

# Intraoperative Hypotension

Intraoperative teaching · CA-2

## THE QUESTION

### Where the evidence disagrees

This topic was selected because an evidence synthesis beats a textbook on it: the trials disagree, or the guidance has moved recently.

## THE EVIDENCE

### What each source contributes, and how strong it is

Study design first — a cohort and a randomised trial do not carry the same weight.

| Design           | Year | Journal                            | What it found                                                                       |
|------------------|------|------------------------------------|-------------------------------------------------------------------------------------|
| Guideline        | 2019 | British journal of anaesthesia     | Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,     |
| Meta-analysis    | 2018 | British journal of anaesthesia     | Organ injury is reported after 10 minutes or more below a mean arterial pressure of |
| Randomised trial | 2018 | Anesthesiology                     | Hypotension on the four days after surgery carried a far stronger association with  |
| Cohort           | 2025 | British journal of anaesthesia     | Cumulative intraoperative norepinephrine dose is independently associated with      |
| Randomised trial | 2021 | Journal of the American College of | Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg |
| Cohort           | 2018 | Anesthesia and analgesia           | A maximum intraoperative heart rate above 100 bpm together with a minimum systolic  |

6 resolved citations behind this deck; every point above traces to one of them.

## WHERE THE GUIDANCE SITS

### What the guidelines and pooled evidence say

2 findings, each on the slide that follows.

BRITISH JOURNAL OF ANAESTHESIA 2019

**Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,**

Mean arterial pressures below 60-70 mmHg are associated with myocardial injury, acute kidney injury and death

BRITISH JOURNAL OF ANAESTHESIA 2018

**Organ injury is reported after 10 minutes or more below a mean arterial pressure of**

Organ injury is reported after 10 minutes or more below a mean arterial pressure of 80 mmHg, after shorter periods below 70 mmHg

## WHERE THE GUIDANCE SITS

### Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,

Guideline · British journal of anaesthesia

Mean arterial pressures below 60-70 mmHg are associated with myocardial injury, acute kidney injury and death, and the injury is a function of both how far the pressure falls and how long it stays there.

Perioperative Quality Initiative Consensus Statement on Intraoperative Blood Pressure, Risk and Outcomes for Elective Surgery, British journal of anaesthesia 2019 · PMID 30916004

## WHERE THE GUIDANCE SITS

### Organ injury is reported after 10 minutes or more below a mean arterial pressure of

Meta-analysis · British journal of anaesthesia

Organ injury is reported after 10 minutes or more below a mean arterial pressure of 80 mmHg, after shorter periods below 70 mmHg, and at any exposure below 55-50 mmHg.

Intraoperative Hypotension and the Risk of Postoperative Adverse Outcomes: A Systematic Review, British journal of anaesthesia 2018 · PMID 30236233

## WHAT THE TRIALS FOUND

### Where randomised evidence moved the question

2 findings, each on the slide that follows.

ANESTHESIOLOGY 2018

#### Hypotension on the four days after surgery carried a far stronger association with

Hypotension on the four days after surgery carried a far stronger association with myocardial infarction and death (odds ratio 2.83) than each extra...

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY 2021

#### Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg

Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg by roughly 60% but did not reduce acute myocardial injury or...

## WHAT THE TRIALS FOUND

### Hypotension on the four days after surgery carried a far stronger association with

Randomised trial · Anesthesiology

Hypotension on the four days after surgery carried a far stronger association with myocardial infarction and death (odds ratio 2.83) than each extra 10 minutes of intraoperative hypotension (odds ratio 1.08).

