Perioperative management of cardiac risk in patients undergoing non-cardiac surgery

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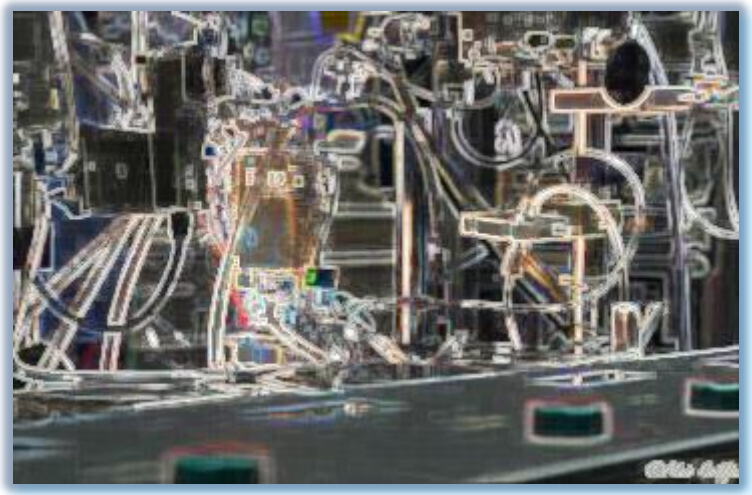

Rencontres des Anesthésistes Sanofi Aventis (RASA) 2023, des 24 & 25 juin à Biarritz.

CONFLICTS OF INTEREST

Personal (consulting or lectures) fees from:

- ORION Pharma,
- NORDIC Pharma,
- MEDTRONIC,
- i-SEP,
- VIFOR Pharma,
- BAXTER,
- And SANOFI-AVENTIS

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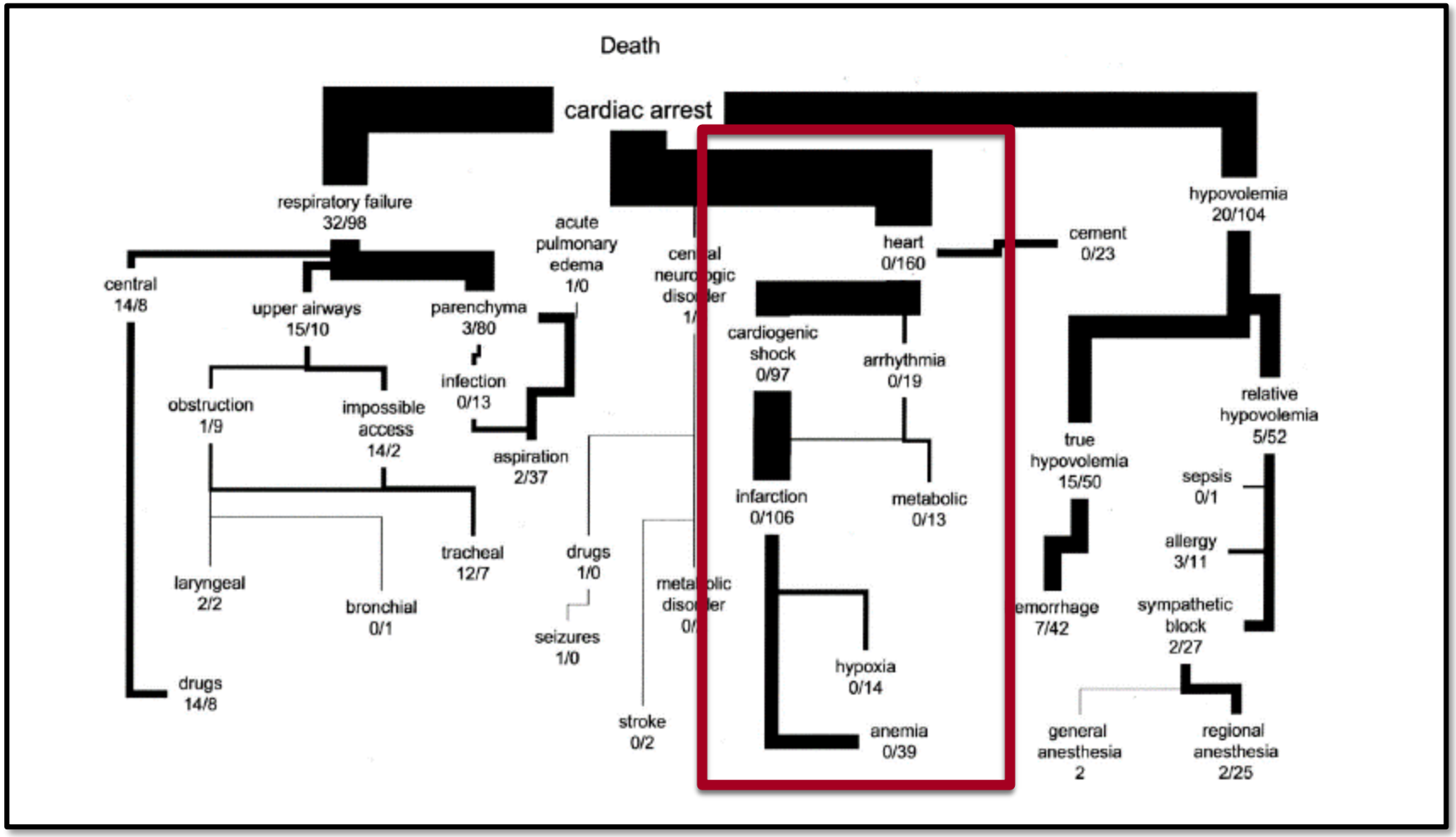
ESC GUIDELINES

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)

Sigrun Halvorsen, Julinda Mehilli, Salvatore Cassese, Trygve S Hall, Magdy Abdelhamid ...



« Although airway management and postoperative respiratory complications remained important causes, no deaths related to hypoxia during recovery or equipment problems were found. *Intraoperative hypotension and anemia are now the most important concerns associated with the occurrence of postoperative ischemia and infarction…* »

Perioperative cardiovascular complications in Europe

In 2004, the number of **major non cardiac surgical procedures has estimated to be at 5%** of the world population per year.

Applied to Europe with an overall population of over 468 millions, **an estimation of 23 million major non cardiac surgical procedures annually.**

Considering that half of patients present cardiac comorbidities, **11,5 million procedures annually are performed in European patients** with increased risk of cardiovascular complications.

Considering an incidence of overall complications between 9-11% and that 42% of them are related to cardiovascular complications, **≃ 500 000 postoperative cardiac complications annually**

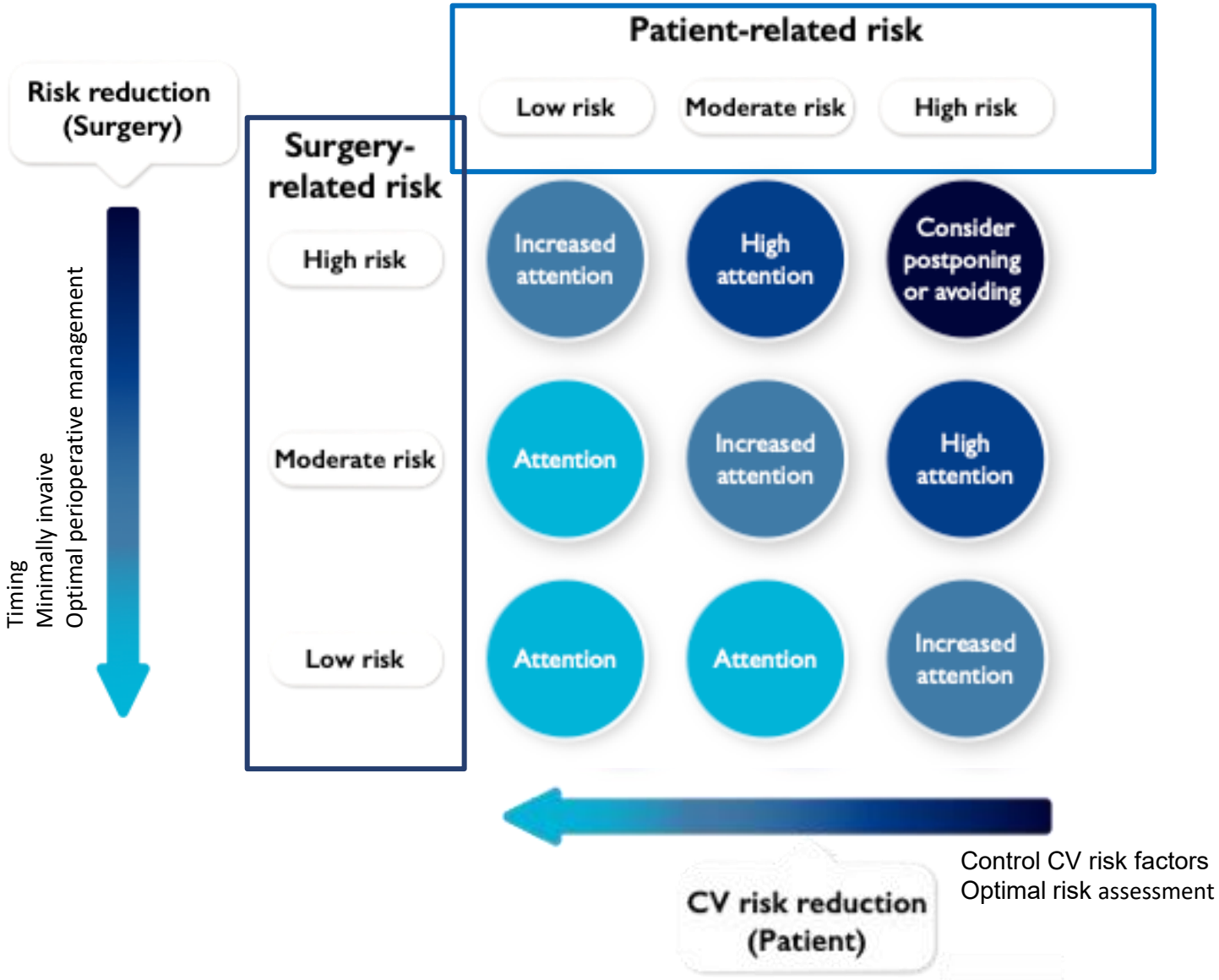
Considering that 4% of these complications are life-threatening **(≈20 000 deaths annually)**

Weiser TG et al. Lancet 2015;385:S11

Halvorsen S et al. Eur Heart J. 2022;43:3826-924

POSTOPERATIVE ENDPOINTS

- Perioperative myocardial infarction/injury (to be defined…)
- Acute heart failure
- Sustained Arrhythmias
- Ischemic stroke
- Cardiovascular death
- Thrombo-embolic events and bleeding through medications interfering with haemostasis (initiating factors…?)


Patient-related risk
Low risk
Moderate risk
High risk
Risk reduction (Surgery)
Surgery-related risk
High risk
Moderate risk
Low risk
Timing
Minimally invaive
Optimal perioperative management
Increased attention
High attention
Consider postponing or avoiding
Attention
Increased attention
High attention
Attention
Attention
Increased attention
Control CV risk factors
Optimal risk assessment
CV risk reduction (Patient)

Surgery-related risk (cardiovascular death and/or myocardial infarction and /or stroke at 30 day)

Low surgical risk (<1%)

- Breast
- Dental
- Endocrine: thyroid
- Eye
- Gynaecological: minor
- Orthopaedic minor (meniscectomy)
- Reconstructive
- Superficial surgery
- Urological minor: (transurethral resection of the prostate)
- VATS minor lung resection

Intermediate surgical risk (1–5%)

- 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

High surgical risk (>5%)

- 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

Glance LG et al. Ann Surg 2012; 255;696-702
Halvorsen S et al. Eur Heart J. 2022;43:3826-924

« Surgical stress »

Tissue injury and inflammation

Prothombotic state and/or bleeding

Neuro-humoral stress response (cortisol, catecholamines…)

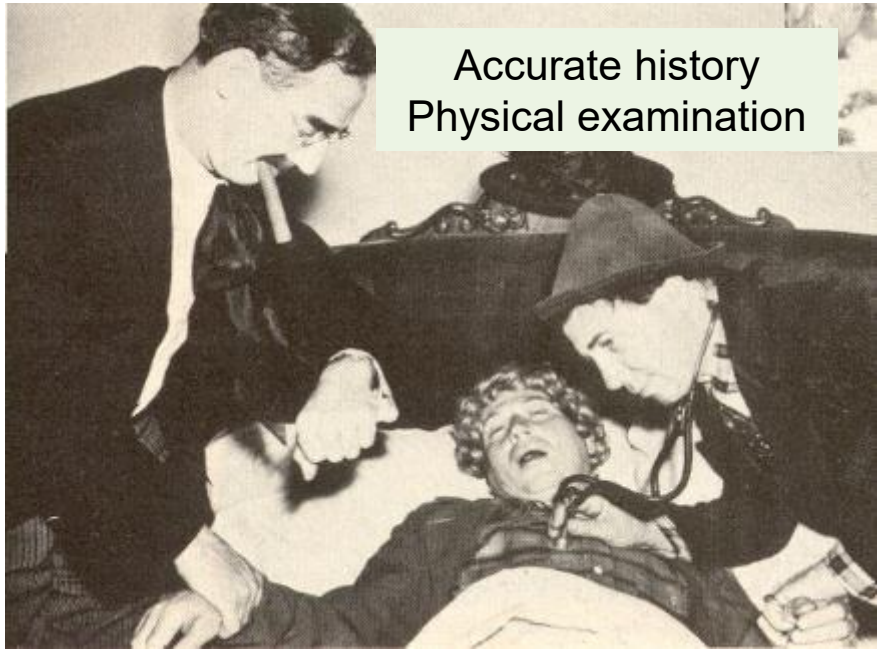
Modulated by

- Team experience
- Urgency of procedure (elective, time-sensitive, urgent, emergency)
- Protocol of anaesthesia (General versus neuro-axial anaesthesia)
- Biological and haemodynamic stress (related to bleeding +++)
- Invasiveness of surgery (laparoscopy, endovacular approach, video-robot-assisted surgery)

