Perioperative Ischämie – Immer noch ein silent killer?

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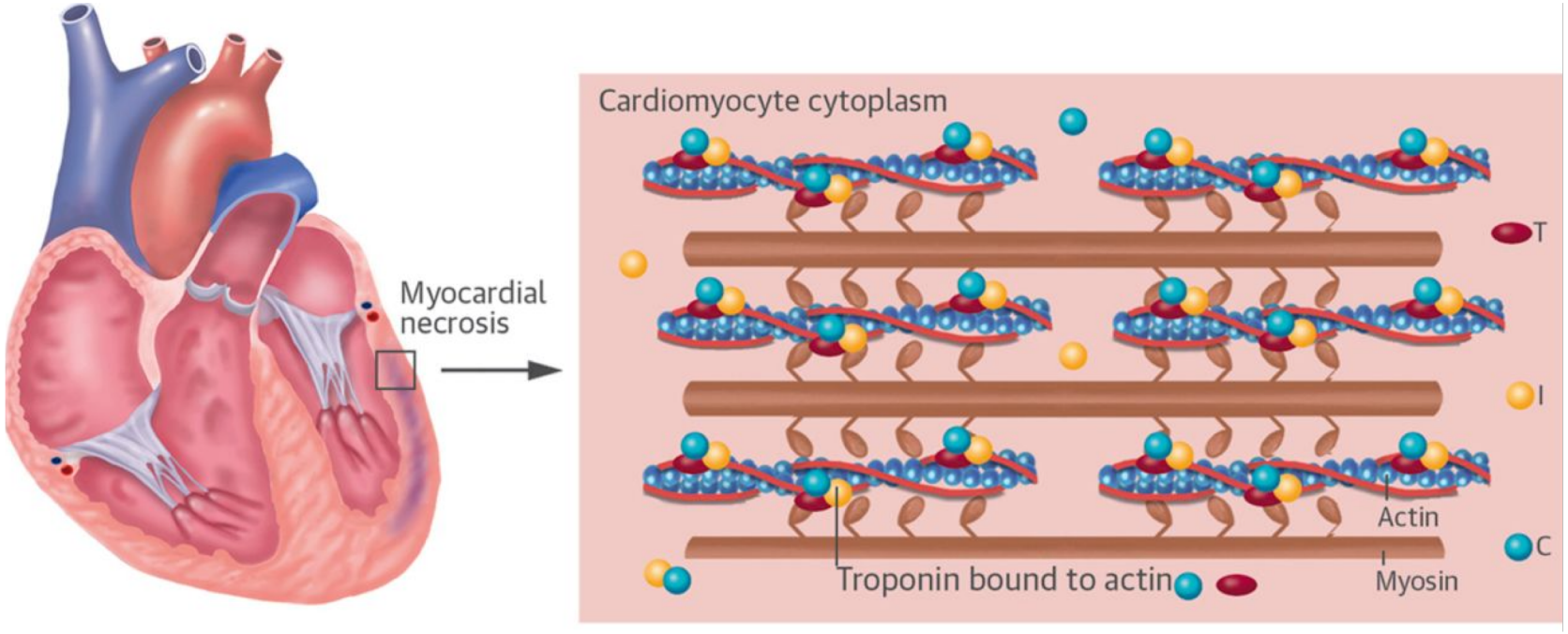
Declaration of Interest

- No conflict of interest to declare

"A cat killer? Is that the face of a cat killer? Cat chaser maybe. But hey—who isn't?"

Myocardial Injury in Non-Cardiac Surgery - MINS



Brush JE. JACC 2016; 68:2365-75.

hs-Troponin

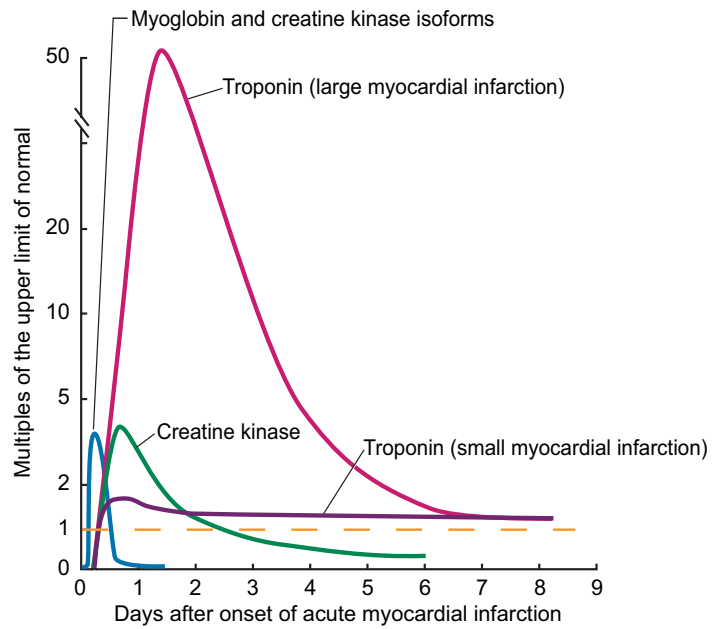


FIGURE 1. Time of release of selected cardiac biomarkers after myocardial infarction.

Acute Coronary Syndrome:

Cut-off for rule-out < 12 ng/L

Cut-off for rule-in > 52 ng/L

MINS:

Cut-off: > 20 ng/L

Horr S.Cleve Clin J Med 2015;82:595-568.
Roffi M Eur Heart J 2016;37: 267-315

JAMA | Original Investigation

Association of Postoperative High-Sensitivity Troponin Levels With Myocardial Injury and 30-Day Mortality Among Patients Undergoing Noncardiac Surgery

Writing Committee for the VISION Study Investigators

CONCLUSIONS AND RELEVANCE Among patients undergoing noncardiac surgery, peak postoperative hsTnT during the first 3 days after surgery was significantly associated with 30-day mortality. Elevated postoperative hsTnT without an ischemic feature was also associated with 30-day mortality.

Table 2. Peak Postoperative hsTnT Thresholds Associated With 30-Day Mortality[a]

	hsTnT Thresholds, ng/L					
	<5	5 to <14	14 to <20	20 to <65	65 to <1000	≥1000
Patients, No. (%)	5318 (24.4)	8750 (40.1)	2530 (11.6)	4049 (18.6)	1118 (5.1)	54 (0.2)
Deaths, No. (%)	6 (0.1)	40 (0.5)	29 (1.1)	123 (3.0)	102 (9.1)	16 (29.6)
Adjusted hazard ratio (95% CI)	1 [Reference]	3.73 (1.58-8.82)	9.11 (3.76-22.09)	23.63 (10.32-54.09)	70.34 (30.60-161.71)	227.01 (87.35-589.92)
P Value		.003	<.001	<.001	<.001	<.001

Abbreviation: hsTnT, high-sensitivity troponin T.

