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# Prediction Software Helps Reduce Hypotension and Improve Outcomes

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# Learning objective

- Articulate the relationship between hypotension and postoperative outcomes for surgical patients.
- Articulate the relationship between hypotension and increased costs for surgical patients.
- Explain the role of hypotension prediction index software in reducing hypotension in the surgical patient, thus improving patient outcomes and decreasing costs.



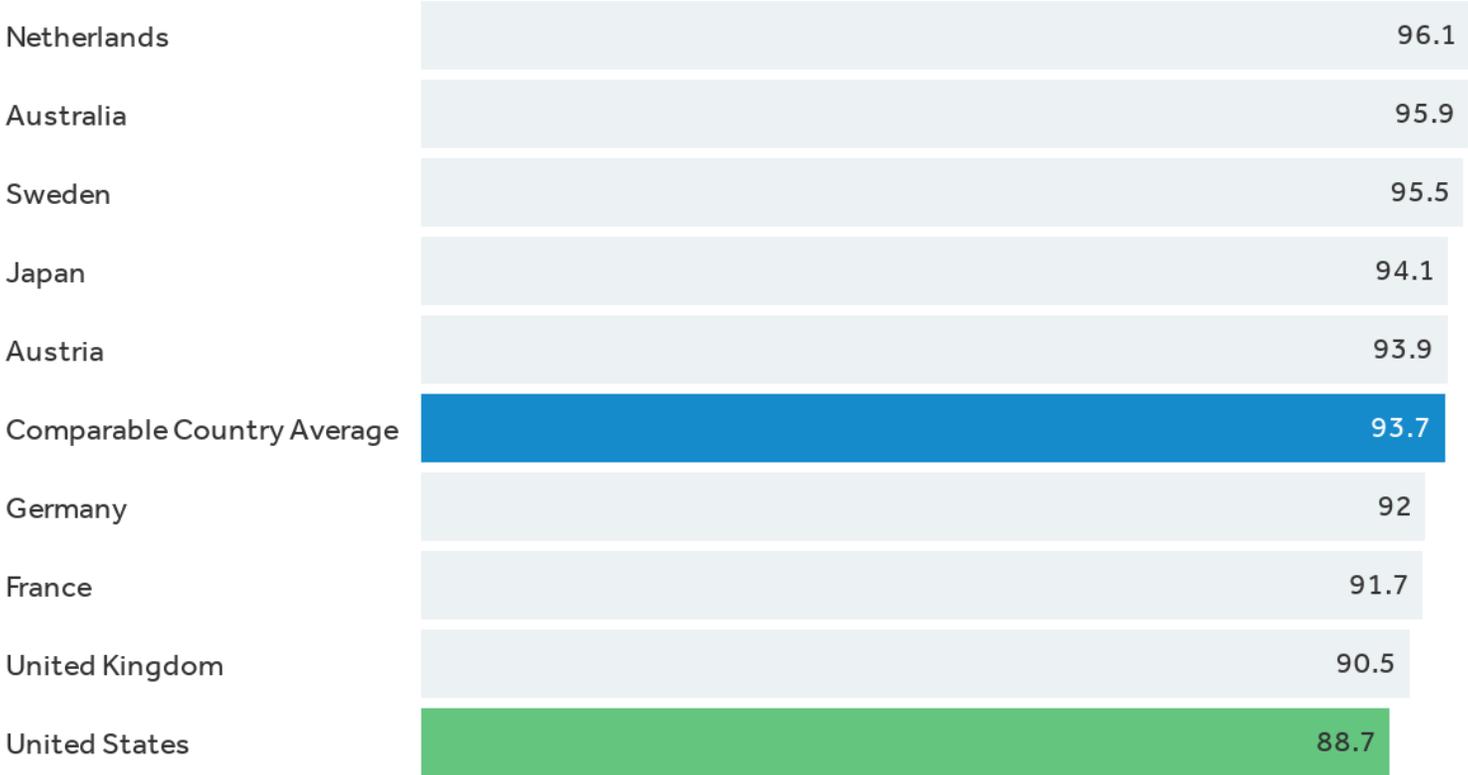
# Prediction Software Helps Reduce Hypotension and Improve Outcomes

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# The Problem

“highest rates of death considered preventable by timely and effective care”

Healthcare Quality and Access (HAQ) Index Rating, 2016



Source: KFF analysis of data from: “Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016,” The Lancet, 23 May 2018.