Patient-related risk

Mainly conditioned by:

- Age
- CV risk factors (HT, smoking, diabetes, dyslipidemia, genetic predisposition)
- Co-morbidities
- Established cardiovascular disease
- Functional capacity



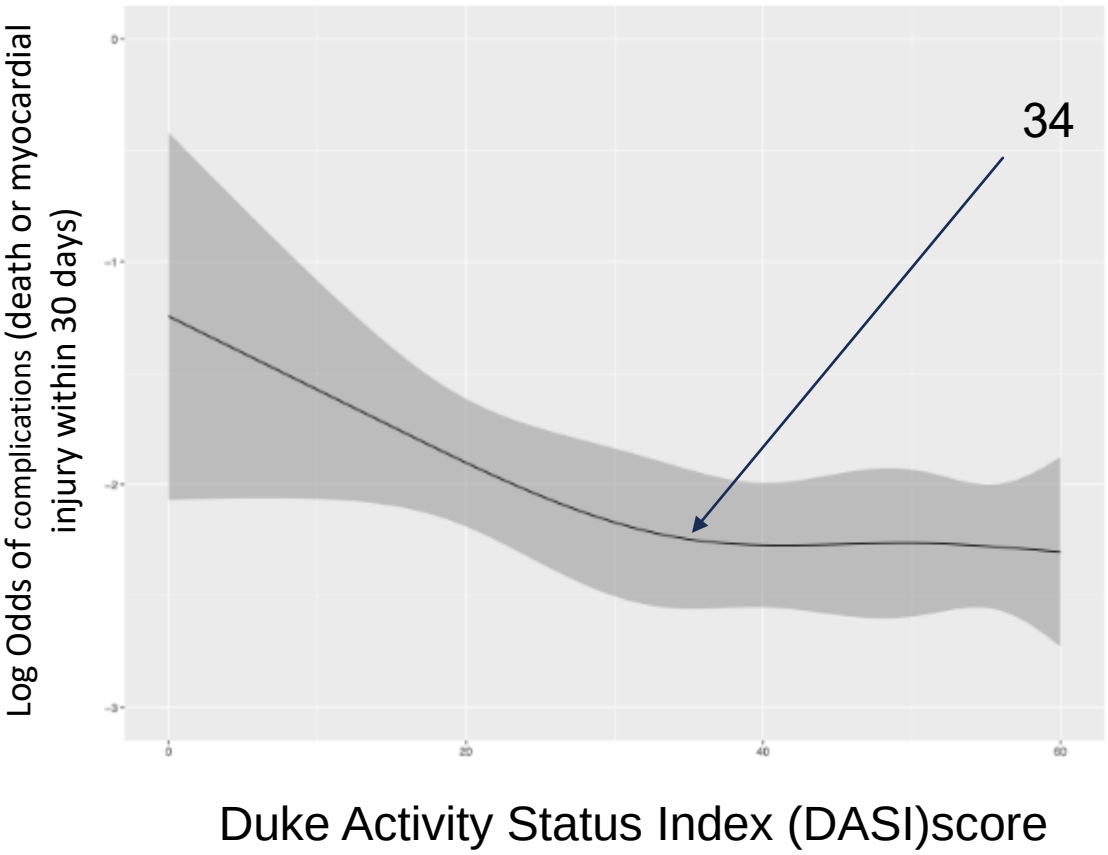
Patient-related Risk

	Revised Cardiac Risk Index (RCRI) (1999)[a]	Surgical Risk Calculator (2011)	The American College of Surgery National Surgical Quality Improvement Program (ACS NSQIP) (2013)	Surgical Outcome Risk Tool (SORT) (2014)
Variables	Ischaemic heart disease Cerebrovascular disease History of congestive heart failure Insulin therapy for diabetes Serum creatinine level ≥2 mg/dL High-risk surgery (each assigned 1 point)	Age ASA–PS grade Pre-operative dependent functional status Creatinine >1.5 mg/dL Type of surgery	Age Sex Functional status Emergency case ASA class Current steroid use Ascites within 30 days Systemic sepsis within 48 h Ventilator dependence Disseminated cancer Diabetes Hypertension on treatment Congestive HF Dyspnoea Current smoker History of severe COPD Dialysis Acute renal failure Body mass index Surgery code	ASA–PS grade Urgency of surgery High-risk surgical specialty Surgical severity (from minor to complex major) Cancer Age ≥65 years or over
Score range	Score 1; risk 6.0% (4.9–7.4) Score 2; risk 10.1% (8.1–10.6) Score ≥3; risk 15% (11.1–20.0)	Absolute risk: 0–100%	Absolute risk: 0–100%	Absolute risk: 0–100%
Outcome	30 day MI, cardiac arrest, death	Intra-operative and 30 day MI or cardiac arrest	Serious complications and any complications at 30 days	30 day mortality
Derivation population	1422	211 410	1 414 006	11 219
Model performance (AUC)	0.68–0.76	0.81–0.85	0.73	0.81–0.92

Functional capacity

Duke Activity Status Index (DASI)

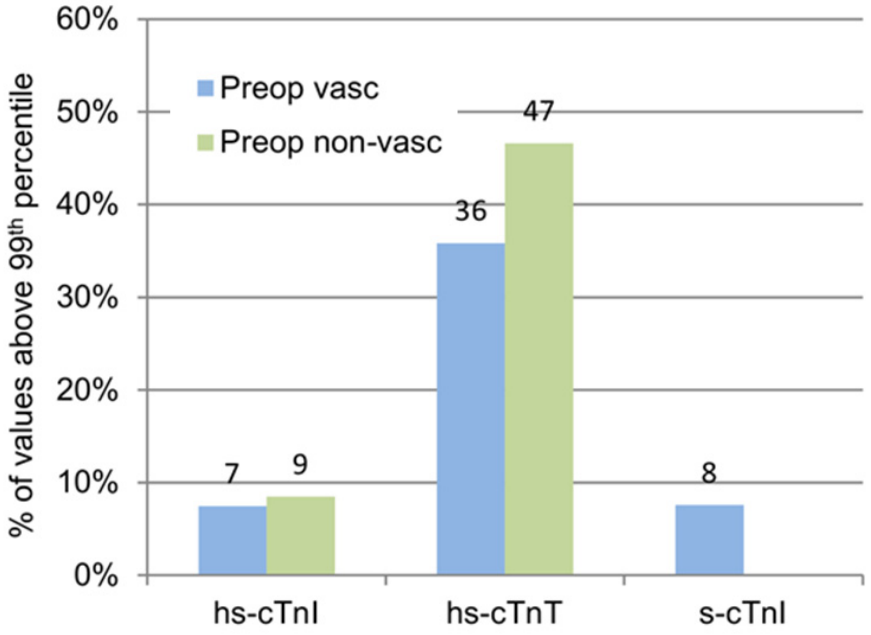
		Yes	No
1	Can you take care of yourself (eating, dressing, bathing or using the toilet)?	2.75	0
2	Can you walk indoors, such as around your house?	1.75	0
3	Can you walk a block or two on level ground?	2.75	0
4	Can you climb a flight of stairs or walk up a hill?	5.50	0
5	Can you run a short distance?	8.00	0
6	Can you do light work around the house, such as dusting or washing dishes?	2.70	0
7	Can you do moderate work around the house, such as vacuuming, sweeping floors or carrying in groceries?	3.50	0
8	Can you do heavy work around the house, such as scrubbing floors or lifting and moving heavy furniture?	8.00	0
9	Can you do yard work, such as raking leaves, weeding or pushing a power mower?	4.50	0
10	Can you have sexual relations?	5.25	0
11	Can you participate in moderate recreational activities, such as golf, bowling, dancing, doubles tennis or throwing a baseball or football?	6.00	0
12	Can you participate in strenuous sports, such as swimming, singles tennis, football, basketball or skiing?	7.50	0



Adjusting risk assessments according to self-reported ability to climb two flights of stairs should be considered in patients referred for intermediate- or high-risk NCS.[94]	IIa	B

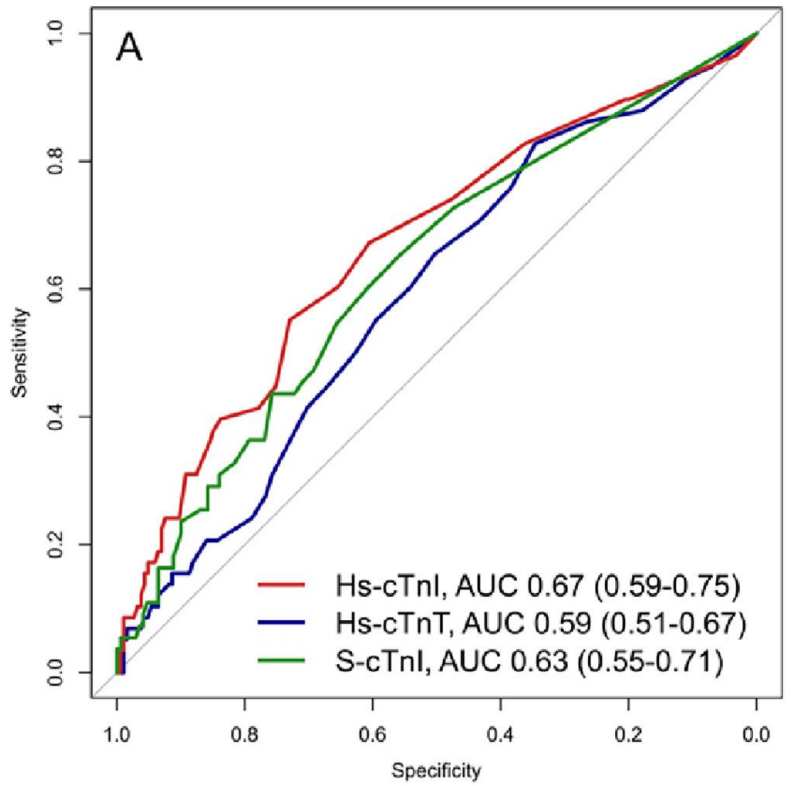
CARDIAC BIOMARKERS FOR PREDICTING POSTOPERATIVE CARDIAC COMPLICATIONS

- High-sensitivity cardiac troponin I/T (Hs-cTn T/I) quantifies myocardial injury
- BNP or NT-proBNP quantifies haemodynamic cardiac wall stress



Perfomance of HS-cTnI for prediction of postoperative cardiac complications

Primary endpoint: cardiac death, cardiac arrest, perioperative MI, arrhythmias and AHF within 30 postoperative days



Gualandro MD et al. Am J Heart 2018; 203:67-73

Preoperative *N*-Terminal Pro–B-Type Natriuretic Peptide and Cardiovascular Events After Noncardiac Surgery

A Cohort Study

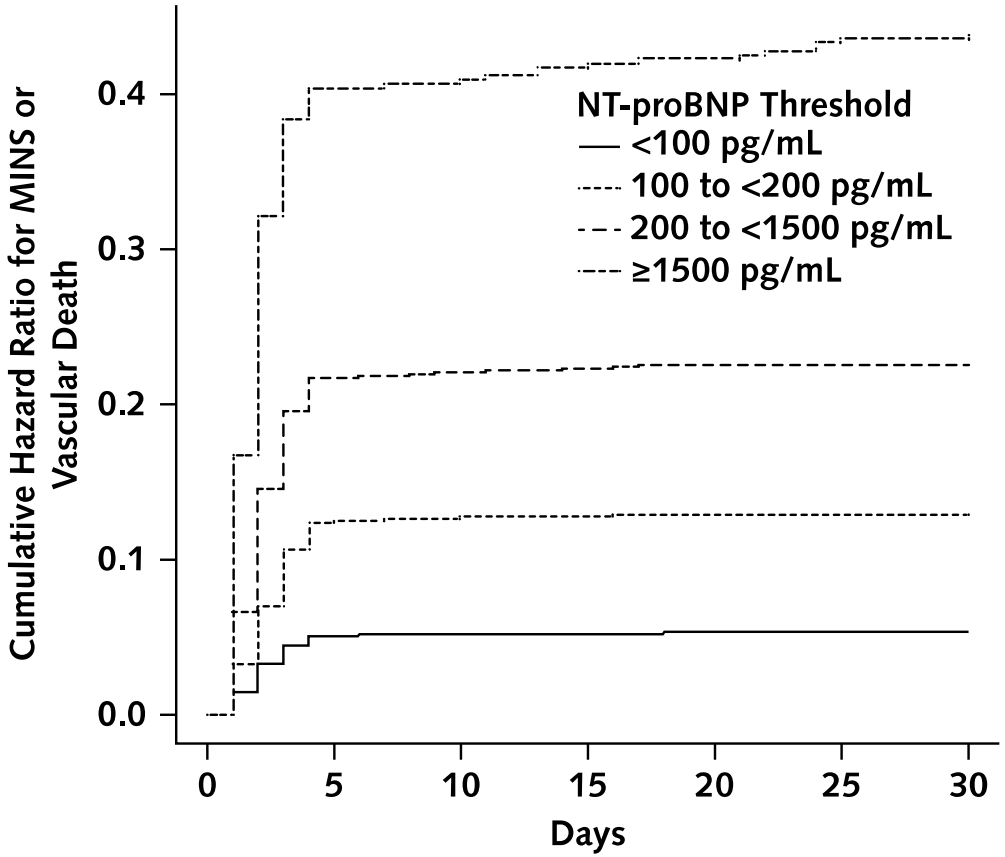
10 402 patients ≥ 45 yrs undergoing non cardiac surgery

