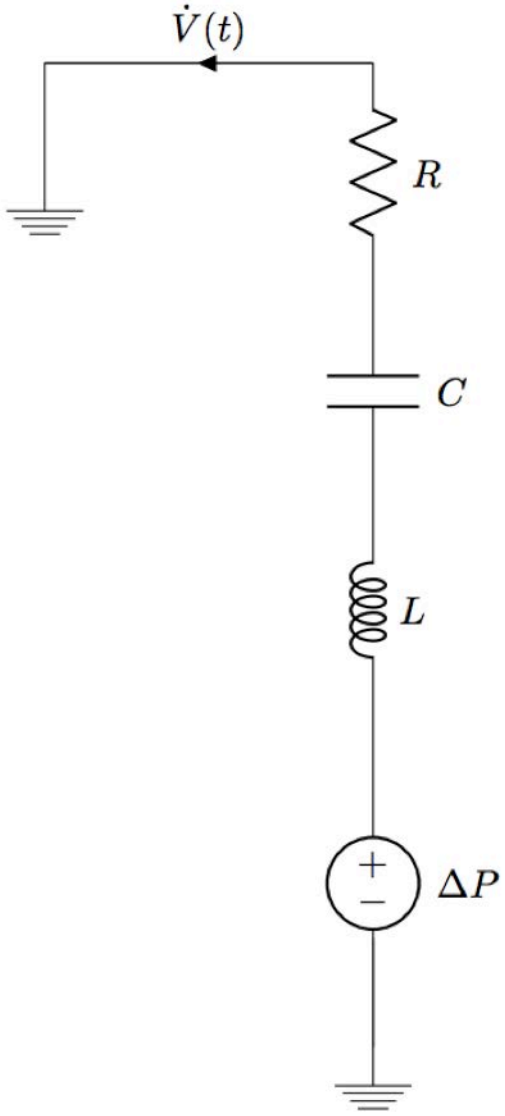
Effort-independent

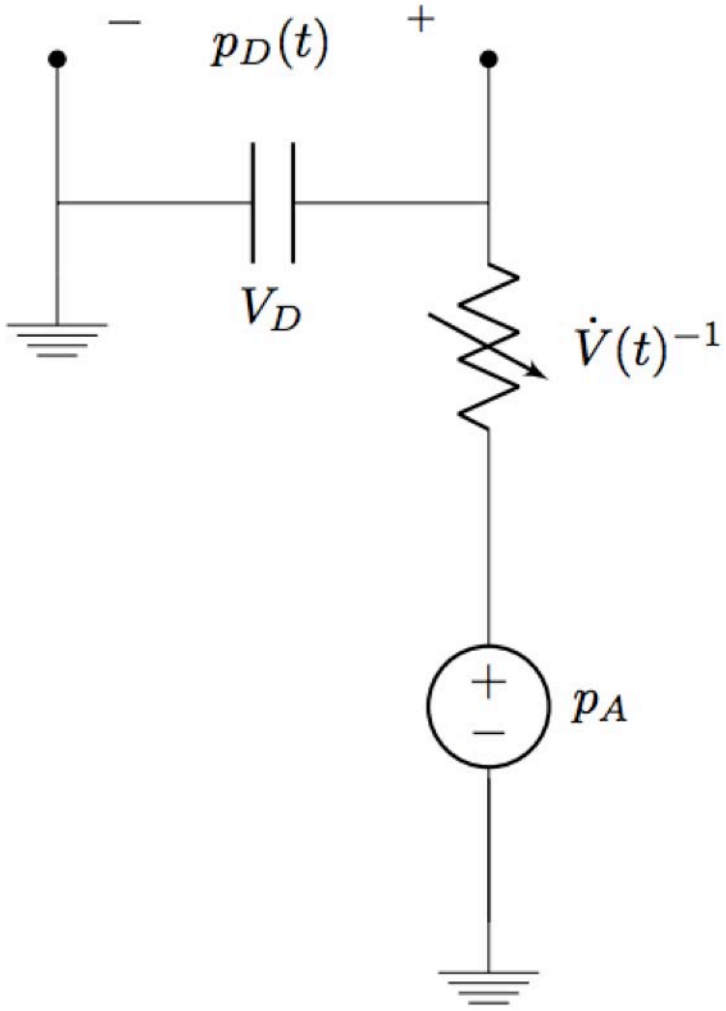
Portable (point-of-care)

Oridion. Microstream Bedside Capnography Monitoring - CS08653 Data Sheet, 2012.