• Created with Datawrapper

Peterson-KFF  
**Health System Tracker**

# Quality and Safety

## Goal

- Improve quality and safety

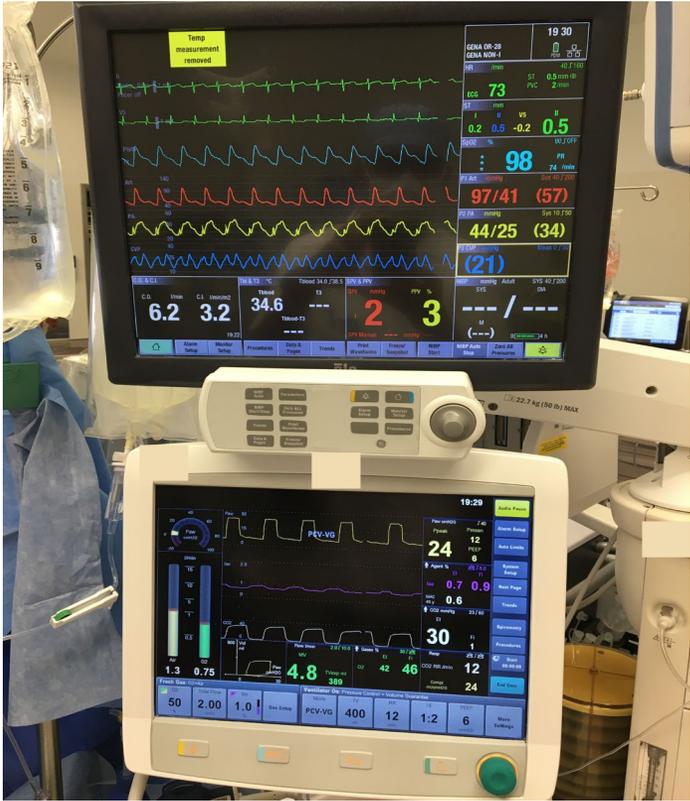
## Quality

- Provide consistent care which is supported by scientific evidence