Preoperative evaluation

- Lee Score
- Preoperative level of NT-proBNP

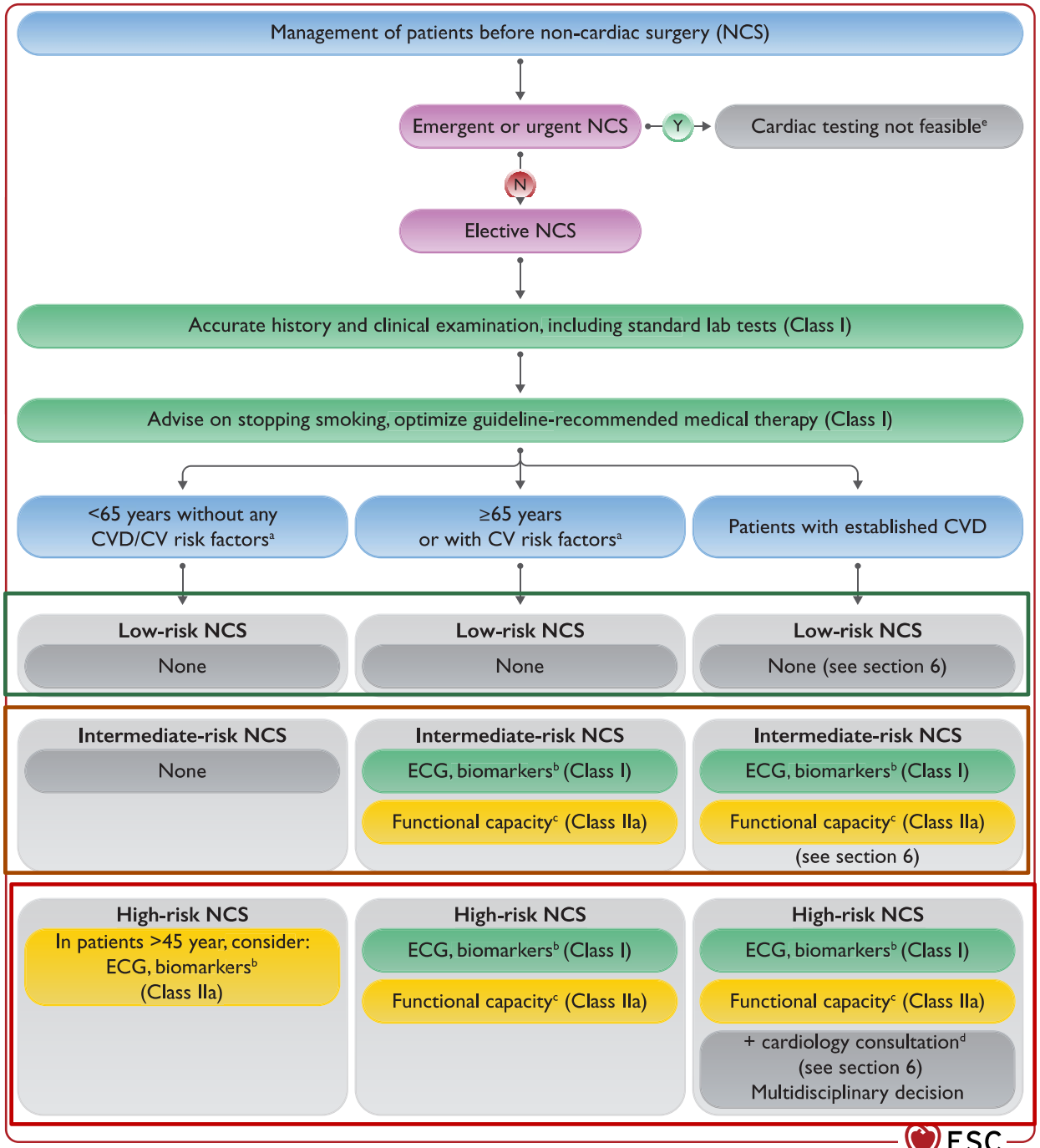
Endpoint

- CV death and myocardial injury within 30 days



Duceppe E et al. Ann Intern Med 2020; 172:96-104

Recommendations	Class[a]	Level[b]
In patients who have known CVD or CV risk factors (including age ≥65 years), or symptoms or signs suggestive of CVD it is recommended to obtain a pre-operative 12-lead ECG before intermediate- and high-risk NCS.[97–99]	I	C
In patients who have known CVD, CV risk factors (including age ≥65 years), or symptoms suggestive of CVD it is recommended to measure hs-cTn T or hs-cTn I before intermediate- and high-risk NCS, and at 24 h and 48 h afterwards.[53,105–107,109–111,117]	I	B
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


Management of patients before non-cardiac surgery (NCS)
Emergent or urgent NCS
Y
Cardiac testing not feasible[e]
N
Elective NCS
Accurate history and clinical examination, including standard lab tests (Class I)
Advise on stopping smoking, optimize guideline-recommended medical therapy (Class I)
<65 years without any CVD/CV risk factors[a]
≥65 years or with CV risk factors[a]
Patients with established CVD
Low-risk NCS
None
Low-risk NCS
None
Low-risk NCS
None (see section 6)
Intermediate-risk NCS
None
Intermediate-risk NCS
ECG, biomarkers[b] (Class I)
Functional capacity[c] (Class IIa)
Intermediate-risk NCS
ECG, biomarkers[b] (Class I)
Functional capacity[c] (Class IIa)
(see section 6)
High-risk NCS
In patients >45 year, consider: ECG, biomarkers[b] (Class IIa)
High-risk NCS
ECG, biomarkers[b] (Class I)
Functional capacity[c] (Class IIa)
High-risk NCS
ECG, biomarkers[b] (Class I)
Functional capacity[c] (Class IIa)
+ cardiology consultation[d] (see section 6) Multidisciplinary decision
ESC

EJA

Eur J Anaesthesiol 2023; **40:**1–26

INFOGRAPHIC

GUIDELINES

ESAIC focused guideline for the use of cardiac biomarkers in perioperative risk evaluation

Giovanna Lurati Buse*, Bernardo Bollen Pinto*, Fernando Abelha, Tom E.F. Abbott, Gareth Ackland, Arash Afshari, Stefan De Hert, Jean-Luc Fellahi, Laure Giossi, Peter Kavsak, Dan Longrois, Rene M'Pembele, Anthony Nucaro, Ekaterine Popova, Christian Puelacher, Toby Richards, Sebastian Roth, Mootii Sheka, Wojciech Szczeklik, Judith van Waes, Bernhard Walder and Michelle S. Chew

STRESS IMAGING

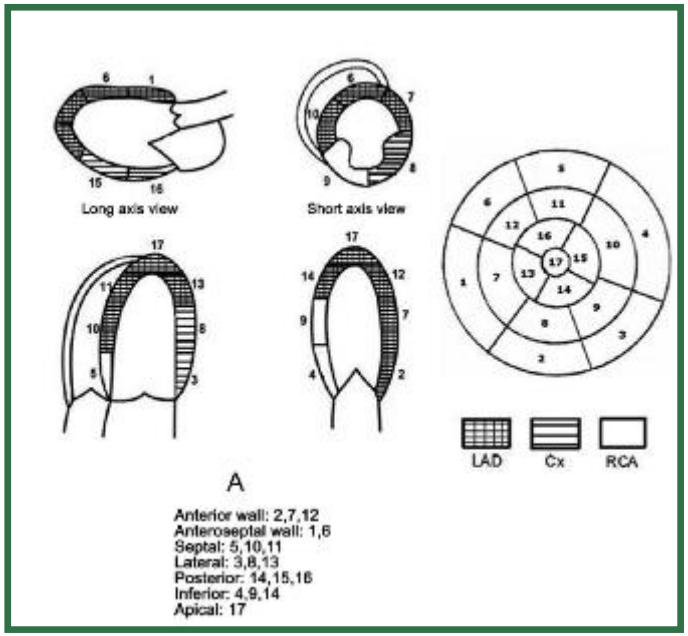
Appropriate for risk assessment in stable patients:

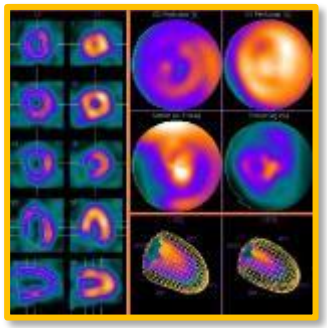
1. With clinical cardiovascular risk (**Lee Score≥2**…)
2. Who undergo **intermediate** or **high-risk** non cardiac elective surgery
3. With poor functional capacity (DASI< 34 or inability to climb **two flights of stairs**)

Cullen MW et al. J Am Soc Echocardiogr 2020;33:423-31

DOBUTAMINE STRESS ECHOCARDIOGRAPHY (DSE)

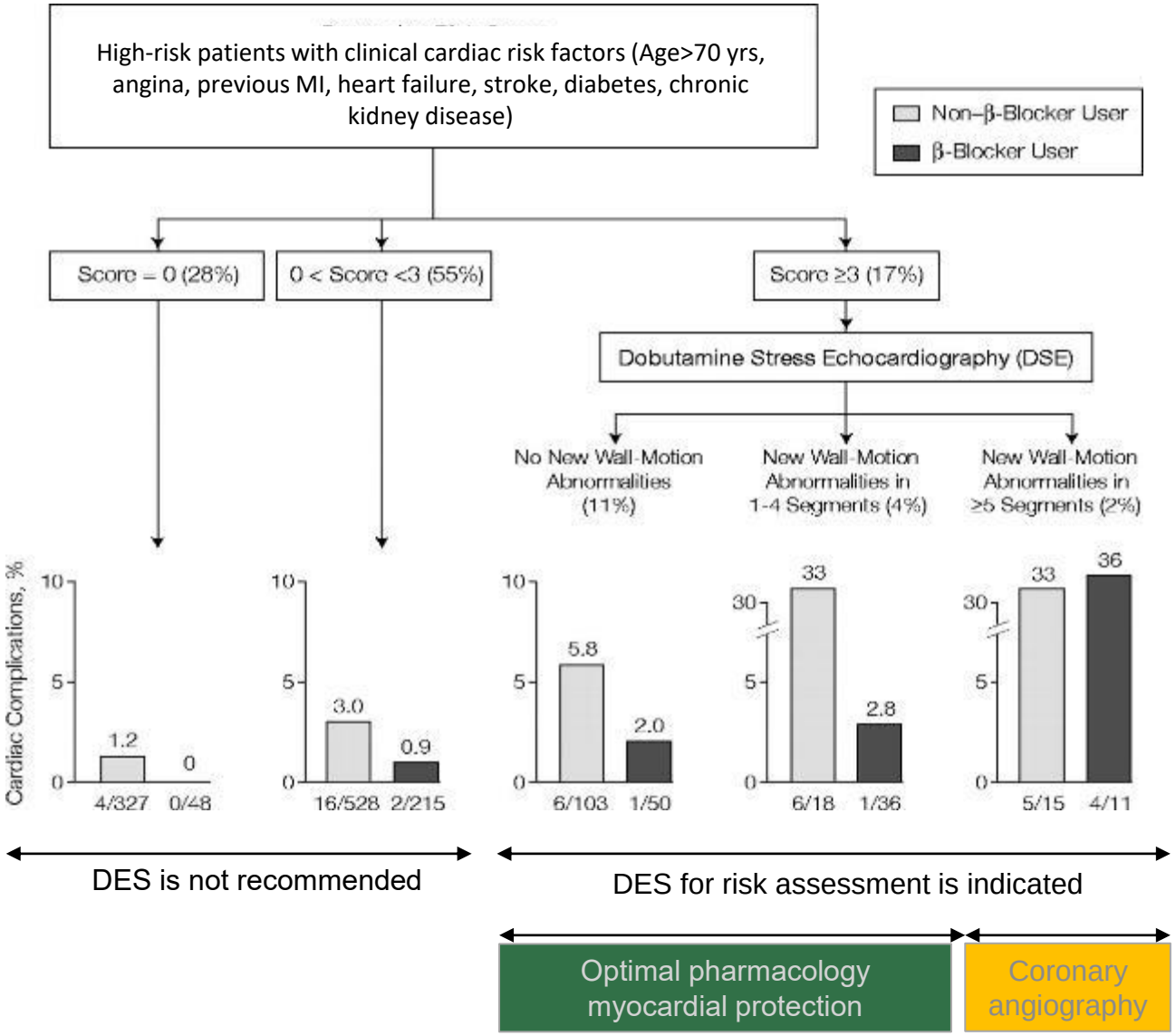
- Prediction of perioperative cardiac events based on myocardial ischaemia induced by pharmacological stress testing
- High negative predictive value (95-100%)
- Strongest predictor of postoperative cardiac events is wall motion abnormality interesting **> 4 ventricular segments** (over 17)
- Myocardial perfusion imaging (myocardial scintigraphy) should be proposed in patients having poor acoustic windows for DSE **(perfusion defect > 20%)**





Torrens MR et al. Am J Cardiol 2002;90:238-42

Cohen MC et al. J Nucl Cardiol 2003;10:464-72



Boersma E et al. JAMA 2001;285:1865-73

Recommendations	Class[a]	Level[b]
Stress imaging is recommended before high-risk elective NCS in patients with poor functional capacity[c] and high likelihood of CAD[d] or high clinical risk.[e,146,156–158]	I	B
Stress imaging should be considered before high-risk NCS in asymptomatic patients with poor functional capacity,[d] and previous PCI or CABG.[147]	IIa	C
Stress imaging may be considered before intermediate-risk NCS when ischaemia is of concern in patients with clinical risk factors and poor functional capacity.[d,152,157,158]	IIb	B
Stress imaging is not recommended routinely before NCS.	III	C

EXPERT CONSENSUS DOCUMENT

Third Universal Definition of Myocardial Infarction

Acute myocardial infarction (AMI) should be used when there is evidence of myocardial necrosis in a clinical setting consistent with acute myocardial ischemia. Un der these conditions any one of the following criteria meets the diagnosis for AMI:

Detection of a rise of cardiac biomarker (cardiac troponin with at least one value above the 99th percentile upper reference limit with one of the following:

- Symptoms of ischemia.
- New or presumed new significant ST-segment–T wave (ST–T) changes or new left bundle branch block (LBBB).
- Development of pathological Q waves in the ECG.
- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality.
- Identification of an intracoronary thrombus by angiography or autopsy.

