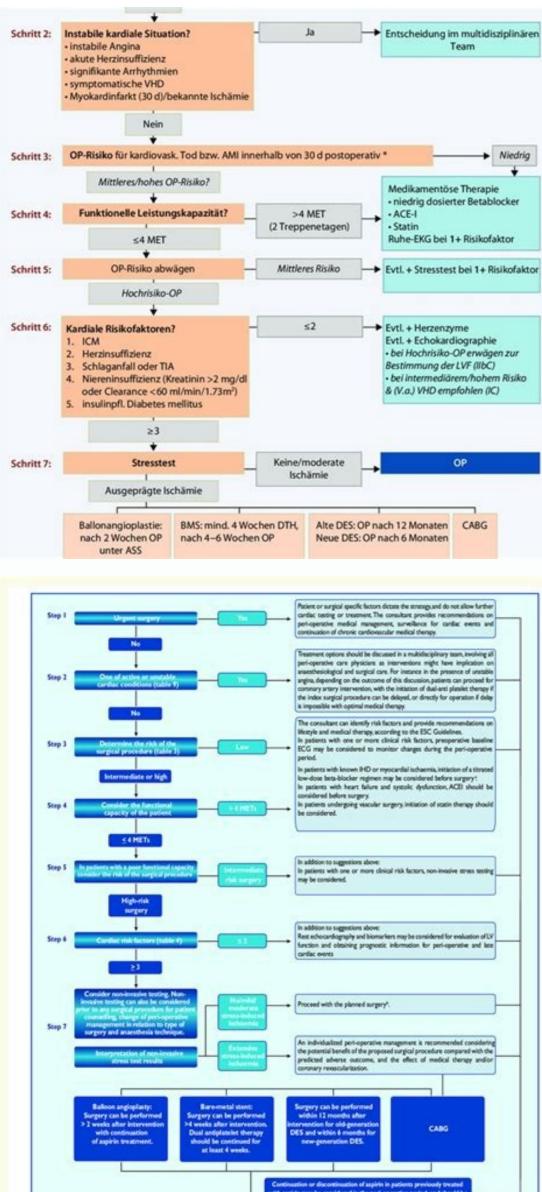
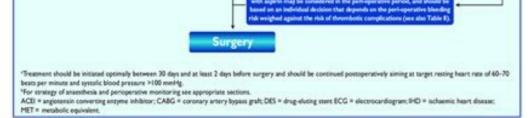
Esc guidelines 2014 non cardiac surgery







COMPARISON OF 2014 ACCAHA VS. **EDITORIAL**

2014 ESC/ESA guidelines on noncardiac surgery: Cardiovascular assessment and management

Are the differences clinically relevant? The European perspective

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In 2012, the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA) established a guideline task force comprising experts within the field of a noncardiac surgery. After a fruitful review process, the guideline document was published in 2014.1.2 The group consisted of experts within anaesthesiology, surgery, and all subspecialities of cardiology including cardiovascular imaging. In this issue of the Journal, Velasco et al. have prepared a comparison of the latest revision of the US and European guidelines on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery and the editorial by Port providing the US perspective.3.4

The major goal of the European Guidelines was to provide a step-by-step guidance for clinicians managing cardiac patients undergoing noncardiac surgery. The following points were updated and emphasized:

- A multidisciplinary expert team should be consulted for perioperative evaluations of patients with known or high-risk cardiac disease undergoing high-risk surgery.
- The surgical risk assessment was completely updated

- Patient risk assessment was based on the Lee score,3 but also other validated risk scores such as NSQIP* were recommended.
- The risk reduction section including the indication for preoperative use of beta-blockers was updated and changed.
- The recommendations of the use of aspirin and P2Y12 inhibitors were updated, and a section on new oral anticoagulants was included.
- The recommendations of the timing of noncardiac surgery in patients with recent revascularization were updated. Routine prophylactic myocardial revascularization before low- and intermediate-risk surgeries in patients with ischemic heart disease (IHD) is not recommended, but may be considered before highrisk surgery depending on the extent of stress-induced ischemia.
- The section on specific diseases including several cardiac and vascular conditions and also pulmonary and renal disease was updated.
- The perioperative monitoring section was updated, and new anaesthesiological techniques were recommended.

(Table 3, Ref 1).

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As for other ESC Guidelines, the approach is to establish recommendations and to evaluate the level of evidence on the best patient management to guide clinicians in their decision making. Clearly this also holds true for optimal use of preoperative cardiovascular imaging in these patients. In general, the view on this topic is that we should be careful not to overuse expensive imaging techniques that are not evidence based. In each case, the

Dopo le Linee Guida ACC/AHA ed ESC

La valutazione cardiologica preoperatoria nella chirugia non cardiaca: le certezze, le aree controverse e le opportunità di una gestione in team

After ACC/AHA and ESC Guidelines

Pre-operative cardiological evaluation in non-cardiac surgery: certainties, controversial areas and opportunities for a team approach

Stefano Urbinati, Pompilio Faggiano, Furio Colivicchi, Carmine Riccio, Maurizio Giuseppe Abrignani, Alberto Genovesi-Ebert, Francesco Fattirolli, Stefania De Feo, Simona Gambetti e Massimo Uguccioni

ABSTRACT: After ACC/AHA and ESC Guidelines. Preoperative cardiological evaluation in non-cardiac surgery: certainties, controversial areas and opportunities for a team approach. S. Urbinati, P. Faggiano, F. Coliricchi, C. Riccio, M.G. Abrignani, A. Genovesi-Ebert, F. Fattirolli, S. De Feo, S. Gambetti, M. Uguccioni.

A standardized and evidence-based approach to the cardiological management of patients undergoing noncardiac surgery has been recently defined by Task Forces of the American Heart Association (AHA), American College of Cardiology (ACC) and the European Society of Cardiology (ESC) that published their guidelines in 2007 and 2009, respectively. Both the recommendations moved from risk indices to a practical, stepwise approach of the patient, which integrates clinical risk factors and test results with the estimated stress of the planned surgical procedure.

In the present paper the main topics of the guidelines

are discussed, and moreover, emphasis is placed on four controversial issues such as the use of prophylactic coronary revascularization in patients with myocardial ischemia, the perioperative management of patients with congestive heart failure, the routine use of betablockers and statins, and, finally, the management of antiplatelet therapies in patients with coronary stents.

In addition to promoting an improvement of immediate perioperative care, the preoperative cardiological evaluation should be a challenge for identifying subjects with enhanced risk of cardiovascular events, who should be treated and monitored during a long-term follow-up.

Keywords: noncardiac surgery, perioperative management, nonivasive testing, preoperative revascularization, betablockers, statins, coronary stents.

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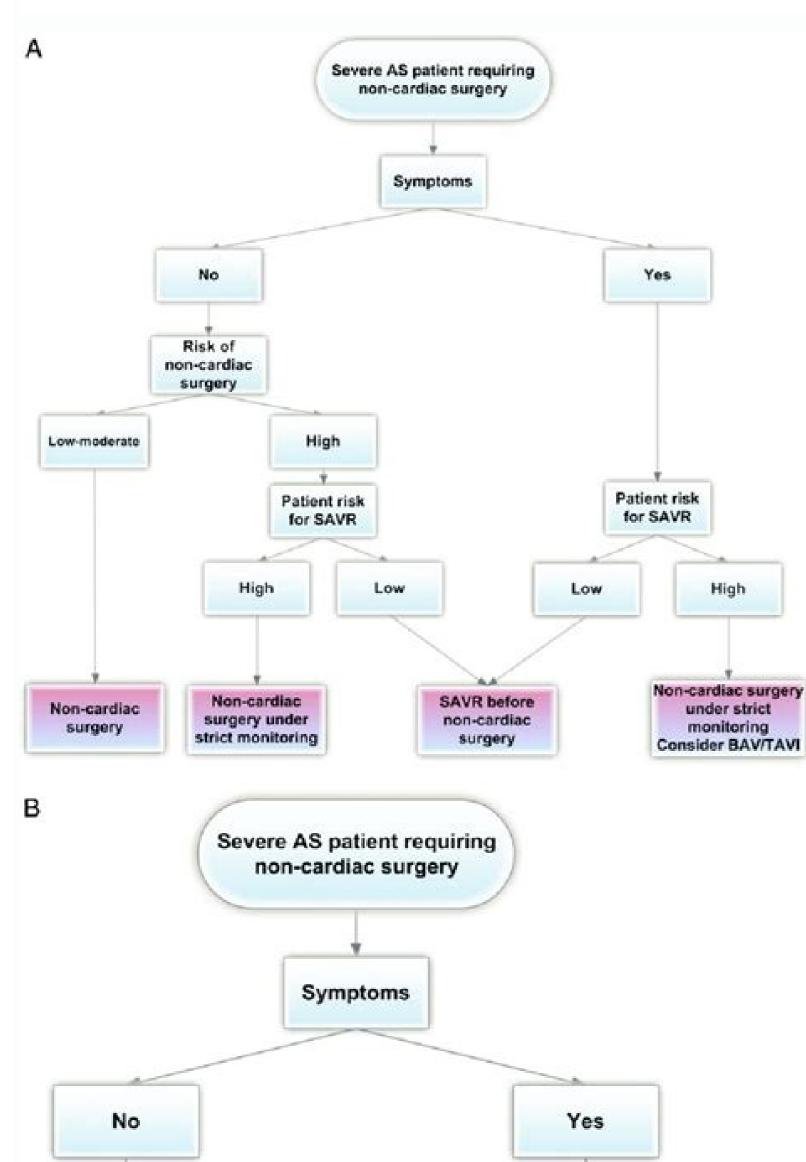
La consulenza cardiologica pre-operatoria, pur rappresentando un'attività clinica rilevante di ogni Cardiologia, è raramente standardizzata e continua a svolgersi spesso in maniera empirica e con percorsi eterogenei. La necessità di una sua organizzazione è urgente se si considera che in Europa vengono effettuati ogni anno 40 milioni di interventi chirurgici con un'incidenza di 400.000 infarti miocardici perioperatori e 133.000 morti per cause cardiovascolari [3]. American College of Cardiology (ACC) e American Heart Association (AHA) hanno pubblicato le loro prime Linee Guida sull'argomento nel 2002, aggiornate nel 2007 [1, 2], mentre la Società Europea di Cardiologia (ESC) ha pubblicato per la prima volta le Linee Guida nel 2009 [3] con l'endorsement della Società Europea di Anestesiologia.