## Safety

- Do not cause harm or prevent complications

# How can we improve quality and safety for surgical patients?

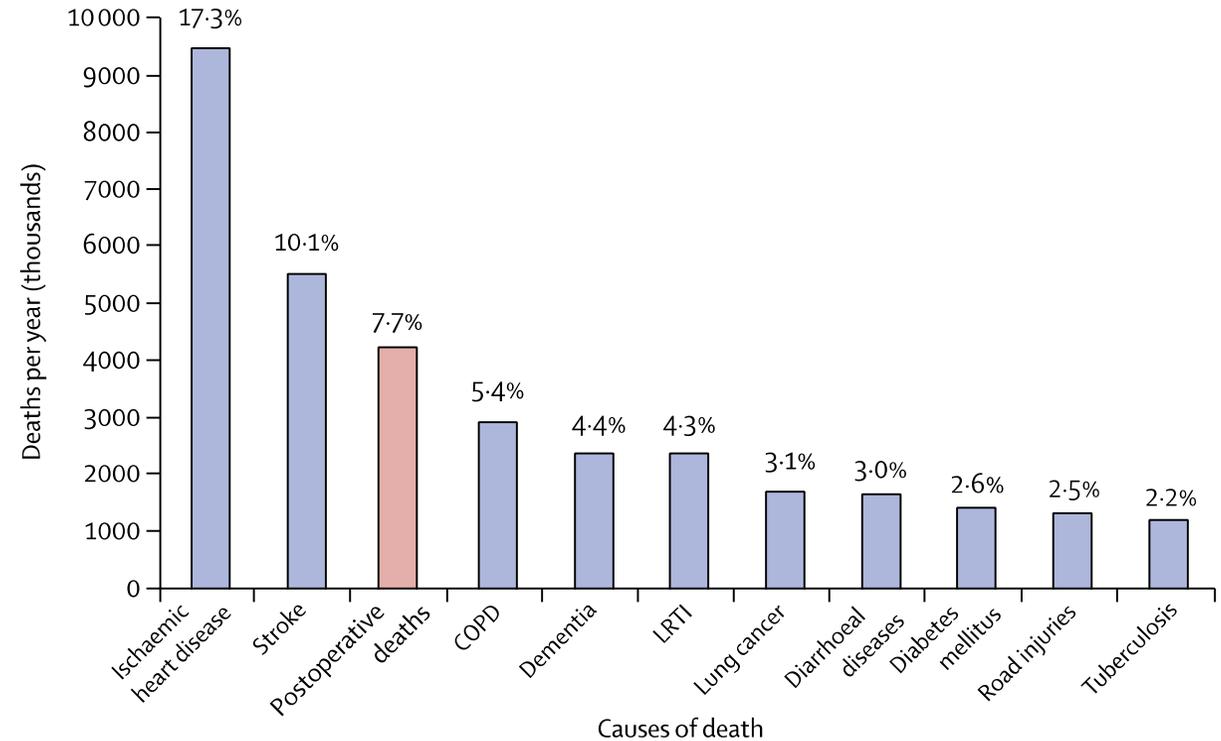


# Hypotension

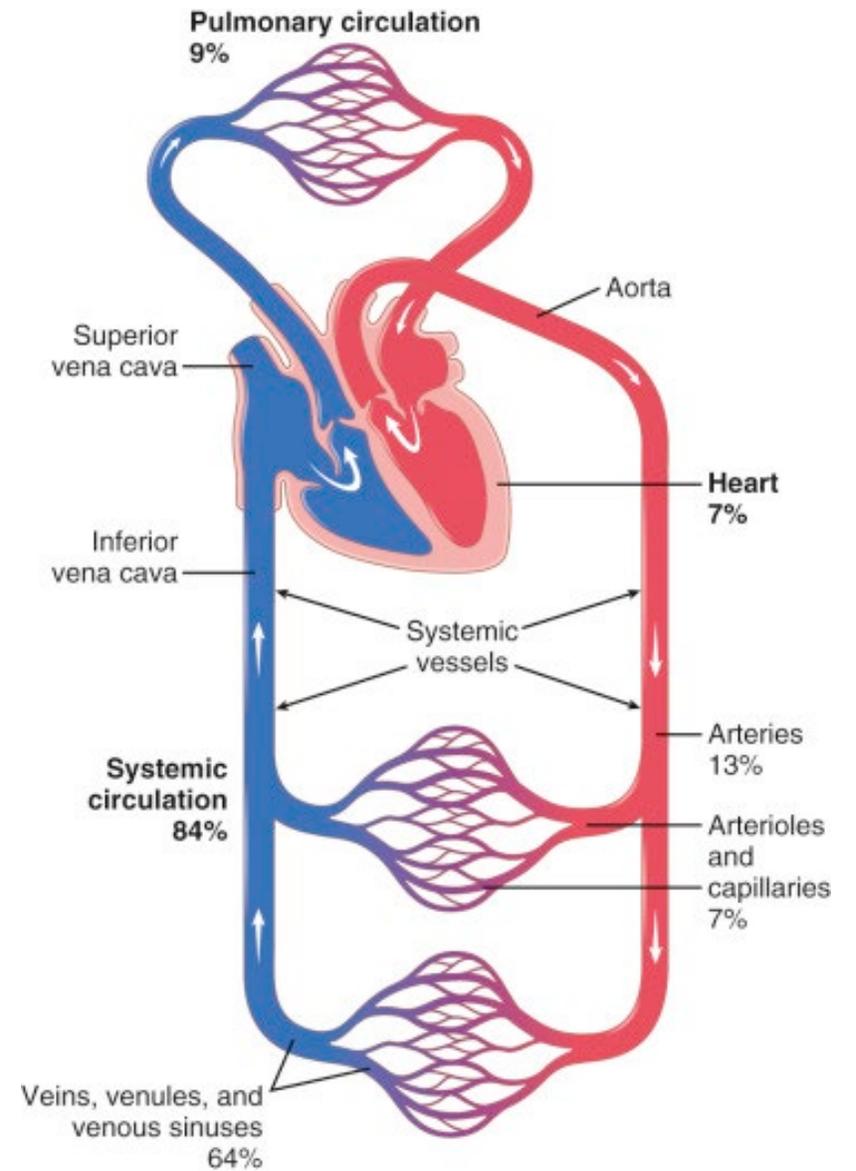
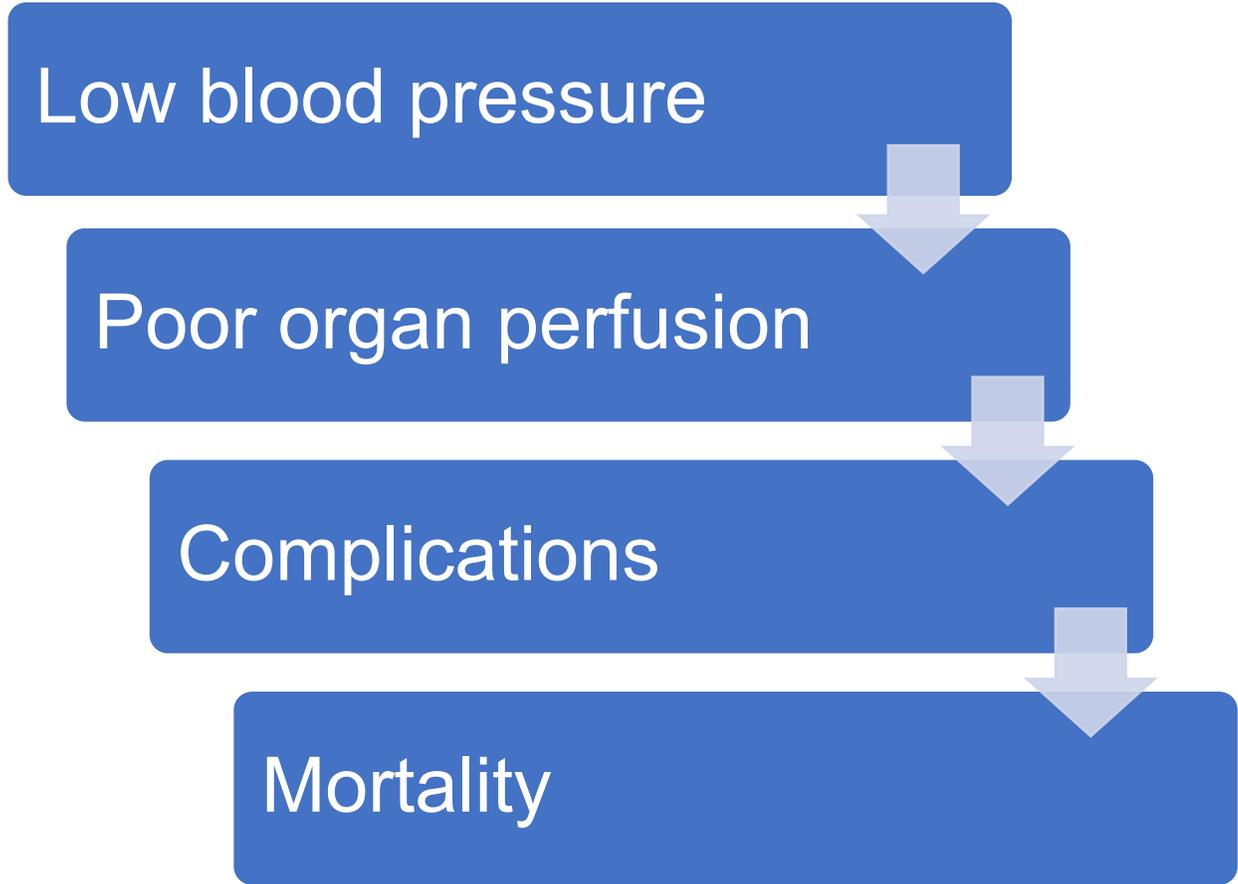
- Hypotension is associated with complication (like *myocardial injury, acute kidney injury, SSI, mortality*) and the amount of hypotension varies among clinicians and hospitals
- *Care delivery excellence*
  - *Reliable care delivery, variation*
  - *Patient care excellence, outcomes*

