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GUIDELINES

Preoperative assessment of adults undergoing elective noncardiac surgery

Updated guidelines from the European Society of Anaesthesiology and Intensive Care

Massimo Lamperti, Carolina S. Romero, Fabio Guarracino, Gianmaria Cammarota, Luigi Vetrugno, Boris Tufegdzic, Francisco Lozsan, Juan Jose Macias Frias, Andreas Duma, Matthias Bock, Kurt Ruetzler, Silvia Mulero, Daniel A. Reuter, Luigi La Via, Simon Rauch, Massimiliano Sorbello and Arash Afshari

BACKGROUND When considering whether a patient is fit for surgery, a comprehensive patient assessment represents the first step for an anaesthetist to evaluate the risks associated with the procedure and the patient's underlying diseases, and to optimise (whenever possible) the perioperative surgical journey. These guidelines from the European Society of Anaesthesiology and Intensive Care Medicine (ESAIC) update previous guidelines to provide new evidence on existing and emerging topics that consider the different aspects of the patient's surgical path.

DESIGN A comprehensive literature review focused on organisation, clinical facets, optimisation and planning. The methodological quality of the studies included was evaluated using the GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) methodology. A Delphi process agreed on the wording of recommendations, and clinical practice statements (CPS) supported by minimal evidence. A draft version of the guidelines was published on the ESAIC website for 4 weeks, and the link was distributed to all ESAIC members, both individual and national, encompassing most European national anaesthesia societies. Feedback was gathered and incorporated into the guidelines accordingly. Following the finalisation of the draft, the Guidelines Committee and ESAIC Board officially approved the guidelines.

RESULTS In the first phase of the guidelines update, 17 668 titles were initially identified. After removing duplicates and restricting the search period from 1 January 2018 to 3 May 2023, the number of titles was reduced to 16 774, which were then screened, yielding 414 abstracts. Among these, 267 relevant abstracts were identified from which 204 appropriate titles were selected for a comprehensive GRADE analysis. Additionally, the study considered 4 reviews, 16 meta-analyses, 9 previously published guidelines, 58 prospective cohort studies and 83 retrospective studies. The guideline provides 55 evidence-based recommendations that were voted on by a Delphi process, reaching a solid consensus (>90% agreement).

DISCUSSION This update of the previous guidelines has covered new organisational and clinical aspects of the preoperative anaesthesia assessment to provide a more objective evaluation of patients with a high risk of postoperative complications requiring intensive care. Telemedicine and more predictive preoperative scores and biomarkers should guide the anaesthetist in selecting the appropriate preoperative blood tests, x-rays, and so forth for each patient, allowing the anaesthetist to assess the risks and suggest the most appropriate anaesthetic plan.

CONCLUSION Each patient should have a tailored assessment of their fitness to undergo procedures requiring the involvement of an anaesthetist. The anaesthetist's role is essential in this phase to obtain a broad vision of the patient's clinical conditions, to coordinate care and to help the patient reach an informed decision.

From the Anesthesiology Division, Integrated Hospital Institute, Cleveland Clinic Abu Dhabi, United Arab Emirates (ML, BT, SM), Department of Anesthesia and Intensive Care, University General Hospital of Valencia (CSR). Department of Methodology, Universidad Europea de Valencia, Spain (CSR), Azienda Ospedaliero Universitaria Pisana, Cardiothoracic and vascular Anaesthesia and Intensive Care, Pisa (FG), Department of Translational Medicine, Università degli Studi del Piemonte Orientale, Novara (GC), Department of Medical, Oral and Biotechnological Sciences, University of Chieti-Pescara, Chieti, Italy (LV), Péterfy Sándor Hospital, Anesthesia and Intensive Care Unit. Budapest, Hungary (FL), Servei d'Anestesiologia i Medicina Periopeatòria, Hospital General de Granollers, Spain (JJMF), Department of Anaesthesia and

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Preamble

The scope of these guideline is to provide an update on the previous European Society of Anaesthesiology and Intensive Care (ESAIC) recommendations published in 2018[1] on the preoperative assessment and evaluation of adults undergoing noncardiac surgery.

These new guidelines differ from the previous ones[1] by focusing more on selected topics. Their aim is to avoid repetition of what is already well established from previous ESAIC guidelines,[2–4] and to create a structured pathway on how patients should be assessed preoperatively. We take for granted that some of the basic concepts of preoperative tests, previously described as best clinical practice,[5] are already implemented.

We provide evidence-based recommendations whenever possible or, if there is no primary research, the authors issue clinical practical statements (CPS), based on consensus through a Delphi process, to guide clinical patient management across Europe.

Since the previous guidelines,[1] our specialty has faced the convergence of mounting affordability challenges, increased waiting time for surgery due to clinical staff shortages[6] and the impact of COVID-19, coupled with insufficient progress in overall treatment outcomes. This looming storm could reshape our speciality. Despite a significant and increasing demand, investment in medical training positions has remained stagnant, leaving Europe confronting a shortage of over 20 000 anaesthetists by 2040.

The shortage of anaesthetists leads to delays and a backlog of patient awaiting assessment and surgical treatment: this backlog seems difficult to solve. This implies we should initiate discussions about overall health conditions and perioperative options as early as possible. Considering that many patients have experienced deconditioning, malnourishment and unmanaged comorbidities because of limited medical care during the pandemic, as anaesthetists, we have to address this considerable workload.

ESAIC has embraced the concept of professional roles for anaesthetists beyond the operating room, to coordinate multidisciplinary teams (MDTs), optimise patient care from the preanaesthesia clinics to the intensive care unit (ICU) and to reduce postoperative morbidity and mortality.

The ESAIC Guidelines Committee assessed the previous guidelines and appointed a new taskforce to update and significantly revise the format and recommendations. The taskforce decided to focus on specific topics, and to make these guidelines a modular document that could be updated with supplements quickly as new evidence emerges.

This taskforce conducted a thorough revision of the previous guidelines and defined specific areas of interest intended to guide anaesthetists in the rational use of resources, in assessing the patients' preoperative conditions promptly, in optimising modifiable conditions (e.g. preoperative anaemia) before surgery and in the provision of an overall clinical risk assessment suitable for discussion with the patients or their carers during the informed consent process.

Clinical practice statements (CPS) are typically developed when evidence is incomplete, indirect or contradictory. hence, there is always some uncertainty about the best course of action, and this is why guidelines cannot be considered definitive answers for all patients. Guidelines should be used according to the clinical context.

Clinical decision-making is complex, and it requires to be individualised for each patient. Guidelines are developed for populations and such general advice can conflict with personalised precision medicine. Individual patients may have different needs that must be considered when implementing recommendations from clinical practice guidelines.[7]

These guidelines are not explicitly devised to improve the quality of the preoperative journey, or to help allocate resources, or to adopt new technologies such as artificial intelligence (AI),[8] which may ease our daily work but is still far from being consolidated in our daily clinical practice. However, with the evolution of new technologies, collecting relevant clinical information will provide a more rapid, precise and reliable perioperative risk assessment, creating a personalised perioperative plan to be discussed and agreed with patients.

Introduction

These guidelines target the preoperative assessment of adults undergoing elective, noncardiac surgery (NCS). However, we do not simply focus on patients about to undergo surgical procedures in the operating theatre as there is an increasing number of procedures outside this

Intensive Care, University Hospital Tulln, Austria (AD), Department of Anaesthesiology and Intensive Care Medicine, Hospital of Merano (SABES-ASDAA), Merano - Meran, Italy (MB), Teaching Hospital of Paracelsus Medical University and Department of Anaesthesiology, Perioperative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria (MB), the Outcomes Research Consortium, Department of Anesthesiology, Cleveland Clinic, Cleveland, Ohio, USA (KR), Department of Anesthesiology, Intensive Care Medicine and Pain Therapy, Rostock University Medical Center, Rostock, Germany (DAR), Anesthesia and Intensive Care. Policlinico "G. Rodolico-San Marco", Catania, Italy (LLV), Department of Anaesthesiology and Intensive Care Medicine, Hospital of Merano (SABES-ASDAA), Merano - Meran (SR), Teaching Hospital of Paracelsus Medical University, Anesthesia and Intensive Care, School of Medicine, Kore University, Enna (SR), Anesthesia and Intensive Care, Giovanni Paolo II Hospital, Ragusa, Italy (SR), Rigshospitalet & Institute of Clinical Medicine, University of Copenhagen (MS) and Department of Paediatric and Obstetric Anaesthesia, Juliane Marie Centre, Rigshospitalet, Denmark University of Copenhagen, Denmark (AA)

Correspondence to Massimo Lamperti, Anesthesiology Division, Integrated Hospital Institute, Cleveland Clinic Abu Dhabi, Al Maryah Island, PO Box 112412, United Arab Emirates.
E-mail: docmassimomd@gmail.com

area, such as endoscopy or interventional radiology (i.e. nonoperating room anaesthetic locations, NORA) where the presence of an anaesthetist is required, not only because of specific patient characteristics or a patient's request for deep sedation but also because of the evolution of treatment options and an increasing number of patients with comorbidities made worse by ageing and long-term survival from chronic diseases.