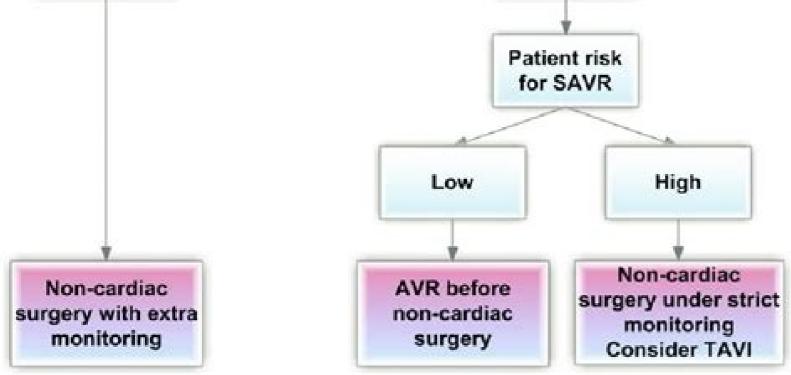
Questi documenti, pur basandosi più su un consenso di esperti che su forti evidenze scientifiche [4-7], hanno avuto il pregio di fornire un metodo con cui eseguire la consulenza stessa. Le Linee Guida europee in particolare, riprendono l'impianto di quelle americane, ma sono più fraibili nella pratica clinica, perché hanno una impostazione multidisciplinare e forniscono indicazioni più precise su comportamenti da adottare, indicazioni ai test non invasivi, terapia farmacologica e indicazioni alla rivascolarizzazione pre-operatoria. In Italia, prima della pubblicazione delle Linee Guida europee, la ricerca di comportamenti condivisi aveva già prodotto due pubblicazioni, una curata dall'Agenzia Nazionale per i Servizi Sanitari [10] e l'altra dall'Area Prevenzione ANMCO che ha realizzato anche una serie di corsi educazionali sull'argomento [11].

La applicazione delle Linee Guida nella pratica clinica va implementata perché, dopo la pubblicazione delle Linee Guida americane, è stato dimostrato che la loro adozione riduce l'assorbimento di risorse e migliora la prognosi [8, 9] e anche la presente review è stata redatta al fine di fornire un ulteriore contributo in tale senso.

L'epoca degli "score"

La ricerca di "score" per stratificare il rischio cardiovascolare dei candidati a chirurgia non cardiaca è iniziata negli anni '70 con gli ormai classici criteri di Goldman [12], perfezionati da Detsky [13] e da Lee [14] che ha semplificato il sistema a punteggio prevedendo solo 6 variabili (tabella 1), che sono risultate correlate con la prognosi [15] e che per questo sono state adottate dalle Linee Guida sia ameri-





2014 esc/esa guidelines on non-cardiac surgery. Non cardiac surgery esc guidelines.

PDF Split View Article contents Figures & tables Video Audio Supplementary Data Guidelines, Non-cardiac surgery, Pre-operative cardiac risk assessment, Pre-operative cardiac risk assessment, Pre-operative cardiac risk assessment, Pre-operative cardiac risk assessment, Pre-operative cardiac surgery, Pre-operative cardiac risk assessment, Pre-operative cardiac risk ass failure, Renal disease, Pulmonary disease, Cerebrovascular disease, Anaesthesiology, Post-operative cardiac surveillanceSee page 2342 for the editorial comment on this article (doi:10.1093/eurheartj/ehu295) Table of Contents Abbreviations and acronyms 51. Preamble 72. Introduction 102.1. The magnitude of the problem 102.2. Change in demographics 112.3. Purpose and organization 113. Pre-operative evaluation 133.1. Surgical risk for cardiac events 133.2. Type of surgery 143.2.1. Endovascular vs. open vascular vs. open vascular procedures 143.2.2. Open vs. laparoscopic or thoracoscopic or thoracoscopic procedures 153.3. 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Anesthesiologists bis in diem (twice daily) Beta-Blocker in Spinal Anesthesia B-type natriuretic peptide coronary Artery Study cardiac failure, hypertension, age ≥ 75 (doubled), diabetes, stroke (doubled)-vascular disease, age 65-74 and sex category (female) contrast-induced acute kidney injury Chronic Kidney Disease Epidemiology Collaboration cardiovascular magnetic resonance chronic obstructive pulmonary exercise test cardiac resynchronization therapy defibrillator dual anti-platelet therapy Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography electrocardiography/e Cardiology endovascular abdominal aortic aneurysm repair Forced expiratory volume in 1 second heart failure with preserved left ventricular ejection fraction implantable cardioverter defibrillator international normalized ratio iso-osmolar contrast medium Kidney Disease: Improving Global Outcomes low molecular weight heparin low-osmolar contrast medium left ventricular ejection fraction Metoprolol after Vascular Surgery Modification of Diet in Renal Disease magnetic resonance imaging non-vitamin K oral anticoagulant National Surgical Quality Improvement Program non-ST-elevation acute coronary syndromes obesity hypoventilation syndrome pulmonary artery catheter peripheral artery disease pulmonary artery hypertension prothrombin complex concentrate percutaneous coronary intervention 2 Risk, Injury, Failure, Loss, End-stage renal disease single photon emission computed tomography supraventricular tachycardia Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery transcatheter aortic valve implantation transient ischaemic attack transposed echocardiography transcatheter active transcatheter active transcatheter active transcatheter active transcatheter active transposed echocardiography transtactive transcatheter active transposed echocardiography transcatheter active transcatheter active transcatheter active transcatheter active transposed echocardiography transactive transposed echocar Noncardiac Surgery Patients Cohort Evaluation ventricular premature beat 1. Preamble Guidelines summarize and evaluate all available evidence, at the time of the writing process, on a particular issue with the aim of assisting health professionals in selecting the best management strategies for an individual patient with a given condition, taking into account the impact on outcome, as well as the risk-benefit ratio of particular diagnostic or therapeutic means. Guidelines and recommendations should help health professionals to make decisions in their daily practice; however, the final decisions concerning an individual patient must be made by the responsible health professional(s), in consultation with the patient and caregiver as appropriate. A great number of guidelines have been issued in recent years by the European Society of Anaesthesiology (ESA), as well as by other societies and organisations. Because of their impact on clinical practice, quality criteria for the development of

