Intraoperative Hypotension: Should We Initiate Vasopressors Sooner, and is the 20% of Baseline Rule still the Gold Standard?

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Outline of Today's Presentation

3 Main Goals

DEFINITION

COMPLICATIONS

OUR ROLE

1. Definition

1. Definition

Definitions of Intraoperative Hypotension

Physiology of Blood Pressure

Blood Pressure Monitoring

2. Complications

2. Complications

Major complications associated with perioperative hypotension

Incidence as a function of a given definition

3. Our Role

3. Our Role

Why Patients Become Hypotensive

What can we do?

Shift from Treatment to Prevention

Is this hypotension?

120/80

(93)

Patient's Baseline

160/90

(113)

Is this hypotension?

75/48

(57)

Is this hypotension?

96/50

(65)

Is this hypotension?

92/50

(64)

1. Definition

Intraoperative Hypotension (IOH)

- Independently associated with adverse perioperative outcomes and an increase in long-term mortality[1,2]
- No clear or widely accepted defintion[3]

Intraoperative Hypotension (IOH)

- 2016 Study by Bijker et al.[1]
- Found **140** definitions in **130** studies of **15,000** adults
- Incidence of IOH varied between **5-99%** depending on the definition

Intraoperative Hypotension (IOH)

- Defined as either:
  - Absolute
    - Mean under 65
  - Relative
    - 20% Drop from baseline

Intraoperative Hypotension (IOH)

- Problem with these definitions is that both:
  - **<u>Baseline Blood Pressures</u>**

    &

  - **<u>Lower Limits of Autoregulation</u>**
- Vary considerably from individual to individual[3]

Intraoperative Hypotension (IOH)

- Problem with relative:
- Need an **unambiguous** definition of baseline
- Immediate preinduction blood pressures **poorly reflect** ambulatory blood pressure

Intraoperative Hypotension (IOH)

- Problem with absolute:
- Almost all data comes from critical care literature
- Showed a **negative** correlation between using vasoactive agents to maintain a MAP >65

Intraoperative Hypotension (IOH)

- Problem with absolute:
  - Assumes your BP measurement of 95/60(65) is 100% accurate
- Exact size cuff
- Perfectly level with Tragus (reflects flow circle of Willis)
- No confounding factors:
  - Medical student on cuff
  - Surgeon on vessel

Intraoperative Hypotension (IOH)

- Problem with absolute:
  - Why is our goal the absolute minimum threshold before treatment?

Intraoperative Hypotension (IOH)

- Boeing 737-900
- Needs about **6800 ft** to land safely
- Avg runway at Dulles International Airport is **11,500 ft**
- Longest runway at RIC is **8100 ft**

Intraoperative Hypotension (IOH)

- Evidence shows these definitions, that is **hypotensive or not**, poorly characterize what is going on

- More sophisticated definitions consider **both**

  - **Duration & Severity**

Intraoperative Hypotension (IOH)

- Also referred to as

"Time under the Curve"

Intraoperative Hypotension (IOH)

- Calculated as units of mmHg x minutes
- Ex. MAP = 50 for 20 mins (Goal MAP of 65 mmHg)
- = 15 mmHg x 20 = 300 mmHg hypotensive mins

Physiology

- Etiology of IOH is complex and multifactorial

- Occurs because most anesthetics:
  - Decrease vascular smooth muscle tone
  - Impair myocardial contractility
  - Decrease the circulating concentrations of the catecholamines norepinephrine (NE) and epinephrine by up to 50% (E)[4,5]

Measurement

- Continuous arterial measurement = gold standard

- Intermittent Oscillometric:
  - Overestimates low BP
  - Underestimates high BP
  - Dependent on appropriate cuff size and location
  - Detects ½ as many hypotensive minutes

