The European Society of Cardiology and European Society of Anaesthesiology Guidelines on non-cardiac surgery: cardiovascular assessment and management.

An abridged version.

ABSTRACT

In 2014, a joint task force involving the European Society of Cardiology and European Society of Anaesthesiology, assembled 'Guidelines on non-cardiac surgery: cardiovascular assessment and management'. The guidelines, subsequently published in the European Heart Journal, are intended for physicians and collaborators involved in the perioperative care of patients undergoing non-cardiac surgery, in whom heart disease is a potential source of complications. Whilst the guidelines are therefore an extremely relevant and useful aid for most, if not all, medics within the hospital environment, the sheer size of the document (49 pages) renders it a feat to read and digest. Given the importance of the document for optimising patient care, we have condensed the guidelines down to facilitate familiarisation of a number of the important details.

KEY POINTS

1. The incidence of cardiac complications after non-cardiac surgery depends on the interaction between the type of surgery and the circumstances under which it occurs, and patient-related risk factors.
2. Surgical interventions can be divided into those associated with low-, intermediate- and high-cardiac risk.
3. Preoperative cardiac evaluation must be tailored to the patient and surgical urgency.
4. Cardiac imaging should be performed only where results would influence management.

5. Continuing or ceasing dual antiplatelet therapy in those with coronary stents, must be discussed between surgeon and cardiologist, weighing risk of surgical bleeding against life-threatening stent thrombosis.

KEY WORDS X5

- Cardiology
- Anaesthesia
- Surgery
- Assessment
- Management

INTRODUCTION

The European Society of Cardiology and European Society of Anaesthesiology 'Guidelines on non-cardiac surgery: cardiovascular assessment and management'(Kristensen et al,2014), are an extremely relevant aid for all hospital medics. Herewith, we provide a markedly abridged version to accompany, but not replace them.

The incidence of cardiac complications after non-cardiac surgery depends on surgery type and circumstance, and patient-related risk factors.

TYPE OF SURGERY REQUIRED

Surgical interventions can be classified as being associated with low, intermediate and high cardiac risk (CR) (<1%, 1–5%, and >5% 30-day risk of cardiac death and myocardial infarction respectively, (Table 1)).

Vascular surgery is 'high-risk', especially infra-inguinal revascularisation, whose risk is greater than that of aortic procedures – perhaps due to patients' advanced age and high incidence of diabetes, renal dysfunction and ischaemic heart disease (IHD). Laparoscopic/endoscopic/endovascular techniques generally confer lower CR than 'open' alternatives, however older, sicker, and 'urgent' patients featured more frequently in the 'open' cohorts leading to possible bias. Importantly debilitated patients, and those with cardiac disease, may tolerate pneumoperitoneum/Trendelenburg position less well.

PATIENT RELATED RISK FACTORS

Preoperative cardiac evaluation must be tailored to the patient/surgical urgency. After comprehensive history-taking and examination, including assessment of functional capacity and risk indices (below), most 'low CR' patients can undergo low- and intermediate-risk surgery without delay - risk isn't significantly reduced by pharmacological intervention. Cardiac imaging should be performed only where results would influence management.

i) Functional capacity

Functional capacity is assessed objectively through exercise testing, but estimated from the 'metabolic equivalents' (METs) of normal activities (one MET =basal metabolic rate at rest; 4 METs =climbing two flights of stairs; 10 METs =strenuous sports) (Fletcher et al,2001). Inability to run a short distance/climb two flights of stairs (<4 METs) indicates poor functional capacity and raised perioperative CR. Risk is low when functional capacity is high, even in the presence of stable IHD or other risk factors.

ii) Risk indices

'Lee's revised CR index' (Lee et al,1999) includes six variables: type of surgery, and presence of IHD/heart failure/cerebrovascular disease/renal failure (creatinine >170mmol/L)/insulin-dependent diabetes. The American College of Surgeons National Surgical Quality Improvement Program database (Gupta et al,2011) uses five predictors of myocardial infarction/cardiac arrest: age/American Society of Anesthesiologists (ASA) class/type of surgery/functional status/elevated creatinine (>130mmol/L).

iii) Biomarkers

These can suggest myocardial injury (cardiac troponins T and I) or left ventricular dysfunction (B-type natriuretic peptide (BNP) and N-terminal pro-BNP (NT-proBNP)). Whilst small perioperative troponin increases reflect poorer cardiac prognosis, with limited data routine biomarker assessment in non-cardiac surgery isn't advised, but may be considered in high-risk patients.

iv) Non-invasive testing

Myocardial ischaemia, left ventricular dysfunction and heart valve abnormalities are major determinants of risk. Pre-operative non-invasive testing (e.g. resting/stress echocardiography, cardiopulmonary exercise testing, myocardial perfusion imaging, cardiovascular magnetic resonance imaging, CT angiography) may be informative. Risk

stratification and investigation should be similar to that for patients in the non-surgical setting, and considered if coronary artery revascularisation would also be considered, or to help inform patient choice/change perioperative management (e.g. type of surgery or anaesthetic technique).