guidelines have been established in order to make all decisions transparent to the user. The recommendations for formulating and issuing ESC/ESA guidelines represent the official position of these two societies on this given topic and are regularly updated. Members of this Task Force were selected by the ESC and ESA to represent professionals involved with the medical care of patients with this pathology. Selected experts in the field undertook a comprehensive review of the published evidence for management (including diagnosis, treatment, prevention and rehabilitation) of a given condition, according to the ESC Committee for Practice Guidelines (CPG) and ESA Guidelines Committee policy. A critical evaluation of diagnostic and the recommendation of the risk-benefit ratio. Estimates of expected health outcomes for larger populations were included, where data exist. The level of evidence and the strength of recommendation of particular management options were weighed and graded according to pre-defined scales, as outlined in Tables 1 and 2. Table 1 Classes of recommendations of interest' forms which might be perceived as real or potential sources of conflicts of interest. These forms were compiled into one file and can be found on the ESC/ESA and updated. The Task Force received its entire financial support from the ESC and ESA, without any involvement from the healthcare industry. The ESC CPG supervises and co-ordinates the preparation of new guidelines produced by Task Forces, expert groups or consensus panels. The ESC and Joint Guidelines undergo extensive review by the CPG and partner Guidelines Committee and external experts. After appropriate revisions it is approved by all the experts involved in the Task Force. The finalized document is approved by the CPG/ESA for simultaneous publication in the European Journal of Anaesthesiology. It was developed after careful consideration of the scientific and medical knowledge and the evidence available at the time of their dating. The task of developing ESC/ESA guidelines covers not only the integration of the most recent research, but also the creation of educational tools and implementation programmes for the recommendations. To implement the guidelines, condensed pocket versions, summary slides, booklets with essential messages, summary cards for non-specialists, electronic versions for digital applications (smart phones etc.) are produced. These versions are abridged and thus, if needed, one should always refer to the full-text version, which is freely available on the ESC and ESA web sites. The national societies of the ESC and of the ESA are encouraged to endorse, translate and implement the ESC guidelines. Implementation programmes are needed because it has been shown that the outcome of disease may be favourably influenced by the thorough application of clinical recommendations. the guidelines, thus completing the loop between clinical research, writing of guidelines, disseminating them and implementation of the exercising their clinical judgment, as well as in the determination and the implementation of preventive, diagnostic or therapeutic medical strategies; however, the ESC/ESA guidelines do not, in any way whatsoever, override the individual responsibility of health and in consultation with that patient and, where appropriate and/or necessary, the patient's caregiver. It is also the health professional's responsibility to verify the rules and regulations applicable to drugs and devices at the time of prescription. 2. Introduction 2.1 The magnitude of the problem The present Guidelines focus on the cardiovascular management of patients in whom heart disease is a potential source of complications during non-cardiac surgery. The risk of perioperative complications depends on the condition of the surgical procedure. More specifically, cardiac complications can arise in patients with documented or asymptomatic ischaemic heart disease (IHD), left ventricular (LV) dysfunction, valvular heart disease (VHD), and arrhythmias, who undergo surgical procedures that are associated with prolonged haemodynamic and cardiac stress. In the case of perioperative myocardial ischaemia, two mechanisms are important: (i) a mismatch in the supply-demand ratio of blood flow, in response to metabolic demand due to a coronary syndromes (ACS) due to stress-induced rupture of a vulnerable atherosclerotic plaque in combination with vascular inflammation and altered vasomotion, as well as haemostasis. LV dysfunction and arrhythmias may occur for various reasons at all ages. Because the prevalence of not only IHD but also VHD and arrhythmias increases with age, perioperative cardiac surgery. The magnitude of the problem in Europe can best be understood in terms of (i) the size of the adult non-cardiac surgical group and (ii) the average risk of cardiac complications in this cohort. Unfortunately, systematic data on the annual number and type of operations—and on patient outcomes—are only available at a national level in 23 European countries (41%).1 Additionally, data definitions vary, as do data quantity and quality. A recent modelling strategy, based on worldwide data available in 2004, estimated the number of major procedures of 4% of the world population per year.1 When applied to Europe, with an overall population per year.1 When applied to Europe, with an overall population of over 500 million, this figure translates into a crude estimate of 19 million major procedures. annually. While the majority of these procedures are performed in patients with minimal cardiovascular risk, 30% of patients undergo extensive surgical procedures annually are performed in European patients who present with increased risk of cardiovascular complications.Worldwide, non-cardiac surgery is associated with an average overall complication rate of 7-11% and a mortality rate of 0.8-1.5%, depending on safety precautions.2 Up to 42% of these are caused by cardiac complications.3 When applied to the population in the European Union member states, these figures translate into at least 167 000 cardiac complications annually due to non-cardiac surgical procedures, of which 19 000 are life-threatening. 2.2 Change in demographics Within the next 20 years, the ageing of the population will have a major impact on perioperative patient management. It is estimated that elderly people require surgery four times as often than the rest of the population.4 In Europe, it is estimated that the number of patients undergoing surgery will increase by 25% by 2020. Over the same time period, the elderly population will increase by 50%. The total number of surgical procedures may increase even faster because of the rising frequency of interventions with age.5 The results of the United States National Hospital Discharge Survey show that the number of surgical procedures will increase in almost all age groups and that the largest increase will occur in the middle-aged and elderly. Demographics of patients undergoing surgery show a trend towards an increasing number of elderly patients and comorbidities. 6 Although mortality from cardiac disease is decreasing in the general population, the prevalence of IHD, heart failure, and cardiovascular risk factors—especially diabetes—is increasing. Among the significant comorbidities in elderly patients presenting for general surgery, cardiovascular disease (CVD) is the most prevalent.7 Age per se, however, seems to be responsible for only a small increase in the risk of complications; greater risks are associated with urgency and significant cardiac, pulmonary, and renal disease; thus, these conditions should have greater risks are associated with urgency and collaborators involved in the pre-operative, operative, and post-operative care of patients undergoing non-cardiac surgery. The objective is to endorse a standardized and evidence-based approach to perioperative cardiac surgery. The objective is to endorse a standardized and evidence-based approach to perioperative care of patients undergoing non-cardiac surgery. The objective is to endorse a standardized and evidence-based approach to perioperative cardiac surgery. The objective is to endorse a standardized and evidence-based approach to perioperative cardiac surgery. estimated stress of the planned surgical procedure. This results in an individualized cardiac risk assessment, with the opportunity of initiating medical therapy, coronary interventions, and specific surgical setting, data from randomized clinical trials—which provide the ideal evidence-base for the guidelines—are sparse. Consequently, when no trials are available on a specific cardiac-management regimen in the surgical setting, data from the non-surgical setting. who are experts on the specific demands of the proposed surgical procedure, will usually co-ordinate the pre-operative evaluation. The majority of patients with stable heart disease can undergo low and intermediate-risk surgery (Table 3) without additional evaluation. Selected patients require evaluation by a team of integrated multidisciplinary specialists including anaesthesiologists, cardiologists, and surgeons and, when appropriate, an extended team (e.g. internists, intensivists, pulmonologists or geriatricians).8 Selected patients include those identified by the anaesthesiologist because of suspected or known cardiac disease with sufficient complexity to carry a potential perioperative risk (e.g. congenital heart disease, unstable symptoms or low functional capacity), patients in whom pre-operative medical optimization is expected to reduce perioperative medical optimization is expected to reduce perioperativ post-operative outcomes and highlight the existence of a clear opportunity for improving the quality of care in this high-risk group of patients. In addition to promoting an improvement in immediate perioperative care, guidelines should provide long-term advice. the availability of new evidence and the international impact of the controversy over the DECREASE trials, the ESC/ESA and American College of Cardiology/American Heart Association both began the process of revising their respective writing committees independently performed their literature review and committees independently performed to the committees and analysis, and then developed their recommendations. Once peer review of both guidelines was completed, the writing committees chose to discuss their respective recommendations were discussed and clearly articulated in the text; however, the writing committees aligned a few recommendations to avoid confusion within the clinical community, except where international practice variation was prevalent. Following the development and introduction of perioperative cardiac guidelines, their effect on outcome should be monitored. The objective evaluation of changes in outcome will form an essential part of future perioperative guideline development. Recommendations on pre-operative evaluation 3. Pre-operative evaluation 3.1 Surgical risk for cardiac surgery, and on the circumstances under which it takes place.9 Surgical factors that influence cardiac risk are related to the urgency, invasiveness, type, and duration of the procedure, as well as the change in body core temperature, blood loss, and fluid shifts. 5 Every operation elicits a stress response. This response is initiated by tissue injury and mediated by neuro-endocrine factors, and may induce sympatho-vagal imbalance. Fluid shifts in the perioperative period add to the surgical stress. This stress increases myocardial oxygen demand. Surgery also causes alterations in the balance between prothrombotic and fibrinolytic factors, potentially resulting in increased coronary thrombogenicity. The extent of such changes is proportionate to the extent and duration of the intervention. These factors, together with patient position, temperature management, bleeding, and type of anaesthesia, may contribute to haemodynamic derangements, leading to myocardial ischaemia and heart failure. anaesthetic techniques may reduce early mortality in patients at intermediate-to-high cardiac risk and limit post-operative complications.10 Although patient-specific factors in predicting the cardiac risk for non-cardiac surgical procedures, the type of surgery cannot be ignored.9With regard to cardiac risk, surgical interventions—which include open or endovascular procedures—can be broadly divided into low-risk, intermediate-risk, and high-risk groups, with estimated 30-day cardiac evaluation will also depend on the urgency of surgery. In the case of emergency surgical procedures, such as those for ruptured abdominal aortic aneurysm (AAA), major trauma, or for a perforated viscus, cardiac evaluation will not alter the course or result of the intervention but may influence management in the immediate perioperative period. In non-emergency but urgent surgical conditions, such as bypass for acute limb ischaemia or treatment of bowel obstruction, the morbidity and mortality of the untreated underlying condition may influence the perioperative measures taken to reduce cardiac risk but will not influence the decision to perform the interventions, such as peripheral arterial angioplasty instead of infra-inguinal bypass, or extra-anatomical reconstruction instead of an aortic procedure, even when these may yield less favourable results in the long term. Finally, in some situations, the cardiac evaluation (in as far as it can reliably predict perioperative cardiac complications and late survival) should be taken into consideration when deciding whether to perform an intervention or manage conservatively. This is the case in certain prophylactic interventions, such as the treatment of small AAAs or asymptomatic carotid stenosis, where the life expectancy of the patient and the risk of the operation are important factors in evaluating the potential benefit of the surgical intervention. 