# Postoperative Complications

- 4 million people die from postoperative complication
- Avoidable complications can help reduce waste(25%) in US healthcare spending



Shrank, JAMA, 2019  
Nepogodiev, Lancet, 2019



Guyton and Hall Textbook of Medical Physiology, Chapter 14, 169-178

Hypotension

Mortality  
Readmission  
LOS

Leading  
indicators

Lagging  
indicators

# The evidence

OXFORD

*BJS Open*, 2021, 5(1), zraa018

DOI: [10.1093/bjsopen/zraa018](https://doi.org/10.1093/bjsopen/zraa018)

Systematic Review

## Association of intraoperative hypotension with postoperative morbidity and mortality: systematic review and meta-analysis

M. Wijnberge <sup>1,2,3</sup>, J. Schenk<sup>1</sup>, E. Bulle<sup>1,2</sup>, A. P. Vlaar<sup>2,3</sup>, K. Maheshwari<sup>4</sup>, M. W. Hollmann<sup>1,3</sup>, J. M. Binnekade<sup>2</sup>, B. F. Geerts<sup>1,\*</sup> and D. P. Veelo<sup>1</sup>

ORIGINAL RESEARCH

 OPEN ACCESS  Check for updates

## Hospital costs associated with intraoperative hypotension among non-cardiac surgical patients in the US: a simulation model

Eric L. Keuffel<sup>a</sup> , John Rizzo<sup>b</sup>, Mitali Stevens<sup>c</sup>, Candace Gunnarsson<sup>d</sup> and Kamal Maheshwari<sup>e</sup>

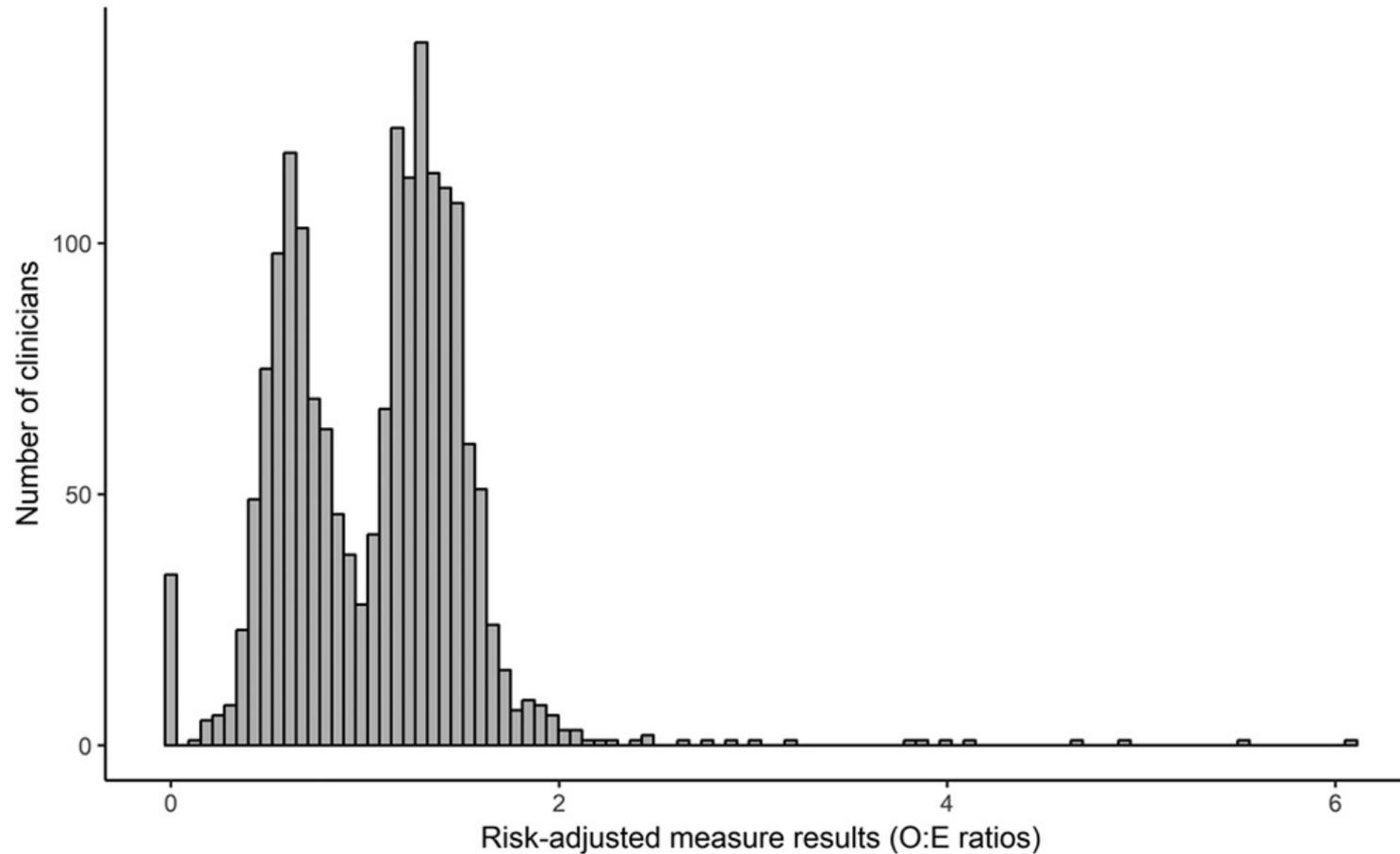
<sup>a</sup>Health Finance & Access Initiative, Bryn Mawr, PA, USA; <sup>b</sup>Stony Brook University Medical Center, Stony Brook University (New York), Stony Brook, NY, USA; <sup>c</sup>Edwards Lifesciences, Irvine, CA, USA; <sup>d</sup>Gunnarsson Consulting, Jupiter, FL, USA; <sup>e</sup>Cleveland Clinic, Cleveland, OH, USA

- The model results suggest improved intraoperative hypotension control in a hospital (10,000 surgery)
  - is associated with mean cost reductions ranging from \$1.2–\$4.6 million per year.