Consequently, we provide an overview of how to match low-risk procedures (surgical/nonsurgical) and high-risk medical conditions that cannot be modified or optimised.[9,10]

The ESAIC-focused guidelines on cardiac biomarkers and risk assessment for major perioperative cardiac events[4,11] are comprehensive documents that provide recommendations on using cardiac biomarkers for patient risk evaluation in the preoperative setting. The guidelines discuss the benefits and risks of using cardiac biomarkers while recommending patient selection and careful interpretation of results. Cardiac biomarkers combined with other clinical signs or laboratory tests can be helpful in risk assessment, but they should not be used in isolation. The overall clinical assessment of the patients is equally important, including age, comorbidities, and surgical risk. Considering these factors, we can more accurately estimate the patient's risk of complications.

We will also refer to the 2023 ESAIC guidelines on using antithrombotic agents in patients undergoing regional anaesthesia,[2] which focus on optimising patients' antithrombotic medications when surgery requires neuraxial or peripheral nerve blocks.

These new guidelines will complete the bundle of evidence-based recommendations on the perioperative evaluation of adult patients undergoing NCS. The guidelines aim to offer a comprehensive guide for the anaesthetist conducting the preoperative assessment, enabling them to create and follow a well defined flowchart with an optimal perioperative plan.

The taskforce also formulated new clinical questions not covered by previous guidelines. In the guidelines, the answers to these questions are based on the existing literature and supported by a graded and evidence-based set of practice recommendations.

Materials and methods

The European Society of Anaesthesiology and Intensive Care (ESAIC) appointed a taskforce to update the existing guidelines on the preoperative assessment of adult patients undergoing mainly elective NCS. The taskforce developed clinical queries using the Population/Intervention/Comparison/Outcome (PICO) questions. These PICO questions were then further refined for the search strategy. The initial list of 20 PICO questions was revised and some were combined and initially, the taskforce approved a compact set of 11 PICOs. However, recently, many new adverse reactions have been registered in the Food and Drug Administration (FDA) adverse event reporting system (FDAER), including glucagon-like peptide I (GLP-1) agonists[12] as a risk factor for gastric aspiration during induction of general anaesthesia, and sodium-glucose cotransporter-2 (SGLT2) inhibitors as a risk factor for euglycemic diabetic ketoacidosis (eDKA).[13] Consequently, the ESAIC Board asked the taskforce to add one specific PICO question to address recommendations for these two drugs.

The 12 final PICOs were generated based on the research questions addressed in this article. The main new clinical queries arising from the research questions were divided into three main areas: organisational aspects, clinical assessment and optimisation and planning.

For the clinical questions raised in each PICO, the members of each PICO subgroup were requested to provide keywords that were then used for the literature search.

Eligibility criteria

Studies involving adults (18 years or older) undergoing elective NCS were predominantly included. Previous guidelines, systematic reviews, randomised controlled trials and cohort observational studies were considered eligible for inclusion, while narrative reviews, case reports, series and reviews were excluded.

Electronic literature search

A guideline information specialist, Janne Vendt (Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark), developed the literature search strategy in close collaboration with the author (M.L.) and the ESAIC group methodologists (C.S.R. and A.A.). The literature search was conducted in MEDLINE (OvidSP), EMBASE (OvidSP) and Cochrane Central Register of Controlled Trials (CENTRAL). The searches were not restricted to specific languages and ran with high precision on the topics. A similar search strategy was used for all the databases. The electronic database searches were limited from 2016 to 2023. The panel members were also encouraged to add any missing papers of interest of which they were aware and to conduct a 'snowballing' search themselves. Two task force members were appointed for each PICO and asked to perform the first screening of relevant articles, and to assess relevant abstracts and titles in a second round. A third task force member was asked to solve conflicts in case of disagreement. After removing all duplicates, the authors again screened the abstracts and titles before making a final decision on including or excluding studies. All relevant articles were retrieved for full-text assessment and data extracted using Rayyan[14] or Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia).

If the search strategy yielded no eligible literature or evidence to answer the clinical questions and PICOs, the task force members were allowed to extend the search dates and include either newer or older publications of relevance. For such purposes, only studies of the best quality were included.

During the first phase, 17 668 titles were identified; after removal of duplicates and limitation of the search to the period from the 1 January 2018 to 3 May 2023, the remaining 16 774 titles were screened, resulting in 414 abstracts. From these, 267 relevant abstracts were used to select 204 appropriate titles for a detailed GRADE (Grading of Recommendations, Assessment, Development and Evaluation) analysis. In addition, 4 reviews, 16 meta-analyses, 9 previously published guidelines, 58 prospective cohort studies and 83 retrospective studies were considered. For a more detailed description of the search strategy and literature results from each PICO question, the readers are referred to Appendix 1, http://links.lww.com/EJA/B36.

Risk-of-bias assessment

The risk-of-bias assessment for the final articles retrieved from the literature was conducted following the guidance in both the *Cochrane Handbook for Systematic Reviews and Interventions* for randomised clinical trials and the SIGN checklist for observational studies supplied by the ESAIC methodologist (C.S.R.). All summary tables are available in Appendix 2, http://links.lww.com/EJA/B37. Any disagreements regarding assessing the risk of bias were resolved through discussion with the methodologist (C.S.R and A.A).

Quality-of-evidence assessment

The ESAIC guidelines committee uses the GRADE methodology to formulate recommendations: these are based on the findings of the included studies in conjunction with their methodological quality. The GRADE system was selected because it is simple to use and has two levels of recommendations (1 and 2) and three levels related to the quality of the evidence (A, B and C), which makes it easier for clinicians to understand the implications of the recommendations. The taskforce members were asked to define relevant outcomes across all clusters and rank the relative importance of outcomes. Each group member was responsible for grading the articles for each cluster. The level of evidence for a recommendation was downgraded if the included literature needed to be of better quality, if there were inconsistencies in the results or if the evidence was indirect or not applicable to the clinical question. The level of evidence was upgraded if the study quality was high, if the magnitude of the effect was significant or if there was a dose–response gradient. The GRADE system is summarised in Table 1 following ESAIC methodology guidelines.