[a] A total of 21 819 patients were included in this analysis. The Cox proportional hazards model includes the following preoperative variables: active cancer, general surgery, urgent/emergent surgery, history of peripheral vascular disease, history of chronic obstructive pulmonary disease, age, recent high-risk coronary artery disease, history of stroke, and neurosurgery. Postoperative hsTnT measurements during the first 3 days after surgery were assessed in these analyses.

Devereaux PJ. JAMA 2017;317:1642-1651

REVIEW ARTICLE

Troponin elevations after non-cardiac, non-vascular surgery are predictive of major adverse cardiac events and mortality: a systematic review and meta-analysis

S. Ekeloef[1,*], M. Alamili[1], P. J. Devereaux[2,3] and I. Gögenur[1]

[1]Department of Surgery, Center for Surgical Science, Zealand University Hospital, Koege and Roskilde, Denmark, [2]Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada and [3]Department of Medicine, McMaster University, Hamilton, Ontario, Canada

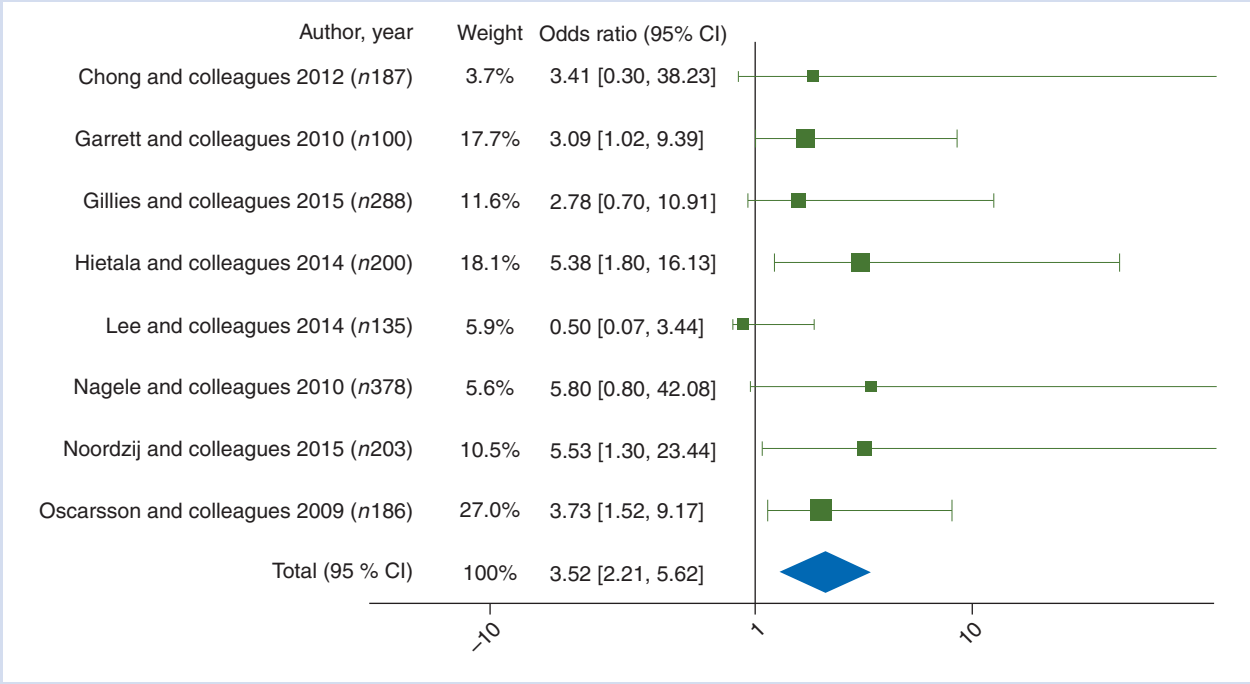
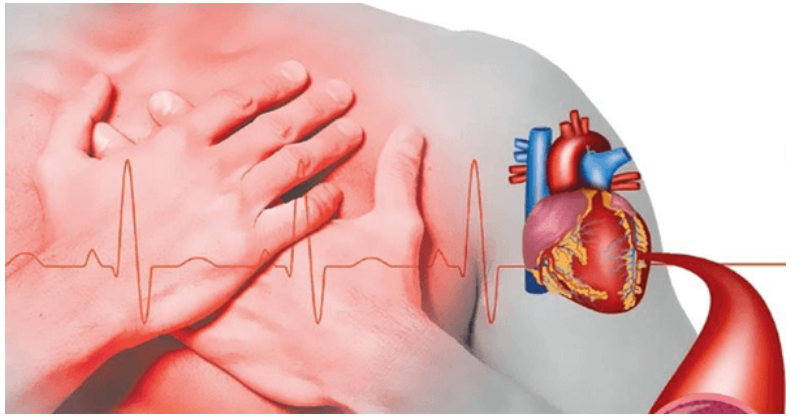


Fig 2 Forest plot showing the association between postoperative troponin elevation and odds ratio of 30 day mortality. I^2=0%. The size of the box represents the weight of that study estimate. Horizontal lines represent 95% confidence intervals.

Ekeloef S. BJA 2016;117:559-568

Causes for myocardial injury

- Type I myocardial infarction (intraluminal thrombosis)
- Direct or traumatic damage of the myocardium
- **Imbalance between oxygen demand/supply ratio**

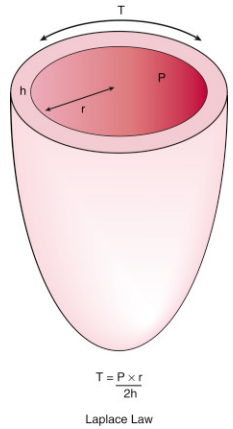


Myocardial Oxygen Demand

1. Ventricular wall tension (pressure work)
2. Contractility (Changing $\Delta P/\Delta t$ will change MVO_2)
3. Heart rate – proportional change in MVO_2

Myocardial Oxygen Supply

1. Coronary artery flow
2. Oxygen content
3. Oxygen extraction



Normal myocardial oxygen consumption (MVO_2) is 21-27ml.min^{-1}
Basal oxygen consumption ca. 8 ml/min/100g = 25% of the MVO_2

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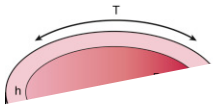