# Reduce hypotension

- How do we encourage hospitals and clinicians to change practice?

# Hypotension as quality metric



Anesthesia & Analgesia 133(2):445-454, August 2021

# Hypotension as quality metric

Patient Safety

■ ORIGINAL CLINICAL RESEARCH REPORT

**OPEN** **Development and Evaluation of a Risk-Adjusted Measure of Intraoperative Hypotension in Patients Having Nonemergent, Noncardiac Surgery**

Anna L. Christensen, PhD,\* Ethan Jacobs, MPP,† Kamal Maheshwari, MD, MPH,‡  
Fei Xing, PhD,\* Xiaohong Zhao, PhD,§ Samuel E. Simon, PhD,† Karen B. Domino, MD, MPH,||  
Karen L. Posner, PhD,|| Alvin F. Stewart, MD,¶ Joseph A. Sanford, MD,¶ and Daniel I. Sessler, MD#

- Metric: Number of cases in one year who qualify for hypotension which is defined as **MAP <65 mm Hg for 15 minutes per case**
- Now eligible for CMS Qualified clinical data registry (QCDR) Merit-based incentive program MIPS program

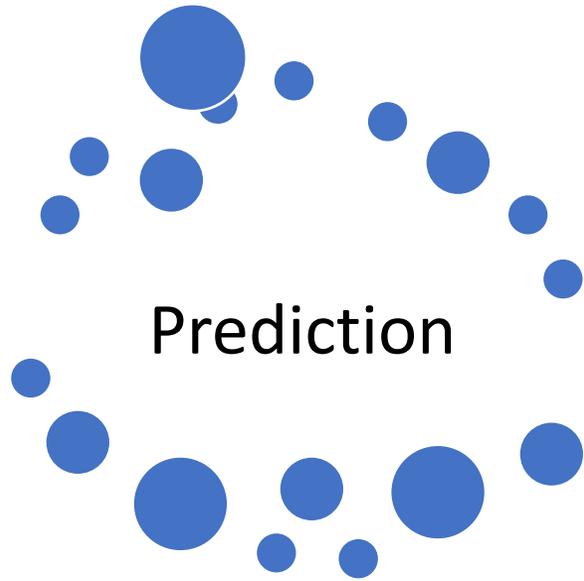
# Key takeaway

1. Hypotension reduction may help improve quality and safety

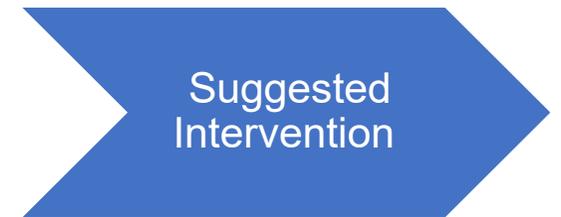
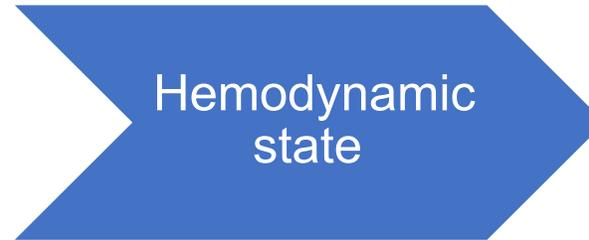
# How do I prevent hypotension?