3.2 Type of surgery In general, endoscopic and endovascular techniques speed recovery, decrease hospital stay, and reduce the rate of complications.12 However, randomized clinical trials comparing laparoscopic vs. open cholecystectomy) have shown no significant differences in conversion rate, pain, complications, length of hospital stay, or readmissions.13The wide variety of surgical procedures, in a myriad of different contexts, makes difficult the assignation of a specific risk of a major adverse cardiac event to each procedures, the potential trade-offs between early benefits due to reduced morbidity and mid- to long-term efficacy need to be taken into account. 3.2.1 Endovascular vs. open vascular procedures Vascular interventions, but also because of the many studies that have shown that this risk can because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complications, but also because they carry the highest risk of cardiac complexity of the highest risk of the highest risk influenced by adequate perioperative measures in these patients.14 Open aortic and infra-inguinal procedures must both be regarded as high-risk procedures. Although it is a less-extensive intervention, infra-inguinal revascularization entails a cardiac risk similar to—or even higher than—that of aortic procedures. This can be explained by the higher incidence of diabetes, renal dysfunction, IHD, and advanced age in this patient group. This also explains why the risk related to peripheral artery angioplasties, which are minimally invasive procedures, is not negligible. Endovascular AAA repair (EVAR) has been associated with lower operative mortality and morbidity than open repair but this advantage reduces with time, due to more frequent graft-related complications and re-interventions in patients who underwent EVAR, resulting in similar long-term AAA-related mortality.15–17A meta-analysis of studies, comparing open surgical with percutaneous transluminal methods for the treatment of femoropopliteal arterial disease, showed that bypass surgery is associated with higher 30-day morbidity [odds ratio (OR) 2.93; 95% confidence interval (CI) 1.34-6.41] and lower technical failure than endovascular treatment, with no differences in 30-day mortality; however, there were higher amputation-free and overall survival rates in the bypass group at 4 years.18 Therefore, multiple factors must be taken into consideration when deciding which type of procedure serves the patient best. An endovascular-first approach may be offered as a first-line interventional treatment for fit patients with a longer life expectancy.19 Carotid artery stenting has appeared as an attractive, less-invasive alternative to CEA; however, although CAS reduces the rate of periprocedural myocardial infarction and cranial nerve palsy, the combined 30-day rate of stroke or death is higher than CEA, particularly in symptomatic and older patients, driven by a difference in the risk of periprocedural non-disabling stroke.20,21 The benefit of carotid revascularization is particularly high in patients with recent (60% carotid artery bifurcation stenosis.22 In neurologically asymptomatic patients, carotid stenosis and an estimated life expectancy of >5 years.21 The choice between CEA and CAS must integrate operator experience and results, anatomical characteristics of the arch vessels, neck features, and comorbidities.21-23 3.2.2 Open vs. laparoscopic procedures the arch vessels, neck features, and comorbidities.21-23 3.2.2 Open vs. laparoscopic procedures the arch vessels are compared with open procedures. advantage of causing less tissue trauma and intestinal paralysis, resulting in less incisional pain, better post-operative fluid shifts related to bowel paralysis.24 However, the pneumoperitoneum required for these procedures results in elevated intra-abdominal pressure and a reduction in venous return. Typical physiological sequelae are secondary to increased intra-abdominal pressure and absorption of the gaseous medium used for insufflation. While healthy individuals on controlled ventilation typically tolerate pneumoperitoneum, debilitated patients with cardiopulmonary compromise and obese patients. may experience adverse consequences.25 Pneumoperitoneum and Trendelenburg position result in increased mean arterial pressure, central venous pressure, and systemic vascular resistance impairing cardiac function.26,27 Therefore, compared with open surgery, cardiac risk in patients with heart failure is not reduced in patients undergoing laparoscopy, and both should be evaluated in the same way. This is especially true in patients undergoing interventions for morbid obesity, but also in other types of surgery, considering the risk of conversion to an open procedure.28,29 Superior short-term outcomes of laparoscopic vs. open procedures have been reported, depending on type of surgery, operator experience and hospital volume, but few studies provide direct measures of cardiac complications.30–32 Benefit from laparoscopic procedures is probably greater in elderly patients, with reduced length of hospital stay, intra-operative blood loss, incidence of post-operative blood loss, inci pneumonia, time to return of normal bowel function, incidence of post-operative cardiac complications, and wound infections.33 Few data are available for video-assisted thoracic surgery (VATS), with no large, randomized trial comparing VATS with open thoracic lung resection. In one study involving propensity-score-matched patients, VATS lobectomy was associated with no significant difference in mortality, but with significantly lower rates of overall perioperative morbidity, pneumonia, and atrial arrhythmia.34 Recommendations on the selection of surgical approach and its impact on risk 3.3 Functional capacity between the selection of surgical approach and its impact on risk approach and its impact on risk 3.4 Recommendations on the selection of surgical approach and its impact on risk cardiac risk assessment and is measured in metabolic equivalents (METs). One MET equals the basal metabolic rate. Exercise testing provides an objective assessment of functional capacity. Without testing, functional capacity can be estimated from the ability to perform the activities of daily living. One MET equals the basal metabolic demand at rest; climbing two flights of stairs demands 4 METs, and strenuous sports, such as swimming, >10 METS (Figure 1). Open in new tabDownload slideEstimated energy requirements for various activities. Based on Hlatky et al. and Fletcher et al.36,37 km per h = kilometres per hour; MET = metabolic equivalent. The inability to climb two flights of stairs or run a short distance (170 µmol/L (>2 mg/dL), and used to be considered by many clinicians and researchers to be the best currently available cardiac-risk prediction index in non-cardiac surgery. All of the above-mentioned risk indices were, however, developed years ago and many changes have since occurred in the treatment of IHD and in the anaesthetic, operative and perioperative management of non-cardiac surgical patients. A new predictive model was recently developed to assess the risk of intra-operative/post-MICA model was built on the 2007 data set, based on patients from 180 hospitals, and was validated with the 2008 data set, both containing >200 000 patients and having predictability. The primary endpoint was intra-operative/post-o myocardial infarction/cardiac arrest were identified: type of surgery, functional status, elevated creatinine (>130 µmol/L or >1.5 mg/dL), American Society of Anesthesiologists (ASA) class II, patient is completely healthy; Class II, patient is completely healthy; Class II, patient is completely healthy; Class IV, patient patient has incapacitating disease that is a constant threat to life; and Class V, a moribund patient who is not expected to live for 24 hours, with or without the surgery), and age. This model is presented as an interactive risk scores, there is a constant threat to life; and Class V, a moribund patient who is not expected to live for 24 hours, with or without the surgery), and age. NSQIP model did not establish a scoring system but provides a model-based estimate of the probability of myocardial infarction/cardiac arrest for an individual patient. The risk calculator performed better than the Lee risk index, with some reduction in performance in vascular patients, although it was still superior; however, some perioperative cardiac complications of interest to clinicians, such as pulmonary oedema and complete heart block, were not considered in the NSQIP database. By contrast, the Lee index allows estimation of the risk of perioperative pulmonary oedema and of complete heart block, in addition to death and myocardial infarction (. A recent systematic review of 24 studies covering >790 000 patients found that the Lee index discriminated moderately well patients at low vs. high risk for cardiac surgery, but its performance was hampered when predicting cardiac events after mixed non-cardiac surgery or predicting death.45 Therefore, the NSQIP and Lee risk index models do not dictate management decisions but should be regarded as one piece of the puzzle to be evaluated, in concert with the more traditional information at the physician's disposal. 3.5 Biomarkers A biological marker, or 'biomarker', is a characteristic that can be objectively measured and which is an indicator of biological processes. In the perioperative setting, biomarker', is a characteristic that can be divided into markers focusing on myocardial ischaemia and damage, inflammation, and LV function. Cardiac troponins T and I (cTnT and cTnI, respectively) are the preferred markers for the diagnosis of myocardial infarction because they demonstrate sensitivity and tissue specificity better than other available biomarkers.46 The prognostic information is independent of—and complementary to—other important cardiac indicators of risk, such as ST deviation and LV function. It seems that cTnI and cTnT are of similar value for risk assessment in ACS in the presence and absence of renal failure. Existing evidence suggests that even small increases in cTnT in the period reflect clinically relevant myocardial injury with worsened cardiac prognosis and outcome. 47-49 The development of new biomarkers, including highsensitivity troponins, will probably further enhance the assessment of myocardial damage.48 Assessment of cardiac troponins in high-risk patients, both before and 48-72 hours after major surgery, may therefore be considered.3 It should be noted that troponin elevation may also be observed in many other conditions; the diagnosis of non-ST-segment elevation myocardial infarction should never be made solely on the basis of biomarkers. Inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data are currently available on how inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data are currently available on how inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data are currently available on how inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data are currently available on how inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data are currently available on how inflammatory markers might pre-operatively identify those patients with an increased risk of unstable coronary plaque; however, in the surgical setting, no data many cardiac diseases in non-surgical settings.50 Pre-operative BNP and NT-proBNP levels have additional prognostic value for long-term mortality and for cardiac events after major non-cardiac vascular surgery.51-53Data from prospective, controlled trials on the use of pre-operative BNP and NT-proBNP levels have additional prognostic value for long-term mortality and for cardiac events after major non-cardiac events after major no serum biomarkers for patients undergoing non-cardiac surgery cannot be proposed for routine use, but may be considered in high-risk patients (METs <4 or with a revised cardiac risk stratification 3.6 Non-invasive testing Pre-operative non-vascular surgery). Recommendations on cardiac risk stratification 3.6 Non-invasive testing Pre-operative non-vascular surgery). invasive testing aims to provide information on three cardiac risk markers: LV dysfunction, myocardial ischaemia, and heart valve abnormalities, all of which are major determinants of adverse post-operative outcome. LV function is assessed at rest, and various imaging methods are available. For detection of myocardial ischaemia, exercise ECG and non-invasive imaging techniques may be used. Routine chest X-ray before non-cardiac surgery is not recommended without specific indications. The overall theme is that the diagnostic algorithm for risk stratification of myocardial ischaemia and LV function should be similar to that proposed for patients in the non-surgical setting with known or suspected IHD.56 Non-invasive testing should be considered not only for coronary artery revascularization but also for patient counselling, change of perioperative management in relation to type of surgery, anaesthetic technique, and long-term prognosis. 