Development of recommendations

Each PICO group assigned one task force member to write the initial draft of the recommendations discussed within their PICO group and then submit it to the entire task force for further discussion and final agreement in

Table 1 GRADE definitions

Grade of recommendation	Clarity of risk/benefit	Quality of supporting evidence
1A	Strong recommendation, high-quality evidence	Consistent evidence from well performed randomised, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk.
1B	Strong recommendation, moderate-quality evidence	Evidence from randomised, controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence from some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate.
1C	Strong recommendation, low-quality evidence	Evidence from observational studies, unsystematic clinical experience, or from randomised, controlled trials with serious flaws. Any estimate of effect is uncertain.
2A	Weak recommendation/suggestion, high-quality evidence	Consistent evidence from well performed randomised, controlled trials or overwhelming evidence of some other form. Further research is unlikely to change our confidence in the estimate of benefit and risk.
2B	Weak recommendation/suggestion, moderate-quality evidence	Evidence from randomised, controlled trials with important limitations (inconsistent results, methodologic flaws, indirect or imprecise), or very strong evidence from some other research design. Further research (if performed) is likely to have an impact on our confidence in the estimate of benefit and risk and may change the estimate.
2C	Weak recommendation/suggestion, low-quality evidence	Evidence from observational studies, unsystematic clinical experience, or from randomised, controlled trials with serious flaws. Any estimate of effect is uncertain.
Clinical practice statements (CPS)	Very low-quality evidence	Clarity of risk/benefit: high uncertainty in the estimates of benefits, risks, and burdens; benefits may outweigh risks and burdens. Quality of supporting evidence: evidence from observational studies, unsystematic clinical experience, case reports or extrapolated from other settings and populations or from trials with serious flaws. Any estimate of effect is uncertain.

line with the GRADE provided for each of the recommendations. The authors' aim was to incorporate the relevant supporting references for each recommendation within a concise explanation, prioritising studies of the highest quality. The taskforce decided to include additional clinical practice statements (CPS) for each PICO when there was a lack of evidence on a specific question. The voting process was conducted via two virtual Delphi rounds in which each recommendation/CPS was rephrased according to the various comments and suggestions of the panel. We accepted a prespecified level of agreement of 80% on a given recommendation/CPS. The new recommendations/CPSs were sent again to the taskforce members for a new voting round. If, after a third round, agreement was not reached, we presented the result as 'no agreement' in the text.

The taskforce chairman (M.L.) merged the final document and shared it with all the taskforce members for final approval. All the relevant comments were included in the revision of the final document, which the ESAIC Guidelines Committee, the ESAIC Board and all the ESAIC members then approved after an open-peer review assessment.

The dissemination and implementation of these guidelines depend on the ESAIC, which facilitates the harmonisation of education and training throughout Europe by preparing and updating the European Training Requirements (ETR). Dissemination and implementation can also be facilitated by the ESAIC, including guidelines and content in the European Diploma in Anaesthesia and Intensive Care (EDAIC) questions, by repetitive podcasting, webinars and applications. Dissemination and implementation are also incumbent on every European academic institution and European Anaesthesia Society integrating these guidelines into clinical practice to guarantee the highest safety and best standard of care during the preoperative journey of our patients.

A summary of all recommendations and CPS for each PICO is presented in Table 2.

Organisational aspects

Timing of the preoperative anaesthesia assessment

When and how should the preoperative anaesthesia assessment happen?

R1.1: We recommend an early outpatient preoperative anaesthesia assessment to reduce day-of-surgery cancellations and length of hospital stay. (1C)

R1.2: We recommend that telemedicine and standardised questionnaires be used as part of the preoperative anaesthesia assessment to improve patient accessibility to preanaesthesia care and their satisfaction. (1B)

R1.3: We suggest performing the preoperative assessment before the day of surgery, preferably within 30 days. However, we advise an updated comprehensive review by the attending anaesthetist within the 48 h before surgery. (CPS)

R1.4: We suggest conducting the preoperative assessment as early as possible, but within 30 days of the planned procedure for high-risk patients, to allow patient optimisation and fitness improvement for surgery.

Existing evidence and comments

Clinical evaluation of the patient's fitness to undergo any procedure under general anaesthesia or sedation is one of the foundations for providing safe and effective anaesthesia care.[15,16] Our previous guidelines focused on how, but did not clearly define when, to perform this evaluation and consider the patient ready for surgery. We found new evidence on using telemedicine to facilitate preanaesthesia assessment and thus enhance efficiency in the scheduling of surgical procedures and so improve the patient's experience.[17]

We found scarce evidence on this question. Most of the recommendations made in previous guidelines[18] were based on a consensus of consultant anaesthetists on the timing of the assessment based on the patient's conditions and surgical invasiveness. They suggested that preoperative anaesthesia assessment should be completed before the day of surgery for both high-risk patients and high-risk surgery. According to common clinical practice, it has been agreed that the preoperative screening and MDT meeting should happen within the 30 days before the surgical procedure so that the surgeon can decide on the actual procedure to be undertaken. According to the national/regional requirements, legally binding timings should be considered because, in routine clinical practice, we combine risk assessment and patient education to obtain informed consent, where timing is legally relevant. Nevertheless, it must then be updated within 48 h of surgery[19,20] to allow rescheduling of patients in case of a need for further optimisation (e.g. preoperative anaemia). A recent small study[21] on the actual effect of timing of the preoperative assessment before the surgical intervention showed that an assessment closer to the procedure date was correlated with reduced ICU admission and major complications. When the preoperative assessment was carried out 4 days or less before the procedure date, there was a significant reduction in length of stay (3.91 *vs.* 4.49 days; $P = 0.03$). When the preoperative evaluation was carried out 11 days or less before the procedure date, there was a four-fold decrease in the intensive care admission rate ($P = 0.04$). Furthermore, the primary complication rate was also significantly reduced ($P < 0.05$). However, when preoperative evaluation took place 30 days or less before the procedure date compared with more than 30 days prior, there were no significant changes in the outcomes.

High-risk operations have been defined as those with a mortality of more than 5%. This can be either a procedure with an overall mortality of more than 5% or a patient