RISK-REDUCTION STRATEGIES

Pharmacological

The risk:benefit profile of medicating to decrease perioperative CR should be considered, and contraindications respected.

Beta-blockers

Cardiac beta-receptor antagonists (beta-blockers) decrease myocardial oxygen consumption by reducing heart rate and myocardial contractility. Data from trials of beta-blockers use to reduce perioperative cardiac complications are conflicting - perhaps due to differences in patients, surgery, and beta-blocker type/timing of onset/duration/dose titration. Consensus however is that beta-blockers may be commenced preoperatively in known IHD. $Beta_1$-selective antagonists without intrinsic sympathomimetic activity are preferred, with atenolol and bisoprolol over metoprolol. Treatment should ideally be initiated 30days (and >2days) preoperatively, dose up-titrated to a resting heart rate of 60-70bpm and systolic blood pressure >100mmHg.

Statins

Statins prevent atheromatous plaque progression, induce their regression and stabilise them. Data concerning perioperative statin impact on all-cause/cardiovascular mortality,

and myocardial infarction are conflicting, but patients with peripheral artery disease (PAD) should receive statins, continued after vascular surgery or endovascular intervention. Statin-naive PAD patients should receive them starting- >2weeks prior to intervention, and continuing for >1month post-surgery. Statin withdrawal >4days following aortic surgery is associated with a three-fold risk of post-operative myocardial ischaemia. In non-vascular surgery, no evidence supports pre-operative statin treatment if without other indications.

Angiotensin-converting enzyme inhibitors(ACEIs) and angiotensin-receptor blockers (ARBs)

Their use until the day of surgery is associated with increased risk of hypotension under anaesthesia, particularly following induction and if simultaneously taking beta-blockers. Vasopressor response may also be impaired. They should thus be stopped 24hours preoperatively when prescribed for hypertension, and restarted at the earliest opportunity postoperatively. In heart failure and systolic LV dysfunction, ACEIs should be continued perioperatively, and commencement considered for those not already taking them.

Calcium channel blockers

Routine use of dihydropyridines and non-dihydropyridines is not recommended, and short acting dihydropiridines (especially nifedipine capsules) should be avoided.

Alpha$_2$ receptor agonists or nitrates

Routine perioperative intravenous nitroglycerine use conveys no benefit in non-cardiac surgery, and may increase haemodynamic risk. Alpha$_2$ receptor agonists increase risk of hypotension/non-fatal cardiac arrest.

Diuretics

Diuretics should be continued until the day of surgery, and resumed as soon as possible afterwards – assuming appropriate dose adjustment and volume status allows. Serum electrolytes should be monitored and corrected appropriately.

Perioperative management in patients taking anti-platelet agents

Aspirin

As continuation increases bleeding complication risk by 50% (but not severity), aspirin may need to be discontinued for >7days before certain ophthalmological/neurosurgical/spinal operations. In subjects at risk of IHD, aspirin non-adherence/withdrawal tripled major adverse cardiovascular event (MACE) risk. Low-dose aspirin use in non-cardiac surgery should therefore be individualised, balancing perioperative bleeding/thrombotic risk against cardiovascular benefit.

Dual anti-platelet therapy

Coronary stenting requires post-procedural dual anti-platelet therapy (DAPT) to avoid stent thrombosis. Whenever possible, surgery should proceed without discontinuation of aspirin, with elective surgery postponed (and DAPT continued) for a minimum of; 4weeks and ideally <3months after bare metal stent implantation, 6months for second- and third-generation drug eluting stents (DES), and for 12months for first generation DES. In patients undergoing myocardial revascularisation for high-risk acute coronary syndromes, DAPT is recommended for one year irrespective of stent type. If surgery can't be delayed, it should be undertaken in hospitals where 24/7 cardiac catheterisation availability allows immediate treatment of stent occlusion. DAPT management must be discussed between surgeon and cardiologist, weighing risk of surgical bleeding against life-threatening stent thrombosis (on or off DAPT respectively). Excessive or life-threatening perioperative bleeding in a patient receiving anti-platelet therapy should be treated with platelet transfusion.