Measurement

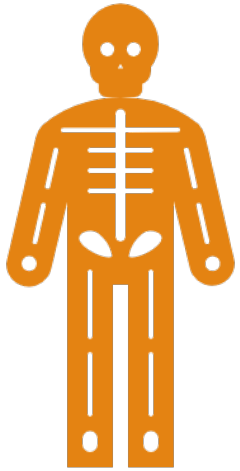
- Other factors include:
  - Hypotension caused by pressure on a vessel by surgeon
  - Changes in position
    - Trendelenburg / Reverse Trendelenburg
    - Beach chair

2. Complications

Major Complications

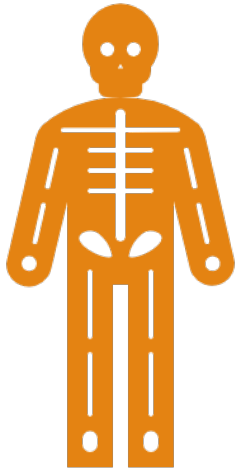
- Basic physiology teaches that if blood pressure becomes…

"Low enough for a period long enough, organ perfusion is compromised."[6]



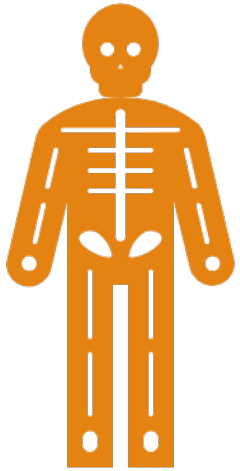
Major Complications

- Studies to date[6] show a close relationship between **IOH** and **increased** incidence of:



Major Complications

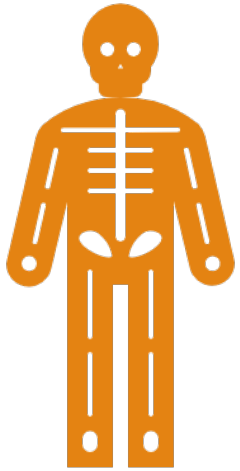
- Mortality
- Major Morbidity
- Watershed Stroke
- Early Cognitive Dysfunction
- Post-op Delirium
- Acute Kidney Injury
- Myocardial Ischemia
- Myocardia Infarction



Major Complications

2 most common

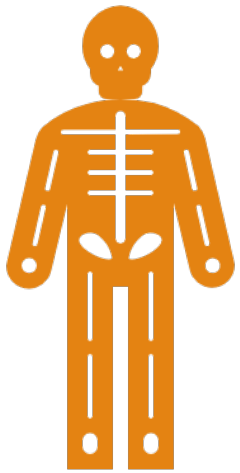
- Acute Kidney Injury (AKI)
- Myocardial Injury



Major Complications

- A 2013 retrospective study by Walsh et al.[7] of 33,330 patients found:

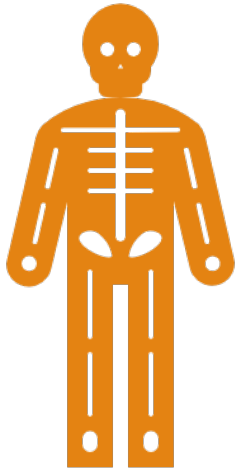
- "Any amount of time spent with **MAP <55mmHg** was associated with AKI and Myocardial injury"



Major Complications

- Evidence shows that the association between organ injury and IOH is a function of both **severity** and **duration**

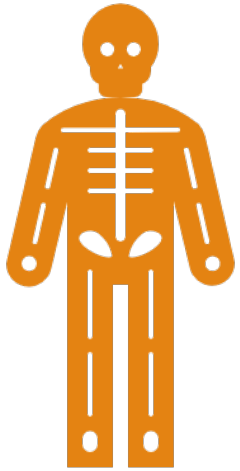
- Lower pressures require shorter exposures



Major Complications

- A 2018 Systematic Review[8] of 42 studies found the risk of organ injury was:

- **Slightly** increased when mean arterial pressure < **70mmHg** was sustained for just **10 minutes**
- **Moderately** increased when mean arterial pressure < **65mmHG** was sustained for at least **5 minutes**
- **High** risk for **<u>any pressure less than 55mmHg</u>**



Acute Kidney Injury

- Defined as a sudden decrease in kidney function
- **7.5%** incidence in noncardiac surgery patients[9]

Acute Kidney Injury

- Increase in serum creatinine greater than **0.3mg/dl** within **48 hours**

- Urine volume less than **0.5ml^kg^hr** for **6 hours**

Myocardial Infarction

- Defined as a postoperative increase in troponin
- **18%** incidence in noncardiac surgery patients[10]

Myocardial Infarction

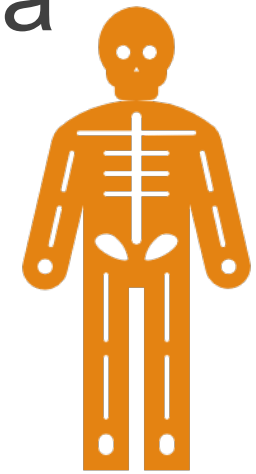
90% of myocardial injury is **silent** and accompanied by **no clinical signs** such as EKG changes[10]

Major Complications

- A 2017 retrospective study of **53,315** noncardiac surgical patients by Salmasi et al.[11] found that:

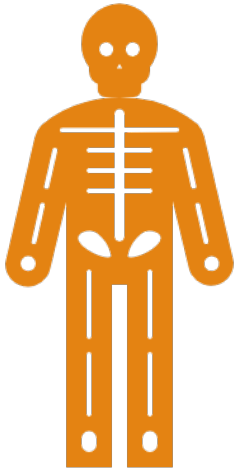
- The threshold for **myocardial infarction** was at a MAP **<65 mmHg**

- The threshold for **AKI** was at a MAP **<75 mmHg**



Major Complications

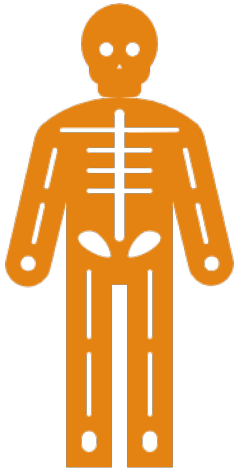
- Randomized trials (RCT) of intra-operative blood pressure control are rare and difficult to conduct
- Only one has been done so far



Major Complications

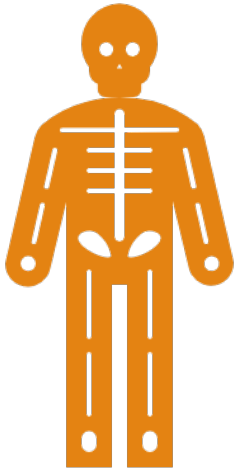
- A 2017 RCT by Fuier et al.[12] of 298 patients undergoing abdominal surgery >2 hours

Group 1	Group 2
SBP within 10% baseline	SBP within 40% of baseline or SBP < 80



Major Complications

- Found that the **2nd group** had a **25%** increased risk of organ dysfunction



3. Our Role

Why Patients become Hypotensive

- Almost as important as

WHY

is

WHEN

Why Patients become Hypotensive

During induction

- **Propofol** causes vasodilation
  - ↓ Afterload, ↓ Preload, ↓ SV
- **Lidocaine & Fentanyl**
  - Blunt the sympathetic response to laryngoscopy
- **Ventilator**, transitioning from **negative** to **positive** pressure
  - ↓ Venous Return & Preload

Why Patients become Hypotensive

- MAP = CO x SVR
- CO = HR x SV
- MAP = HR x SV x SVR

Why Patients become Hypotensive

- With decreased **SVR** and **SV**

- **Heart rate** must **increase** to maintain **MAP**

- We prevent an increase in HR, sometimes even giving esmolol during induction

Why Patients become Hypotensive

- Even though **induction** and the **preincision** period are relatively short

- Accounts for **1/3** of all hypotension[12]

Why Patients become Hypotensive

During surgery

- Factors include:
  - Blood loss
  - Pneumoperitoneum
  - Position changes

Why Patients become Hypotensive

"Acute **increases** in blood pressure & heart rate **commonly occur** in the setting of **adequate depth** of anesthesia & analgesia."[9]

What can we do?