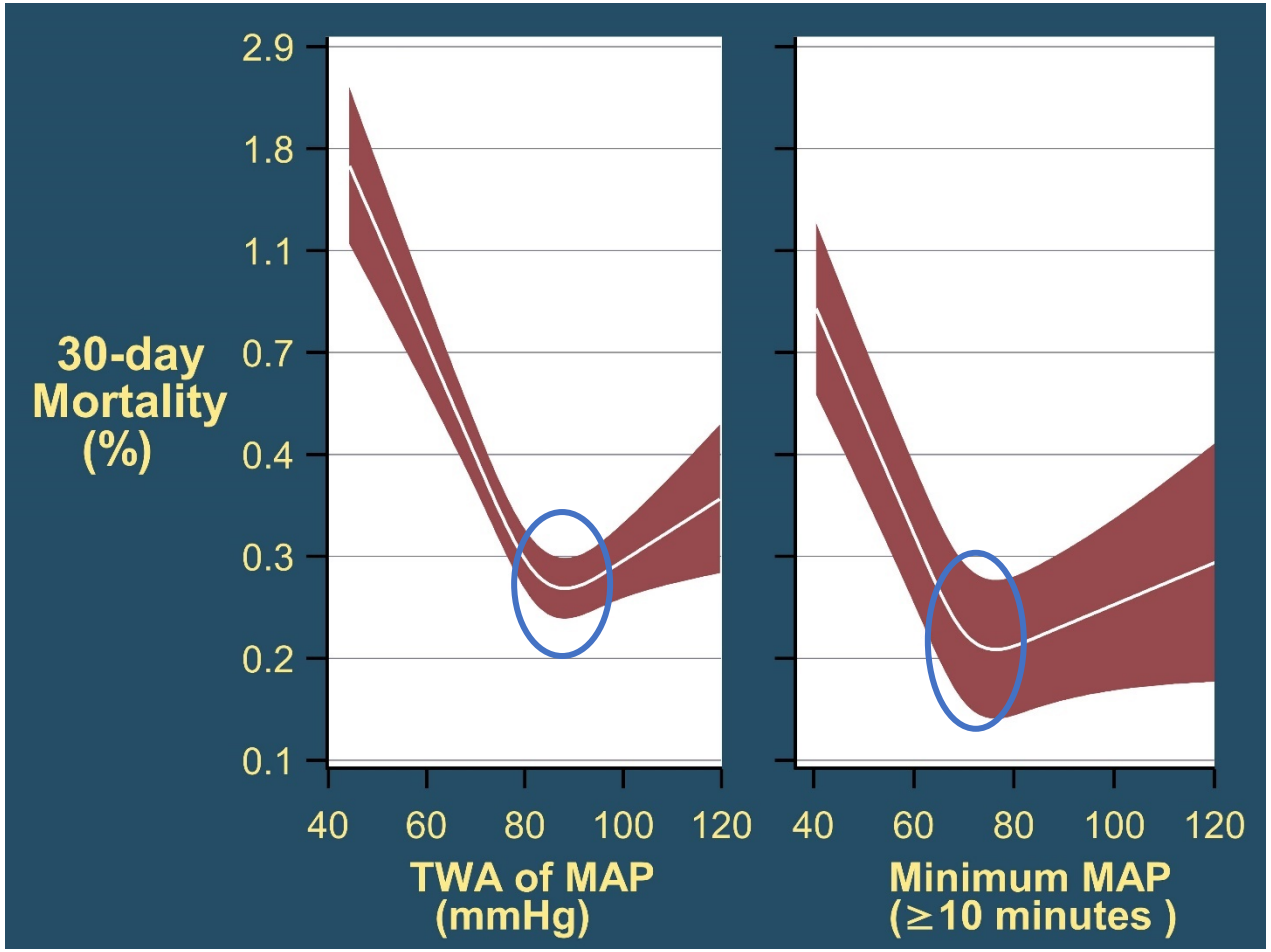
Two determinants of Oxygen demand/supply mismatch is the perfusion pressure and the heart rate

$\frac{\cdot \times r}{2h}$

Laplace Law

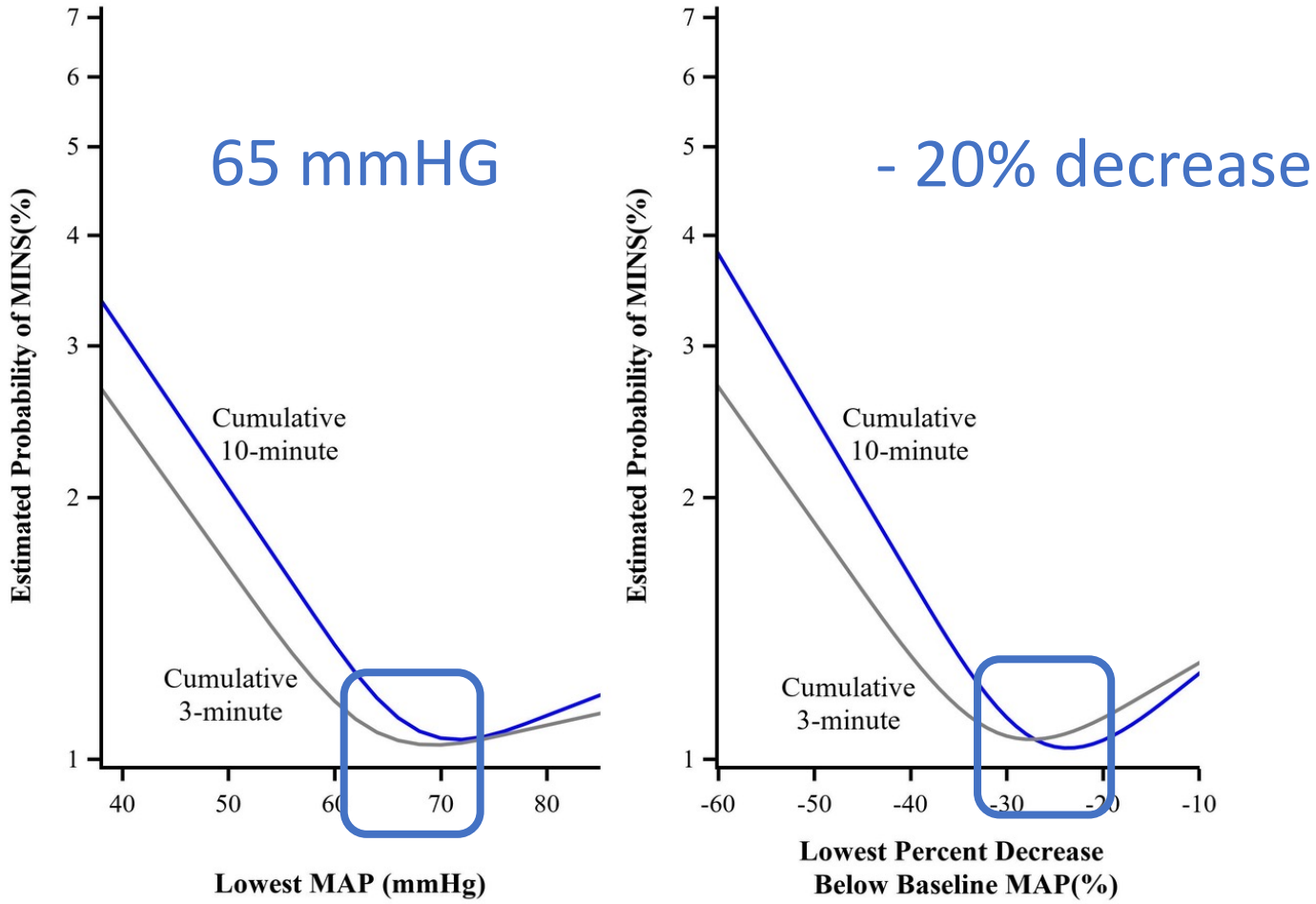
Normal myocardial oxygen consumption (MVO_2) is 21-27ml.min^{-1}
Basal oxygen consumption ca. 8 ml/min/100g = 25% of the MVO_2