Table 2 Summary of recommendations

Timing of the preoperative anaesthesia assessment
When and how should the preoperative anaesthesia assessment happen?
R1.1: We recommend an early outpatient preoperative anaesthesia assessment to reduce day-of-surgery cancellations and length of hospital stay. (1C)
R1.2: We recommend that telemedicine and standardised questionnaires be used as part of the preoperative anaesthesia assessment to improve patient accessibility to preanaesthesia care and their satisfaction. (1B)
R1.3: We suggest performing the preoperative assessment before the day of surgery, preferably within 30 days. However, we advise an updated comprehensive review by the attending anaesthetist within the 48 h before surgery. (CPS)
R1.4: We suggest conducting the preoperative assessment as early as possible but within 30 days of the planned procedure for high-risk patients, to allow patient optimisation and fitness improvement for surgery. (CPS)
Requests for preoperative consultations
When does a consultation with another specialist add value to the preoperative assessment?
R2.1: We suggest referral to a specialist (cardiologist, pneumologist, allergologist, etc.) to make an accurate diagnosis and, if the patient's underlying condition can be improved, to set out a time scale and treatment regimen to obtain this improvement. Only at the end of this process, when the patient is 'optimised', can the anaesthetist make a prediction/estimate of the risk. (CPS))
Who should coordinate patients' consultations with other specialists?
R2.2: An expert anaesthetist should coordinate the preoperative evaluation involving a multidisciplinary team discussion when needed. (CPS)
Cardiovascular assessment
What kind of tools could we use to assess the cardiovascular system preoperatively?
R3.1: We suggest using the Revised Cardiac Risk Index (RCRI) score in preoperative patient risk stratification. (2C)
R3.2: When ordering preoperative blood tests, we suggest using natriuretic peptides as biological markers in high-risk patients (RCRI >2) undergoing high-risk surgery. (2C)
R3.3: We discourage using METs as a subjective measurement of the patient's functional capacity before medical decision-making. The preoperative patient-subjective estimate of METs correlates poorly with the METs measured by exercise stress testing. Nonetheless, in selected individuals, the preoperative assessment of patient-subjective METs is used as a surrogate marker of preoperative performance even if this is not seen as a substitute for preoperative cardiopulmonary testing. (1A)
R3.4: We recommend combining natriuretic peptides and Duke Activity Status Index questionnaires to evaluate cardiac reserve in high-risk patients undergoing high-risk surgery. (1C)
R3.5: We recommend completing the WHO Disability Assessment Schedule 2.0 in high-risk patients before surgery as this could be useful to inform the patients about the risks of postoperative disability. (1C)
Use of Point-of-Care Ultrasound (POCUS)
Should POCUS of the heart and lung be an integral part of the preoperative assessment in all patients with heart disease who are about to undergo high-risk surgery?
R4.1: We suggest using a focused POCUS examination of the heart and lung, performed by a trained anaesthetist, in patients with any concerns regarding cardiovascular comorbidity before urgent or emergency surgery to address significant cardiac abnormalities and request a cardiology consultation and trigger more thorough cardiovascular monitoring, but it should not delay surgery. (2B)
R4.2: There is no compelling evidence that a preoperative focused cardiac POCUS exam in patients with or without known chronic heart failure or coronary artery disease before elective high-risk surgery could reduce postoperative morbidity. (2B)
Previous SARS-CoV2 (COVID-19) infection
Should we screen all patients who are suspected of COVID-19 infection?
R5.1: We recommend that preoperative antigen testing (detecting specific proteins on the surface of the SARS-CoV-2 virus) be performed only on symptomatic patients. (1C) R5.2: We recommend not using chest computed tomography (CT) as a screening tool for diagnosing SARS-CoV2 in asymptomatic patients. (1C)
Should patients with previous COVID-19 infection (any severity) but who developed persistent moderate/severe symptoms (e.g. muscular fatigue) be screened differently? Who should coordinate patients' consultations with other specialists?
R5.3: We suggest that patients admitted for hospital care with a previous clinical–radiological diagnosis of SARS-CoV2 infection that required intensive care unit or high dependency unit admission should go through more extensive cardiorespiratory preoperative evaluation [echocardiography, chest computed tomography, cardiopulmonary exercise testing (CPET)]. (CPS)
Airway evaluation
What should be the minimum number of tests required for effective planning of airway management?
R6.1: We recommend assessing the patient's airway before any procedure. (1C)
R6.2: We recommend performing multiple tests to improve the positive-predictive and negative-predictive values of preprocedural airway assessment. (1A)
R6.3: We suggest using the minimum set of airway assessment tests that may vary among patients depending on specific underlying pathologies. (2C).
R6.4: For a comprehensive risk assessment, including the postanaesthesia care, the minimum set of airway assessment tests should include, apart from anatomical tests, the evaluation of physiology, environment, devices and the individual and team expertise. (1C).
R6.5: More evidence is required before recommendations can be made regarding the need for instrumental tests (e.g. ultrasound) for airway assessment. (CPS)
R6.6: In case of predicted and previously experienced difficult airway, we recommend informing the patient adequately and obtaining consent for specific procedures (e.g. awake intubation), and an alert form should be given to the patient in case of future procedures requiring airway management. (1C)
Renal function assessment
Should the patient with established renal dysfunction be tested preoperatively specifically to predict a worsening of their renal function after anaesthesia?
R7.1: In patients with known chronic kidney disease (CKD), we recommend quantifying the estimated glomerular filtration rate (eGFR) and proteinuria before surgery for risk stratification regarding postoperative acute kidney injury (AKI) and worsening of CKD. (1C)
R7.2: We suggest considering NT-Pro BNP testing combined with eGFR to add additional information on risk stratification for postoperative acute kidney injury (AKI) and worsening of CKD. (2C)
Evaluation of coagulation disorders
How should we manage patients undergoing minor/major surgery with acquired/primary coagulation disorders?
R8.1: In elective procedures, we suggest that the perioperative continuation of antithrombotic therapy should be weighed against the bleeding risk of surgery, patient-related factors, and the specific antithrombotic medication. (2C)
R8.2: We recommend continuing antiplatelet therapy for 6 months after elective percutaneous intervention and 12 months after an urgent coronary intervention. In the case of drug-coated balloon angioplasty, the duration of dual antiplatelet therapy could vary from a minimum of 1 month to a maximum of 12 months, depending on the status of the disease (stable vs. unstable, chronic vs. acute), the dimension of the occluded vessel, presence of in-stent restenosis, type of stenosed stent and bleeding risk. (1C)
R8.3: We recommend managing anticoagulant medication before an emergency/urgent procedure based on its pharmacokinetic characteristics, reversal agent availability, the patient's renal function and the likelihood of major bleeding (1A)
R8.4: We suggest that the bleeding risk should be balanced with the thrombotic risk to assess the necessity of withdrawing the anticoagulant or antiplatelet therapy. (2C)
R8.5: We suggest that patients with previous percutaneous coronary intervention require a careful risk–benefit assessment to manage perioperative antiplatelet therapy. (2C)

Table 2 Continued

R8.6: We suggest that the preoperative evaluation of patients undergoing noncardiac surgery should include an educational program for patients and their caregivers on the perioperative handling of their antithrombotic therapy. (2C)
R8.7: We suggest that the perioperative assessment of coagulation status should be implemented through thromboelastometry and thromboelastography in patients with cirrhosis and significant coagulopathy, as well as in a hypercoagulability state with tranexamic acid administration. (2C)
R8.8: In haemophilia patients, pharmacokinetic-guided treatment should be implemented over real-body weight-guided treatment to assure an optimal perioperative achievement of the prespecified coagulation factor range. (2B)
R8.9: We recommend that patients with haemophilia, von Willebrand disease and factor X deficiency should be managed with a coordinated, multidisciplinary approach to their care. (1C)
The high-risk patient
How to care for a patient at high-risk of postoperative complications but requiring a low-risk procedure?
R9.1: We recommend using frailty testing as an effective tool for predicting postoperative outcomes, especially for assessing the risk of delirium. (1C)
R9.2: We recommend using the Clinical Frailty Scale if the preoperative anaesthesia physical examination reveals the presence of a frailty phenotype. We should ask for an evaluation from a geriatrician to improve the cognitive, nutritional and comorbidity status by delaying surgery (time-sensitive or elective procedures) whenever possible. (1C)
R9.3: We recommend using the Clinical Frailty Scale because of its high feasibility and predictive values. (1C)
Role of prehabilitation
How should patients at high risk of postoperative complications (respiratory, cardiac) be prehabilitated (physical therapy, nutrition)?
R10.1: The role of prehabilitation should be established in noncardiac surgery patients. (2B)
R10.2: Nutritional support before surgery should be considered in noncardiac surgery patients. (2C)
Postoperative admission to the intensive care unit (ICU)
Should all patients with preexisting cardiac disease undergoing elective major surgery be admitted routinely to the ICU postoperatively?
R11.1: We do not recommend routine admission to the ICU for patients with stable cardiac diseases undergoing elective major surgery. Selective access to the ICU in this subset of patients following a multidisciplinary evaluation of the risk-to-benefit ratio might be more appropriate. (1C)
Use of GLP-1 agonists and SGLT2 inhibitors
Is using GLP-1 agonists or SGLT2 inhibitors changing the perioperative management of patients undergoing procedures requiring sedation/anaesthesia?
R12.1: When a GLP-1 agonist is prescribed as a weekly injection and considering the long half-life of GLP-1 agonists, we recommend pausing GLP-1 agonists at least 1 week before a scheduled procedure requiring sedation/anaesthesia. If these drugs are given for obesity, then 2 weeks (three half-lives) are recommended. (CPS)
R12.2: If the medication is prescribed as daily oral or subcutaneous administration, we recommend pausing GLP-1 agonists on the day of the procedure. (CPS)
R12.3: There is no evidence to show that stopping these medications even 1 week before the procedure will eliminate the risk of delayed gastric emptying, despite following the usual fasting timing for surgery. (CPS)
R12.4: A clear fluid diet for 24 h before any procedure should be considered in patients taking GLP-1 agonists. (CPS)
R12.5: All patients taking GLP-1 agonists should be considered as at risk of having a full stomach despite a lack of gastrointestinal symptoms. (CPS)
R12.6: Whenever possible, a gastric ultrasound should be performed. If gastric contents are found by ultrasound and these are considered as a high risk for aspiration, patient should be counselled about this risk before deciding to proceed with sedation/general anaesthesia. (CPS)
R12.7: If the procedure is of such urgency that postponement is not desirable, endotracheal intubation by rapid sequence induction/intubation is advised. (CPS)
R12.8: SGLT2 inhibitors (SGLT2i) drugs should be withheld for 3 to 4 days before elective procedures to reduce the risk of euglycemic diabetic ketoacidosis. (CPS)
R12.9: Patients taking SGLT2i medications should consume clear fluids approximately 2 h before the procedure to keep regular hydration. (CPS)
R12.10: Euglycemic diabetic ketoacidosis should be suspected in this category of patients, and blood β-hydroxybutyrate is a functional confirmatory test. (CPS)
R12.11: If a patient taking SGLT2i drugs did not discontinue the medication in time, dehydration caused by bowel preparation for endoscopy can increase the ketone levels, and the patient should be adequately hydrated before leaving the hospital. (CPS)

with an individual mortality risk of more than 5%. Simple clinical criteria can identify high-risk surgical patients (HRSPs).[21–23] Surgery can be high risk because of patient-specific factors or procedure-specific factors; in 2011 in the UK, the incidence of mortality for high-risk patients was 12.5%, accounting for 80% of all perioperative deaths.[24] In this specific category of patients, assessing the 'high-risk' surgical patient should quantify each risk of an adverse outcome. This should be made explicit to the patient, clearly documented and used to stratify patients to receive appropriate perioperative care.[25]