Focus on 3 interrelated goals

What can we do?

1. Maintenance of adequate perfusion pressure and flow
2. Appropriate anesthesia depth
3. Hypotension **prevention**

What can we do?

1. Maintenance of adequate perfusion pressure and flow

What can we do?

- Most **IOH** is either from:
  - Reduced volume
  - Reduced tone
  - Both

What can we do?

- Early initiation of vasopressors to treat vasodilation
- Increasing **CO** with inotropes

What can we do?

- Adequate blood pressure is necessary for adequate flow, but **not sufficient**[13]
- During severe **hypovolemia**, vasoconstriction can only maintain blood pressure for a finite amount of time

What can we do?

- Treating intravascular **hypovolemia** with crystalloids, colloids, or blood products
- Cardiac output monitors can help provide **objective data** regarding blood flow (**SV, SVV**)

What can we do?

2. Appropriate anesthesia depth

What can we do?

- The goals of general anesthesia are **hypnosis, analgesia,** and **neuromuscular blockade** all while maintaining hemodynamic stability

What can we do?

- When a patient is over-anesthetized, autoregulation is lost, and tissue perfusion becomes **pressure dependent**
- Both **NMBs** and **anesthetic adjuncts** can decrease MAC

What can we do?

- Consider depth of anesthesia monitor like the BIS
- Letting go of “train track” anesthesia

What can we do?

3. Hypotension prevention

Shift from Treatment to Prevention

- We know **IOH** is associated with adverse outcomes
- Establish and target the **middle** acceptable blood pressure range rather than just the **minimum**

Shift from Treatment to Prevention

- Shift from **reaction** to **prevention**
- Why wait until the undesirable event has **already occurred**?

Shift from Treatment to Prevention

***Surgeon**: "Is the patient on pressors?"*

***Anesthesia**: "Yes, on low-dose NE, but not hypotensive"*

***Surgeon**: "Then why are they on pressors?"*

Summary

Key Points

- Brief periods of **IOH** (mean arterial pressure < 60 – 70 mmHg) resulted in **increased** incidences of **acute kidney injury**, **myocardial ischemia**, and **perioperative mortality.**

Key Points

- The only **RCT** to date showed that maintaining intraoperative blood pressure with a tight range (**10%**) resulted in **improved outcomes**.

Key Points

- Goals to maintain hemodynamic stability should be an integral part of the anesthesia plan.

Questions

References

1. Bijker JB, van Klei WA, Kappen TH, van Wolfswinkel L, Moons KG, Kalkman CJ. Incidence of intraoperative hypotension as a function of the chosen definition: literature definitions applied to a retrospective cohort using automated data collection. Anesthesiology. 2007;107(2):213-220. doi:10.1097/01.anes.0000270724.40897.8e

2. Südfeld S, Brechnitz S, Wagner JY, et al. Post-induction hypotension and early intraoperative hypotension associated with general anaesthesia. Br J Anaesth. 2017;119(1):57-64. doi:10.1093/bja/aex127

3. Saugel B, Sessler DI. Perioperative Blood Pressure Management. Anesthesiology. 2021 Feb 1;134(2):250-261. doi: 10.1097/ALN.0000000000003610. PMID: 33206118.

4. Goldmann A, Hoehne C, Fritz GA, et al. Combined vs. Isoflurane/Fentanyl anesthesia for major abdominal surgery: Effects on hormones and hemodynamics. Med Sci Monit. 2008;14(9):CR445-CR452.