3.6.1 Non-invasive testing of cardiac disease 3.6.1.1 Electrocardiography The 12-lead ECG is commonly performed as part of pre-operative cardiovascular risk assessment in patients undergoing non-cardiac surgery. In IHD patients, the pre-operative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive of long-term outcome, independent of clinical findings and perioperative eCG offers important prognostic information and is predictive eCG of specific in patients with myocardial ischaemia or even with infarction. Recommendations on routine pre-operative ECG 3.6.1.2 Assessment of left ventriculography, gated single photon emission computed tomography (SPECT), echocardiography, magnetic resonance imaging (MRI) or multislice computed tomography is not recommended for the pre-operative evaluation of ventricular function. Routine echocardiography is not recommended for the pre-operative evaluation of ventricular function. patients with high surgical risk.58 Pre-operative LV systolic dysfunction, moderate-to-severe mitral regurgitation, and increased aortic value of LV function assessment for perioperative outcome may be related to the failure to detect severe underlying IHD. Recommendations on resting echocardiography in asymptomatic patients without signs of cardiac disease or electrocardiographic abnormalities 3.6.2 Non-invasive testing of ischaemic heart disease Physical exercise, using a treadmill or bicycle ergometer, provides an estimate of functional capacity, evaluates blood pressure and heart rate response. and detects myocardial ischaemia through ST-segment changes. The accuracy of exercise ECG varies significantly among studies. 56 Risk stratification with an exercise test is not suitable for patients with limited exercise capacity, owing to their inability to reach their target heart rate. Also, pre-existing ST-segment abnormalities at rest—especially in precordial leads V5 and V6—hamper reliable ST-segment analysis. A gradient of severity in the test result relates to the perioperative outcome: the onset of a myocardial ischaemic response at low exercise workloads is associated with a significantly increased risk of perioperative and long-term cardiac events. In contrast, the onset of myocardial ischaemia at high workloads is associated with only a minor risk increase, but higher than a totally normal test. Pharmacological stress testing with either nuclear perfusion imaging for pre-operative risk stratifications is well established. In patients with limited exercise capacity, pharmacological stress (dipyridamole, adenosine, or dobutamine) is an alternative stressor. Studies are performed both during stress and at rest, to determine the presence of reversible defects, reflecting isona at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of reversible defects are performed both during stress and at rest, to determine the presence of the performed both during stress are performe prognostic value of the extent of ischaemic myocardial perfusion imaging, has been investigated in a meta-analysis of patients undergoing vascular surgery.60 Study endpoints were perioperative cardiac death and myocardial infarction. The authors included nine studies, totalling 1179 patients undergoing vascular surgery, with a 7% 30-day event rate. In this analysis, reversible ischaemia in 100 mm Hg.83 The heart rate goal applies to the whole period, using intravenous administration when oral administration is not possible. High doses should be avoided, particularly immediately before surgery. A retrospective study suggests that intra-operative mean arterial pressure should remain above 55 mm Hg.104 Post-operative tachycardia should firstly lead to treatment of the underlying cause-for example, hypovolaemia, pain, blood loss, or infection-rather than simply increasing the beta-blocker dose. When beta-blockers are indicated, the optimal duration of perioperative beta-blockade cannot be derived from randomized trials. The occurrence of delayed cardiac events indicates a need to continue beta-blocker therapy should be used. A high priority needs to be given to new, randomized, clinical trials to better identify which patients derive benefit from beta-blocker therapy in the perioperative setting, and to determine the optimal method of beta-blockade.105 4.1.2 Statins 3-Hydroxy-3-methylglutaryl coenzyme A reductase inhibitors (statins) are widely prescribed in patients with or at risk of IHD. Patients with non-coronary atherosclerosis (carotid, peripheral, aortic, renal) should receive statin therapy for secondary prevention, irrespective of non-cardiac surgery. Statins also induce coronary plaque stabilization through pleiotropic effects, which may prevent plaque stabilization through pleiotropic effects. that perioperative statin use has a beneficial effect on the 30-day rate of death or myocardial infarction, and on long-term mortality and cardiovascular surgery were allocated to 20 mg of either atorvastatin or placebo once daily for 45 days, irrespective of their serum cholesterol concentrations.111 At 6-month follow-up, atorvastatin significantly reduced the incidence of cardiac events (8% vs. 26%; P = 0.03). In patients in whom statins were introduced before intervention, two meta-analyses showed a significant reduction in the risk of post-operative myocardial infarction following invasive procedures, 112, 113 however, these meta-analyses included more clinical trials relating to cardiac surgery or percutaneous procedures than to non-cardiac surgery. All-cause post-operative mortality was not reduced in most series, except in one observational study that used propensity score adjustment to account for differences in patient characteristics according to the treatment.114 A recent Cochrane review focusing on vascular surgery in statin-naïve patients did not find any significant difference between statin-treated and control groups for the separate endpoints of all-cause mortality, cardiovascular mortality, and myocardial infarction, but these endpoints were assessed in only 178 patients.115 Statins have also been associated with a decreased risk of complications after endovascular repair of AAA and a decreased risk of stroke after carotid stenting.116,1170bservational series suggest that perioperative statin therapy is also associated with a decreased risk of acute renal failure and with lower mortality in patients experiencing post-operative complications or multiple organ dysfunction syndrome.114 Statins may decrease the risk of post-operative atrial fibrillation (AF) following major non-cardiac surgery. Statin withdrawal more than four days after aortic surgery is associated with a three-fold higher risk of post-operative myocardial ischaemia.118 A potential limitation of perioperative statin use is the lack of a parenteral formulation; therefore, statins with a long half-life (e.g. atorvastatin) or extended release formulations (e.g. lovastatin) may be favoured to bridge the period immediately after surgery when oral intake is not feasible. risk of statin-induced myopathy and rhabdomyolysis. Perioperatively, factors increasing the risk of statin-induced myopathy are numerous, e.g. the impairment of renal function of statins allows for better detection of statins allows for better detection of statins allows for better detection of statin stating to current guidelines. most patients with peripheral artery disease (PAD) should receive statins. If they have to undergo open vascular surgery or endovascular intervention, statins should ideally be initiated at least 2 weeks before intervention for maximal plaque-stabilizing effects and continued for at least 1 month after surgery. In patients undergoing non-vascular surgery, there is no evidence to support pre-operative statin treatment if there is no evidence to support pre-operative intravenous nitroglycerine on perioperative ischaemia is a matter of debate and no effect has been demonstrated on the incidence of myocardial infarction or cardiac death. Also perioperative use of nitroglycerine may pose a significant haemodynamic risk to patients, since decreased pre-load may lead to tachycardia and hypotension. angiotensin-receptor blockers Independently of the blood pressure-lowering effect, angiotensin converting enzyme inhibitors (ACEIs) preserve organ function; however, data from an observational study suggested that, regardless of the prescription of beta-blockers and statins, ACEIs did not decrease the frequency of 30-day or 1-year death or cardiac complications after major vascular surgery in high-risk patients (revised cardiac index ≥3).110 Despite the lack of specific data on angiotensin-receptor blockers (ARBs), the following recommendations apply to ACEIs and ARBs, given their numerous common pharmacological properties. Additionally, perioperative use of ACEIs or ARBs carries a risk of severe hypotension under anaesthesia, in particular following induction and concomitant beta-blocker use. Hypotension is less frequent when ACEIs are discontinued the day before surgery. Although this remains debatable, ACEIs withdrawal should be resumed after surgery as soon as blood volume and pressure are stable. The risk of hypotension is at least as high with ACEIs under close monitoring with ACEIs under close monitoring. during the perioperative period. When LV dysfunction is discovered during pre-operative evaluation in untreated patients in a stable condition, surgery should if possible be postponed, to allow for diagnosis of the underlying cause and the introduction of ACEIs and beta-blockers. Recommendations on use of ACEIs and ARBs 4.1.5 Calcium channe blockers The effect of calcium channel blockers on the balance between myocardial oxygen supply and demand makes them theoretically suitable for risk-reduction strategies. It is necessary to distinguish between dihydropyridines, which do not act directly on heart rate, and diltiazem or verapamil, which lower the heart rate. The relevance of randomized trials assessing the perioperative effect of calcium channel blockers is limited by their small size, lack of risk stratification, and the absence of systematic reporting of cardiac death and myocardial infarction. A meta-analysis pooled 11 randomized trials totalling 1007 patients. All patients underwent non-cardiac surgery under calcium channel blocker treatment. There was a significant reduction in the number of episodes of myocardial ischaemia and supraventricular tachycardia (SVT) in the pooled analyses; however, the decrease in mortality and myocardial infarction reached statistical significance only when both endpoints were combined in a composite of death and/or myocardial infarction (relative risk 0.35; 95% CI 0.08-0.83; P < 0.02). Subgroup analyses favoured diltiazem. Another study in 1000 patients undergoing acute or elective aortic aneurysm surgery showed that dihydropyridine use was independently associated with an increased incidence of perioperative mortality.119 The use of short-acting dihydropyridines—in particular, nifedipine capsules—should be avoided. Thus, although heart rate-reducing calcium channel blockers are not indicated in patients who do not tolerate beta-blockers Additionally, calcium channel blockers should be continued during non-cardiac surgery in patients with vasospastic angina. 4.1.6 Alpha2 receptor agonists reduce post-ganglionic noradrenaline output and might therefore reduce the catecholamine surge during surgery. The European Mivazerol trial randomized 1897 patients with vasospastic angina. with IHD who underwent intermediate- or high-risk non-cardiac surgery. Mivazerol did not decrease the incidence of death or myocardial infarction in the whole population; however, there was a reduction of post-operative death or myocardial infarction at the international Peri Operative ISchemic Evaluation 2 (POISE-2) trial randomized 10 010 patients undergoing non-cardiac surgery to clonidine or placebo. Clonidine did not reduce the rate of death or non-fatal myocardial infarction in general, or in patients undergoing vascular surgery (relative risk 1.08; 95% Cl 0.93–1.26; P = 0.29). On the other hand, clonidine increased the risk of clinically important hypotension (relative risk 1.32; 95% Cl 1.24-1.40; P < 0.001) and non-fatal cardiac arrest (relative risk 3.20; 95% Cl 1.17-8.73; P = 0.02).120 Therefore, alpha2 receptor agonists should not be administered to patients undergoing non-cardiac surgery. with hypertension or heart failure. In general, diuretics for hypertension should be considered if symptoms or signs of fluid retention are present. Dosage reduction should be considered in patients with hypovolaemia, hypotension, or electrolyte disturbances. In general, diuretic treatment—if necessary to control heart failure—should be considered in patients with heart failure should be monitored carefully and optimized by loop diuretics. Hypokalaemia is reported to occur in up to 34% of patients undergoing surgery (mostly non-cardiac). It is well known to significantly increase the risk of ventricular fibrillation and cardiac arrest in cardiac disease. In a study of 688 patients with cardiac disease undergoing non-cardiac surgery, hypokalaemia was independently associated with perioperative mortality. Importantly, the use of K+ and Mg++-sparing aldosterone antagonists reduces the risk of mortality in severe heart failure. be given to patients taking diuretics and patients prone to developing arrhythmias. Any electrolyte disturbance-especially hypokalaemia and hypomagnesaemia-should be corrected in due time before surgery. Acute pre-operative repletion in asymptomatic patients may be associated with more risks than benefits; thus, minor asymptomatic electrolyte disturbances should not delay acute surgery. 