Modifiable risk factors for MINS:
->Association Between MAP & Death



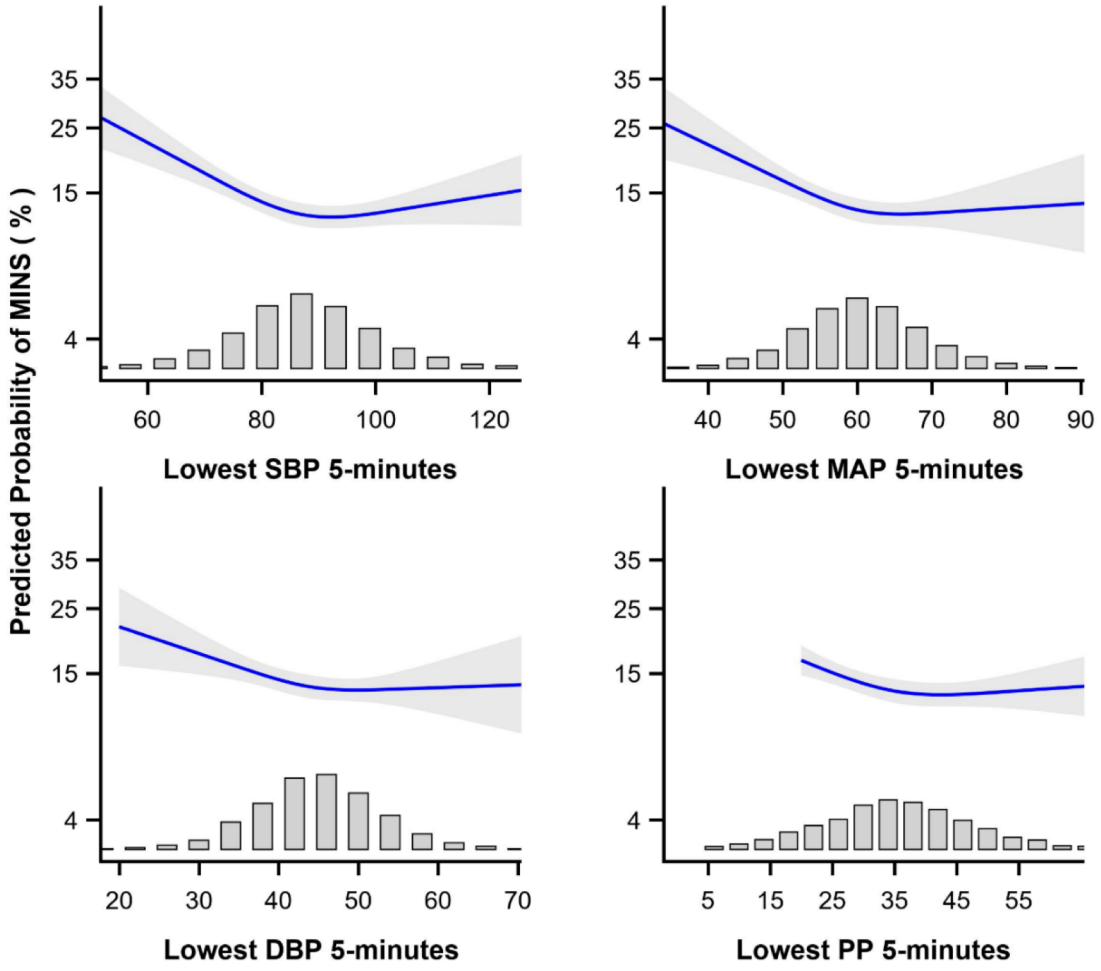
Mascha, *et al*., 2015, Anesthesiology

Intraoperative blood pressure & MINS



Salmasi, *et al*., 2016, Anesthesiology

Which BP component ?