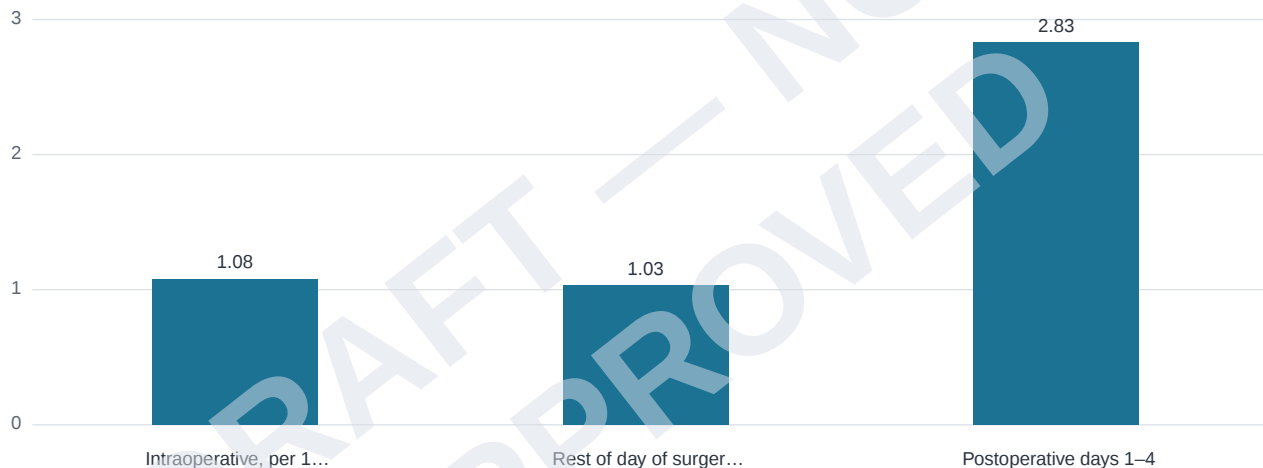
Period-Dependent Associations Between Hypotension During and for Four Days After Noncardiac Surgery and a Composite of Myocardial Infarction and Death: A Substudy of the POISE-2 Trial, Anesthesiology 2018 · PMID 29189290

## THE NUMBERS

### Postoperative hypotension carries the stronger association

Odds of the 30-day composite of myocardial infarction and death, POISE-2 substudy.

odds ratio



**Hypotension on the ward carried an odds ratio of 2.83 against 1.08 per 10 intraoperative minutes — the danger does not end when the case does.**

Period-Dependent Associations Between Hypotension During and for Four Days After Noncardiac Surgery and a Composite of Myocardial Infarction and Death: A Substudy of the POISE-2 Trial, Anesthesiology 2018 · PMID 29189290

## WHAT THE TRIALS FOUND

### Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg

Randomised trial · Journal of the American College of

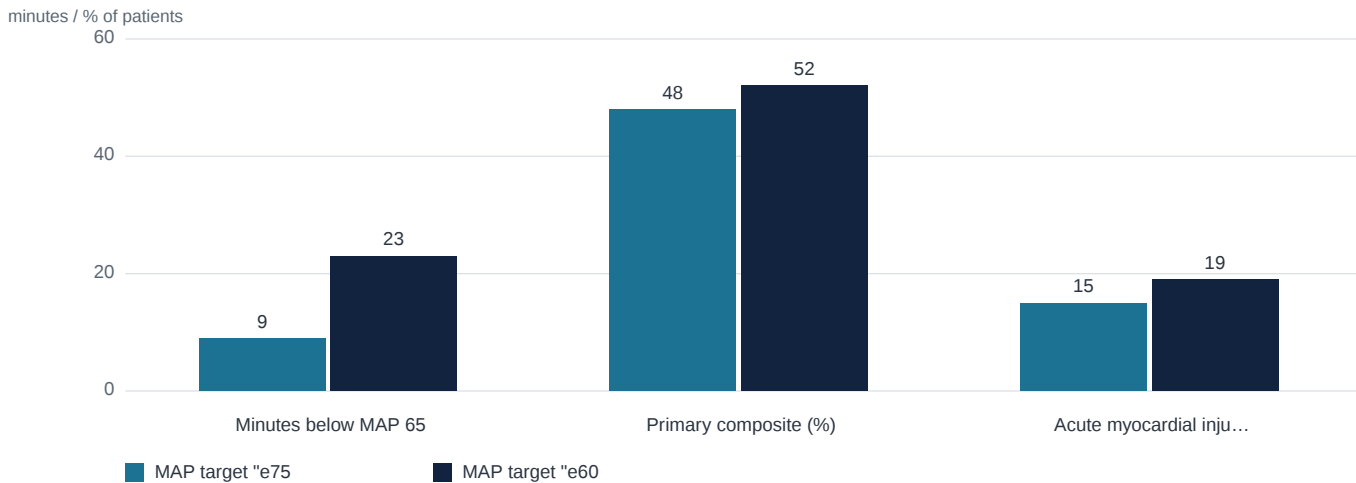
Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg by roughly 60% but did not reduce acute myocardial injury or 30-day major cardiac events and acute kidney injury.

Targeting Higher Intraoperative Blood Pressures Does Not Reduce Adverse Cardiovascular Events Following Noncardiac Surgery, Journal of the American College of Cardiology 2021 · PMID 34711333

## THE NUMBERS

### Targeting a higher MAP cut hypotension without changing outcomes

Time below MAP 65 fell by 60%. The composite outcome did not move.