Thygesen K et al. J Am Coll Cardiol 2012;60:1581-98

Perioperative Myocardial Infarction

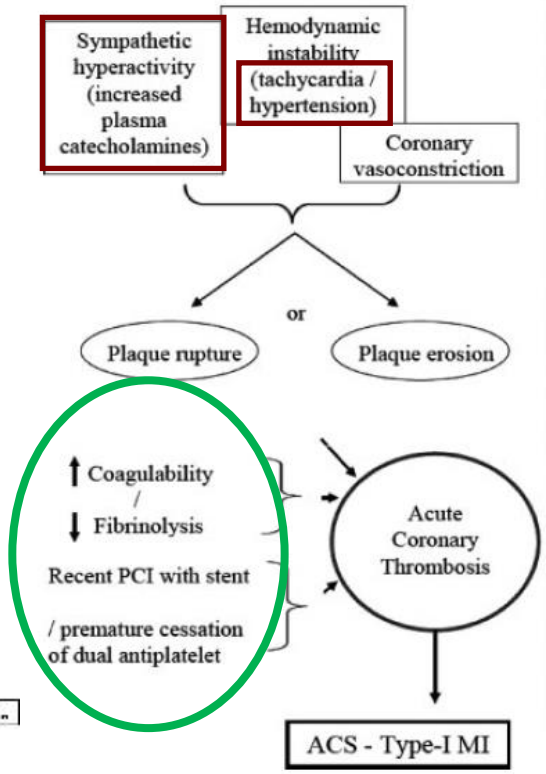
Giora Landesberg, MD, DSc; W. Scott Beattie, MD, PhD; Morris Mosseri, MD;
Allan S. Jaffe, MD; Joseph S. Alpert, MD

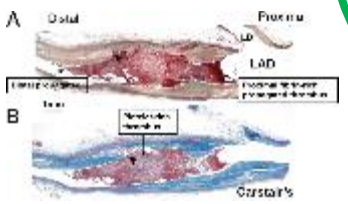
Plaque rupture (acute stent thrombosis)

Oxygen myocardial Supply-demand mismatch

Type I

Type 2





OXYGEN MYOCARDIAL SUPPLY-DEMAND MISMATCH (TYPE II MI)

- More frequent
- Haemodynamic (hypoTA, tachycardia, sympathic hyperréactivity,…) and biological (hyperglycemia, anemia, hypoxemia, neuro-hormonal system) stress
- Endothelial dysfonction (less reactivity, inflaamtoire repsonse, prothrombotic state…)
- Pre-existing coronary artery disease
- Without clinical symptoms (silent…)
- Atypical ECG abnormalities
- Isolated tropinin postoperative elevation
- Strongly associated with poor outcomes

Thygesen K et al. J Am Coll Cardiol 2012;60:1581-98

Diagnosis and Management of Patients With Myocardial Injury After Noncardiac Surgery **(MINS)**

A Scientific Statement From the American Heart Association

Table 1. Diagnostic Criteria for MINS

Elevated postoperative cTn with ≥1 cTn measurement above the 99th percentile of the URL for the cTn assay, with a rise/fall pattern indicative of acute myocardial injury*†
Occurs in the first 30 d (and typically within 72 h) after surgery
Myocardial injury is attributable to a presumed ischemic mechanism (ie, supply-demand mismatch or atherothrombosis) in the absence of an overt precipitating nonischemic cause (eg, pulmonary embolism)
Clinical symptoms may be masked by sedation or analgesia in the perioperative setting, so an ischemic feature (eg, ischemic symptoms, electrocardiographic changes) is not required

The Vascular events In noncardiac Surgery patIents cOhort evaluatioN (VISION) Writing Group, on behalf of The Vascular events In noncardiac Surgery patIents cOhort evaluatioN (VISION) Investigators

	Prevalence	
Ischemic Feature*	n	% (95% CI)
Ischemic symptoms		
Chest discomfort	85	9.0 (7.4–11.0)
Neck, jaw, or arm discomfort	5	0.5 (0.2–1.2)
Dyspnea	66	7.0 (5.6–8.8)
Pulmonary edema	46	4.9 (3.7–6.5)
Any of the above	149	15.8 (13.6–18.3)
Ischemic electrocardiographic findings		
Q waves	13	1.4 (0.8–2.3)
ST elevation	22	2.3 (1.5–3.5)
LBBB	5	0.5 (0.2–1.2)
ST depression	154	16.4 (14.1–18.9)
T-wave inversion	219	23.3 (20.7–26.1)
Any of the above	328	34.9 (31.9–38.0)

Asymptomatic 85%

ST elevation 2%

Anesthesiology 2014;120:564-78

Outcome	No. (%, 95% CI) of patients							
		Type of major surgery						
	All surgeries *n* = 40 004	General *n* = 7950	Vascular *n* = 2642	Neurosurgery *n* = 2341	Orthopedic *n* = 6982	Thoracic *n* = 1165	Urology or gynecology *n* = 4827	Low-risk surgery only *n* = 14 383
Major bleeding	6238 (15.6, 15.2–16.0)	1454 (18.3, 17.5–19.2)	666 (25.2, 23.6–26.9)	419 (17.9, 16.4–19.5)	2164 (31.0, 29.9–32.1)	119 (10.2, 8.6–12.1)	658 (13.6, 12.7–14.6)	876 (6.1, 5.7–6.5)
MINS	5191 (13.0, 12.7–13.3)	980 (12.3, 11.6–13.1)	633 (24.0, 22.4–25.6)	301 (12.9, 11.6–14.3)	1257 (18.0, 17.1–18.9)	231 (19.8, 17.6–22.2)	503 (10.4, 9.6–11.3)	1335 (9.3, 8.8–9.8)
Sepsis	1783 (4.5, 4.3–4.7)	783 (9.8, 9.2–10.5)	140 (5.3, 4.5–6.2)	132 (5.6, 4.8–6.6)	258 (3.7, 3.3–4.2)	54 (4.6, 3.6–6.0)	162 (3.4, 2.9–3.9)	293 (2.0, 1.8–2.3)
Infection without sepsis	2171 (5.4, 5.2–5.7)	632 (7.9, 7.4–8.6)	152 (5.8, 4.9–6.7)	102 (4.4, 3.6–5.3)	508 (7.3, 6.7–7.9)	44 (3.8, 2.8–5.0)	261 (5.4, 4.8–6.0)	493 (3.4, 3.1–3.7)
Acute kidney injury with dialysis	118 (0.3, 0.2–0.4)	49 (0.6, 0.5–0.8)	25 (0.9, 0.6–1.4)	4 (0.2, 0.1–0.4)	14 (0.2, 0.1–0.3)	3 (0.3, 0.1–0.8)	7 (0.1, 0.1–0.3)	17 (0.1, 0.1–0.2)
Stroke	132 (0.3, 0.3–0.4)	20 (0.3, 0.2–0.4)	25 (0.9, 0.6–1.4)	34 (1.5, 1.0–2.0)	24 (0.3, 0.2–0.5)	5 (0.4, 0.2–1.0)	7 (0.1, 0.1–0.3)	18 (0.1, 0.1–0.2)
Venous thromboembolism	299 (0.7, 0.7–0.8)	71 (0.9, 0.7–1.1)	15 (0.6, 0.3–0.9)	22 (0.9, 0.6–1.4)	114 (1.6, 1.4–2.0)	5 (0.4, 0.2–1.0)	38 (0.8, 0.6–1.1)	39 (0.3, 0.2–0.4)
Congestive heart failure	372 (0.9, 0.8–1.0)	113 (1.4, 1.2–1.7)	46 (1.7, 1.3–2.3)	5 (0.2, 0.1–0.5)	120 (1.7, 1.4–2.1)	12 (1.0, 0.6–1.8)	30 (0.6, 0.4–0.9)	53 (0.4, 0.3–0.5)
New, clinically important atrial fibrillation	370 (0.9, 0.8–1.0)	145 (1.8, 1.6–2.1)	47 (1.8, 1.3–2.4)	9 (0.4, 0.2–0.7)	89 (1.3, 1.0–1.6)	35 (3.0, 2.2–4.1)	29 (0.6, 0.4–0.9)	28 (0.2, 0.1–0.3)
Death	715 (1.8, 1.7–1.9)	240 (3.0, 2.7–3.4)	73 (2.8, 2.2–3.5)	62 (2.6, 2.1–3.4)	124 (1.8, 1.5–2.1)	20 (1.7, 1.1–2.6)	24 (0.5, 0.3–0.7)	177 (1.2, 1.1–1.4)

Note: CI = confidence interval, MINS = myocardial injury after noncardiac surgery.

Spence et al. CMAJ 2019; 191:E830-7

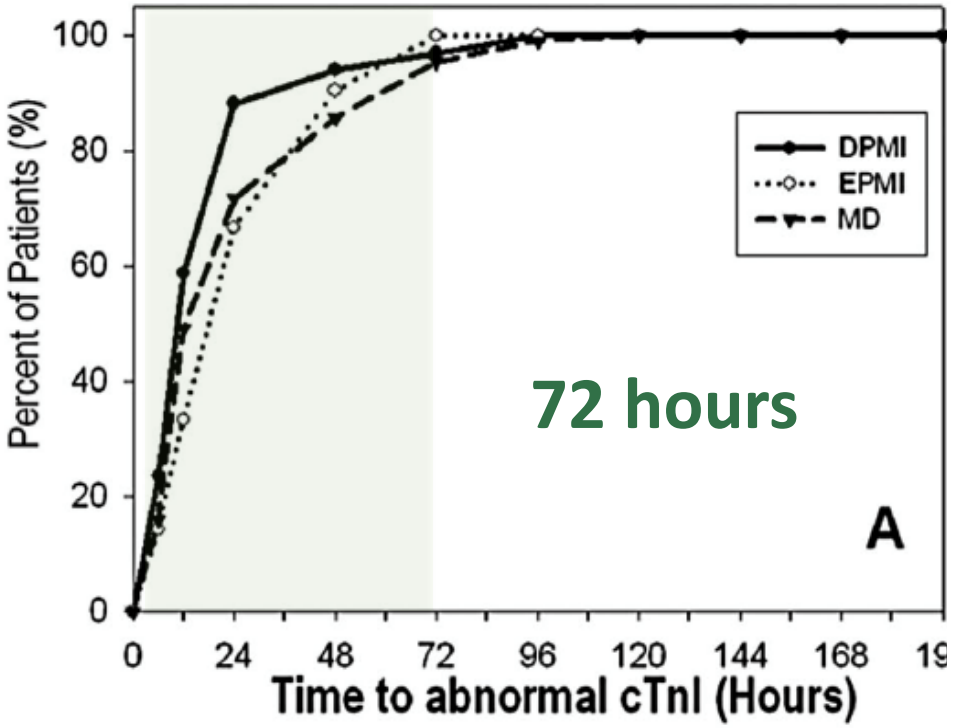
Endovascular surgery

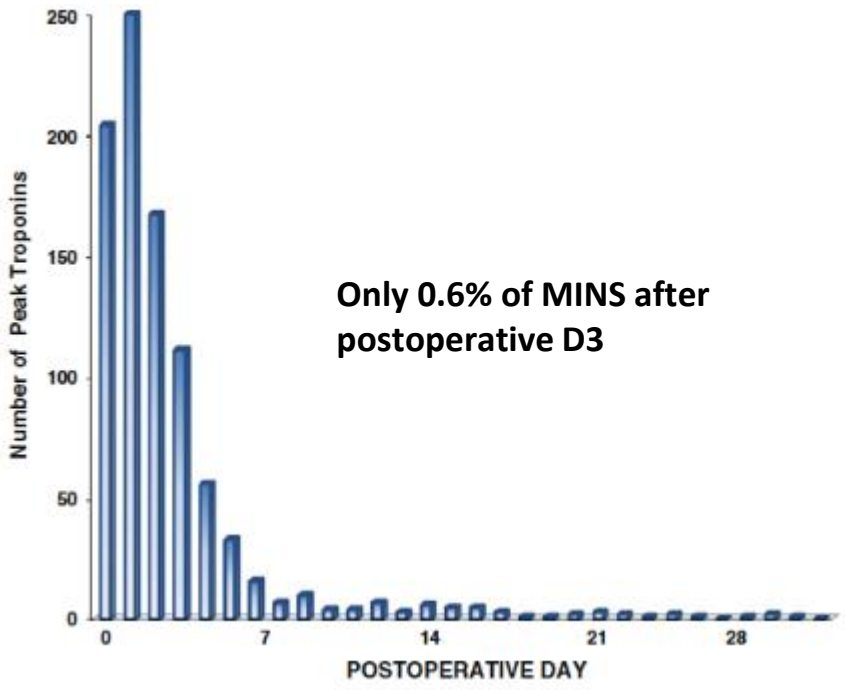
Table 2 Outcome events up to hospital discharge following EVAR