Perioperative management in patients on anticoagulants

Here, risk:benefit ratio must be calculated on an individual basis.

Vitamin K antagonists

In low-risk patients with international normalised ratio (INR) ≤1.5, surgery can usually proceed safely with minimal bleeding risk. In those with high thromboembolic risk (e.g. mechanical prosthetic heart valves, recent venous thromboembolism, or thrombophilia), stopping vitamin K antagonists (VKAs) is dangerous and these patients will need bridging therapy with unfractionated heparin (UFH) or therapeutic-dose low molecular weight heparins (LMWH). Both agents have advantages and disadvantages, and haematologists should help guide choice and timings of starting, stopping, and then re-starting bridging therapy. Depending on type of surgery, and whether adequate haemostasis has been achieved, VKAs should be restarted postoperatively, normally by administering 150% of the pre-operative maintenance dose for two consecutive days. The maintenance dose should be administrated thereafter, and UFH/LMWH continued until INR returns to pre-operative therapeutic levels.

Non-vitamin K antagonist oral anticoagulants

Non-vitamin K oral anticoagulants (NOACs) have short biological half-lives and a well-defined 'on' and 'off' action providing renal function is normal. 'Bridging' to surgery is thus generally unnecessary, and postoperative resumption of treatment should be delayed for 1-2 (in some cases 3-5) days, until post-surgical bleeding risk is diminished. An exception is the patient with high thromboembolic risk, whose surgical intervention is delayed for several days. Here, stop NOACs for 2–3 times their respective half-lives prior to surgery considered to have a 'normal' bleeding risk, and 4–5 times the half-lives before high bleeding risk procedures.

Reversal of anticoagulant therapy

Vitamin K antagonists

If anticoagulation is required before urgent surgery in patients on VKAs, low-dose (2.5-5mg) iv or oral vitamin K will lower INR in 6-12hours. Additional administration of fresh-frozen plasma or prothrombin complex concentrate (PCC) will offer immediate effect. Anticoagulant effects of UFH/LMWH are usually reversed 4-8hours respectively after stopping treatment. Protamine sulphate immediately reverses UFH action - the anti-Xa activity of LMWH will not be completely neutralised (maximum 50%).

Non-vitamin K antagonist oral anticoagulants

Bleeding should be managed with symptomatic and supportive measure and haematological advice sought early. There are no specific NOAC antidotes, although PCC, recombinant factor VIIa, and haemodialysis may offer benefit.

Revascularisation

In patients with known or suspected IHD scheduled for major non-cardiac surgery, indications for coronary angiography or pre-operative revascularisation are similar to those in the non-surgical setting. If surgery can be safely delayed, symptoms of myocardial ischaemia should be fully investigated and treated beforehand. Asymptomatic (silent) myocardial ischaemia should not be sought before non-cardiac surgery - coronary angiography and/or revascularisation prior to non-cardiac surgery confers no benefit beyond optimal medical management.

The role of prophylactic revascularisation in patients with non-ST elevation acute coronary syndromes (NSTE-ACS) requiring non-cardiac surgery isn't known. If surgery can be safely

delayed, priority should be given to NSTE-ACS management. Otherwise balloon angioplasty alone, or PCI using a bare metal stent or new generation DES may be considered.

SPECIFIC DISEASES

Presence of the following conditions increases perioperative cardiac event risk.

i) Chronic heart failure with reduced or preserved left ventricular ejection fraction (HF-REF or HF-PEF).

HF-PEF patients are more likely older, female, hypertensive with AF, and less likely to have coronary artery disease. Generally, their prognoses are also better. Similar perioperative management is recommended in both, including assessment of LVEF, general clinical status and volume overload. Elevated circulating natriuretic peptide concentrations correlate with morbidity and mortality. Routine preoperative transthoracic echocardiography (TTE) should not be performed in all, but considered in patients with known or suspected heart failure and in high-risk surgical populations. Overall functional capacity and cardiopulmonary reserve are best assessed through cardiopulmonary exercise testing - anaerobic thresholds of <11 mlO_2/kg/min suggest increased perioperative morbidity/mortality (Guazzi et al, 2012).