4.2 Perioperative management in patients on anti-platelet agents 4.2.1 Aspirin Perioperative evaluation of the impact of aspirin continuation or cessation on serious cardiovascular events or bleeding has disclosed controversial results with, on the one hand, a reduction of intra- and perioperative stroke—but without influence on myocardial infarction during non-cardiac surgery—and, on the other hand, no statistical significance for the combined endpoint of vascular events. Additionally, concerns of promoting perioperative haemorrhagic complications have often led to the discontinuation of aspirin in the perioperative period. A large metaanalysis, including 41 studies in 49 590 patients, which compared peri-procedural withdrawal vs. bleeding risks of aspirin, concluded that the risk of bleeding complications.121 In subjects at risk of—or with proven—IHD, aspirin nonadherence/withdrawal tripled the risk of major adverse cardiac events. The POISE-2 trial randomized 10 010 patients undergoing non-cardiac surgery to aspirin before the study (initiation stratum, with 5628 patients) or they were already on an aspirin regimen (continuation stratum, with 4382 patients). In the POISE-2 trial, aspirin was stopped at least three days (but usually seven days) before surgery. Patients less than one year after placement of a drug-eluting coronary stent, were excluded from the trial and the number of stented patients outside these time intervals was too small to draw firm conclusions as to the risk-benefit ratio. Additionally, only 23% of the study population had known prior CAD and patients undergoing carotid endarterecomy surgery were excluded. Patients started taking aspirin (at a dose of 200 mg) or placebo just before surgery and continued it daily (at a dose of 100 mg) for 30 days in the initiation stratum and for 7 days in the continuation stratum, after which they resumed their regular aspirin group vs. 7.1% in the placebo group; hazard ratio 0.99; 95% CI 0.86-1.15; P = 0.92). Major bleeding was more common in the aspirin group than in the placebo group (4.6% vs. 3.8%, respectively; hazard ratio 1.23; 95% CI 1.01-1.49; P = 0.04). The primary and secondary outcome results were similar in the two aspirin strata. The trial results do not support routine use of aspirin in patients undergoing non-cardiac surgery, but it is uncertain whether patients with a low perioperative bleeding risk and a high risk of thrombo-embolic events could benefit from low-dose aspirin. Aspirin should be discontinued if the bleeding risk outweighs the potential cardiovascular benefit. 121,123-125 For patients undergoing spinal surgery or certain neurosurgical or ophthalmological operations, it is recommended that aspirin be discontinued for at least seven days. In conclusion, the use of low-dose aspirin in patients undergoing non-cardiac surgery should be based on an individual decision, which depends on the perioperative bleeding risk, weighed against the risk of thrombotic complications. 4.2.2 Dual anti-platelet therapy Five to twenty-five percent of patients with coronary stents require non-cardiac surgery within 5 years following stent implantation. The prognosis of stent thrombosis appears to be worse than for de novo coronary occlusion, and premature cessation of dual anti-platelet therapy (DAPT) in patients with recent coronary stent implantation is the most of stent thrombosis appears to be worse than for de novo coronary stent implantation. powerful predictor for stent thrombosis. The consequences of stent thrombosis will vary according to the site of stent deployment, e.g. thrombosis of a left main stem stent is, in most cases, fatal. The management of anti-platelet therapy, in patients who have undergone recent coronary stent treatment and are scheduled for non-cardiac surgery, should be discussed between the surgeon and the cardiologist, so that the balance between the risk of life-threatening stent thrombosis off DAPT—best understood by the surgeon—and the risk of life-threatening stent thrombosis off DAPT after bare metal stenting (BMS) is different to that for drug-eluting stent (DES) treatment .126To reduce risk of bleeding and transfusion, current Guidelines recommend delaying elective non-cardiac surgery without discontinuation of aspirin.74 Patients who have undergone a previous percutaneous coronary intervention (PCI) may be at higher risk of cardiac events during or after subsequent non-cardiac surgery performed early after balloon angioplasty is not associated with an increased risk of cardiac events, 127 stenting dramatically changes the scenario. Accordingly, mortality rates of up to 20% were reported in relation to perioperative stenting and DAPT was discontinued. 128 Therefore, elective surgery should be postponed for a minimum of 4 weeks and ideally for up to 3 months after BMS implantation. Importantly, whenever possible, aspirin should be continued throughout surgery.129 In 2002, DES were introduced in Europe and became widely accepted as an efficient tool for reducing in-stent re-stenosis; however, the major drawback of the first-generation DES was the need for prolonged DAPT (aspirin plus clopidogrel) for 12 months. A higher risk of non-cardiac surgery early after DES placement has been reported, 126 and a higher risk for major adverse cardiac surgery in patients with implanted stents. 126,130 But, for the new-generation (second- and third-generation) DES, routine extension of DAPT beyond 6 months is no longer recommended based on currently available data. Observational data from new-generation zotarolimus-eluting and everolimus-eluting stents treated with 3 and 12 months of DAPT after PCI.132In patients undergoing myocardial revascularization for high-risk ACS, DAPT treatment is recommended for 1 year irrespective of stent type. Overall, in patients undergoing non-cardiac surgery after recent ACS or stent implantation, the benefits of early surgery for a specific pathology (e.g. malignant tumours vascular aneurysm repair) should be balanced against the risk of stent thrombosis and the strategy should be discussed. In summary, it is recommended that DAPT be administered for at least 1 month after BMS implantation in stable CAD, 133 for 6 months after new-generation DES implantation, 133 and for up to 1 year in patients after ACS, irrespective of revascularization strategy.133 Importantly, a minimum of 1 (BMS) to 3 (new-generation DES) months of DAPT might be acceptable, independently of the acuteness of coronary disease, in cases when surgery cannot be delayed for a longer period; however, such surgical procedures should be performed in hospitals where 24/7 catheterization laboratories are available, so as to treat patients immediately in case of perioperative atherothrombotic events. Independently of the timeframe between DES implantation and surgery, single anti-platelet therapy (preferably with aspirin) should be continued. In patients immediately in case of perioperative atherothrombotic events. recommend withholding clopidogrel and ticagrelor for five days and prasugrel for seven days prior to surgery unless there is a high risk of thrombosis.74 In contrast, other guidelines do not provide the 'ideal' platelet function assay or a 'bleeding cut-off', and more research in this area is needed. For patients with a very high risk of stent thrombosis, bridging therapy with intravenous, reversible intravenous, reversible glycoprotein inhibitors, such as eptifibatide or tirofiban, should be considered. Cangrelor, the new reversible intravenous, reversible glycoprotein inhibitors, such as eptifibatide or tirofiban, should be considered. provide effective platelet inhibition but is not yet available.136 The use of low-molecular-weight heparin (LMWH) for bridging in these patients should be resumed as soon as possible after surgery and, if possible, within 48 hours. 4.2.3 Reversal of anti-platelet therapy For patients receiving anti-platelet therapy, who have excessive or life-threatening perioperative bleeding, transfusion of platelets is recommended. 4.3 Perioperative management in patients, this risk will be outweighed by the benefit of anticoagulants and drug therapy should be maintained or modified, whereas, in patients at low risk of thrombosis, anticoagulation therapy using vitamin K antagonists (VKAs) are subject to an increased risk of peri- and post-procedural bleeding. If the international normalized ratio (INR) is <1.5, surgery can be performed safely; however, in anticoagulated patients with a high risk of thrombo-embolism—for example, patients with a high risk of thrombo-embolism—for example, patients with a high risk of thrombo-embolism. In general, there is better evidence for the efficacy and safety of LMWH, in comparison with UFH, in bridging to surgery.69,137 LMWH is usually administration without laboratory monitoring. In patients with a high thrombo-embolic risk, therapeutic doses of LMWH twice daily are recommended, and prophylactic once-daily doses in low-risk patients. 137 The last dose of LMWH should be administered no later than 12 hours before the procedure. Further adjustment of dose is necessary in patients with moderate-to-high kidney function impairment. It is recommended that VKA treatment be stopped 3-5 days before surgery (depending on the type of VKA), with daily INR measurements, until <1.5 is reached, and that LMWH or UFH therapy be started one day after discontinuation of VKA—or later, as soon as the INR is 1.5. LMWH or UFH is resumed at the pre-procedural dose 1-2 days after surgery, de pending on the patient's naemostatic status, but at least 12 hours after the procedure. VKAs should be resumed on day 1 or 2 after surgery-depending on adequate haemostasis-with the pre-operative maintenance dose should be administrated thereafter. LMWH or UFH should be continued until the INR returns to therapeutic levels. Furthermore, the type of surgical procedure should be taken into consideration, as the bleeding risk varies considerably and affects haemostatic control. Procedures with a high risk of serious bleeding therapy with LMWH are warranted. In patients undergoing surgery with a low risk of serious bleeding, such as cataract- or minor skin surgery, no change in oral anticoagulation therapy is needed; however, it is wise to keep INR levels in the lower therapeutic range. 4.3.2 Non-vitamin K antagonist oral anticoagulants In patients treated with the non-VKA direct oral anticoagulants (NOACs) dabigatran (a direct thrombin inhibitor), rivaroxaban, apixaban, or edoxaban (all direct factor Xa inhibitors), all of which have a well-defined 'on' and 'off' action, 'bridging' to surgery is in most cases unnecessary, due to their short biological half-lives (Table 6).138 Table 6Pharmacological features of non-vitamin K antagonist oral anticoagulants An exception to this rule is the patient with high thrombo-embolic risk, whose surgical intervention is to stop NOACs for 2-3 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surgical interventions with 'normal' bleeding risk, and 4-5 times their respective biological half-lives prior to surgery in surger biological half-lives before surgery in surgical interventions with high bleeding risk. 139,140 New tests for better quantification of activity levels of the various NOACs. If patients are pre-treated with dabigatran, which has about an 80% renal excretion rate, the individual glomerular filtration rate determines the time of its cessation prior to surgery.139,141 Kidney function is thus essential for tailoring dabigatran therapy, and earlier cessation is recommended for all NOACs if the bleeding risk is increased. Because of the fast 'on'-effect of NOACs (in comparison with VKAs), resumption of treatment after surgery should be delayed for 1-2 (in some cases 3-5) days, until post-surgical bleeding tendency is diminished. 