An algorithmic approach
to the very high risk surgical patient

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Disclosures:
Member of the Medical Advisory Board of Pulsion Medical Systems

Scientific collaborations with:

Draeger Medical
Fresenius Medical
B. Braun
Why an algorithmic approach?

An algorithm is a set of rules that precisely defines a sequence of operations to perform a procedure or to solve a problem.

“I lift, you grab. ... Was that concept just a little too complex, Carl?”
To analyze and to reduce the perioperative risk for the „high-risk surgery patient“

- Define the risk of surgery
- Define the risk of the patient
- Optimizing preoperative status
- Define the adequate hemodynamic monitoring
- Define the adequate hemodynamic management
• Define the risk of surgery
• Define the risk of the patient
• Optimizing preoperative status
• Define the adequate hemodynamic monitoring
• Define the adequate hemodynamic management
Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery

The Task Force for Preoperative Cardiac Risk Assessment and Perioperative Cardiac Management in Non-cardiac Surgery of the European Society of Cardiology (ESC) and endorsed by the European Society of Anaesthesiology (ESA)
**Table 4** Surgical risk\(^a\) estimate (modified from Boersma et al.\(^6\))

<table>
<thead>
<tr>
<th>Low-risk &lt;1%</th>
<th>Intermediate-risk 1–5%</th>
<th>High-risk &gt;5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>Abdominal</td>
<td>Aortic and major vascular surgery</td>
</tr>
<tr>
<td>Dental</td>
<td>Carotid</td>
<td>Peripheral artery surgery</td>
</tr>
<tr>
<td>Endovascular</td>
<td>orthopaedic—major</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(hip and spine surgery)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pulmonary renal/</td>
<td></td>
</tr>
<tr>
<td></td>
<td>liver transplant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urologic—major</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)Risk of MI and cardiac death within 30 days after surgery.

But ...
... always incorporate the experience of the surgeon!
• Define the risk of surgery
• **Define the risk of the patient**
• Optimizing preoperative status
• Define the adequate hemodynamic monitoring
• Define the adequate hemodynamic management
<table>
<thead>
<tr>
<th>Variable</th>
<th>N, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 flights</td>
<td>82</td>
</tr>
<tr>
<td>&lt; 3 flights</td>
<td>84</td>
</tr>
<tr>
<td>&lt; 4 flights</td>
<td>89</td>
</tr>
<tr>
<td>&lt; 5 flights</td>
<td>95</td>
</tr>
</tbody>
</table>

*Sens = specific value; N = number of observations.*
Patient-specific Risk

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- Active cardiovascular/pulmonary diseases
- Functional capacity
- Clinical risk factors
Patient-specific Risk

- Active cardiovascular disease:
  - Instable coronary syndrome
  - Acute heart insufficiency
  - Significant arrhythmias
  - Symptomatic valvular disease
  - Recent MI (<30d)

(ESC Guidelines)
Patient-specific Risk

• Functional capacity

(ESC Guidelines)
Patient specific risk:

- Clinical risk factors:

Revised Lee Cardiac Risk Index

- Known CAD
- Heart insufficiency
- IDDM
- Cerebrovascular Diseases
- Renal insufficiency, creatinine $\geq 2$mg/dl
How to put that in an algorithmic approach?
The preoperative algorithmic approach:

### Patienten-

**Action: Further evaluation by cardiologists:**

- **Initiate further evaluation, if:**
  - O A

**And defining the strategy for perioperative Monitoring / Management!**

- O known CAD CC2 1-2, and no evaluation within the last 2 years
  - - A mean
  - - valve area < 1 cm²
  - - symptomatic MVS
Escalation of Monitoring / Management

Patient associated Risk

Low
intermediate
high

Complexity / Invasiveness of Monitoring

Risk of Surgery

Low
intermediate
high
Perioperative hemodynamic optimization:

**Ratio:**

*Optimizing blood flow:*

*Means reaching adequate circulation*

- ensuring endorgan function
- Minimizing complications
- leads to improved Outcome
Flow is more important than pressure
Preload Volume and Parameters of Fluid responsiveness are better than Filling pressures to guide fluid therapy.
CO Technologies

PA Thermodilution
Transcardiopulmonary Indicator dilution
Pulse contour analysis centrally / calibrated
Pulse contour analysis peripherally / uncalibrated
Echo / Doppler
CNAP / BMeye
Bioimpedance
Bioreactance
Ability of pulse power, esophageal Doppler, and arterial pulse pressure to estimate rapid changes in stroke volume in humans

José Marquez, MD; Kenneth McCurry, MD; Donald A. Severyn, MS; Michael R. Pinsky, MD

Bland-Altman Analysis Pulse Contour (LiDCO™) to Aortic Flow Probe (Cineflo™) Measures of Left Ventricular Stroke Volume during Transient IVC Occlusion
Our approach:

- **Low** risk: Basic Monitoring (NIBP, ECG, Pulse Ox, Capno) plus A-line/BMeye.
- **Intermediate** risk: Basic Monitoring plus A-line/BMeye.
- **High** risk: A-line plus ProAct.