Outcome	*n* = 267 *n* (%)	95% CI (%)
Myocardial injury*	78 (29.2)	24.1 to 34.9
Myocardial infarction	18 (6.7)	4.3 to 10.4
AKI	25 (9.4)	6.4 to 13.5
New atrial fibrillation	12 (4.5)	2.6 to 7.7
Stroke/TIA	2 (0.7)	0.2 to 2.7
Acute CHF	16 (6.0)	3.7 to 9.5
Death	7 (2.6)	1.3 to 5.3

Duceppe J et al. Can Anesth 2019; 66:1338-46

Early postoperative period





Only 0.6% of MINS after postoperative D3

Le Manach Y et al. Anesthesiology 2005; 102:885-91

Scott Battie Can J Anesth 2012;59:1013-22

The Vascular Events In Noncardiac Surgery Patients Cohort Evaluation (VISION) Study Investigators

Multicentre observational study international

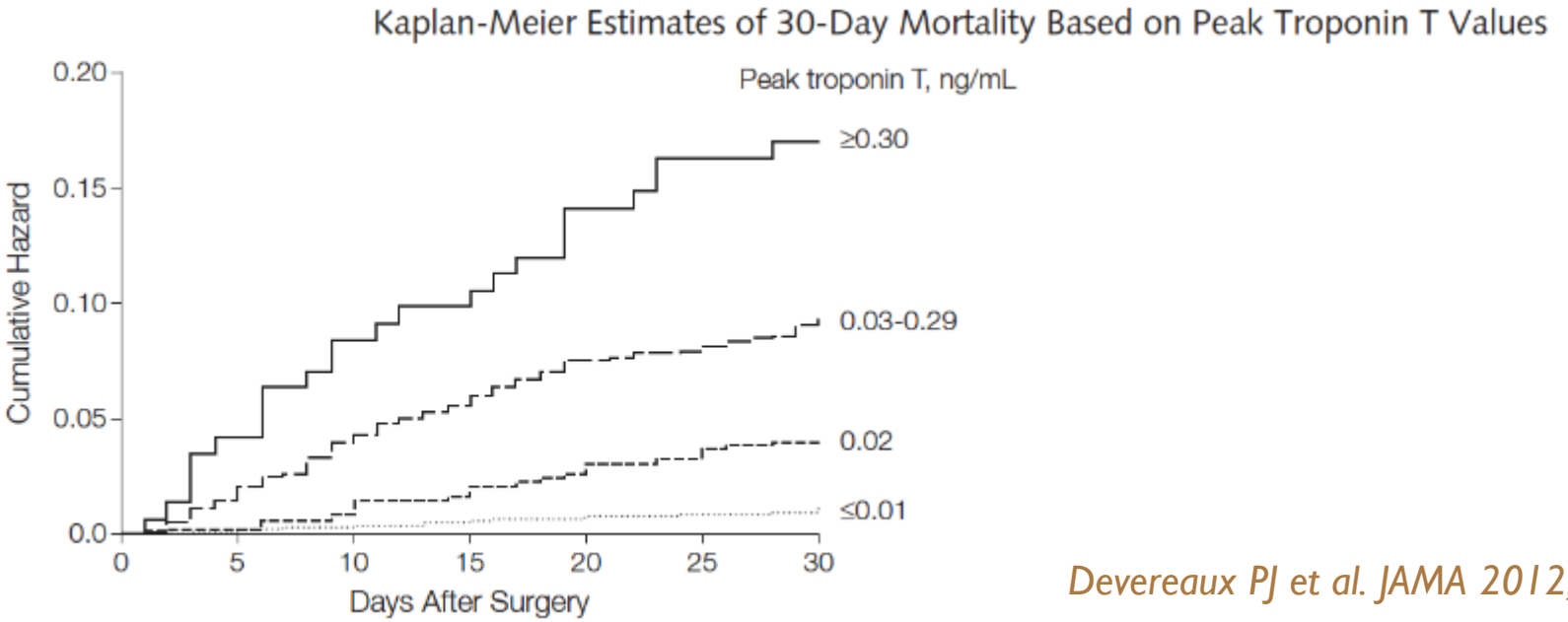
Adults > 45 yr undergoing non cardiac surgery GA or RA (n=15133)

Determination of troponin T level during the three first postoperative days

Relationship between peak of Troponin T and 30-day mortality

Results

1263 patients presented troponin T peak > 0,03 ng/ml (**8,3%**)



Devereaux PJ et al. JAMA 2012;307:295-304

Pronostic value

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

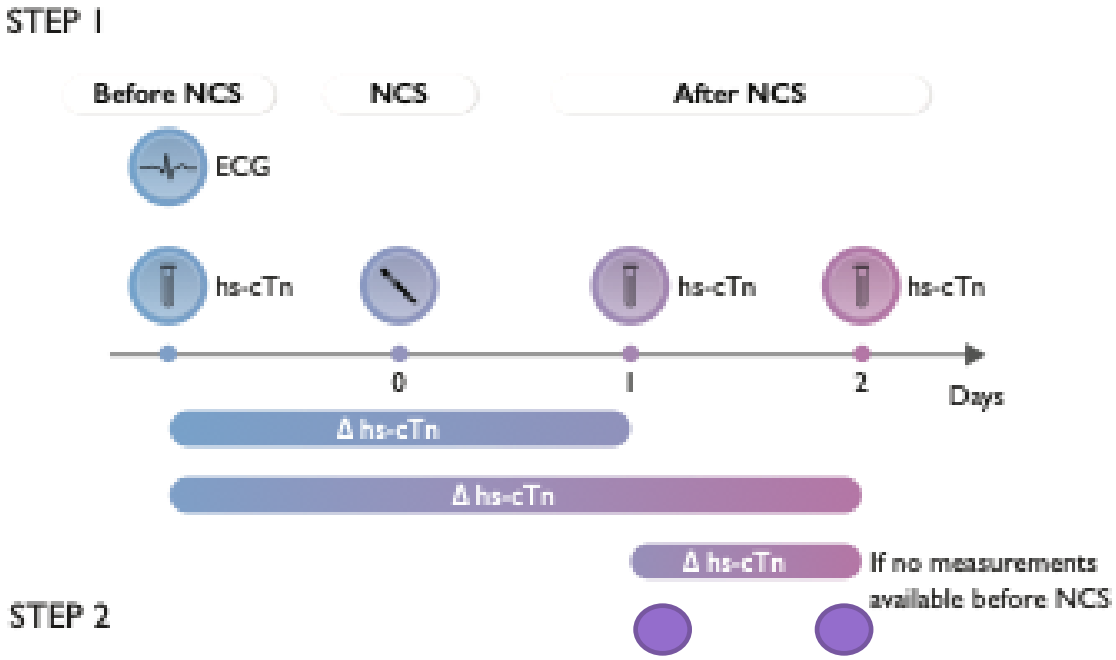
	hsTnT Thresholds, ng/L					
	<5	5 to <14	14 to <20	20 to <65	65 to <1000	≥1000
Patients, No. (%)	5318 (24.4)	8750 (40.1)	2530 (11.6)	4049 (18.6)	1118 (5.1)	54 (0.2)
Deaths, No. (%)	6 (0.1)	40 (0.5)	29 (1.1)	123 (3.0)	102 (9.1)	16 (29.6)
Adjusted hazard ratio (95% CI)	1 [Reference]	3.73 (1.58-8.82)	9.11 (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

Association Between Absolute Changes in hsTnT Values and 30-Day Mortality[a]

	Absolute Change Between Preoperative and Peak Postoperative hsTnT Values Among 7857 Patients With Preoperative and Postoperative Measurements		
	Analysis 1		
	<5 ng/mL	≥5 to <40 ng/mL	≥40 ng/mL
Patients, No. (%)	5116 (65.1)	2369 (30.2)	372 (4.7)
30-d mortality, No. (%)	23 (0.4)	35 (1.5)	36 (9.7)
Adjusted hazard ratio (95% CI)	1 [Reference]	2.81 (1.63-4.82)	15.68 (8.94-27.51)
P Value		<.001	<.001

Absolute Change Between Postoperative hsTnT Values Among 18 023 Patients With ≥2 Postoperative Measurements		Absolute Change Between hsTnT Values Among 19 373 Patients With ≥2 Measurements	
<5 ng/mL	≥5 ng/mL	<5 ng/mL	≥5 ng/mL
11 542 (64)	6481 (36)	11 950 (61.7)	7423 (38.3)
62 (0.5)	217 (3.3)	64 (0.5)	226 (3)
1 [Reference]	5.24 (3.92-7.01)	1 [Reference]	4.69 (3.52-6.25)
	<.001		<.001

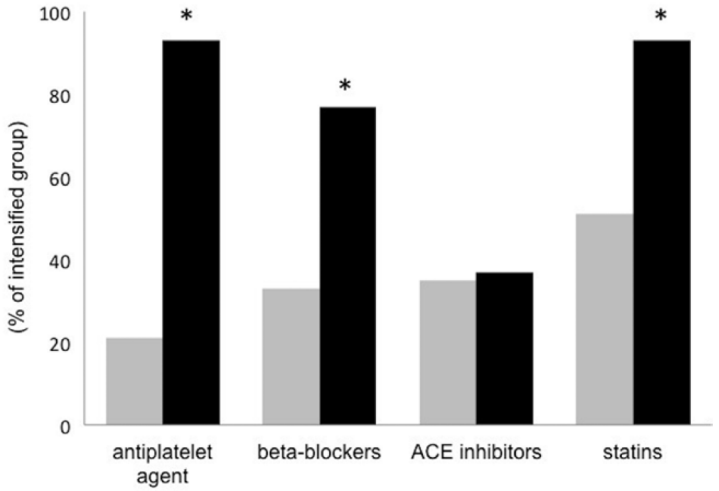
Devereaux PJ et al. JAMA 2017;317:1642-51

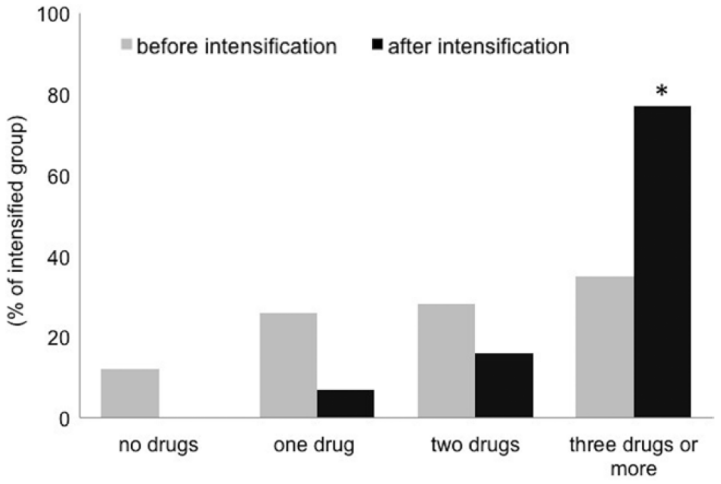


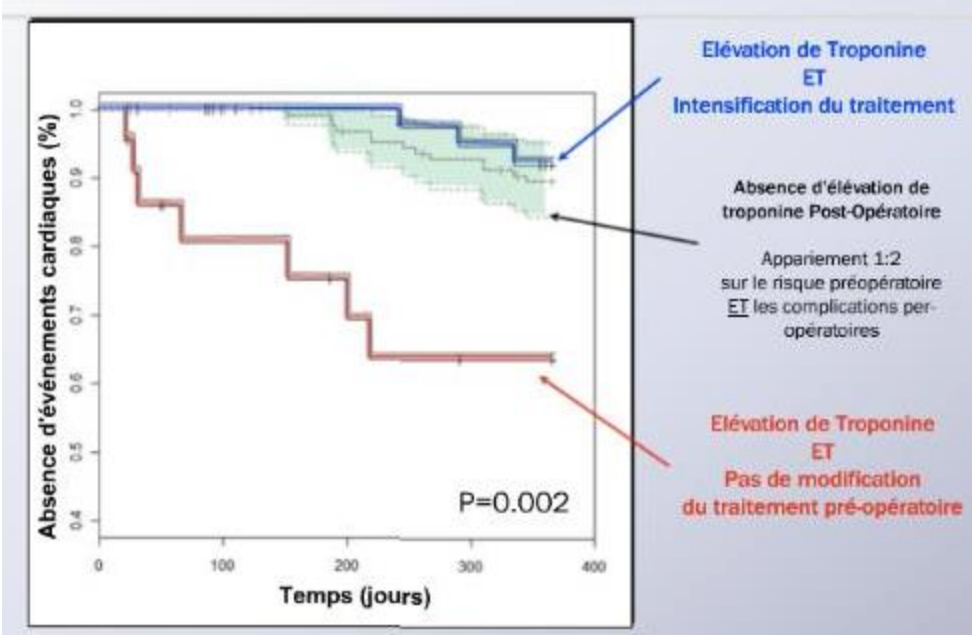
Δ value =l X 99th percentile **Absolute value = 5 X 99th Percentile**