For patients newly diagnosed with heart failure, non-urgent surgery should be delayed >3months. Heart failure medications should be continued throughout the perioperative period, especially beta-blockers. In general, all should be continued until the day of surgery - in those very susceptible to perioperative hypotension, transient discontinuation on the day before surgery may be considered (see ACEI/ARB section above). If stopped, all heart failure medications should be restarted as soon as possible postoperatively: administration via nasogastric tube or bioequivalent intravenous doses should be considered.

ii) Arterial hypertension

Patients with pre-existing hypertension more commonly demonstrate profound hypotension at induction, or intra-operative blood pressure lability. As a decrease in BP >20mmHg for more >1hour is a risk factor for postoperative complications, perioperative BP should be maintained 70–100% of baseline, avoiding excessive tachycardia.

In patients with preoperative hypertension, signs of organ damage should be sought. In patients with grade 1 or 2 hypertension (systolic BP <180mmHg; diastolic BP <110mmHg), delaying surgery to optimise therapy offers no benefit. However, in such cases, antihypertensive medications should be continued during the perioperative period.

iii) Valvular heart disease

Any patient with known or suspected valvular heart disease should have echocardiography to determine the need for treatment prior to surgery.

Aortic stenosis

Severe aortic stenosis (valve area <1.0cm^2, maximum jet velocity >4m/sec, and/or mean aortic pressure gradient ≥40mmHg) is particular high risk. If symptomatic, valve replacement should be considered before elective surgery. For those at high risk for valvular surgery or where replacement is contraindicated, balloon aortic valvuloplasty (BAV) or transcatheter aortic valve implantation (TAVI) may be considered. In asymptomatic patients, non-cardiac surgery of low/intermediate risk can be performed safely - invasive haemodynamic monitoring and avoiding rapid changes in volume status and heart rate and rhythm are essential.

Mitral stenosis

With valve area >1.5cm^2 or in asymptomatic patients with significant mitral stenosis (valve

area <1.5cm^2) and systolic pulmonary artery pressure <50mmHg, non-cardiac surgery can be performed with low-risk of MACE. With significant mitral stenotic signs and symptoms, risk from non-cardiac surgery is significantly higher - percutaneous mitral commissurotomy (or open surgical repair) should be considered preoperatively.

Primary aortic regurgitation and mitral regurgitation

In severe aortic or mitral regurgitation, LV function should be assessed. If preserved, non-cardiac surgery can be performed without additional risk. If impaired (<30%), or symptomatic, non-cardiac surgery should be performed only if necessary. Non-significant aortic regurgitation and mitral regurgitation do not independently increase the cardiovascular risk during non-cardiac surgery.

Patients with prosthetic valve(s)

Those without valvular/ventricular dysfunction can undergo non-cardiac surgery without additional risk. Oral anticoagulants are temporarily replaced by UFH or LMWH at therapeutic doses.

iv) Arrhythmias

Their discovery mandates preoperative cardiological review and appropriate investigation, referring to appropriate guidelines (Yegnasubramanian,2016).

v) Renal disease

Impaired renal function is associated with adverse post-operative cardiovascular outcomes, including myocardial infarction/stroke/progression of heart failure. Chronic kidney disease (CKD) is a risk factor for the development of acute kidney injury (AKI) following non-cardiac

surgery: estimated glomerular filtration rate (eGFR) should be calculated in all (a value of <60 mL/min/1.73m^2 correlates significantly with MACE) and proteinuria assessed (as urinary albumin – creatinine ratio). AKI risk is also associated with age >56years; male sex; presence of cardiac failure, ascites, hypertension or diabetes; or emergency or intraperitoneal surgery. Supportive measures (e.g. maintenance of adequate intra-vascular volume, use of vasopressors, avoidance of nephrotoxic agents) should be considered in all at risk. Strategies to prevent AKI caused by iodinated contrast (contrast-induced AKI, (CI-AKI)) include minimising administered volume, using less-nephrotoxic agents, provision of prophylactic renal-replacement therapy, and use of pharmacological agents to counteract contrast nephrotoxicity. Pre-procedural hydration with intravenous isotonic fluids is the most effective method of reducing the risk of CI-AKI, and normal saline or isotonic sodium bicarbonate (1.26%) may be administered. The benefit of N-acetyl-cysteine in CI-AKI prophylaxis remains unproven.

vi) Cerebrovascular disease

Stroke (usually thromboembolic) occurs in 0.1% of non-cardiac surgical patients, but is associated with a 700% increase in perioperative mortality (absolute risk >20%) (Mashour et al,2011). Perioperative arterial hypotension is a risk factor, as is withdrawal of anticoagulation for atrial fibrillation (AF) or of antiplatelet agents (in those with atheromatous disease) during the hypercoagulable perioperative state. Patients with symptoms suggestive of transient ischaemic attack (TIA) or stroke in the preceding six months should receive pre-operative neurological consultation.