The current evidence on preoperative anaesthesia clinics (PACs) demonstrates their impact in optimising a patient's condition before surgery, reducing laboratory testing and consultations and showing an apparent reduction in the duration of hospital stay[26] and cancellation of surgery.[27–31] One study demonstrated only a significant decrease in mortality from 18 of 298 (6.1%) patients without a PAC assessment to 14 of 1147 (1.2%) patients with a PAC assessment ($P = 0.001$).[32] More recent research[33] in an urban academic medical centre with the patients stratified according to date of procedure, procedure type, emergency status, certain preoperative comorbidities, gender, age, ASA physical classification score, Johns Hopkins surgical grade, in-hospital mortality and whether or not the patient was seen in the PAC before the procedure, showed that the visit to the PAC was associated with a reduction in mortality (odds ratio 0.48; 95% CI, 0.22 to 0.96, $P = 0.04$) by comparison with the matched cohorts. A sub-analysis of failure-to-rescue suggested that the proportion of deaths attributable to an unanticipated surgical complication was not significantly different between the two groups ($P = 0.141$).

With the recent need to maintain preanaesthesia evaluation while minimising the risk of disease transmission during the COVID-19 pandemic, telemedicine has become used more commonly, with an anaesthesia team member contacting the patient via a phone call or videoconference platform. A recent meta-analysis[34] revealed that, when compared with to face-to-face evaluation, surgery cancellation rates with virtual care were no different, with a pooled cancellation rate (in eight of the studies analysed with a random effects model) of 2 (95% CI, 1 to 3)%. Most studies reported a positive patient experience, with a pooled estimate of 90 (95% CI, 81 to 95)%. There was a high success rate of 92 to 100% in

using the information collected with virtual care to diagnose and manage patients,[17,35,36] without increasing surgery cancellations.[37–42] It seems clear that preoperative teleconsultation results in a positive patient experience, because of improved communication and less time required for a PAC.[35,38,43] The high patient satisfaction rate with virtual care was primarily attributed to an efficient and accurate preanaesthesia assessment, which reduced both the time and the monetary costs associated with travel to a clinic, in the range of 24 to 137 min and $60 to 67 per patient, respectively, without increasing surgery cancellations.[15,17,32,33,35,36–40,43]

However, applying this technology to a broader population could be challenging because of the limited access to, or difficulty with technology. Virtual physical examination with electronic stethoscopes is promising but rare.[17,35,44,45] Still, even when an electronic stethoscope was not used, similar or lower surgery cancellation rates were reported compared with a face-to-face assessment.[17,36,37,39,46]

Future research

No evidence exists regarding when the preanaesthesia and fitness for surgery assessments should be performed. The current recommendations are still based on clinical judgment. A more objective relationship between the timing of preoperative optimisation and subsequent postoperative outcome needs to be established.

ASA I and II patients can be triaged in a preoperative telephone interview, however, specific patient conditions create substantial challenges in the perioperative management for those undergoing same-day surgery.

Future research should measure the risk of postoperative complications and 30-day outcomes for patients undergoing virtual preanaesthesia assessment.

Requests for preoperative consultations

When does a consultation with another specialist add value to the preoperative assessment?

R2.1: We suggest referral to a specialist (cardiologist, pneumologist, allergologist, etc.) to make an accurate diagnosis and, if the patient's underlying condition can be improved, to set out a time scale and treatment regimen to obtain this improvement. Only at the end of this process, when the patient is 'optimised', can the anaesthetist make a prediction/estimate of the risk. (CPS)

Who should coordinate patients' consultations with other specialists?

R2.2: An expert anaesthetist should coordinate the preoperative evaluation involving a multidisciplinary team discussion when needed. (CPS)

Existing evidence and comments

In general, a consultation with another specialist adds value in high-risk and frail patients undergoing high-risk operations if, on the one hand, it allows physicians to improve the patient's condition before surgery, while on the other hand, informing the patient about long-term survival. These two aspects can be achieved in most oncologic procedures, which, although time-sensitive, can be delayed by 1 to 6 weeks, and in all nononcologic elective procedures, which can be delayed up to 1 year.

It is worth considering that the first aspect – improving the patient's condition before surgery – cannot be realised in an emergency procedure, typically within 6 h, nor even in an urgent scenario, typically between 6 and 24 h. In these cases, the main goal is to inform the patient about long-term survival and related disabilities, if any.

Future research

A multidisciplinary approach to perioperative risk and management of patients should consider not only organ-specific risks (e.g. the risk of acute myocardial events, or stroke) and procedure-specific risks (e.g. impotence with prostate surgery, a significant neurological deficit after back surgery) but also the overall functional capacity of the patient such that they can achieve a good outcome. The specialist's consultation should be done with specific queries on the possible reversible/nonreversible factors affecting the patient, and a timeline set out for the required treatment to optimise the patient's condition before surgery and so help to improve the perioperative outcome.

Clinical assessment

Cardiovascular assessment

What kind of tools could we use to assess the cardiovascular system preoperatively?

R3.1: We suggest using the Revised Cardiac Risk Index (RCRI) score in preoperative patient risk stratification. (2C)

R3.2: When ordering preoperative blood tests, we suggest using natriuretic peptides (NPs) as biological markers in high-risk patients (RCRI >2) undergoing high-risk surgery. (2C)

R3.3: We discourage using METs as a subjective measurement of the patient's functional capacity before medical decision-making. The preoperative patient-subjective estimate of METs correlates poorly with the METs measured by exercise stress testing. Nonetheless, in selected individuals, the preoperative assessment of patient-subjective METs is used as a surrogate marker of preoperative performance even if this is not seen as a substitute for preoperative cardiopulmonary testing. (1A)

R3.4: We recommend combining natriuretic peptides and Duke Activity Status Index questionnaires to evaluate cardiac reserve in high-risk patients undergoing high-risk surgery. (1C)

R3.5: We recommend completing the WHO Disability Assessment Schedule 2.0 in high-risk patients before surgery as this could be useful to inform the patients about the risks of postoperative disability. (1C)

Existing evidence and comments

In a 7-day cohort study including 46 539 patients, the European Surgical Outcomes Study (EuSOS, reported that 1855 of the patients enrolled died after surgery, an overall mortality rate of 4%.[47] Mortality was 3% for elective surgery, 5% for urgent surgery and 10% for emergency surgery. The study also showed heterogeneity between different countries, with Finland recording the lowest mortality rate of 0.44%, compared with 6.92% in Poland. Compared with data from outside Europe, which demonstrates postoperative mortality rates ranging from 1.3 to 2%, the European mortality rates leave scope for improvements in perioperative care.[47,48]

In the postoperative period, cardiac complications in elderly patients undergoing NCS are the most frequent cause of morbidity and mortality, occurring between 0.5 and 30% of cases.[49]

During patient history and physical examination, anaesthetists can contribute to risk assessment and cardiac risk reduction. However, as reported in the National Confidential Enquiry into Perioperative Deaths registry, anaesthetists recorded an increased risk of death in only 66% of the patients who died.[50] Although previous studies have highlighted the limitations of the RCRI (Table 3), it is still the most objective tool in patient risk estimation (e.g. cardiac death, myocardial infarction and nonfatal cardiac arrest) after NCS.[51,52]

Of note, when patients were stratified across the four classes of RCRI, there was no significant difference in the rate of postoperative myocardial infarction in those receiving preoperative cardiological consultations and those who did not.[53,54] In other words, preoperative cardiological consultation did not reduce the rate of postoperative myocardial infarction nor did it improve other postoperative outcomes after major NCS.