Duceppe E et al. Can J Anesth 2019;66:1338-42
Ruetzler K et al. Circulation 2021; 144:e287-e305

Intensive perioperative therapy







ORIGINAL CLINICAL RESEARCH REPORT

Prediction of Acute Myocardial Injury in Noncardiac Surgery in Patients at Risk for Major Adverse Cardiovascular and Cerebrovascular Events: A Multivariable Risk Model

Single-center cohort study (2017-2019, n=732)
Patients underoing intermediate-to-high risk non-cardiac surgery

Objectives of study:

1) Investigate whether preoperative cardiac biomarker findings can identify those patients at the highest risk for acute myocardial injury (AMI),
2) Develop a risk model to further identify such patients at risk
3) Propose a decision-making algorithm for planning postoperative troponin surveillance

Mases A et al. Anesth Analg 2023

Primary endpoint = Acute myocardial injury (high-sensitivity troponin T (hsTnT) ≥30 ng/L with a rise of at least 20% of baseline value)

Secondary endpoints: All-cause mortality and MACCE within 30 days of surgery. (nonfatal cardiac arrest, acute myocardial infarction, congestive heart failure, new cardiac arrhythmia, angina, stroke, cardiovascular death, and cerebrovascular death)

Cardiac biomarkers

HsTnT levels were determined immediately after anesthesia induction (baseline), and postoperatively at 3 hours and on the 1st, 2d, and 3rd postoperative day.
NT-proBNP level was also determined just after anesthesia induction.

Myocardial infarction was defined as ischemic symptoms, ischemic electrocardiographic findings, development of pathological Q waves in the electrocardiogram, imaging evidence of new loss of viable myocardium or new regional wall motion abnormalities, or identification of an intra- coronary thrombus

Mases A et al. Anesth Analg 2023

RESULTS (I)

308 (42.1%) had elevated baseline hsTnT findings (≥14 ng/L)
273 (37.3%) had elevated baseline NT-proBNP findings (≥300 pg/mL)
Both biomarkers were elevated in 196 patients (26.8%).

AMI occurred in 161 patients (22.0%)

One hundred forty-six of them (90.7%) were free of any additional criteria required for a diagnosis of myocardial infarction.

One hundred thirty-five (43.8%) of patients with elevated baseline hsTnT developed AMI

An elevated baseline NT-proBNP was also more prevalent in patients with AMI (61.5% vs 30.5% of those without myocardial injury, $P < .001$)

Patients with AMI experienced more MACCE than those without myocardial injury (24% vs 6%, $P < .001$)

Mases A et al. Anesth Analg 2023

RESULTS (2)

Strong association between elevated baseline hsTnT concentration and occurrence of postoperative AMI (OR, 12.08; 95% CI, 7.78–19.42).

Strong association between elevated baseline NT-proBNP and occurrence of postoperative AMI (OR, 3.73; 95% CI, 2.60–5.39)

INDEPENDENT RISK FACTORS OF AMI

Independent predictors	β coefficient	Bivariate analysis, OR (95% CI) (n = 732)	Multivariable analysis, OR (95% CI) (n = 726)	Multivariable analysis, (95% CI) boostrapping ×2000
Age (y)	0.030	1.05 (1.03–1.07)	1.03 (1.01–1.05)	(1.01–1.06)
Sex (male)	0.589	1.48 (1.002–2.18)	1.80 (1.17–2.83)	(1.19–2.91)
eGFR <45 mL·min^{-1}·1.73 m^{-2}	1.169	5.11 (3.26–8.02)	3.22 (1.95–5.33)	(1.91–5.28)
METs <4 or unknown	0.849	3.02 (2.10–4.36)	2.34 (1.56–3.49)	(1.52–3.42)
ProBNPbasal ≥300 pg/mL	0.848	3.64 (2.53–5.24)	2.34 (1.54–3.55)	(1.55–3.52)
Blood loss (mL)	0.001	1.001 (1.000–1.001)	1.001 (1.001–1.001)	(1.001–1.001)

Abbreviations: CI, confidence interval; eGFR, estimated glomerular filtration rate; METs, metabolic equivalents; OR, odds ratio.

+ hsTnT concentration baseline > 14 ng/L

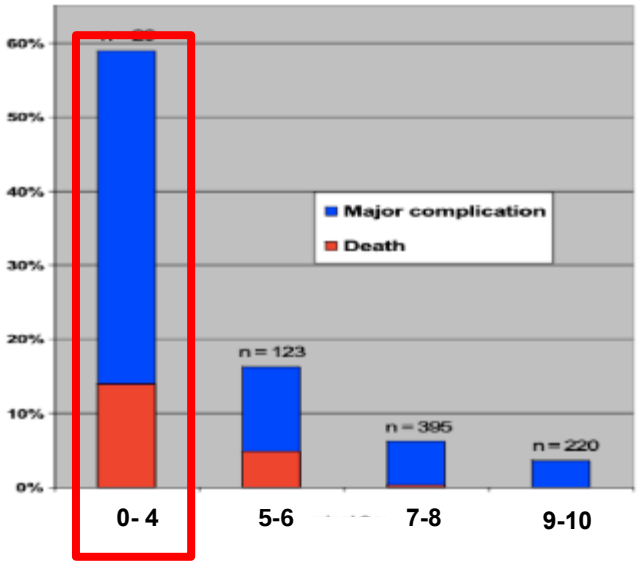
Mases A et al. Anesth Analg 2023

Extra cardiac causes of tropinin increase

- ✓ Sepsis
- ✓ Pulmonary embol
- ✓ Acute heart failure
- ✓ Atrial fibrillation
- ✓ Cardioversion
- ✓ Chronic kidney disease
- ✓ Rhabdomyolysis

An Apgar Score for Surgery

	0 points	1 point	2 points	3 points	4 points
Estimated blood loss (mL)	> 1,000	601–1,000	101–600	≤ 100	—
Lowest mean arterial pressure (mmHg)	< 40	40–54	55–69	≥ 70	—
Lowest heart rate (beats/min)	> 85	76–85	66–75	56–65	≤ 55†



Surgical Apgar score is associated with myocardial injury after noncardiac surgery☆,☆☆

Journal of Clinical Anesthesia

2016

Intraoperative SAS	MINS
0-4	1.42 (1.04-1.93)*
5-7	1.08 (0.88-1.33)
8-10	1 (reference)

Gawande et al. JACS 2007

PHARMACOLOGICAL TREATMENT

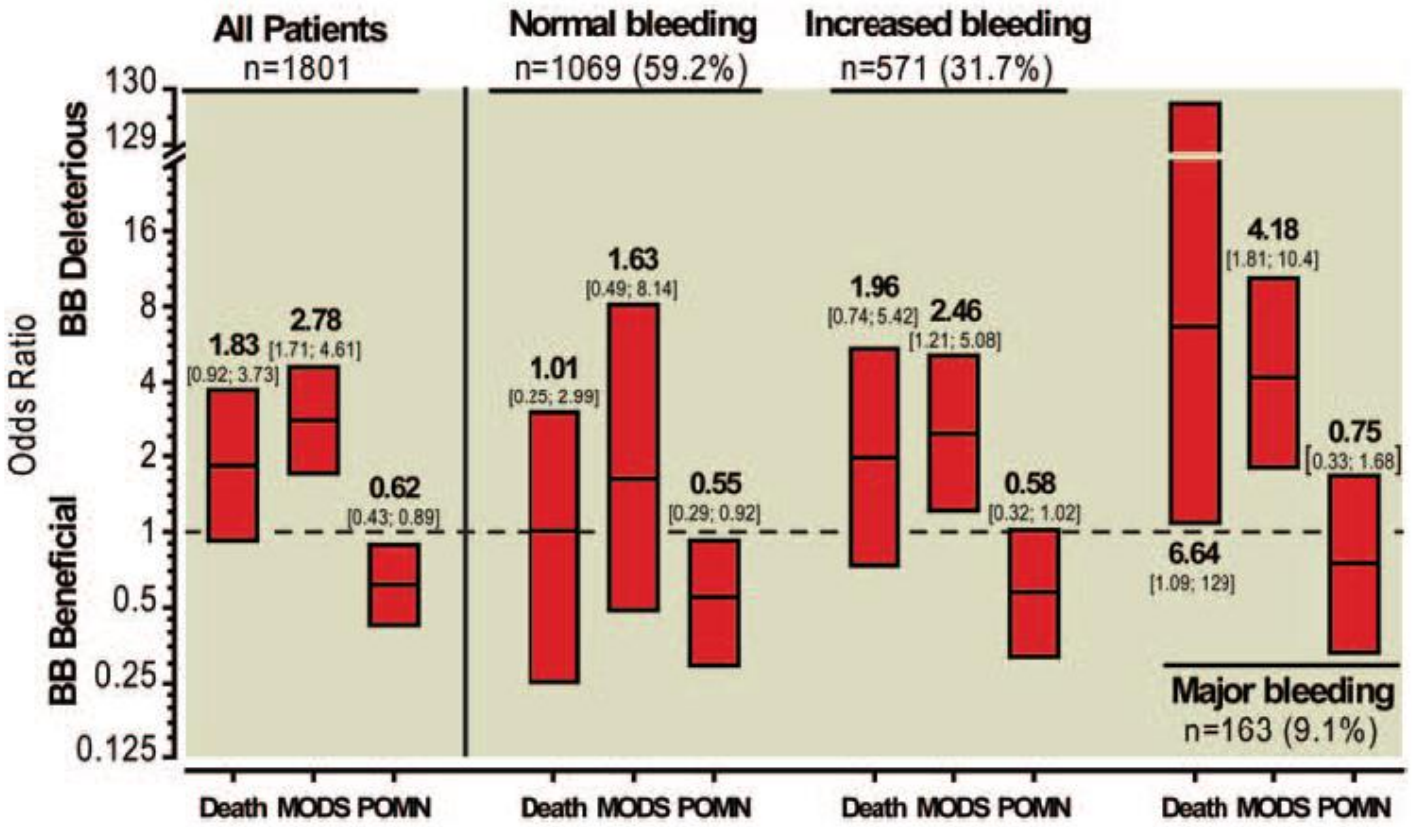
Initiation		
In patients with an indication for statins, it should be considered to initiate statins peri-operatively.	IIa	C
Pre-operative initiation of beta-blockers in advance[c] of high-risk NCS may be considered in patients who have two or more clinical risk factors,[d] in order to reduce the incidence of peri-operative myocardial infarction.[188,190–192]	IIb	A
Pre-operative initiation of beta-blocker in advance of NCS may be considered in patients who have known CAD or myocardial ischaemia.[e,230–232]	IIb	B
Routine initiation of beta-blocker peri-operatively is not recommended.[185,187,189,233,234]	III	A

Continuation		
Peri-operative continuation of beta-blockers is recommended in patients currently receiving this medication.[190,196–199]	I	B
In patients already on statins, it is recommended to continue statins during the peri-operative period.[235]	I	B
In patients with stable HF, peri-operative continuation of RAAS inhibitors may be considered.	IIb	C

Interruption		
In patients without HF, withholding RAAS inhibitors on the day of NCS should be considered to prevent peri-operative hypotension.[215,216]	IIa	B
For patients on diuretics to treat hypertension, transient discontinuation of diuretics on the day of NCS should be considered.[236]	IIa	B
It should be considered to interrupt SGLT-2 inhibitor therapy for at least 3 days before intermediate- and high-risk NCS.	IIa	C

Impact of Perioperative Bleeding on the Protective Effect of β-Blockers during Infrarenal Aortic Reconstruction