4.3.3 Reversal of the anticoagulant therapy 4.3.3.1 Vitamin K antagonists In patients who are receiving VKAs and who require reversal of the anticoagulant effect for an urgent surgical procedure, low-dose (2.5-5.0 mg) intravenous or oral vitamin K is recommended. The effect of VKAs is needed, treatment with fresh-frozen plasma or prothrombin complex concentrate (PCC), is recommended, in addition to low-dose intravenous or oral vitamin K.In patients receiving UFH and requiring reversal of the anticoagulant effect for an urgent surgical procedure, cessation. When UFH is given subcutaneously, the anticoagulant effect is more prolonged. For immediate reversal, the antidote is protamine sulphate. The dose of protamine sulphate for reversal of a heparin infusion is 1 U per 1 U of heparin sodium. In patients who are receiving LMWHs, the anticoagulant effect may be reversed within eight hours of the last dose because of the short half-life. If immediate reversal is required, intravenous protamine sulphate can be used, but anti-Xa activity is never bleeding complications occur under the influence of NOACs, symptomatic treatment should be initiated (Figure 2) because of the lack of specific antidotes (these are currently under development). Preliminary data have shown a potential benefit for the use of PCC or activated PCC when bleeding occurs under the direct factor Xa inhibitor rivaroxaban, and is also applicable to apixaban142 and dabigatran,143 whereas haemodialysis is an effective method for eliminating dabigatran from the circulation but does not help when a direct factor Xa inhibitor has been used (Figure 2). Open in new tabDownload slideManagement of bleeding in patients taking non-vitamin K antagonist direct oral anticoagulants. From Camm et al. 2012.144 *With dabigatran; aPTT = activated partial thromboplastin time; NOAC = non-vitamin K antagonist direct oral anticoagulant; PCC = prothrombin coagulation complex; rFVIIa = activated recombinant factor VII. Recommendations on anti-platelet therapy 4.4 Revascularization The role of routine, prophylactic, invasive, coronary diagnostic evaluation and revascularization in reducing coronary risk for non-cardiac surgery remains ill-defined. Indications for pre-operative coronary angiography and revascularization, in patients with known or suspected IHD who are scheduled for major non-cardiac surgery, are similar to those in the non-surgical setting.74 Control of myocardial ischaemia before surgery is recommended whenever non-cardiac surgery can be safely delayed. There is, however, no indication for routinely searching for the presence of myocardial (silent) ischaemia before non-cardiac surgery. The main reason for pre-operative myocardial revascularization is the potential prevention of perioperative myocardial ischaemia before non-cardiac surgery. The main reason for pre-operative myocardial revascularization is the potential prevention of perioperative myocardial ischaemia before non-cardiac surgery. instability at the time of surgery. Coronary pathology underlying fatal perioperative myocardial infarctions revealed that two-thirds of the patients did not exhibit plaque fissuring and only one-third had an intracoronary thrombus. These findings suggest that a substantial proportion of fatal perioperative myocardial infarctions may have resulted from low-flow, high-demand ischaemia, owing to the stress of the operation in the presence of fixed coronary artery stenoses and therefore amenable to revascularization. In patients who underwent coronary angiography before vascular surgery, a number of non-fatal perioperative myocardial infarctions occurred as a consequence of plaque rupture in arteries without high-grade stenosis. These results are not surprising, considering the extreme and complex stress situations associated with surgery—such as trauma, inflammation, anaesthesia, intubation, pain, hypothermia, bleeding, anaemia, fasting, and hypercoagulability—which may induce multiple and complex pathophysiological responses.146The Coronary Artery Surgery Study (CASS) database includes almost 25 000 patients with CAD, initially allocated to either coronary artery bypass graft (CABG) surgery or medical management, with a follow-up of >10 years, and 3368 underwent noncardiac surgery during follow-up.147 A retrospective analysis of this population suggested that vascular, abdominal, and major head and neck surgeries were associated with a higher risk of perioperative myocardial infarction and death in the presence of non-revascularized CAD. Furthermore, the study showed that patients who were clinically stable in the years after CABG had a reduced risk of cardiac complications in the event that they required non-cardiac surgery. This protective effect of previous coronary revascularization was more pronounced in patients with triple-vessel CAD and/or depressed LV function, as well as in those undergoing high-risk surgery, and lasted for at least six years; however, the study was performed at a time when medical therapy did not meet current standards. It can be concluded that asymptomatic patients who undergon non-cardiac surgery without routine preoperative stress testing. This may not be the recommendation for patients with decreased LV function, as illustrated in a small cohort of 211 patients who underwent non-cardiac surgery, instruction in chest physiotherapy and lung expansion manoeuvres, muscular endurance training, and re-nutrition if required. Beta-adrenergic agonists and anticholinergic agonists and anticholinergic agents should be considered. Any associated ventricular failure should be managed accordingly. Where there is active pulmonary infection, appropriate antibiotics should be delayed.2150HS is defined as the triad of obesity, daytime hypoventilation, and sleep-disordered breathing. Although distinct from simple obesity and sleep apnoea, it is estimated that 90% patients with OHS also have obstructive sleep apnoea. The prevalence of OHS is 0.15-3% of adults, and 7-22% in patients undergoing bariatric surgery.216 Obesity and obstructive sleep apnoea are associated with a number of comorbidities including CAD, heart failure, stroke, and metabolic syndrome. OHS is associated with even higher morbidity, including heart failure (and obesity-related cardiomyopathy), angina pectoris, pulmonary hypertension (30-88%) and cor pulmonale, and increased perioperatively, the presence of a high body mass index and apnoea-hypopnea index should alert the physician to screen for OHS, including the use of screening questionnaires, peripheral oxygen saturations, and serum bicarbonate levels. Patients at high risk of OHS who are undergoing major surgery should be referred for additional specialist investigation for sleep disordered breathing and pulmonary hypertension, with pre-operative initiation of appropriate positive airway pressure therapy, and planning of perioperative techniques (anaesthetic and surgical) and post-operative positive airway pressure management within an appropriate monitored environment.216Pulmonary hypertension is a haemodynamic and pathophysiological condition, defined as an increase in mean pulmonary arterial pressure >25 mm Hg at rest, as assessed by right heart catheterization, and can be found in multiple clinical conditions.217 Pulmonary hypertension (PAH) is a clinical condition, characterized by the presence of pre-capillary pulmonary hypertension (PAH) is a clinical condition. embolic pulmonary hypertension, or other rare diseases. Pulmonary artery hypertension includes different forms that share a similar clinical picture and virtually identical pathological changes of the lung microcirculation. 217 From surveys and population studies, the prevalence of PAH is reported to be between 15-150 cases per million adults, with approximately 50% of cases being idiopathic. The prevalence is thus low and consequently the condition is uncommon in surgical practice. Pulmonary artery hypertension is associated with increased post-operative complications, including right ventricular failure, myocardial ischaemia, and post-operative hypoxia and, in patients undergoing cardiopulmonary bypass surgery, a mean pre-operative pulmonary artery pressure >30 mm Hg is an independent predictor of mortality. In patients with pulmonary hypertension undergoing non-cardiac surgery, right ventricular dysfunction, and long duration of anaesthesia. This condition has an associated perioperative cardiopulmonary complication of general measures and supportive therapy, and referral to an expert centre for initiation of advanced pulmonary hypertensive therapies. Owing to the potential for anaesthesia and surgery to be complicated by acute right heart failure and pulmonary hypertensive crisis, surgical interventions in patients with PAH who are undergoing surgery should have an optimized treatment regimen before any surgical intervention, and be managed in a centre with appropriate expertise. Interventions for high-risk patients should be planned by the multidisciplinary pulmonary hypertension team. 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 nebulized treatment until they are able to reliably absorb via the enteral route. As the highest mortality is in the post-operative period, it is recommended that facilities for appropriate monitoring should be available, and monitoring continued for at least 24 hours. In case of progression of right heart failure in the post-operative period, it is recommended that the diuretic dose should be optimized and, if necessary, inotropic support with dobutamine be initiated. Starting new, specific PAH drug therapy in the period has not been established. In the case of severe right heart failure that is not responsive to support with dobutamine be initiated. vasodilators (inhaled and/or intravenous) may be considered, under the guidance of a physician experienced in PAH. Recommendations on PAH and pulmonary diseases 5.9 Congenital heart disease Children, adolescents and adults with congenital heart disease Children, adolescents and adults with congenital heart disease are generally regarded as being at increased risk when undergoing non-cardiac surgery but this risk will vary enormously, according to the degree of associated heart failure, pulmonary hypertension, arrhythmias, and shunting of the underlying condition.222 A thorough understanding of the underlying congenital heart disease, including anatomy, physiology, and identification of risk factors, is vital before surgery. When the defect is simple, the circulation physiologically normal and the patients with congenital heart disease should only undergo non-cardiac surgery after thorough evaluation by a multidisciplinary team in a specialized centre. Prophylaxis for endocarditis should be initiated according to the ESC Guidelines on congenital heart disease and infective monitoring 6.1 Electrocardiography Continuous ECG monitoring is recommended for all patients undergoing anaesthesia. The patient should be connected to the ECG monitor before induction of a regional block. The duration of ST-segment changes occur, the clinician should assume that myocardial ischaemia is present if the patients who have intraventricular conduction defects and ischaemia. In addition, ECG monitoring is of limited value in patients who have intraventricular conduction defects and ventricular paced rhythms. In one study, Holter recordings were used as the reference standard for detection of intra-operative ischaemia and the ST-trending monitors were found to have overall sensitivity of 74% and specificity of 73%.224The choice and configuration of the leads used for monitoring may influence the ability to detect significant ST-trending monitors were found to have overall sensitivity of 74% and specificity of 73%.224The choice and configuration of the leads used for monitoring may influence the ability to detect significant ST-trending monitors were found to have overall sensitivity of 74% and specificity of 73%.224The choice and configuration of the leads used for monitoring may influence the ability to detect significant ST-trending monitors were found to have overall sensitivity of 74% and specificity of 73%.224The choice and configuration of the leads used for monitoring may influence the ability to detect significant ST-trending monitors were found to have overall sensitivity of 74% and specificity of 73%.224The choice and configuration of the leads used for monitoring may influence the ability to detect significant ST-trending monitors were found to have overall sensitivity of 74% and specificity of 74% and specifici segment changes. Although V5 has for many years been regarded as the best choice for the detection of intra-operative ischaemia, one study found that V4 was more sensitive and appropriate than V5 for detected by the same lead, reliance on a single lead for monitoring results in a greater risk of failing to detect an ischaemic event. With the use of selected lead combinations, more ischaemic events can be precisely diagnosed in the intra-operative setting. In one study, although the best sensitivity was obtained with V5 (75%), followed by V4 (61%), combining leads V4 and V5 increased the sensitivity to 90%. When the leads II, V4 and V5 were used simultaneously, the sensitivity was greater than 95%.225,226 In another study, in which two or more pre-cordial leads were used, the sensitivity of ECG monitoring was greater than 95% for detection of perioperative ischaemia and infarction.225 It was also shown that ECG monitoring with fewer leads (as few as three) has lower sensitivity than monitoring with 12 leads and there is a statistically significant association, independent of perioperative troponin values, between perioperative ischaemia on a 12-lead ECG monitoring with fewer leads (as few as three) has lower sensitivity than monitoring is recommended especially in