© Medtronic. All rights reserved. This content is excluded from our Creative Commons license.
For more information, see https://ocw.mit.edu/help/faq-fair-use/

Mechanistic model for capnography



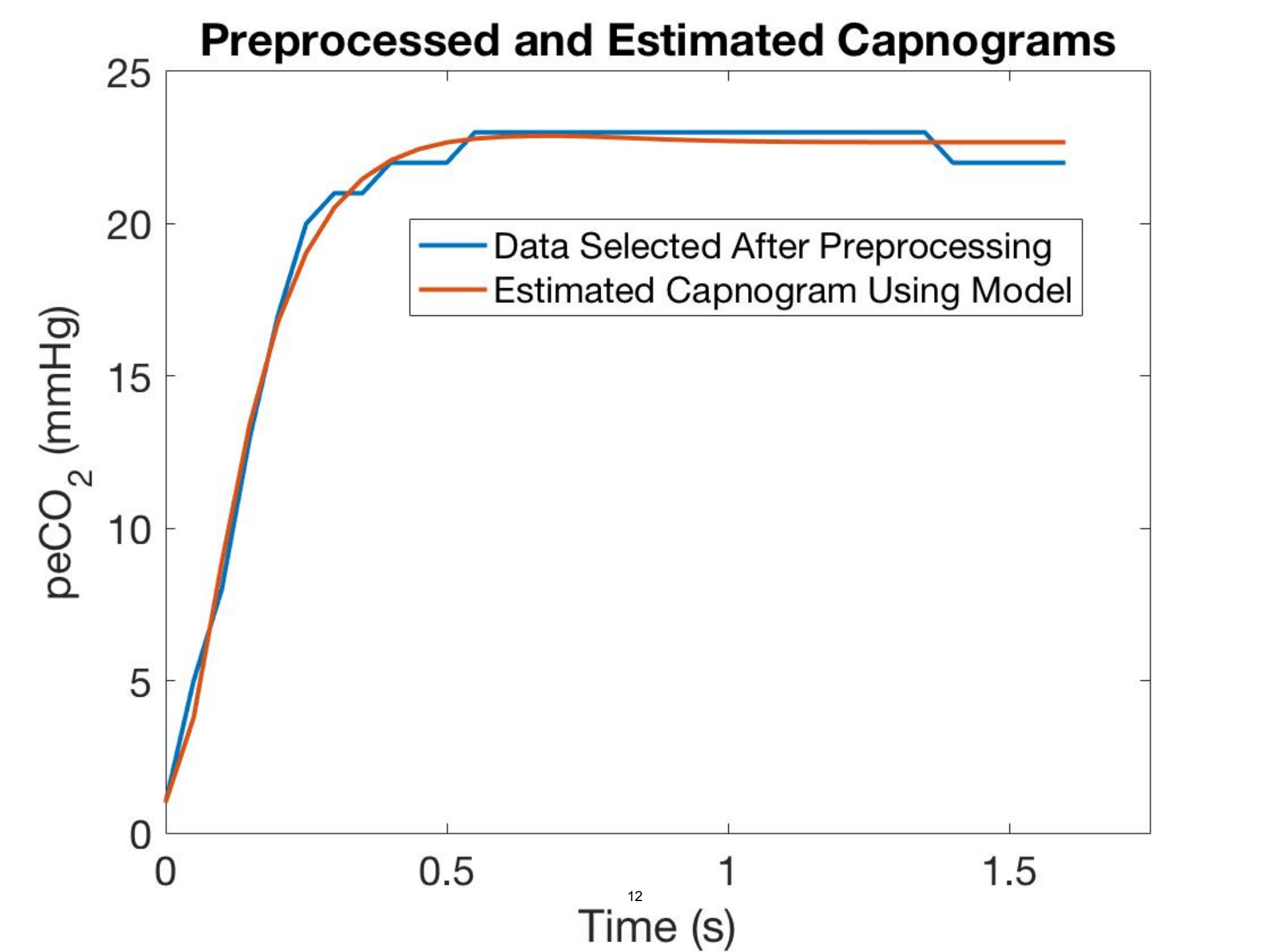


… and the governing equations

$$L\ddot{V}(t) + R\dot{V}(t) + \frac{V(t)}{C} = \Delta P$$

$$\dot{p}_D(t) = \frac{-p_D(t) + p_A}{V_D}\,\dot{V}(t)\,, \quad \dot{V}(t) > 0$$

$$\dot{p}_D(t) = \frac{p_D(t)}{V_D} \quad \dot{V}(t)\,, \quad \dot{V}(t) < 0$$


Preprocessed and Estimated Capnograms
Data Selected After Preprocessing
Estimated Capnogram Using Model
peCO2 (mmHg)
Time (s)
0
5
10
15
20
25
0
0.5
1
1.5

What we'll (un)cover

- Brief review of linear, time-invariant (LTI) system models in continuous and discrete time (CT and DT), and in the frequency domain. Deterministic autocorrelation. (Sections 1.1–1.3)
- State–space models (mainly LTI). (Chapters 4, 5 and 6)
- Brief review of random variables. (Chapter 7)
- Estimation. (Chapter 8)
- Stationary random processes in time and frequency domains. (Chapters 10 and 11)

What we'll (un)cover

- Signal estimation. (Chapter 12)
- Hypothesis testing. (Chapter 9)
- Some intimations of machine learning: training and applying quadratic discriminators in feature space. (Based on Chapter 9)
- Signal detection. (Chapter 13)
- Hidden Markov models (briefly, as a counterpoint to LTI state-space models).

MIT OpenCourseWare
https://ocw.mit.edu

6.011 Signals, Systems and Inference
Spring 2018

For information about citing these materials or our Terms of Use, visit: https://ocw.mit.edu/terms.