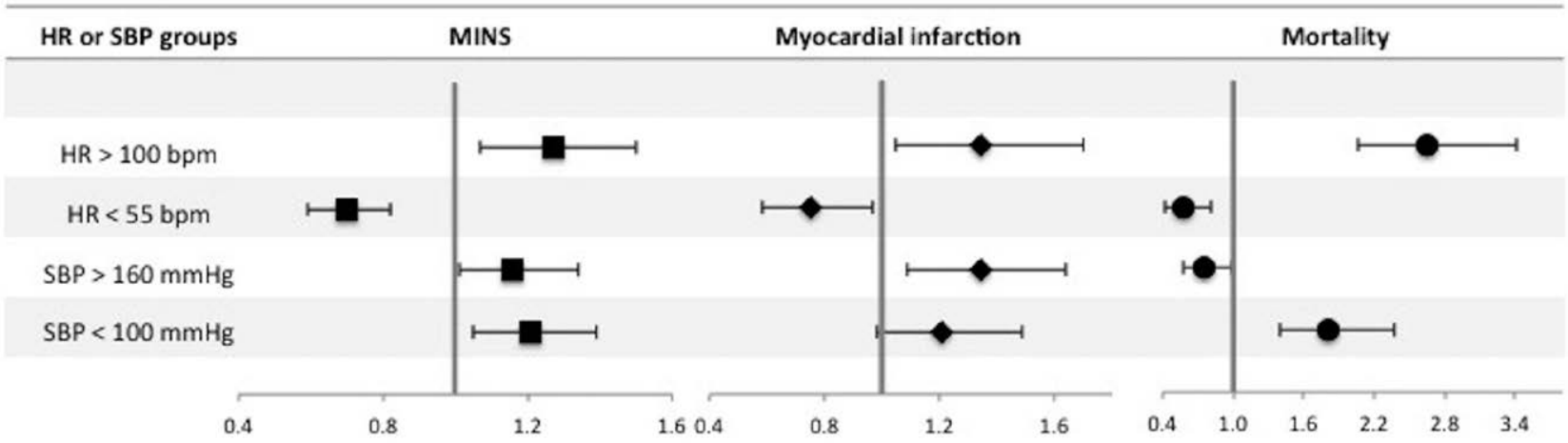
Systolic 90 mmHg

MAP 65 mmHg

Ahuja, *et al*., 2019, Anesthesiology

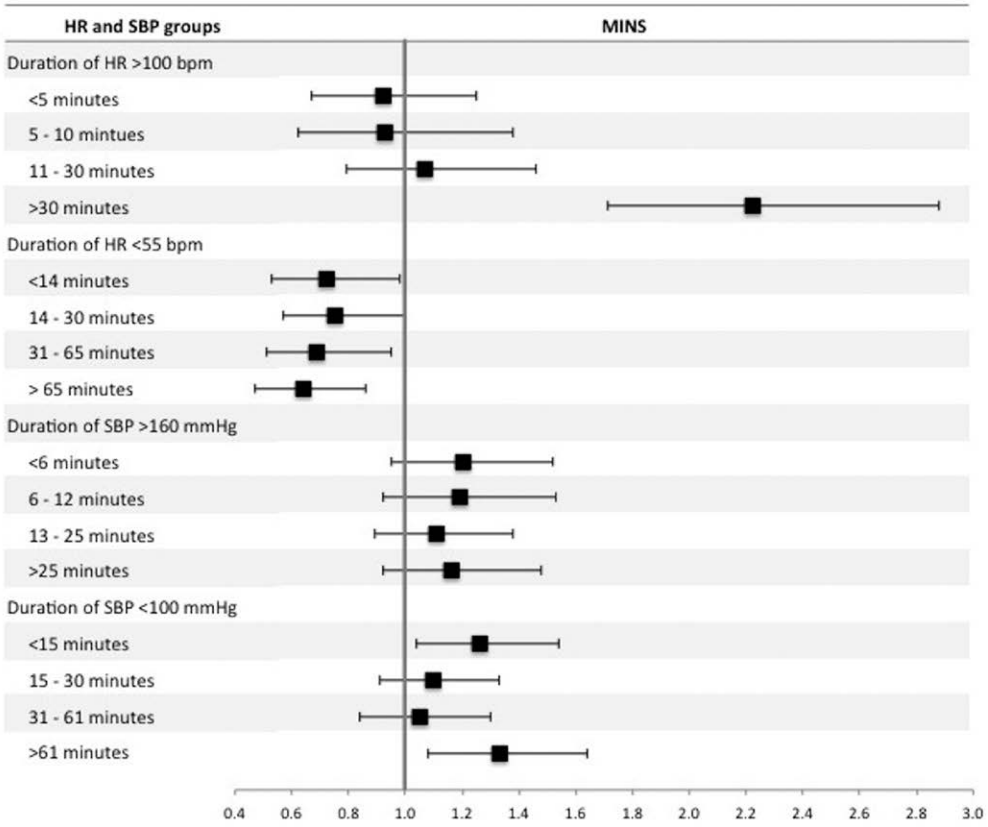
A Prospective International Multicentre Cohort Study of Intraoperative Heart Rate and Systolic Blood Pressure and Myocardial Injury After Noncardiac Surgery: Results of the VISION Study

Tom E. F. Abbott, MRCP,* Rupert M. Pearse, MD,* R. Andrew Archbold, MD,†
Tahania Ahmad, MPH,* Edyta Niebrzegowska, MSc,† Andrew Wragg, FRCP,†
Reitze N. Rodseth, PhD,‡ Philip J. Devereaux, PhD,§ and Gareth L. Ackland, PhD*



Abbott TEF Anesth Analg 2018;126:1936-1945

Determinant Time of Tachycardia



Abbott TEF Anesth Analg 2018;126:1936-1945

Prolonged Tachycardia with Higher Heart Rate Is Associated with Higher ICU and In-hospital Mortality

Masao Hayashi[a]*, Arata Taniguchi[a], Ryuji Kaku[a], Shusaku Fujimoto[b], Satoshi Isoyama[a], Sei Manabe[c], Tsubasa Yoshida[d], Satoshi Suzuki[a], Kazuyoshi Shimizu[a], Hiroshi Morimatsu[a], and Ryusuke Momota[e]

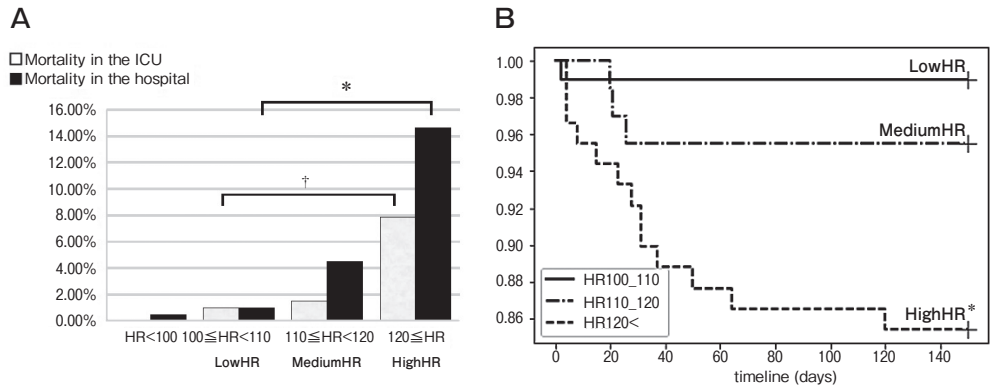


Fig. 2 **A**, The mortality in the ICU and in the hospital. The patients were stratified by HR alone as LowHR (100 ≤HR ＜110), MediumHR (110 ≤HR ＜120), and HighHR (HR ≥120). Both the ICU and in-hospital mortality rates were significantly higher in the HighHR group compared to the LowHR group. †$p < 0.05$, ＊$p < 0.01$ by Fisher's exact test; **B**, The Kaplan-Meier curves of the LowHR, MediumHR, and HighHR groups. These results confirmed those illustrated in panel A. †$p < 0.05$, ＊$p < 0.01$ by log rank test.