Contrarily, some biological markers like high-sensitivity cardiac troponin test (hs-cTnT) and preoperative natriuretic peptides [brain natriuretic peptide (BNP) and N-terminal prohormone of BNP (NT-proBNP)] can be used to add predictive value to RCRI for cardiac events and long-term mortality after major NCS.[54,55] In a recent study, the inclusion of hs-cTnT (>14 ng l^{-1}) and NT-proBNP (>300 ng l^{-1}) along with RCRI was shown to significantly improve the prediction of postoperative MI (event rate 5.2%, 30/572), the area under the receiver-operating curve (AUC-ROC) increased from 0.590 to 0.716 with a net reclassification index of 0.66 (95% CI, 0.32 to 0.99, $P < 0.001$) in the immediate postoperative period after major NCS.[56] In recent years, natriuretic peptides have shown high negative-predictive values when used as a 'rule-out' test for discriminating between low-risk *vs.* high-risk cardiac patients.[56]

Table 3 Revised Cardiac Risk Index score

Variable	Points
High-risk surgery	1
History of ischaemic heart disease	1
History of congestive heart failure	1
History of cerebrovascular disease	1
Preoperative treatment with insulin	1
Preoperative serum creatinine >2 mg dl^{-1}	1

The interpretation of the Revised Cardiac Risk Index score is generally as follows: 0 points, low risk; 1–2 points, intermediate risk; 3 or more points, high risk.

The most recent guidelines about heart failure patients from the European Society of Cardiology (ESC), the American Heart Association/American College of Cardiology and the American Diabetes Association not only suggest measuring natriuretic peptides to rule out heart failure in out-patients but also suggest cut-off values related to age to rule in heart failure as follows: NT-pro-BNP at least 125 pg ml^{-1} under 50 years, at least 250 pg ml^{-1} for patients aged 50 to 75 years, and at least 500 pg ml^{-1} for patients over 75 years.[57] The consensus[57] also defines a new condition named 'heart stress' when NT-proBNP levels are elevated in asymptomatic patients with risk factors for heart failure (e.g. diabetes, hypertension, coronary artery disease), which could evolve into cardiac dysfunction and a further increased risk.[48,49] We do not know if a cardiological consultation could improve the management of patients with 'heart stress', this should be investigated in future research.

Cardiac reserve is the second most crucial aspect to be considered when assessing if a patient is likely to be able to tolerate the stress of surgery: for this, the cardiopulmonary exercise test (CPET) on an bicycle ergometer with an incremental exercise protocol represents the gold standard.[58] It is mostly used in thoracic surgery, where the American College of Chest Physicians, the European Respiratory Society and the European Society of Thoracic Surgeons recommend CPET in all patients with a predicted postoperative diffusing capacity of the lung for carbon monoxide (DLCO) less than 40% or forced expiratory volume in 1 s (FEV1) below 60%.[59]

CPET is underused in general surgery, where only 10 to 30% of patients receive this evaluation.[60] As an alternative to CPET, the 6-min walk test (6MWT) and the stair-climbing test (SCT) could be considered. But again, in the literature, these tests were predominantly used in patients having thoracic surgery where the 6MWT distance was predictive, not specifically for cardiac complications but for all postoperative complications.[61] Furthermore, a recent study found a weak correlation between the 6MWT and CPET measurements.[62]

Regarding the SCT, the inability to climb two flights of stairs has shown a positive-predictive value of 82% for postoperative pulmonary and cardiac complications or death within 30 days of general surgery.[63] However, compared with thoracic surgery, the inability to climb two flights of stairs does not increase the risk of

perioperative mortality in NCS.[64] Therefore, it is impossible to estimate the risk of perioperative mortality associated with stair climbing capacity in significant surgery that is neither cardiac nor thoracic. In conclusion, we do not have a specific exercise test for general surgery to test cardiac reserve other than CPET.

Functional capacity can also be estimated through a patient-subjective interview with metabolic equivalents (METs) and questionnaires like the Duke Activity Status Index (DASI) (as shown in Table 4) which provides a more precise estimation of cardiac reserve to be integrated with natriuretic peptides.[65]

The recent MET REPAIR (REevaluation for Peri-operative cArdiac Risk) study showed that self-reported functional capacity measures were independently associated with major cardiac events in NCS.[11] In conclusion, MET evaluation did not improve discrimination over an internal clinical risk model, and METs did not improve predictive accuracy compared with clinical risk factors.

Conversely, a recent study investigating the DASI questionnaire showed that a score of 34 represents a threshold for identifying patients at risk for myocardial injury, myocardial infarction, moderate-to-severe complications and new disability.[66] In light of this evidence, combining DASI scores and natriuretic peptides to provide a subjective functional capacity assessment with METs could be more logical.

If any clinical signs of heart failure or a new cardiac murmur are discovered during a physical examination, then echocardiography is indicated as a noninvasive test to gather additional information about the major determinants of adverse postoperative outcomes (e.g. the systolic and diastolic function of the left ventricle, and any heart valve abnormalities).[67,68]

Confusion about who should perform echocardiography exists as this depends on the type of procedure (high-risk *vs.* moderate–low-risk procedure), time of operation (elective, time-sensitive, urgent, emergency), and the aim of the examination. In patients undergoing high-risk operations, when a cardiology consultation cannot be obtained, focused cardiac ultrasound (FoCUS) allows one to perform a bedside patient assessment in a critical or emergency situation, integrating clinical information into the respiratory and haemodynamic evaluation.[69] Still, point-of-care ultrasound (PoCUS)/FoCUS goes beyond a strict assessment of cardiac morphology, which is left to the cardiologist. In that way, the need for an ultrasound evaluation in an urgent or emergency setting does not lead to surgical delays or increased financial costs.[70] On the other hand, an urgent cardiology consultation should be obtained in cases where FoCUS suggests significant findings, such as myocardial infarction, cardiac mass, suspected endocarditis, severe valve disorder or cardiac tamponade.[71] A full echocardiography examination should be performed in the cardiology suite for elective procedures in cases where new abnormal findings are discovered during the physical examination.[72] The same applies when a new arrhythmia, such as atrial fibrillation or bradycardia, is discovered at the preoperative anaesthesia visit, indicating an underlying structural heart disease.[73]

In the case of patients with any of atrial fibrillation and pacemaker, automatic internal cardiac defibrillator receiving anticoagulation and antiplatelet therapy, bare-metal stent, drug-eluting stent or drug-coated balloon angioplasty, the decision to interrupt or continue anticoagulation and antiplatelet therapy should follow the guidelines on perioperative management published in the *British Journal of Haematology*.[74] We recommend consulting a haematologist in the specific case of a genetic or acquired coagulation disorder.

The 2011 Heart Rhythm Society/American Society of Anesthesiologists Expert Consensus Statement was a collaboration with the American Heart Association, the American College of Cardiology and the Society of Thoracic Surgeons. It provides detailed information on a team approach to managing cardiovascular implantable electronic devices (CIEDs). Each patient's individualised care is achieved through clear communication between the anaesthetists, surgeons and the CIED team. The consensus statement emphasises that a single recommendation for all CIED patients is inappropriate. The surgical or procedural team must communicate with the CIED team to inform them of the type of procedure and the likely risk of electromagnetic interference, and the CIED team should communicate with the surgical/procedure

Table 4 Duke Activity Status Index

Are you able to	Yes	No
Take care of self (e.g. eating, dressing)	+2.75	0
Walk indoors	+1.75	0
Walk 1 to 2 block outdoors	+2.75	0
Climb up a hill or stairs	+5.5	0
Run a short distance	+8	0
Perform light housework (e.g. dusting)	+2.7	0
Perform moderate housework (e.g. vacuuming)	+3.5	0
Perform heavy housework (e.g. moving furniture)	+8	0
Do yardwork	+4.5	0
Have sexual relations	+5.25	0
Perform recreational activities (e.g. bowling)	+6	0
Perform strenuous sport (e.g. swimming)	+7.5	0