high-risk patients, although correct positioning of 12 leads is not feasible in high abdominal and thoracic surgery. Recommendations on ECG monitoring 6.2 Transoesophageal echocardiography (TOE) has frequently been used as a monitoring tool during cardiac surgery. TOE has several advantages. It is rapidly available, relatively non-invasive, and provides more versatile and comprehensive information; however, although TOE is in general a safe procedure, serious adverse events can occur. The complication rates relate to the experience of the operator and the presence of oesophageal or gastric diseases. Specific training of users is essential to avoid inaccurate interpretation. Myocardial ischaemia can be identified by abnormalities in regional wall motion abnormalities may be difficult to interpret in the presence of left bundle branch block, ventricular pacing, or right ventricular overload. The resolution of ischaemia is not necessarily detectable if ischaemia is followed by myocardial stunning. Episodes of new or worsened wall motion abnormalities have been shown to be relatively infrequent (20%) in high-risk patients undergoing non-cardiac surgery. 229 They were more common in patients submitted to aortic vascular surgery. Episodes were poorly correlated with post-operative ischaemic outcomes, routine monitoring for myocardial ischaemia with TOE or 12-lead ECG during non-cardiac surgery is of little more clinical value than pre-operative clinical data and intra-operative monitoring using a 12-lead ECG.230TOE is recommended if acute and severe haemodynamic instability or life-threatening abnormalities develop during noncardiac surgery. In a prospective study including 42 adults, TOE was performed before any other haemodynamic monitoring when severe hypotension, hypovolaemia, low ejection fraction, severe embolism, myocardial ischaemia, cardiac tamponade, or dynamic LV outflow tract obstruction.232 The value of TOE for systematic haemodynamic monitoring in patients at risk is more controversial. There is no evidence that haemodynamic monitoring by TOE accurately stratifies risk or predicts outcome. TOE can be useful in the operating room in patients with severe valvular lesions. The loading conditions during general anaesthesia differ from those present in the pre-operative evaluation. Secondary mitral regurgitation is usually reduced during general anaesthesia; on the other hand, primary mitral regurgitation can increase. In the setting of severe mitral regurgitation, the LVEF overestimates LV function and other parameters may be more accurate, such as myocardial deformation obtained by two-dimensional speckle tracking. In patients with severe aortic stenosis, appropriate pre-load is important during surgery. Monitoring of LV end-diastolic volume with TOE may be more accurate than by pulmonary capillary pressure. An appropriate heart rate is crucial in patients with mitral stenosis and aortic regurgitation: a sufficient diastolic period in the latter. When inappropriate control of heart rate occurs, the consequences should be assessed: changes in transmitral mean gradient and pulmonary artery pressures in mitral stenosis, and changes in LV volumes and indices of LV function in aortic regurgitation. Recommendations on intra-operative and/or perioperative TOE in patients with or at risk of haemodynamic instability Transoesophageal Doppler (TOD) (without echocardiography) can be also used to monitor cardiac output. A government-sponsored systematic review performed in the USA concluded that a strong level of evidence existed to support the usefulness of TOD in reducing the rate of major complications and the length of hospital stay after major surgery.233 A similar conclusion was drawn in a separate review commissioned by the UK's National Health Service (NHS) Centre for Evidence-based Purchasing, performed in three NHS hospitals, with 626 patients being assessed before- and 621 patients being assessed before- and 621 patients after implementation of an intra-operative TOD-guided fluid optimization strategy. The findings of the NHS review showed a 67% decrease in intra-operative mortality, a 4-day reduction in mean duration of post-operative hospital stay, a 23% reduction in re-operation rate. 234 6.3 Right heart catheterization Despite more than 30 years' experience with the pulmonary artery catheter (PAC) and right heart catheterization, little evidence exists in the medical literature to demonstrate a survival benefit associated with PAC in perioperative patients. A case-control analysis, carried out in a subset of patients from a large observational study who underwent PAC placement, and who were matched with a similar number of patients who did not undergo right heart catheterization, demonstrated a higher incidence of post-operative heart failure and non-cardiac events than the control group.236Similarly, a Cochrane review of 12 randomized, controlled clinical trials studying the impact of PAC in a large spectrum of patients including patients who were undergoing surgery or who were admitted to the ICU with advanced heart failure, acute respiratory distress syndrome, or sepsis—failed to demonstrate a difference in mortality and length of hospital stay, suggesting that PAC does not provide information that is not otherwise available to select a treatment plan.237 Routine PAC and right heart monitoring is therefore not recommended in patients during non-cardiac surgery. The use of other non-invasive perioperative cardiac output and fluid therapy in high-risk patients undergoing non-cardiac surgery, seems to be associated with reduction in length of stay and complications, 238 yet convincing data on hard end-points are still lacking. 6.4 Disturbed glucose metabolic disorder in Europe, with a prevalence of 6.4% in 2010, which is predicted to increase to 7.7% by 2030.239 Type 2 diabetes accounts for >90% of cases, and is expected to increase, probably due to the obesity epidemic in children and young adults. The condition promotes atherosclerosis, endothelial dysfunction, activation of platelets, and synthesis of pro-inflammatory cytokines. According to the World Health Organization, approximately 50% of patients with type 2 diabetes die of CVD. It is well established that surgery in patients with diabetes is associated with longer hospital stay, greater use of healthcare resources, and higher perioperative mortality. Elevated levels of glycosylated haemoglobin (HbA1c)—a marker of poor glycaemic control—are associated with worse outcomes in surgical and critical care patients.240 Further, surgical stress increases the prothrombotic state, which may present a particular issue in patients with diabetes; thus diabetes is an important risk factor for perioperative cardiac complications and death. Critical illness is also characterized by dysglycaemia, which may develop in the absence of previously diagnosed diabetes, and has repeatedly been identified as an important risk factor for morbidity and mortality.240 More recently, the emphasis has shifted from diabetes to hyperglycaemia, where new-onset hyperglycaemia, where new-onset hyperglycaemia in known diabetes to detrimental effect of hyperglycaemia, due to an adverse effect on renal and hepatic function, endothelial function, and immune response, particularly in patients without underlying diabetes. Oxidative stress (a major cause of macrovascular disease) is triggered by swings in blood glucose, more than by sustained and persistent hyperglycaemia. Minimization of the degree of glucose variability may be cardioprotective, and mortality may correlate more closely with blood glucose variability than mean blood glucose variability may be cardioprotective, and mortality may be cardioprotective, and mortality may be cardioprotective hyperglycaemia and the attendant adverse outcomes. Although there is no evidence that screening low- or moderate-risk adults for diabetes improves outcomes, it may reduce complications in high-risk adults. Screening patients using a validated risk calculator (e.g. FINDRISC) can identify high or very high-risk adults; this can be followed up by screening every 3-5 years with HbA1C.242,243 In patients with diabetes, pre-operative or pre-procedural assessment should be undertaken to identify and optimize comorbidities, and determine the peri-procedural diabetes management strategy. For non-cardiac surgery patients without known diabetes, evidence for strict blood glucose control is derived largely from studies in critically ill patients, and is disputed.240,241 Early randomized controlled trials of intensive insulin therapy maintaining strict glycaemic control showed morbidity in surgical patients in ICUs. Subsequent studies, however, found a reduction in mortality in those whose blood glucose control was less strict [7.8-10 mmol/L (140-180 mg/dL)] than in those in whom it was tightly controlled [4.5-6 mmol/L (81-108 mg/dL)], as well as fewer incidents of severe hypoglycaemia. Subsequent meta-analyses have demonstrated no reduction in 90-day mortality with intensive blood glucose control but a five- to six-fold incidence of hypoglycaemia.240,241 Several suggestions have been put forward to explain the differences in outcome between these studies, including enteral vs. parenteral feeding, the target for insulin initiation, compliance with therapy, accuracy of glucose measurements, mechanism or site of insulin infusion, type of protocol used, and the nurse's level of experience. In addition, there is disagreement on the timing of the initiation of insulin therapy: tight intra-operative glucose control may provide benefit but appears to be difficult and, thus far, studies have mainly been undertaken in patients undergoing cardiac surgery. The correlation of poor surgical outcome with high HbA1c suggests that screening patients and improving glycaemic control before surgery may be beneficial. Although recommendations for perioperative management of impaired glucose metabolism are extrapolated largely from the critical care literature, general consensus is that interventions in the acutely unwell or stressed patient should be directed towards minimizing fluctuations in blood glucose concentration whilst avoiding hypoglycaemia and hyperglycaemia. In the ICU setting, insulin infusion should be used to control hyperglycaemia, with the trigger for instigating intravenous insulin therapy set at 10.0 mmol/L (180 mg/dL) and relative trigger at 8.3 mmol/L (150 mg/dL). Although there is a lack official set at 10.0 mmol/L (180 mg/dL) and relative trigger at 8.3 mmol/L (180 mg/dL) and relative trigger at 8.3 mmol/L (180 mg/dL) and relative trigger at 8.3 mmol/L (180 mg/dL). agreement on target glucose range, targets below 6.1 mmol/L (110 mg/dL) are not recommended.240,241 Recommendations on blood glucose control 6.5 Anaemia can contribute to myocardial ischaemia, particularly in patients with CAD. In emergency surgery, transfusion may be needed and should be given according to clinical needs. In elective surgery, a symptom-guided approach is recommended as no scientific evidence is available to support other strategies. 7. Anaesthesia The optimal perioperative course for high-risk cardiovascular patients should be based on close co-operation between cardiologists, surgeons, pulmonologists, and anaesthesiologists. Pre-operative risk assessment and pre-operative optimization of cardiac disease should be performed as a team exercise. Guidelines on pre-operative evaluation of the adult patient undergoing non-cardiac surgery have previously been published by the European Society of Anaesthesiology.244 The present edition focuses on patients with cardiovascular risk factors and diseases and also takes into account more recent developments, as well as perioperative management of patients at increased cardiovascular risk. 7.1 Intra-operative management Most anaesthetic techniques reduce sympathetic tone, leading to a decrease in venous return due to increased compliance of the venous system, vasodilatation and, finally, decreased blood pressure; thus, anaesthesiological management must ensure proper maintenance of organ flow and perfusion pressure value' to define intra-operative arterial hypotension, but percentage decreases >20% in mean arterial pressure, or mean arterial pressure values 30 minutes, are associated with a statistically significant increase in the risk of post-operative complications that include myocardial infarction, stroke, and death.104,245,246 Similarly, increased duration (>30 minutes) of deep anaesthesia (bispectral index scale values 20%). All high-risk patients undergoing major surgery had a benefit from goal-directed fluid therapy in terms of complications.263 A meta-analysis published in 2014 demonstrated that, in patients with CVDs, goal-directed fluid therapy decreased major morbidity without any increase in adverse cardiovascular events.264 7.4 Risk stratification after surgery Several recent studies have demonstrated that it is possible to stratify the risk of post-operative complications and mortality with a simple surgical 'Apgar' score.265 This post-event stratification might allow redirecting patients to higher intensity units or selected post-operative complications.3,266 7.5 Early diagnosis of post-operative complications and troponin.3,266 7.5 Early diagnosis of post-operative complications and troponin.3,266 7.5 Early diagnosis of post-operative complications. publications have demonstrated that differences between hospitals, in terms of post-operative mortality, are not due to the incidence of complications but to the way in which they are managed. 267 These results suggest that early identification of post-operative morbidity and mortality. Several recent meta-analyses have demonstrated that increased post-operative troponin and BNP concentrations after non-cardiac surgery were associated with a significantly increased risk of mortality.55,266,268 The prospective Vascular Events In Noncardiac Surgery Patients Cohort Evaluation (VISION) trial confirmed the results of these meta-analyses.3 Taken together, these results indicate that early troponin measurement in selected patients could trigger therapeutic consequences. A non-randomized trial demonstrated that a bundle of interventions aimed at promoting homeostasis was associated with a significantly decreased incidence of post-operative troponin elevation and decreased morbidity. 269 Pre-operatively, patients who could most benefit from BNP or high-sensitivity troponin measurements are those with METs ≤ 4 or with a revised cardiac risk index value >1 for vascular surgery and >2 for non-vascular surgery. Post-operatively, patients with a surgical Apgar score

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