For those with symptomatic carotid artery disease, revascularisation should be performed prior to other surgery. In asymptomatic patients with severe carotid occlusive disease, carotid revascularisation is more for the long-term prevention of stroke than perioperative stroke reduction and may be performed before or after the planned non-cardiac surgery. Asides from revascularisation, patients with carotid stenosis benefit from aggressive cardiovascular risk-factor modification, and in the perioperative setting, statins should be continued, aspirin and beta-blockers should not be withdrawn if possible, and blood

pressure should be carefully controlled.

Any patient with PAD is at increased risk of CVA and perioperative acute MI, so should be thoroughly assessed and investigated for IHD. Routine exercise or imaging testing isn't warranted in the absence of symptoms or other risk factors.

vii) Pulmonary disease

This increases perioperative risk, especially of post-operative pulmonary complications. Risk is particularly high in smoking-related lung disease, and after abdominal or thoracic surgery. Chronic obstructive pulmonary disease (COPD) and obesity hypoventilation syndrome (OHS) are also especially associated with cardiovascular pathology, and such patients (and any with pulmonary artery hypertension (PAH)) require CR assessment.

Independent of age, gender, and smoking history, every 10% decrease in forced expiratory volume in 1 second is associated with a 30% increase in cardiovascular mortality and 20% increase in non-fatal coronary events (Sin DD et al,2005). COPD is also a risk factor for IHD, and also leads to cor-pulmonale with associated right-heart failure. In COPD, perioperative cardiovascular risk must be assessed and managed, and pulmonary function optimised. Education regarding pre-operative smoking cessation (>2months before surgery), chest physiotherapy and lung expansion manoeuvres is advocated, as may be muscular endurance training and re-nutrition if required. Beta-blockers and anticholinergic agents should be continued until the day of surgery in all symptomatic COPD patients with bronchial hyper-reactivity. In some cases, short-term systemic/inhaled steroids may be considered.

OHS (obesity, daytime hypoventilation, and sleep-disordered breathing) is associated with IHD, heart failure (and obesity-related cardiomyopathy), pulmonary hypertension and cor-pulmonale, and increased perioperative mortality. Patients at high-risk of OHS who are undergoing major surgery should be referred for specialist investigation.

Pulmonary arterial hypertension (PAH) (mean pulmonary arterial pressure >25mmHg at rest) can be primary or the consequence of diverse lung vascular or parenchymal diseases, or of cardiac disease (e.g. mitral valve disease/intra-cardiac shunts). It's associated with

increased post-operative complications, including right ventricular failure, myocardial ischaemia, and post-operative hypoxia. Treatment should be optimised preoperatively, and management should be at a centre with appropriate expertise. Patients receiving PAH-specific therapy must not have drugs withheld for the pre-operative fasting state, and may require temporary conversion to intravenous and/or nebulised treatment until they are able to reliably absorb via the enteral route.

viii) Congenital heart disease

Patients with congenital heart disease are at increased risk from non- cardiac surgery, but risk varies with the degree of associated heart failure, pulmonary hypertension, arrhythmias and blood shunting, and the complexity of the underlying condition. Complicated patients should only undergo non-cardiac surgery after thorough evaluation by a multidisciplinary team in a specialised centre.

ix) Disturbed glucose metabolism & perioperative monitoring

Diabetics face greater perioperative mortality/morbidity. Blood glucose concentration fluctuation should be minimised and hypoglycaemia/hyperglycaemia avoided. In the intensive care unit, insulin infusions should be instigated if blood glucose concentrations reach 10.0mMol/l, with a reactive trigger at 8.3mMol/l. Target concentrations are disputed, but those <6.1mMol/l are not recommended.

SUMMARY

Both surgical and patient-related factors determine the risk of developing cardiac complications after non-cardiac surgery. The extent of preoperative cardiac evaluation must be guided by a comprehensive history and examination. The risks/benefits of delaying non-cardiac surgery to optimise a patient's pathophysiology must be evaluated case-by-case, with advice from other specialties where necessary.

CONFLICT OF INTEREST

None

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