Patients self-report which activities they can do, and each activity is scored as such: Duke Activity Status Index (DASI) score interpretation. The final score can range from 0 to 58.2 points, where the higher the score, the higher the patient's functional status. After calculating the final DASI score, the VO_2 max and metabolic equivalent of the task can be estimated as follows: VO_2 max ($ml\,kg^{-1}\,min^{-1}$) = 0.43 × DASI + 9.6. METs = VO_2 max/3.5. In a study investigating the correlation of DASI scores with postoperative death or complications, a DASI score of 34 or less meant that a patient was at risk of: myocardial injury; myocardial infarction; moderate-to-severe complications and new disability in surgical patients. Reference: Hlatky MA, Boineau RE, Higginbotham MB, *et al.* A brief self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). *Am J Cardiol.* 1989;64:651–654. doi:10.1016/0002-9149(89)90496-7.

team to deliver a prescription for the perioperative management of patients with CIEDs.[75–82]

Finally, for patients with ascertained low functional capacity who are unable to perform adequate exercise, pharmacologic stress testing with dipyridamole, or dobutamine echocardiography can provide a good understanding of the cardiac risk and how to monitor the patient perioperatively.[83]

In general, stress echocardiography has a high negative-predictive value, and a negative test is associated with a very low incidence of cardiac events in patients undergoing surgery; however, the positive-predictive value is relatively low (between 25 and 45%); this means that the postsurgical probability of a cardiac event is low, despite wall motion abnormality detection during stress echocardiography.[84]

Finally, as recent literature highlighted the importance of using patient-centred outcomes based on an individual patient's choice or preference for quality of life after surgery, rather than surrogate measures of outcomes such as mortality, the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) has been shown, in a multicentre, multinational study of over 500 patients, to be a clinically acceptable, valid, reliable, and responsive instrument for measuring postoperative disability in a diverse surgical population.[85]

The WHODAS 2.0 was developed to measure disability cross-culturally in older people, and for disease-related states.[86] It asks about limitations over the last 30 days in six major life domains: cognition, mobility, self-care, interpersonal relationships, work and household roles, and social participation. The WHODAS 2.0 has excellent psychometric properties, is easy to use and score and is available in the public domain as self-report, proxy and telephone-based versions that can be administered in around 5 min.

Future research

Future research avenues should focus on regional disparities in surgical outcomes, specifically investigating variations in postoperative mortality rates among European countries. Studies should delve into healthcare system differences, surgical practices and patient demographics to understand and address these disparities. CPETs are clearly underutilised in general surgery, and we should understand if this is because of a lack of resources or other factors. Research into the perioperative management of patients with atrial fibrillation, pacemakers, stents and other cardiac interventions is crucial for developing standardised guidelines on interrupting or continuing anticoagulation and antiplatelet therapy. We do not know if cardiological consultation could improve the management of patients with 'heart stress', this should also be investigated in future research.

The workload in the pre-anaesthesia clinics (manpower/effort = costs) could be set with reference to the postoperative patient outcome (=effort-effectiveness), considering the effect of three interventions/efforts of prescribing natriuretic peptides preoperatively, planning advanced haemodynamic monitoring intraoperatively and planning outreach care postoperatively. We all know that only assessing another lab test, such as natriuretic peptides, will not rescue patients but can allow us to assess the cardiac risk better, monitor the patient properly and optimise the cardiac function whenever possible. We should move our research interests from simple predictive analyses of one factor to a more holistic bundle concept.

Use of point-of-care ultrasound

Should point-of-care ultrasound of the heart and lung be an integral part of the preoperative assessment in all patients with heart disease who are about to undergo high-risk surgery?

R4.1: We suggest using a focused POCUS examination of the heart and lung, performed by a trained anaesthetist, in patients with any concerns regarding cardiovascular comorbidity before urgent or emergency surgery to address significant cardiac abnormalities and request a cardiology consultation and trigger more thorough cardiovascular monitoring, but it should not delay surgery. (2B)

R4.2: There is no compelling evidence that a preoperative focused cardiac POCUS exam in patients with or without known chronic heart failure or coronary artery disease before elective high-risk surgery could reduce postoperative morbidity. (2B)

Existing evidence and comments

According to retrospective cohort studies, routine transthoracic echocardiography, performed by cardiologists, did not reduce postoperative complications[87,88] but was associated with a delay in surgery that may contribute to poorer outcomes and additional costs.[70] Anaesthetist-led POCUS may be feasible during the preoperative assessment without causing significant delay. The information gained by POCUS may influence clinical management, outcomes and costs.[89,90]

Three randomised controlled trials investigated the feasibility and effects of preoperative POCUS on perioperative management, complications and mortality.[89–91] The multicentre ECHONOF-2 pilot trial randomised 100 hip fracture patients scheduled for urgent surgery to preoperative assessment with or without FOCUS examination.[89] The intervention was feasible, did not delay surgery and changed diagnosis and management in about 25% of patients. This pilot trial was not powered to determine differences in postoperative outcomes but triggered the currently ongoing, larger ECHOGUIDE III trial (ACTRN12619000116123),[92] investigating length of stay and complications. In 660 critically ill

(shock or respiratory failure) patients, Li *et al.* studied the impact on 30-day mortality from POCUS immediately before emergency NCS.[90] Although there were frequent changes in diagnosis (82%) and management (49%) after POCUS, mortality and secondary outcomes such as length of stay, quality of life and hospital costs did not differ between the POCUS and standard care groups.[91] The PREOPFOCUS trial[91] recruited 338 patients (≥65 years, ASA 3 or 4) randomised to receive preoperative FOCUS or not before urgent orthopaedic or abdominal surgery. The primary composite outcome, 30-day mortality or prolonged hospital stay (>10 days), and significant complications did not differ. However, the trial was terminated prematurely because of restrictions related to the COVID-19 pandemic. In summary, the two trials performed to evaluate the use of preoperative POCUS[89,90] showed a frequent change in diagnosis and management without delaying surgery: but no improved outcomes from the use of preoperative POCUS were found.

Future research

Future research should focus on refining the protocols and training involved in preoperative POCUS to maximise its impact on clinical management and outcomes. While the existing trials focus on immediate perioperative outcomes, future research should explore the long-term effects of preoperative POCUS on patient outcomes, including quality of life, postoperative complications and healthcare costs. A comprehensive evaluation over an extended postoperative period will provide valuable insights into the sustained benefits or limitations of incorporating POCUS into preoperative assessments. This longitudinal perspective can guide the integration of POCUS into routine preoperative care more effectively.

Previous SARS-CoV2 (COVID-19) infection

Should we screen all patients who are suspected of COVID-19 infection?

R5.1: We recommend that preoperative antigen testing (detecting specific proteins on the surface of the SARS-CoV-2 virus) be performed only on symptomatic patients. (1C)

R5.2: We recommend not using chest computed tomography (CT) as a screening tool for diagnosing SARS-CoV-2 in asymptomatic patients. (1C)

Should patients with previous COVID-19 infection (any severity) but who developed persistent moderate/severe symptoms (e.g. muscular fatigue) be screened differently?

R5.3: We suggest that patients admitted for hospital care with a previous clinical–radiological diagnosis of SARS-CoV-2 infection that required intensive care unit, or high-dependency unit admission should go through more extensive cardiorespiratory preoperative evaluation (echocardiography, chest CT, cardiopulmonary exercise testing (CPET). (CPS)

Existing evidence and comments

Since the first outbreak of the novel severe acute respiratory syndrome-related coronavirus (SARS-CoV-2, COVID-19) in Wuhan on 7 January 2020,[93] many countries and societies have introduced preoperative assessment guidelines to confirm/reject a diagnosis of COVID-19 to minimise the risk of infected asymptomatic patients spreading the virus to healthcare personnel and other hospitalised patients thereby jeopardising control over the spread of COVID-19. The symptoms of the infection range from asymptomatic through mild respiratory symptoms to potentially life-threatening cardiovascular and pulmonary complications. The extent and severity of the long-term complications remain to be seen, but emerging data indicate impairment in respiratory and cardiovascular function for months after the initial illness.[93–98] Twenty-two prospective and retrospective cohort studies were included in evaluating preoperative assessment of patients with previous moderate-to-severe COVID-19 infection. Unfortunately, there were no randomised controlled studies, and there is a need for more trials, as the large variation in study designs significantly affects the quality of any recommendations. Moreover, specific recommendations in the first waves of COVID-19 infection are not applicable in the post-COVID era.