**Halving hypotension exposure did not reduce myocardial injury or 30-day major cardiac events — the association is not straightforwardly causal.**

Targeting Higher Intraoperative Blood Pressures Does Not Reduce Adverse Cardiovascular Events Following Noncardiac Surgery, *Journal of the American College of Cardiology* 2021 · PMID 34711333

#### IN PRACTICE

### What the cohorts and reviews add

2 findings, each on the slide that follows.

BRITISH JOURNAL OF ANAESTHESIA 2025

#### **Cumulative intraoperative norepinephrine dose is independently associated with**

Cumulative intraoperative norepinephrine dose is independently associated with postoperative acute kidney injury, so escalating vasopressor to chase...

ANESTHESIA AND ANALGESIA 2018

#### **A maximum intraoperative heart rate above 100 bpm together with a minimum systolic**

A maximum intraoperative heart rate above 100 bpm together with a minimum systolic pressure below 100 mmHg is more strongly associated with...

#### IN PRACTICE

### **Cumulative intraoperative norepinephrine dose is independently associated with**

Cohort · *British journal of anaesthesia*

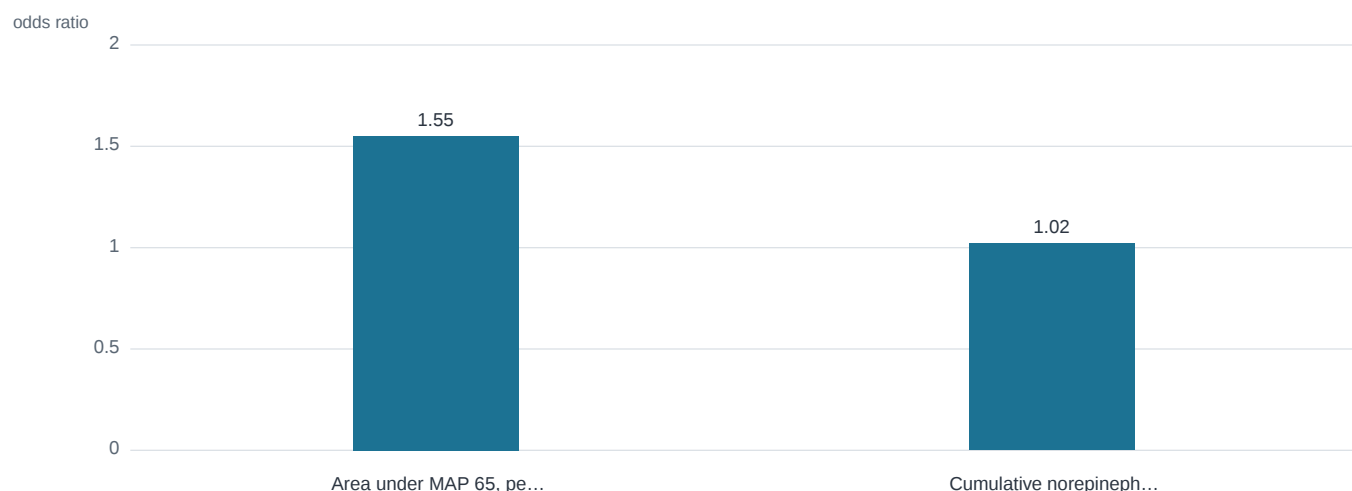
Cumulative intraoperative norepinephrine dose is independently associated with postoperative acute kidney injury, so escalating vasopressor to chase a pressure target is not a risk-free trade.

Association of Intraoperative Hypotension and Cumulative Norepinephrine Dose With Postoperative Acute Kidney Injury in Patients Having Noncardiac Surgery: A Retrospective Cohort Analysis, *British journal of anaesthesia* 2025 · PMID 39672776

#### THE NUMBERS

### **Chasing the pressure with vasopressor is not free**

Both exposures were independently associated with acute kidney injury in 38,338 patients.