5. Ullman J: Influence of neurohumoral blockade on heart rate and blood pressure responses to hemorrhage in isoflurane anaesthetised rats. Acta Physiol Scand, 2000; 169: 189–94

References

6. Meng L, Yu W, Wang T, Zhang L, Heerdt PM, Gelb AW. Blood Pressure Targets in Perioperative Care. Hypertension. 2018 Oct;72(4):806-817. doi: 10.1161/HYPERTENSIONAHA.118.11688. PMID: 30354725.

7. Walsh M, Devereaux PJ, Garg AX, Kurz A, Turan A, Rodseth RN, Cywinski J, Thabane L, Sessler DI. Relationship between intraoperative mean arterial pressure and clinical outcomes after noncardiac surgery: toward an empirical definition of hypotension. Anesthesiology. 2013 Sep;119(3):507-15. doi: 10.1097/ALN.0b013e3182a10e26. PMID: 23835589.

8. Wesselink EM, Kappen TH, Torn HM, Slooter AJC, van Klei WA. Intraoperative hypotension and the risk of postoperative adverse outcomes: a systematic review. Br J Anaesth. 2018 Oct;121(4):706-721. doi: 10.1016/j.bja.2018.04.036. Epub 2018 Jun 20. PMID: 30236233.

9. Hu Y, Lim A. MAP 65-is it enough? Curr Opin Anaesthesiol. 2022 Apr 1;35(2):242-247. doi: 10.1097/ACO.0000000000001115. PMID: 35125394.

References

10. Writing Committee for the VISION Study Investigators, Devereaux PJ, Biccard BM, Sigamani A, Xavier D, Chan MTV, Srinathan SK, Walsh M, Abraham V, Pearse R, Wang CY, Sessler DI, Kurz A, Szczeklik W, Berwanger O, Villar JC, Malaga G, Garg AX, Chow CK, Ackland G, Patel A, Borges FK, Belley-Cote EP, Duceppe E, Spence J, Tandon V, Williams C, Sapsford RJ, Polanczyk CA, Tiboni M, Alonso-Coello P, Faruqui A, Heels-Ansdell D, Lamy A, Whitlock R, LeManach Y, Roshanov PS, McGillion M, Kavsak P, McQueen MJ, Thabane L, Rodseth RN, Buse GAL, Bhandari M, Garutti I, Jacka MJ, Schünemann HJ, Cortes OL, Coriat P, Dvirnik N, Botto F, Pettit S, Jaffe AS, Guyatt GH. Association of Postoperative High-Sensitivity Troponin Levels With Myocardial Injury and 30-Day Mortality Among Patients Undergoing Noncardiac Surgery. JAMA. 2017 Apr 25;317(16):1642-1651. doi: 10.1001/jama.2017.4360. PMID: 28444280.

11. Salmasi V, Maheshwari K, Yang D, Mascha EJ, Singh A, Sessler DI, Kurz A. Relationship between Intraoperative Hypotension, Defined by Either Reduction from Baseline or Absolute Thresholds, and Acute Kidney and Myocardial Injury after Noncardiac Surgery: A Retrospective Cohort Analysis. Anesthesiology. 2017 Jan;126(1):47-65. doi: 10.1097/ALN.0000000000001432. PMID: 27792044.

References

12. Maheshwari K, Turan A, Mao G, et al. The association of hypotension during non-cardiac surgery, before and after skin incision, with postoperative acute kidney injury: a retrospective cohort analysis. Anaesthesia. 2018;73(10):1223-1228. doi:10.1111/anae.14416

13. Mascha EJ, Yang D, Weiss S, Sessler DI. Intraoperative Mean Arterial Pressure Variability and 30-day Mortality in Patients Having Noncardiac Surgery. Anesthesiology. 2015;123(1):79-91. doi:10.1097/ALN.0000000000000686