Maheshwari , Anesthesia and Analgesia, 2022



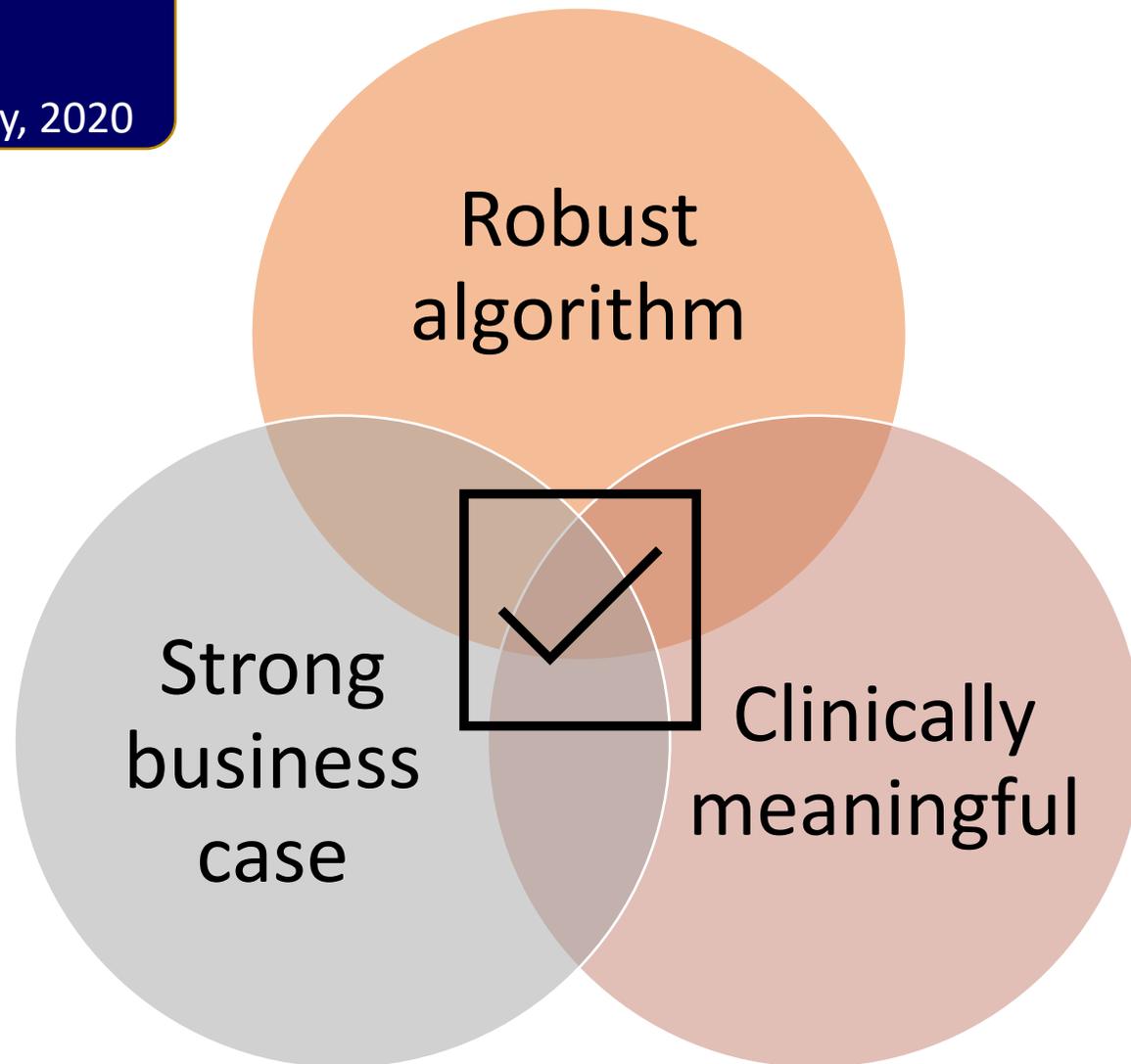
Early  
diagnosis

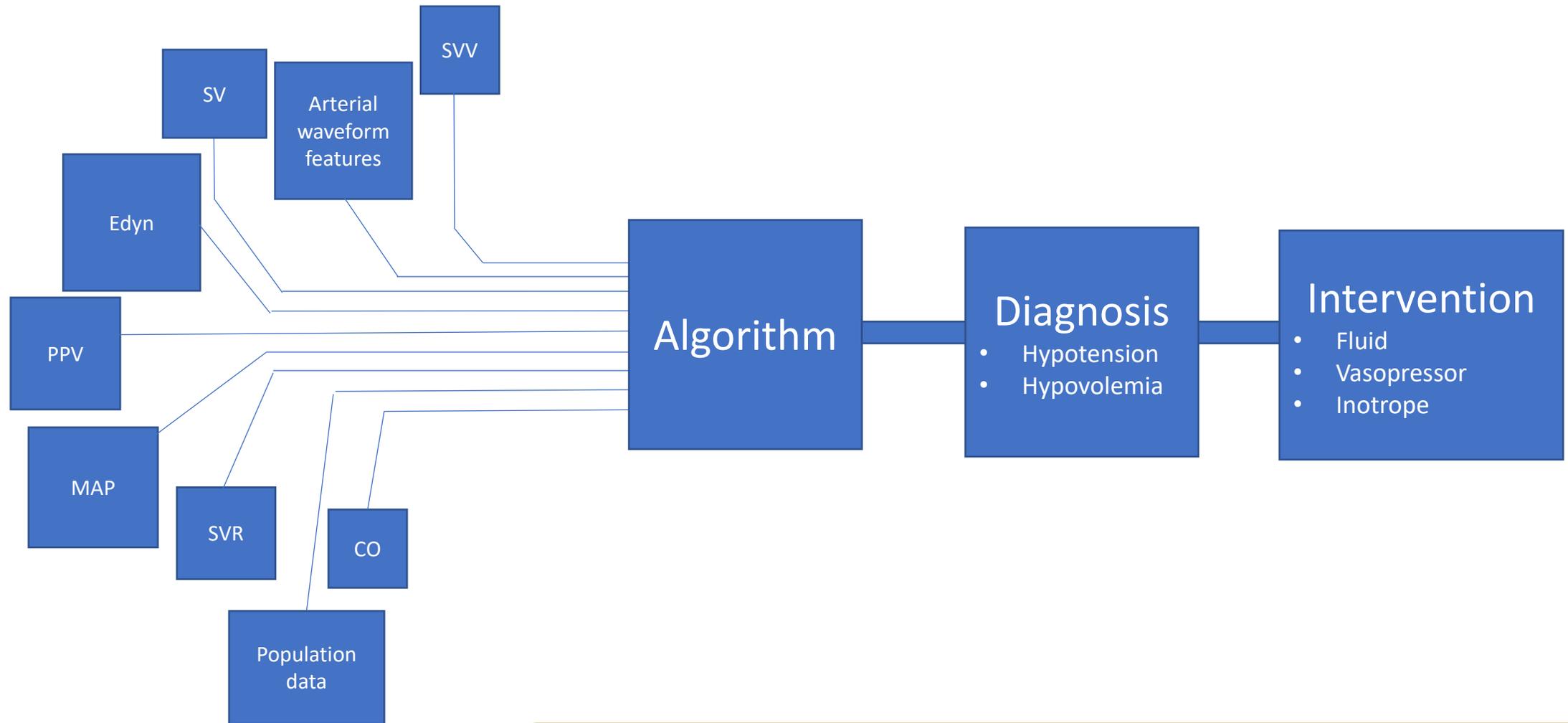


# Hypotension prediction algorithm



Feras, Anesthesiology, 2018  
Wijnberge, JAMA, 2020  
Maheshwari, Anesthesiology, 2020





SVV, stroke volume variation; Edyn, dynamic elastance; PPV, pulse pressure variation; SVR, systemic vascular resistance

# Key takeaway

1. Hypotension reduction may help improve quality and safety
2. Hypotension prediction can help reduce hypotension

# What we did? A clinical trial

- Prospective, single-arm, open-label, multicenter study
- 457 Subjects at 11 U.S. Sites
- **Intervention:** Use of hypotension prediction index software during noncardiac surgery
- **Outcome:** Duration of intraoperative hypotension (defined as MAP < 65 mmHg for at least 1 minute) as compared with a historic retrospective control group.

- **Cohort**

- On an average patients in HPI group were 65 year old, 52% males, 82% white
- 27% general, 13% orthopedic, 12% urology, 10% neurosurgery.

- **Comparisons**

- HPI group was compared with historical patient data from the same hospitals.
- HPI group was compared with propensity matched patients from the same hospitals

# Results

Outcomes			
		No HPI <i>N</i> = 15796	HPI <i>N</i> = 457
1.	Duration of Hypotension (MAP < 65)	15 [5, 39]	9 [3, 20]
2.	Acute Kidney Injury	1898/12421 (15.3%)	45/325 (13.8%)
3.	Postoperative Nausea / Vomiting	1259/15,213 (8.3%)	53/441 (12.0%)

# Lesson learned

## Goal

- Improve quality and safety

## Quality

- Reduce hypotension
- Use technology (predictive software)

## Safety

- Reduce postoperative complications

# Key takeaways

- Postoperative complications are major cause of morbidity and mortality
- Postoperative complications reflect poor quality of care and poor patient safety
- Hypotension reduction can help reduce postoperative complications
- Artificial intelligence technologies like hypotension prediction can help deliver timely and effective care

# Questions?



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