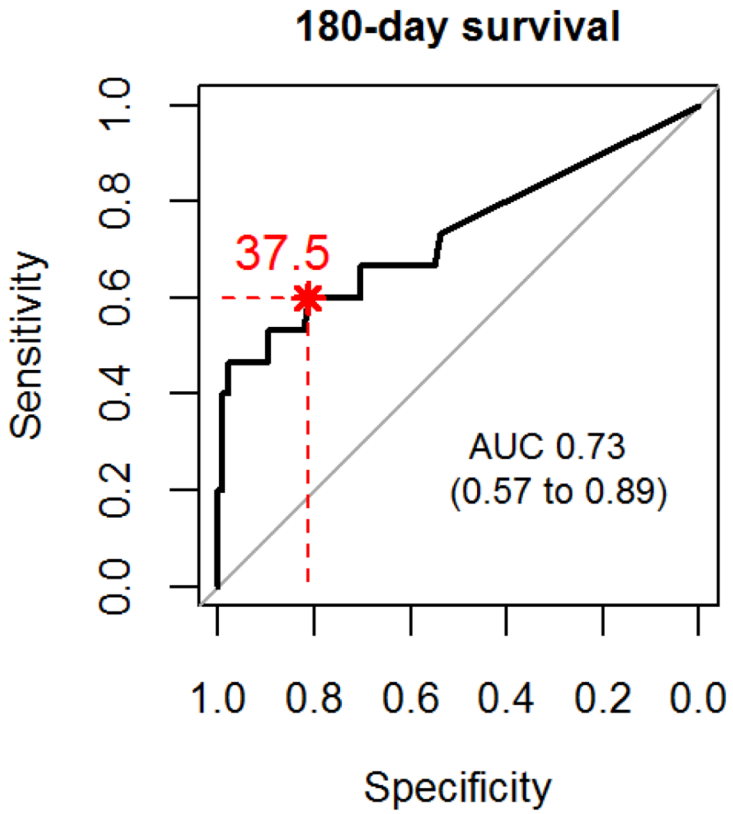
Table 2 Odds Ratio of group MediumHR and HighHR to LowHR

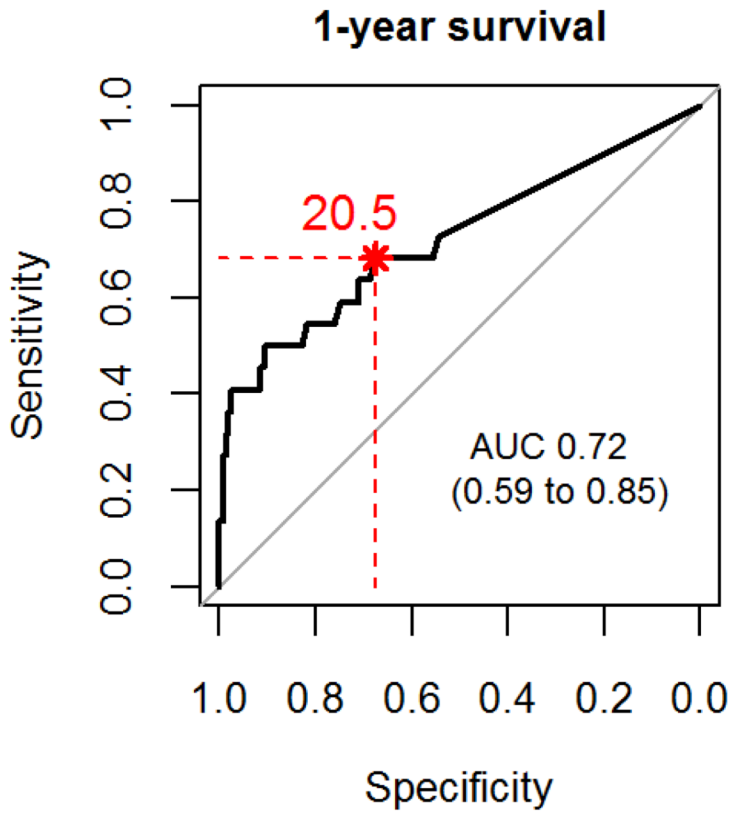
Groups	OR of mortality in ICU			OR of mortality in hospital		
	OR	95%CI	*p* value	OR	95%CI	*p* value
LowHR	1	–	–	1	–	–
MediumHR	1.5	0.1–37.2	0.79	4.5	0.6–91.7	0.16
HighHR	7.3	1.2–138.0	＜0.05†	13.7	2.5–256.6	＜0.01*

（†: ＜0.05, ＊: ＜0.01）

Hayashi M Acta Med Oca 2019;73:147-153

Lung surgery: Troponin and MINS





Kotzinger O under review

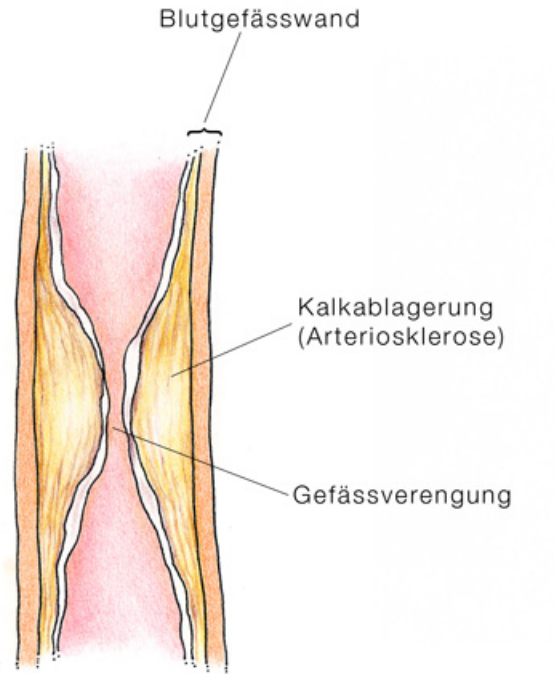
Lung surgery and MINS

Table 3. **Intraoperative tachycardia and hypotension in patients with high-sensitive troponin levels of > 20 ng/L and > 37 ng/L, respectively.**

	Time MAP < 60 mmHg	p - value	Time HR > 90 bpm	p - value
hs-Trop < 20 ng/L	24 ± 26 min	0.003	6 ± 18 min	0.006
hs-Trop ≥ 20 ng/L	36 ± 30 min		14 ± 26 min	
hs-Trop < 37 ng/L	27 ± 28 min	0.178	8 ± 18 min	0.010
hs-Trop ≥ 37 ng/L	33 ± 30 min		16 ± 30 min	

Kotzinger O under review

Pathomechanismus



Myocardial oxygen demand-supply relationship

Koronare Blutfluss

Gesunden: 250 ml/min ~ 5% HZV

ER 60 – 70%

Maximaler Blutfluss beim Gesunden:

390 ml/min bei HF 165

- Tachykardie vermeiden!
  - Frequenz über 100 erhöht den Sauerstoff-demand und erniedrigt gleichzeitig das Sauerstoffangebot!