**Both exposures were independently associated with kidney injury in a retrospective cohort. Whether the norepinephrine contributed or merely marked sicker patients is untested.**

*Association of Intraoperative Hypotension and Cumulative Norepinephrine Dose With Postoperative Acute Kidney Injury in Patients Having Noncardiac Surgery: A Retrospective Cohort Analysis, British journal of anaesthesia 2025 · PMID 39672776*

#### IN PRACTICE

**A maximum intraoperative heart rate above 100 bpm together with a minimum systolic**

*Cohort · Anesthesia and analgesia*

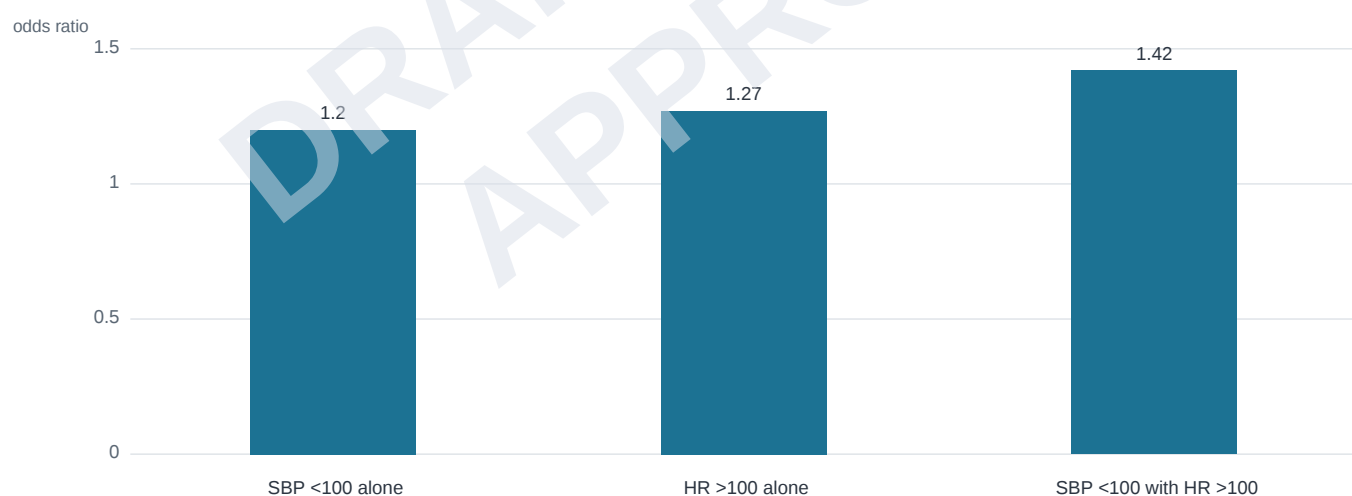
A maximum intraoperative heart rate above 100 bpm together with a minimum systolic pressure below 100 mmHg is more strongly associated with myocardial injury than low systolic pressure alone.

*A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study, Anesthesia and analgesia 2018 · PMID 29077608*

#### THE NUMBERS

**Tachycardia and hypotension together beat either alone**

*Odds of myocardial injury after noncardiac surgery, VISION study.*



**Watch the heart rate as well as the pressure — the combination is more strongly associated with myocardial injury than low pressure by itself.**

*A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study, Anesthesia and analgesia 2018 · PMID 29077608*

## IN THE ROOM

### What this changes about the next case

*Colour is the strength of the evidence behind each step, not the urgency.*

- 1 Mean arterial pressures below 60-70 mmHg are associated with myocardial injury, acute kidney injury and death, and the injury is a function of both how far the pressure falls and how long it stays there.
- 2 Organ injury is reported after 10 minutes or more below a mean arterial pressure of 80 mmHg, after shorter periods below 70 mmHg, and at any exposure below 55-50 mmHg.
- 3 Hypotension on the four days after surgery carried a far stronger association with myocardial infarction and death (odds ratio 2.83) than each extra 10 minutes of intraoperative hypotension (odds ratio 1.08).
- 4 Targeting a MAP of at least 75 mmHg instead of 60 mmHg cut time spent below 65 mmHg by roughly 60% but did not reduce acute myocardial injury or 30-day major cardiac events and acute kidney injury.
- 5 Cumulative intraoperative norepinephrine dose is independently associated with postoperative acute kidney injury, so escalating vasopressor to chase a pressure target is not a risk-free trade.

## KEY TAKEAWAYS

### What to carry into the next case

**Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,**  
British journal of anaesthesia 2019

**Organ injury is reported after 10 minutes or more below a mean arterial pressure of**  
British journal of anaesthesia 2018

**Hypotension on the four days after surgery carried a far stronger association with**  
Anesthesiology 2018

**Cumulative intraoperative norepinephrine dose is independently associated with**  
British journal of anaesthesia 2025

*Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,*

## QUESTIONS I'LL ASK YOU IN THE ROOM

1. How does your plan change if the patient is not optimised?
2. What is the physiology behind what we just did?
3. Talk me through the trade-off you made there.
4. What would make you abandon this plan and do something else?