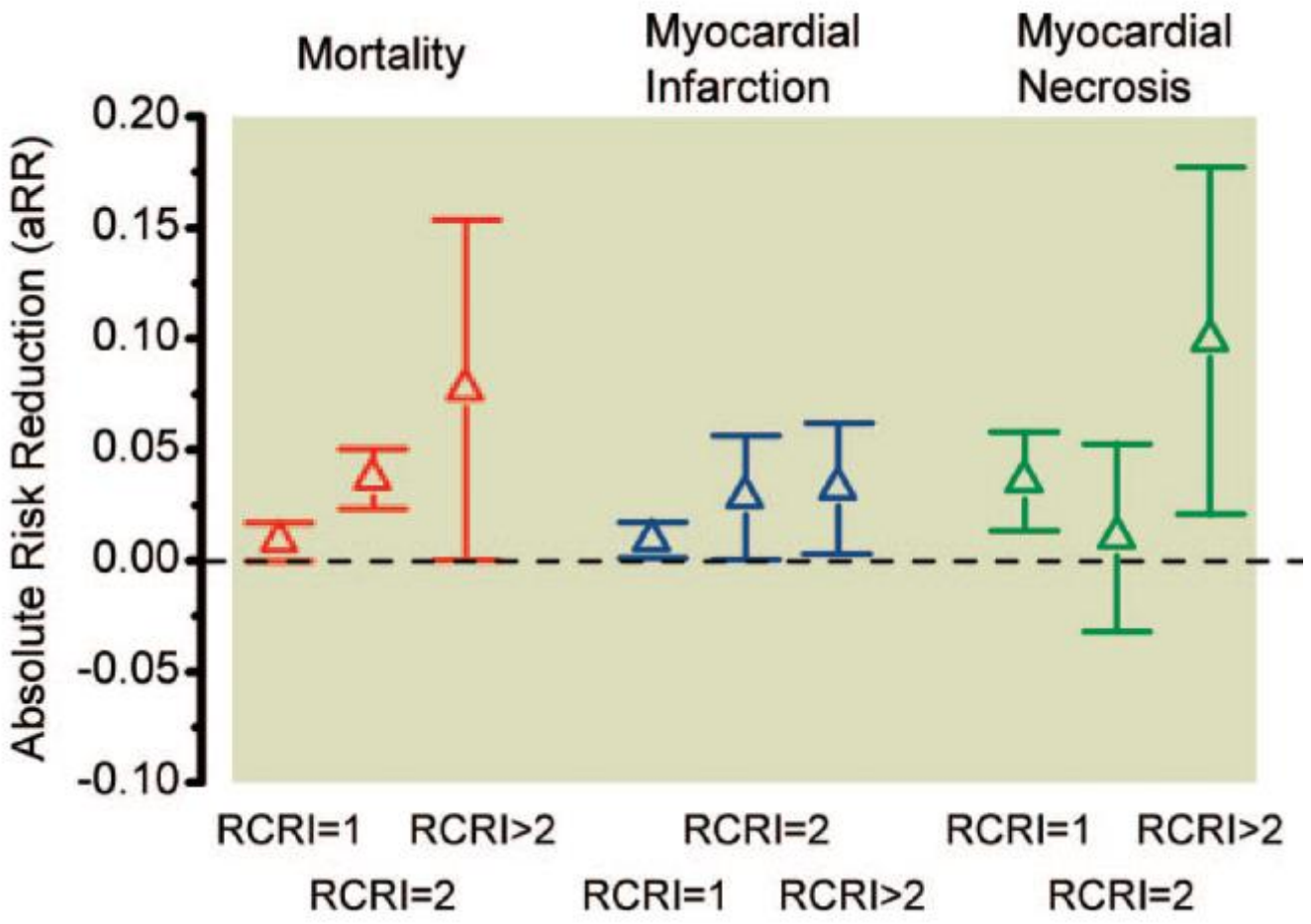
Le Manach Y et al. Anesthesiology 2012;117:1203-11



The beneficial effect of b-blockers is **strongly conditioned** by perioperative conditions (as bleeding…)

Impact of Preoperative Statin Therapy on Adverse Postoperative Outcomes in Patients Undergoing Vascular Surgery

Le Manach Y et al. Anesthesiology 2011;114:98-104



Gestion des agents antiplaquettaires (AAP) pour une procédure invasive programmée

Risque thrombotique du patient			Risque hémorragique de la procédure *À évaluer avec le chirurgien ou le responsable de la procédure*		
			Faible	Intermédiaire	Elevé
	Aspirine en prévention primaire		Arrêt ou poursuite	Arrêt	Arrêt
	AAP en prévention secondaire *(prévention cardiovasculaire, artériopathie des membres inférieurs, antécédent d'accident vasculaire cérébral ischémique)*	Aspirine en monothérapie	Poursuite	Poursuite	Arrêt
		Clopidogrel en monothérapie	Poursuite	Arrêt <u>et</u> relais par aspirine	Arrêt
	Bithérapie antiplaquettaire pour stent coronaire *Différer la procédure à la fin de la bithérapie antiplaquettaire en absence de risque vital ou fonctionnel*	- Stent <1 mois - Stent <6 mois à haut risque thrombotique * - IDM<6 mois	Différer la procédure Si impossible : Poursuivre les 2 AAP	Différer la procédure Si impossible : Poursuivre l'aspirine Interrompre l'anti-$P2Y_{12}$	Différer la procédure Si impossible : Interrompre les 2 AAP **
		Aucun des 3 critères ci-dessus	Poursuivre les 2 AAP	Poursuivre l'aspirine Interrompre l'anti-$P2Y_{12}$	Interrompre les 2 AAP

Risque hémorragique de la procédure
Faible : Réalisable sous bithérapie antiplaquettaire (ex: cataracte)
Intermédiaire : Réalisable sous aspirine seule (ex: PTH)
Elevé : non réalisable sous AAP (ex: ampullectomie endoscopique)

Délai d'arrêt des AAP : dernière prise à :
J-3 pour l'aspirine
J-5 pour le clopidogrel et le ticagrelor
J-7 pour le prasugrel
(Ajouter 2 j à chaque durée si neurochirurgie intra-crânienne)

En post-opératoire, reprendre les 2 AAP au plus vite, en fonction du risque hémorragique

***Caractéristiques d'un stent à haut risque thrombotique**
- Antécédent de thrombose de stent sous bithérapie AAP
- Maladie coronaire diffuse en particulier chez le diabétique
- Insuffisance rénale chronique (i.e. CrCl < 60 ml/min)
- Traitement d'une occlusion coronaire chronique
- Stenting de la dernière artère coronaire perméable
- Au moins 3 stents implantés
- Au moins 3 lésions traitées
- Bifurcation avec 2 stents implantés
- Longueur de stent totale > 60 mm

** Si stent <1 mois, discuter un relais par AAP injectable

Godier A et al. Anesth Réanim 2018

GESTION PÉRIOPÉRATOIRE EN FONCTION DU RISQUE HÉMORRAGIQUE

	Risque hémorragique faible	Risque hémorragique élevé		
Avant le geste	Pas de prise la veille au soir ni le matin de l'acte invasif	rivaroxaban apixaban edoxaban	Cockroft ≥ 30 ml/min	dernière prise J-3
		dabigatran	Cockroft ≥ 50 ml/min	dernière prise J-4
			Cockroft 30-49 ml/min	dernière prise J-5
	Pas de relais Pas de dosage			
Après le geste	Reprise à l'heure habituelle et au moins 6 heures après la fin de l'acte invasif	Anticoagulant à dose « prophylactique » au moins 6 heures après le geste, si une thromboprophylaxie veineuse est indiquée		
		Anticoagulant à dose « curative » dès que l'hémostase le permet (à titre indicatif: entre 24 et 72 heures)		

Valeur de créatinine récente à la consultation pré-anesthésique (dosage régulier d'ordinaire)

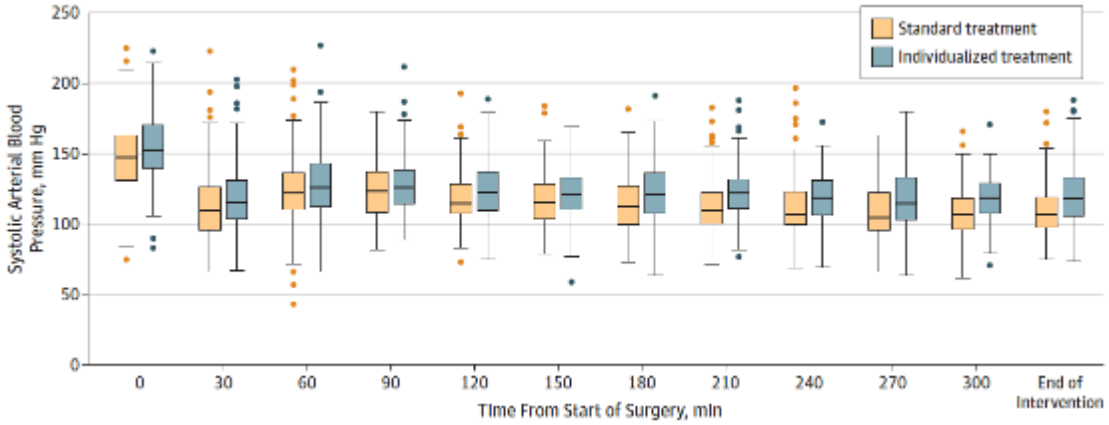
Il faut communiquer en dernière prise à J-X (J0=jour de la procédure)

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Individualized vs Standard Blood Pressure Management Strategies on Postoperative Organ Dysfunction Among High-Risk Patients Undergoing Major Surgery

A Randomized Clinical Trial

Futier E et al. JAMA 2017;318:1346-57



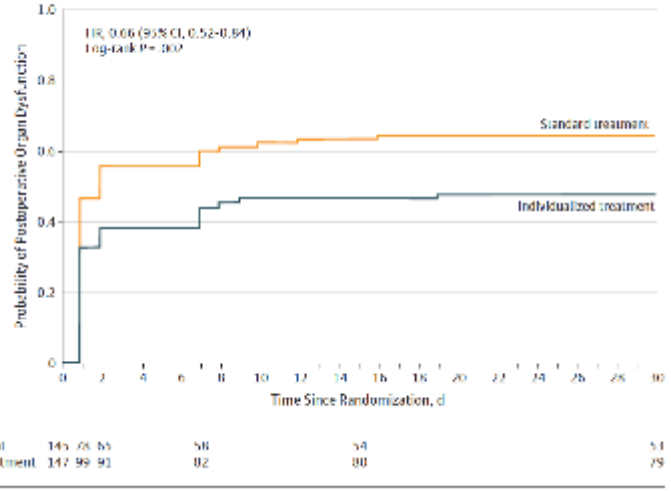
Groupe traitement standard (n=145)

- Ephédrine IV en bolus de 6-mg (maximum 60 mg), ou bolus de 15 mg
- si PAS< 80 mm Hg ou < 40% valeur de référence du patient

Groupe traitement individualisé (n=147)

- PAS cible = ± 10% de la valeur reference
- Par norepinephrine à 10 µg/mL selon un protocole prédefini

Figure 3. Kaplan-Meier Estimates of the Probability of Postoperative Organ Dysfunction by Day 30 After Surgery



Neuraxial block, death and serious cardiovascular morbidity in the POISE trial†

Sous analyse de l'étude POISE

Anesthésie générale (n=4016) versus neuroaxiale (n=3909)

Table 2 Estimated associations with the outcome for neuraxial block. OR, odds ratio; CI, confidence interval; *Wald-test *P*-value from unweighted/weighted logistic regression; †primary outcome, cardiovascular death, non-fatal MI, and non-fatal cardiac arrest

	No neuraxial block (*n*=4016)		Neuraxial block (*n*=3909)		Unadjusted		Propensity score adjusted	
	n	%	*n*	%	OR (95% CI)	*P*-value*	OR (95% CI)	*P*-value*
Primary†	229	5.7	287	7.3	1.31 (1.1, 1.57)	0.003	1.24 (1.02, 1.49)	0.03
MI	177	4.4	230	5.9	1.36 (1.11, 1.66)	0.003	1.32 (1.07, 1.63)	0.01
Stroke	32	0.8	23	0.6	0.74 (0.43, 1.26)	0.27	0.76 (0.44, 1.34)	0.35
Death	111	2.8	96	2.5	0.89 (0.67, 1.17)	0.39	0.87 (0.65, 1.17)	0.37
Hypotension	484	12.1	522	13.4	1.12 (0.98, 1.28)	0.08	1.13 (0.99, 1.3)	0.08

REST TRANSTHORACIC ECHOCARDIOGPRAHY

Recommendations	Class[a]	Level[b]
Newly detected murmur		
In patients with a newly detected murmur *and* symptoms or signs of CVD, TTE is recommended before NCS.	**I**	**C**
In patients with a newly detected murmur suggesting clinically significant pathology, TTE is recommended before high-risk NCS.	**I**	**C**
In patients with a newly detected murmur, but without other signs or symptoms of CVD, TTE should be considered before moderate-risk NCS.	**IIa**	**C**
In patients with dyspnoea and/or peripheral oedema and elevated NT-proBNP/BNP, TTE is recommended before NCS.[c]	**I**	**C**

Conclusions

- Main cause of perioperative morbidity and mortality
- Risk assessment is relatively well protocolized
- Need for Myocardial revascularisation is uncommon
- Pharmacology myocardial protection (beta-blockers, statins, ACEI…)
- Myocardial injury (Acute myocardial injury, AMI or Myocardial injury after Non-cardiac Surgery, MINS)
- Perioperative troponin level (Δ= 1 X 99^{tH} perc ou abs = 5 X 99^{th} perc) up to postoperative day-3
- Intensive therapy (+++) through multidisciplinary approach

Dr. Yannick Le Manach

16 OCTOBRE 1974 – 14 JUILLET 2020

European Heart Journal (2014) **35**, 2372–2381
doi:10.1093/eurheartj/ehu044

CLINICAL RESEARCH
Valvular heart disease

Perioperative risk of major non-cardiac surgery in patients with severe aortic stenosis: a reappraisal in contemporary practice