Tachycardia-Induced Subendocardial Necrosis in Acutely Instrumented Dogs with Fixed Coronary Stenosis

Giora Landesburg, MD, DSc*, Wei Zhou, MD†, and Thomas Aversano, MD*

*Department of Anesthesiology and Critical Care Medicine, Hebrew University-Hadassah Hospital, Jerusalem, Israel; and
†Department of Medicine, Division of Cardiology, Johns Hopkins Hospital, Baltimore, Maryland

HR von 88 auf 150 bpm:

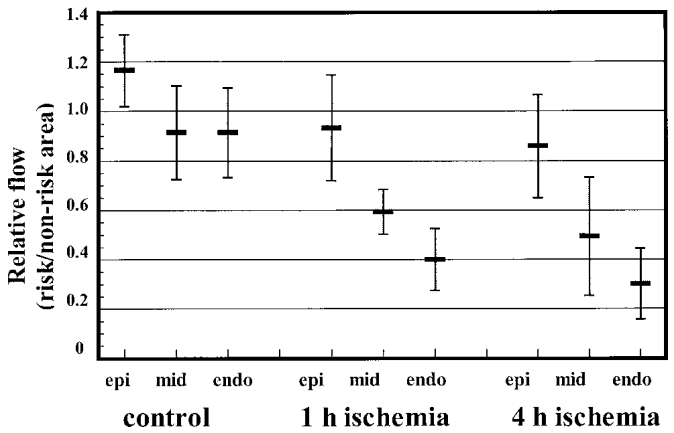
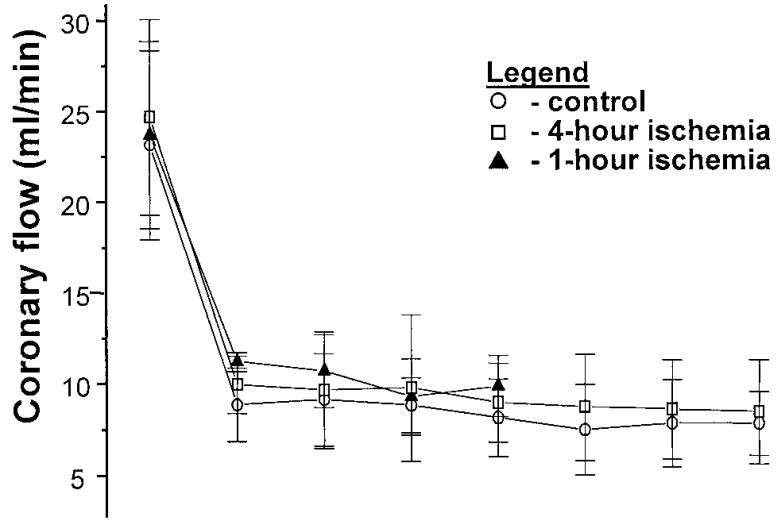


Figure 3. Relative, left anterior descending (LAD) (risk)/left circumplex (LCX) (non-risk) area, myocardial blood flow at the end of the experiment. epi = epicardium, mid = midmyocardium, endo = endocardium.



Landesberg G. Anesth Analg 1999;88:973-979

ESC Guidelines

ESC European Society of Cardiology
European Heart Journal (2022) **43**, 3826–3924
https://doi.org/10.1093/eurheartj/ehac270

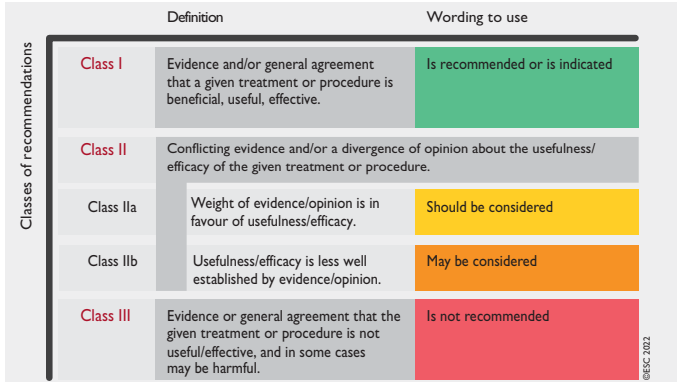
ESC GUIDELINES

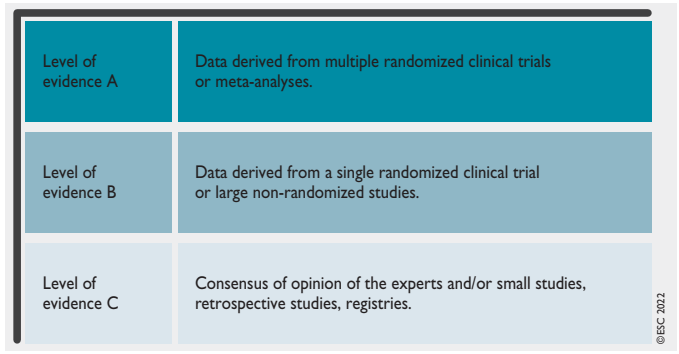
2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing non-cardiac surgery

Developed by the task force for cardiovascular assessment and management of patients undergoing non-cardiac surgery of the European Society of Cardiology (ESC)

Endorsed by the European Society of Anaesthesiology and Intensive Care (ESAIC)

ESC Guidelines





In patients who have known CVD, CV risk factors (including age ≥65 years), or symptoms suggestive of CVD, it should be considered to measure BNP or NT-proBNP before intermediate- and high-risk NCS.[52,104,112–114]	**IIa**	**B**
In low-risk patients undergoing low- and intermediate-risk NCS, it is not recommended to routinely obtain pre-operative ECG, hs-cTn T/I, or BNP/NT-proBNP concentrations.[109,111,117–119]	**III**	**B**

ESC. Eur Heart J 2022; 43:3826-3924

ESC guidelines: Surgical risk

Table 5 **Surgical risk estimate according to type of surgery or intervention**

Low surgical risk (<1%)	Intermediate surgical risk (1–5%)	High surgical risk (>5%)
• Breast • Dental • Endocrine: thyroid • Eye • Gynaecological: minor • Orthopaedic minor (meniscectomy) • Reconstructive • Superficial surgery • Urological minor: (transurethral resection of the prostate) • VATS minor lung resection	• Carotid asymptomatic (CEA or CAS) • Carotid symptomatic (CEA) • Endovascular aortic aneurysm repair • Head or neck surgery • Intraperitoneal: splenectomy, hiatal hernia repair, cholecystectomy • Intrathoracic: non-major • Neurological or orthopaedic: major (hip and spine surgery) • Peripheral arterial angioplasty • Renal transplants • Urological or gynaecological: major	• Adrenal resection • Aortic and major vascular surgery • Carotid symptomatic (CAS) • Duodenal-pancreatic surgery • Liver resection, bile duct surgery • Oesophagectomy • Open lower limb revascularization for acute limb ischaemia or amputation • Pneumonectomy (VATS or open surgery) • Pulmonary or liver transplant • Repair of perforated bowel • Total cystectomy

CAS, carotid artery stenting; CEA, carotid endarterectomy; CV, cardiovascular; MI, myocardial infarction; VATS, video-assisted thoracic surgery.
Surgical risk estimate is a broad approximation of 30 day risk of CV death, MI, and stroke that takes into account only the specific surgical intervention, without considering the patient's comorbidities.