## ORAL BOARDS STEM

*A 74-year-old with treated hypertension is 90 minutes into an open hemicolectomy. The MAP has sat between 58 and 63 mmHg for the last 20 minutes on a low-dose phenylephrine infusion, and the surgeon is asking you to keep the field dry.*

## BOARD QUESTIONS

1. Summarise the mean arterial pressure thresholds and exposure durations at which organ injury has been reported in the systematic review literature on intraoperative hypotension: what is reported below a MAP of 80 mmHg, below 70 mmHg, and below 55-50 mmHg?
2. You are escalating a norepinephrine infusion to hold a MAP target during noncardiac surgery. State what a retrospective cohort analysis found about cumulative intraoperative norepinephrine dose and postoperative acute kidney injury, and what that implies about the trade-off you are making.
3. In a prospective international multicentre cohort study of noncardiac surgery, which combination of intraoperative vital-sign extremes showed a stronger association with myocardial injury than low systolic pressure alone? Name both components with their thresholds.

4. Patients were randomised to an intraoperative MAP target of at least 75 mmHg versus 60 mmHg. Describe what the higher target achieved in terms of hypotension exposure and what it did not achieve in terms of clinical outcomes, then say what this implies about treating time-below-threshold as a surrogate endpoint.

#### ANSWER KEY

- 1. Organ injury is reported after 10 minutes or more below a MAP of 80 mmHg, after shorter periods below 70 mmHg, and at any exposure below 55-50 mmHg.**

There is no single hypotension number - the lower the pressure, the shorter the exposure that has been linked to injury.

*Intraoperative Hypotension and the Risk of Postoperative Adverse Outcomes: A Systematic Review, British journal of anaesthesia 2018 · PMID 30236233*

- 2. Cumulative intraoperative norepinephrine dose was independently associated with postoperative acute kidney injury in that retrospective cohort. It is an association rather than proven causation, but it means escalating vasopressor to chase a pressure target is not a risk-free trade.**

Both sides of the equation carry risk - the low pressure you are treating and the drug you are treating it with.

*Association of Intraoperative Hypotension and Cumulative Norepinephrine Dose With Postoperative Acute Kidney Injury in Patients Having Noncardiac Surgery: A Retrospective Cohort Analysis, British journal of anaesthesia 2025 · PMID 39672776*

- 3. A maximum intraoperative heart rate above 100 bpm together with a minimum systolic pressure below 100 mmHg. That combination was more strongly associated with myocardial injury than low systolic pressure alone - an association reported from a prospective cohort.**

Read the heart rate next to the pressure - tachycardia with a low systolic carried a stronger association with myocardial injury than the low pressure by itself.

*A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study, Anesthesia and analgesia 2018 · PMID 29077608*

- 4. The higher target cut time spent below 65 mmHg by roughly 60%, but did not reduce acute myocardial injury or 30-day major cardiac events and acute kidney injury. Reducing the hypotension exposure did not carry the clinical outcomes with it, so time-below-threshold behaved as a surrogate that moved on its own.**

You can successfully move the number you are targeting and still not move the outcome you actually care about.

*Targeting Higher Intraoperative Blood Pressures Does Not Reduce Adverse Cardiovascular Events Following Noncardiac Surgery, Journal of the American College of Cardiology 2021 · PMID 34711333*

**Mean arterial pressures below 60-70 mmHg are associated with myocardial injury,**

#### SOURCES

- [1] Perioperative Quality Initiative Consensus Statement on Intraoperative Blood Pressure, Risk and Outcomes for Elective Surgery, British journal of anaesthesia 2019 · PMID 30916004
- [2] Intraoperative Hypotension and the Risk of Postoperative Adverse Outcomes: A Systematic Review, British journal of anaesthesia 2018 · PMID 30236233
- [3] Period-Dependent Associations Between Hypotension During and for Four Days After Noncardiac Surgery and a Composite of Myocardial Infarction and Death: A Substudy of the POISE-2 Trial, Anesthesiology 2018 · PMID 29189290
- [4] Association of Intraoperative Hypotension and Cumulative Norepinephrine Dose With Postoperative Acute Kidney Injury in Patients Having Noncardiac Surgery: A Retrospective Cohort Analysis, British journal of anaesthesia 2025 · PMID 39672776
- [5] Targeting Higher Intraoperative Blood Pressures Does Not Reduce Adverse Cardiovascular Events Following Noncardiac Surgery, Journal of the American College of Cardiology 2021 · PMID 34711333
- [6] A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study, Anesthesia and analgesia 2018 · PMID 29077608