Tashiro T et al. Eur Heart J 2014;35:2372-81

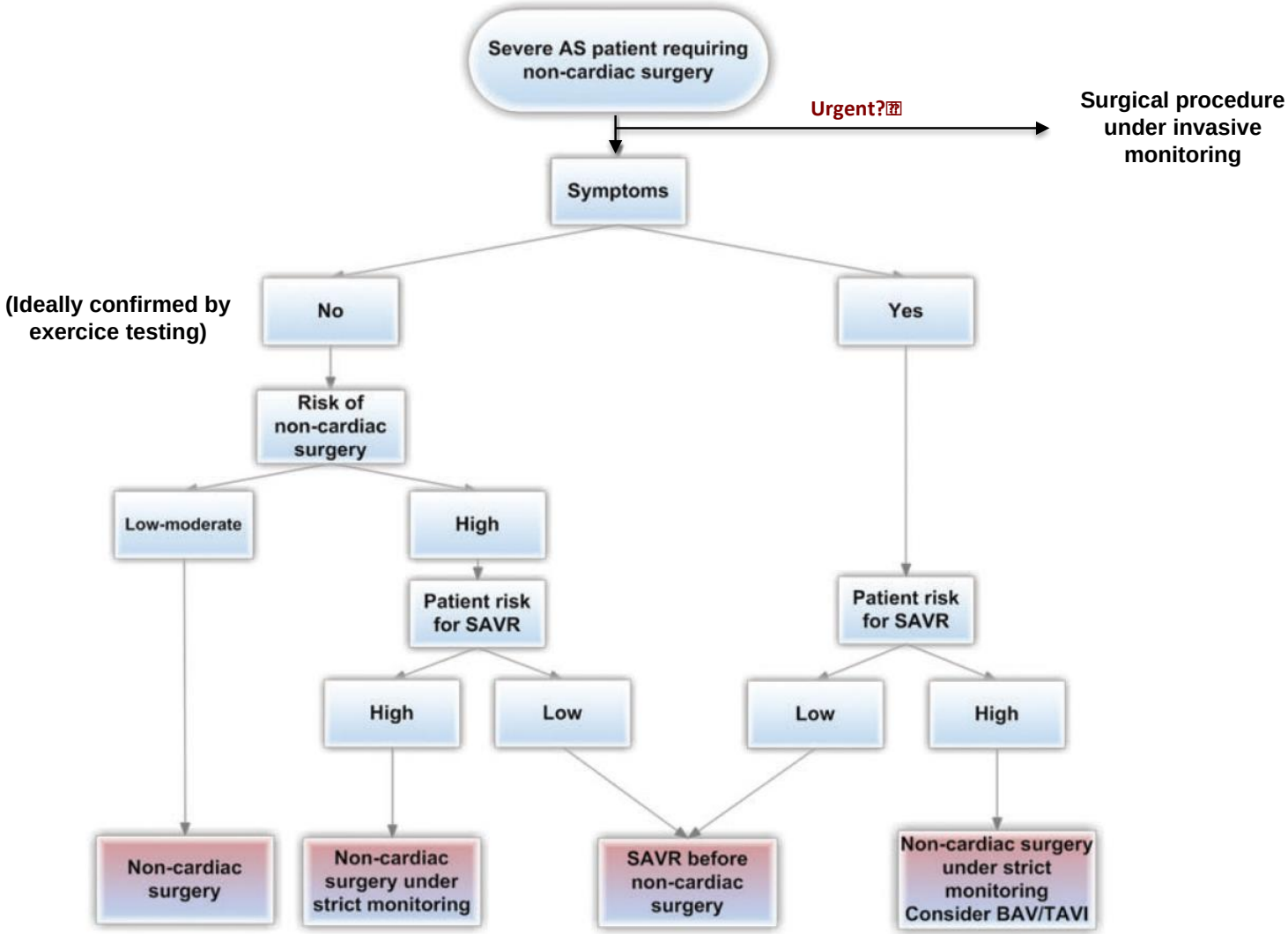
- Analyse rétrospective base échocardiographie Mayo Clinic Rochester (2000-2010)
- Patients avec RAC serré (SA< 1 cm^2, pic vélocité > 4 $m.sec^{-1}$ et gradient moyen > 40 mmHg)
- Chirurgie à risque intermédiaire et élevé (ACC/AHA)
- Appariés avec patients même chirurgie sans RAC (n=256)

Table 2 Perioperative course

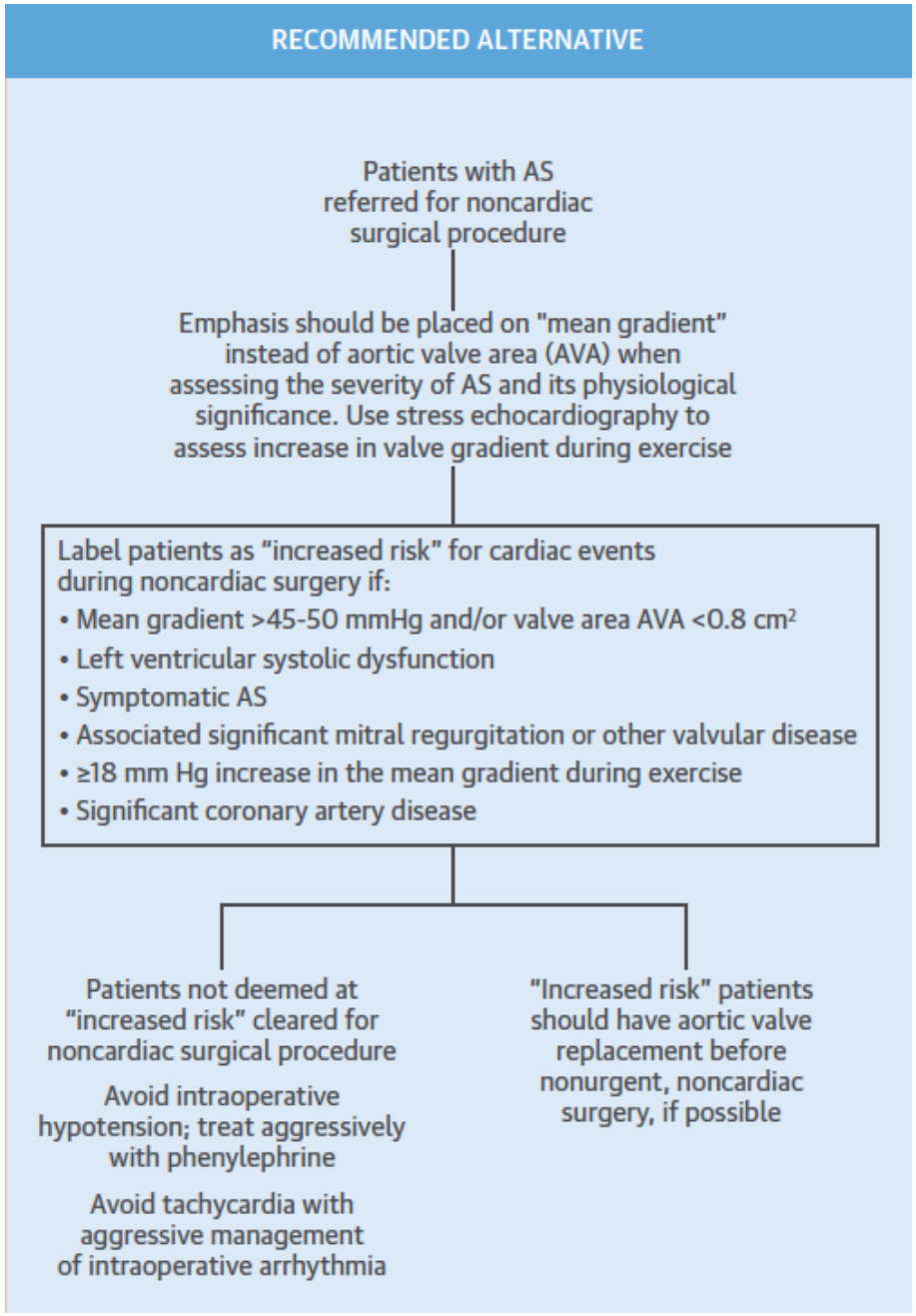
	SAS				Controls	P^b
	Overall	Symptomatic ($N = 106$)	Asymptomatic ($N = 150$)	P^a		
Major adverse cardiovascular events 30 days, *N* (%)						
Total	48 (18.8)	30 (28.3)	18 (12%)	0.001	27 (10.5)	0.01
Death	15 (5.9)	10 (9.4)	5 (3.3)	0.04	8 (3.1)	0.15
Cardiac	3 (1.2)	2 (1.9)	1 (0.7)	0.38	2 (0.8)	0.66
Non-cardiac	12 (4.7)	8 (7.6)	4 (2.7)	0.07	6 (2.3)	0.17
Stroke	2 (0.8)	1 (0.9)	1 (0.7)	0.81	3 (1.2)	0.66
STEMI	2 (0.8)	1 (0.9)	1 (0.7)	0.81	1 (0.4)	0.57
NSTEMI	2 (0.8)	1 (0.9)	1 (0.7)	0.81	4 (1.6)	0.42
VT/VF	2 (0.8)	2 (1.9)	0 (0)	0.06	3 (1.2)	0.66
New/worsening heart failure	33 (12.9)	21 (19.8)	12 (8)	0.04	13 (5.1)	0.004
Intra-operative course, *N* (%)						
Use of Swan-Ganz catheter	67 (26.2)	22 (20.8)	45 (30.0)	0.09	53 (20.7)	0.14
Need for blood transfusion	79 (30.9)	34 (32.1)	45 (30.0)	0.72	48 (18.8)	0.002
Use of catecholamines	63 (24.6)	25 (23.6)	38 (25.3)	0.75	45 (17.6)	0.04
Intubation and hospital stay, *N* (%)						
Intubation >24 h	15 (5.9)	9 (8.5)	6 (4.0)	0.13	10 (3.9)	0.28
Need for re-intubation	4 (1.6)	1 (0.9)	3 (2.0)	0.49	4 (1.6)	1.0
Length of stay (days)	10.3 ± 11.5	11.8 ± 12.9	9.2 ± 10.4	0.09	8.5 ± 9.4	0.06

2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management

ESC/ESA GUIDELINES



Kristensen SD et al. Eur Heart J 2014; 35:2383-431


RECOMMENDED ALTERNATIVE
Patients with AS referred for noncardiac surgical procedure
Emphasis should be placed on "mean gradient" instead of aortic valve area (AVA) when assessing the severity of AS and its physiological significance. Use stress echocardiography to assess increase in valve gradient during exercise
Label patients as "increased risk" for cardiac events during noncardiac surgery if:
• Mean gradient >45-50 mmHg and/or valve area AVA <0.8 cm²
• Left ventricular systolic dysfunction
• Symptomatic AS
• Associated significant mitral regurgitation or other valvular disease
• ≥18 mm Hg increase in the mean gradient during exercise
• Significant coronary artery disease
Patients not deemed at "increased risk" cleared for noncardiac surgical procedure
Avoid intraoperative hypotension; treat aggressively with phenylephrine
Avoid tachycardia with aggressive management of intraoperative arrhythmia
"Increased risk" patients should have aortic valve replacement before nonurgent, noncardiac surgery, if possible

CLASSE NYHA AND PERIOPERATIVE OUTCOMES

New York Heart Association functional classification

Class I 4%	No limitation of physical activity. Ordinary physical activity does not cause undue breathlessness, fatigue, or palpitations.
Class II 11%	Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity results in undue breathlessness, fatigue, or palpitations.
Class III 24%	Marked limitation of physical activity. Comfortable at rest, but less than ordinary physical activity results in undue breathlessness, fatigue, or palpitations.
Class IV 67%	Unable to carry on any physical activity without discomfort. Symptoms at rest can be present. If any physical activity is undertaken, discomfort is increased.

Impact of Heart Failure on Patients Undergoing Major Noncardiac Surgery

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Base de données incluant > 150 000 patients

Patients >65 ans souffrant de cardiopathie ischémique,d' IC ou aucun

Chirurgie majeure non cardiaque

Critères de jugement: Mortalité périopératoire, réhospitalisation de toute origine

Incidence de l'IC **18.4%** (**coronaropathie 34.4%**)
Mortalité (8.0%) et réadmission à 30 jours (17.1%)

Table 4. Regression Models of Outcomes for the Overall Study Population

Effect	Unadjusted*		Adjusted†
Operative mortality			
Heart failure group *vs.* comparison group	2.53 (2.38–2.70)	+63%	1.63 (1.52–1.74)
Coronary artery disease group *vs.* comparison group	1.26 (1.18–1.34)		1.08 (1.01–1.16)
Heart failure group *vs.* coronary artery disease group	2.02 (1.89–2.15)	+51%	1.51 (1.41–1.61)
30-Day readmission			
Heart failure group *vs.* comparison group	1.90 (1.83–1.98)	+51%	1.51 (1.45–1.58)
Coronary artery disease group *vs.* comparison group	1.27 (1.22–1.32)		1.16 (1.12–1.20)
Heart failure group *vs.* coronary artery disease group	1.50 (1.44–1.56)	+30%	1.30 (1.25–1.36)

Impact des chirurgie sur le risque de mortalité périopératoire