ESC. Eur Heart J 2022; 43:3826-3924

ESC Guidelines: CV risk factors

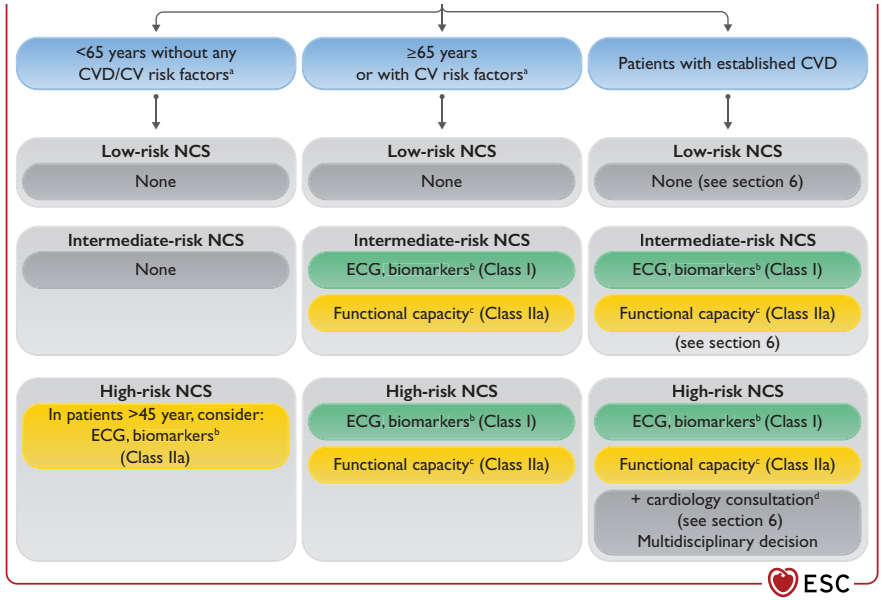
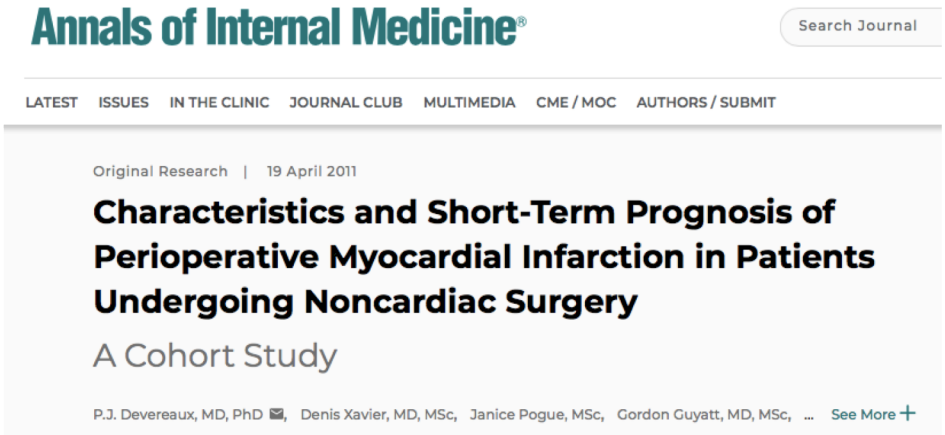


Figure 2 Pre-operative assessment before non-cardiac surgery. CV, cardiovascular; CVD, cardiovascular disease; ECG, electrocardiogram; N, no; NCS, non-cardiac surgery. Y, yes; [a]CV risk factors: hypertension, smoking, dyslipidaemia, diabetes, family history of CVD. [b]Biomarkers: hs-cTn T/I (Class I) and/or BNP/NT-proBNP (Class IIa). If pathological, consult a cardiologist. [c]Functional capacity based on Duke Activity Status Index (DASI) or the ability to climb two flights of stairs. [d]For diagnostic and therapeutic efforts to be considered, see *Section 6*. [e]Close follow-up after intervention and subsequent management of heart disease are advised.

- **65 years or**
- **Arterial hypertension**
- **Smoking**
- **Dyslipidaemia**
- **Diabetes**
- **Family history of CVD**

ESC. Eur Heart J 2022; 43:3826-3924

Why measuring troponin up to 72 hours?



Devereaux PJ et al. Ann Intern Med 2011;154:523-528

Most MI (74.1%) occured within 48 hours of surgery

65.3% of patients did not experience ischemic symptoms

30-day mortality rate was 11.6% among patients who had PMI

Consequences: Basel PMI trial

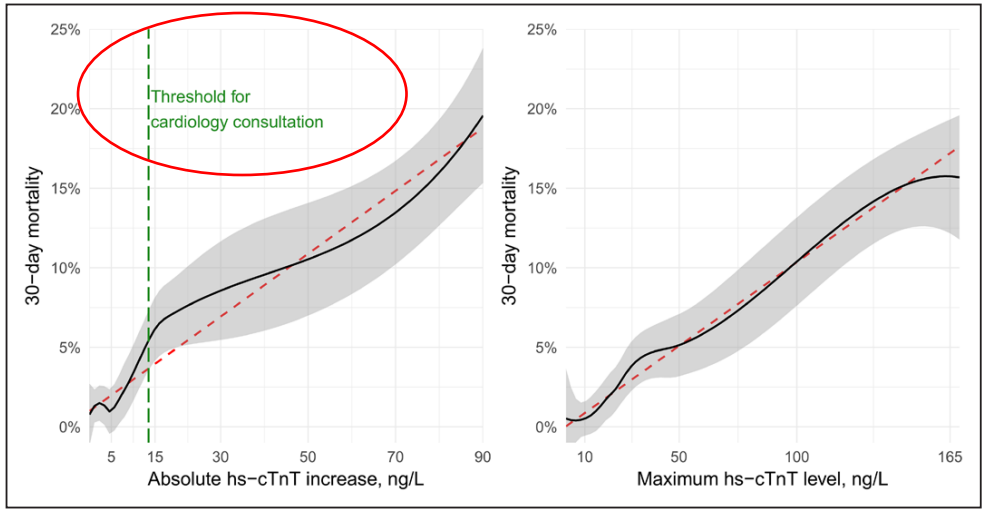


Figure 3. Cardiac troponin and mortality.
Association of absolute high-sensitivity cardiac troponin T (hs-cTnT) increase and maximum postoperative hs-cTnT level with 30-day mortality (black continuous line with 95% confidence intervals in gray). A general linear fit is shown as red dashed line. Because the association of absolute hs-cTnT increases with 30-day mortality might be affected by identifying and flagging patients with perioperative myocardial injury in clinical routine at hs-cTnT deltas of ≥14 ng/L, this threshold was highlighted in the plot of absolute hs-cTnT increase (green dashed line).

Puelacher C et al. Circulation 2018; 137:1221-1232

Conclusion

- MINS und Mortality
- Causes for MINS: oxygen demand/supply imbalance
- Hypotension and MINS
- Tachycardia and MINS
- Discussion

Discussion

'Ether Day' von W.Prosperi, 1846

"Gentlemen, this is no Humbug"

John C. Warren, 1846

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