**Risk of Surgery**

- **Low**
- **Intermediate**
- **High**
• Define the risk of surgery
• Define the risk of the patient
• Optimizing preoperative status
• Define the adequate hemodynamic monitoring
• Define the adequate hemodynamic management
Wherever meaningful: individualized algorithms:

The Principle:

Preload → Flow → Perfusion Pressure → Heart Rate

Avoid Fluid Overload
Perioperative algorithms:

![Algorithm Diagram]

Post-OP Ventilation: \(12.6 \pm 3.6\) h vs. \(15.4 \pm 4.3\) h (p<0.002)

“Fit for ICU-discharge”: \(25 \pm 13\) h vs. \(33 \pm 17\) h (p=0.018)

In case of EVLWI > 12

care for signs of pulmonary edema and give diuretics if necessary

Heterogeneous Ranges for optimal Preload

Preload → Flow → Perfusion Pressure → Heart Rate

Avoid Fluid Overload
Global end-diastolic volume acquired by transpulmonary thermodilution depends on age and gender in awake and spontaneously breathing patients

Stefan Wolf¹,³, Alexander Rieß², Julia F Landscheidt¹, Christiano B Lumenta¹, Patrick Friederich² and Ludwig Schürer¹

101 Patients
When discharged from ICU (neurosurgery)
Global end-diastolic volume acquired by transpulmonary thermodilution depends on age and gender in awake and spontaneously breathing patients
Stefan Wolf¹,³, Alexander Rieß², Julia F Landscheidt¹, Christiano B Lumenta¹, Patrick Friederich² and Ludwig Schürer¹

<table>
<thead>
<tr>
<th>Age [years]</th>
<th>mean male (95% CI)</th>
<th>mean female (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 40</td>
<td>633 (456-880)</td>
<td>559 (402-779)</td>
</tr>
<tr>
<td>41-50</td>
<td>667 (485-916)</td>
<td>592 (432-812)</td>
</tr>
<tr>
<td>51-60</td>
<td>736 (536-1011)</td>
<td>654 (478-897)</td>
</tr>
<tr>
<td>61-70</td>
<td>802 (585-1101)</td>
<td>713 (520-977)</td>
</tr>
<tr>
<td>&gt;70</td>
<td>812 (590-1117)</td>
<td>720 (520-997)</td>
</tr>
</tbody>
</table>

CI = confidence interval; GEDVI = global end-diastolic volume index
Heterogeneous Ranges for optimal Preload

Comparison of values in critically ill patients for global end-diastolic volume and extravascular lung water measured by transcardiopulmonary thermodilution: A metaanalysis of the literature

V. Eichhorn\textsuperscript{a}, M.S. Goepfert\textsuperscript{a}, C. Eulenburg\textsuperscript{b}, M.L.N.G. Malbrain\textsuperscript{c}, D.A. Reuter\textsuperscript{a}

Med Intensiva. 2012. doi:10.1016/j.medint.2011.11.014
This implies individual target ranges:
Volume-limited versus pressure-limited hemodynamic management in septic and nonseptic shock

Ronald J. Trof, MD; Albertus Beishuizen, MD, PhD; Alexander D. Cornet, MD; Ralph J. de Wit, MD; Armand R. J. Girbes, MD, PhD; A. B. Johan Groeneveld, MD, PhD, FCCP, FCCM

Crit Care Med 2012 Vol. 40, No. 4

Indication for fluid challenge

EVLW < 10 mL/kg

Colloids 250-500 mL (30 min)

Increase CI (>10%)

Reassess hemodynamics

No increase CI

Inotropic agents and/or vasopressors

EVLW ≥ 10 mL/kg

GEDVI < 850 mL/m²

Colloids 250-500 mL (30 min)

CI < 2.0 L/min/m²

Increase CI (>10%)

Reassess hemodynamics

No increase CI

Inotropic agents

GEDVI ≥ 850 mL/m²

CI ≥ 2.0 L/min/m²

Inotropic agents and/or vasopressors
Bottom Line for the high risk surgery patient:

- Primary goal: efficiently optimizing blood flow
- Individually tailored management:
  - Patient assessment
  - Assessment of surgical risks
  - Preoperative optimization of patient status
  - Use of monitoring techniques that have proven to be accurate, and where we are experienced in
  - Where appropriate, algorithms with defined goals
  - But individualize the goals!
Thank you