Various telemedicine applications have been reported, substantially increasing scientific output during the COVID-19 pandemic. Although this does not allow the physical examination of a patient, it does allow the gathering of information before a patient's admission to facilitate screening, and triaging of patients with suspected or established infection, including evaluating the severity and progression of the presenting disease. Also, telemedicine can help identify patients who need a face-to-face preoperative evaluation due to numerous comorbidities.[99] Using a standardised questionnaire increases the validity of a patient's history, the reported symptoms and the reproducibility of a medical examination. The questions must be based on validated elements and formulated so that they are unambiguous and understood by the majority of patients.[100–102]

Nucleic Acid Amplification Tests (NAATs) are highly sensitive and specific tests that detect one or more viral ribonucleic acid (RNA) genes. Real-time reverse transcription PCR (RT-PCR) test is the most common type of NAAT. It was considered and recommended as the preoperative screening tool for all patients before surgery.[101–115] However, recommendations during the pandemic are not applicable in postpandemic times. The current meta-analysis showed a low pooled COVID-19 prevalence (0.76%) in asymptomatic patients tested preoperatively, with a correspondingly low positive-predictive value (40.8%).[116] Also, a meta-analysis by Byambasuren *et al.*[117] showed that asymptomatic patients are 42% less likely to transmit COVID-19 than symptomatic patients. None of this supports the routine

mandatory use of RT-PCR as the preoperative screening tool but supports a more individual hospital approach based on local COVID-19 hospital admission levels.[118]

Using CT chest scans as a screening tool in diagnosing COVID-19 asymptomatic patients has caused much controversy, and there has been conflicting advice. During the first waves of the pandemic, different algorithms were published that supported the use of chest CT as a diagnostic and management tool before surgical procedures.[119–121] Studies published in later waves of the pandemic supported RT-PCR with a health questionnaire as the only preoperative screening tool in all patients before surgery. Available studies suggest that low-dose radiation chest CT does not provide additional value for the detection of infection in asymptomatic patients,[101,104,107,114,122–127] with a sensitivity of 68.4% and specificity of 88%[128] Any preoperative chest CT must be balanced against the potential harm of misled patient management, including unnecessarily postponing interventions due to high false-positive findings.[115,116]

Future research

The current evidence on the long-term effects of SARS-CoV2 does not provide sufficient evidence on which preoperative tests are required to evaluate the respiratory functional capacity before any significant surgical intervention. As we move from a pandemic to an endemic problem, to avoid the risk of increased postoperative morbidity, the focus should be on which preoperative screening we should undertake based on the major respiratory symptoms. However, the increased mortality and pulmonary risk is reduced if surgery is postponed until after 2 weeks from a positive test.[129,130]

Airway evaluation

What should be the minimum number of tests required for effective planning of airway management?

R6.1: We recommend assessing the patient's airway before any procedure. (1C)

R6.2: We recommend performing multiple tests to improve the positive-predictive and negative-predictive values of preprocedural airway assessment. (1A)

R6.3: We suggest using the minimum set of airway assessment tests that may vary among patients depending on specific underlying pathologies (2C).

R6.4: For a comprehensive risk assessment, including the postanaesthesia care, the minimum set of airway assessment tests should include, apart from anatomical tests, the evaluation of physiology, environment, devices and the individual and team expertise. (1C)

R6.5: More evidence is required before recommendations can be made regarding the need for instrumental tests (e.g. ultrasound) for airway assessment. (CPS)

R6.6: In case of predicted and previously experienced difficult airway, we recommend informing the patient adequately and obtaining consent for specific procedures (e.g. awake intubation), and an alert form should be given to the patient in case of future procedures requiring airway management. (1C)

Existing evidence and comments

Planning of airway management is a cornerstone of any preoperative assessment involving the surgical patient. Several recent studies showed that many airway-related accidents are due to poor judgment, poor planning, poor expertise and poor communication.[131]

Predicting a difficult laryngoscopy and a difficult airway is challenging from a clinical and statistical point of view. Simple application of mathematics and statistics to single or multiple tests may result in a high number of false positives and a low, dangerous, number of false negatives.[132] Recent evidence suggests the need to tailor airway evaluation to the individual patient, combining anatomical, physiological and environmental issues (Table 5) during a multileveled airway evaluation,[133] as each patient may exhibit a different combination of many factors.[134] Recent studies and extensive systematic reviews address specific tests.[135] However, the design of these studies may unavoidably have a selection bias (i.e. the exclusion of short inter-incisor distance in studies for difficult laryngoscopy). With such a premise, it becomes clear why a 'static' approach to airway evaluation may be faulty and why a purely statistical approach will always result in poor predictive values.

Nevertheless, poorly performed or not-performed airway planning results in poor judgment, poor strategy and unpreparedness. Hence, evaluation and planning of airway management, rather than simply difficult laryngoscopy, should be performed preprocedurally in any patient scheduled for surgical procedures in every setting (operating room, nonoperating room anaesthesia), moving away from the concept of difficult airway prediction to airway management planning. Given that any patient accessing the hospital for a surgical procedure and identified with a difficult airway may undergo unplanned intubation separate from the scheduled surgical procedure, airway evaluation should be performed early, and a system of planning and alerts should be adopted throughout the whole patient's stay in the hospital (perioperative airway planning).

Despite evidence that some predictive tests (i.e. upper lip bite test) perform better than others in predicting a difficult laryngoscopy,[135,136] using a single test may exhibit poor predictive value, low specificity and high sensitivity. Moreover, a single test, which may be appropriate for one technique (e.g. laryngoscopy), may not predict difficulty with a different technique (e.g. supraglottic device or face mask ventilation). The literature suggests that combining multiple tests may be of greater

Table 5 Multileveled airway evaluation

Anatomical	Physiological	Environmental
Reduced inter-incisor distance (less than 3 cm)	History of airway problems	Operator experience
Upper lip bite test, mandibular hypoplasia	Preexisting hypoxaemia ALI/ARDS	Airway management training in the institution/ airway leader/protocols or guidelines in use
Upper airway inspection Mallampati test static Mallampati test phonation Visible masses Face/neck scars Edentulia Full beard Snoring	Shunt Shock Cardiac Failure Anaemia Sepsis Increased oxygen consumption Pregnancy at term	Setting: OR, ICU, ED NORA, MAC out of hospital Airway-conflict surgery
Thyromental distance	BMI (obesity)	Preprocedural ultrasound availability and expertise
Nonpalpable cricothyroid membrane	OSA (STOP-BANG, B-APNEIC)	Devices' availability
Neck circumference Neck motility	Planned avoidance of neuromuscular blocking agents	Techniques' proficiency
Neck surgery, radiation	Risk of postextubation complications	Team expertise

Airway leader, person responsible for airway management. ALI, acute lung injury; ARDS, acute respiratory distress syndrome; ED, emergency department; ICU, intensive care unit; MAC, monitored anaesthesia care; NORA, nonoperating room anaesthesia; OR, operating room; OSA, obstructive sleep apnoea.

predictive value and clinical utility.[137] Specific predictive tests should be considered and included as a 'minimum standard' during airway evaluation, either because of opportunity (i.e. inter-incisor distance, when critically low, should indicate a flexible endoscopy approach in a spontaneously breathing patient, independent of any other test being normal or abnormal) or because of available evidence (i.e. upper lip bite test).[135,136]

A preexisting history of difficult intubation and/or airway management (unplanned awakening and surgery deferral because of failed intubation, history of tracheostomy/cricothyrotomy, unexpected ICU recovery after attempted intubation, previous oral/neck/airway surgery and/or radiation, actual/previous glottic/subglottic pathology and/or surgery)[138–141] is of paramount importance and should be adequately documented preprocedurally for any patient requiring an anaesthetic in any setting (operating room, nonoperating room) and independently of a possible difficult airway.

The minimum set of tests for difficult direct laryngoscopy prediction should include airway history, inter-incisor distance and upper lip bite test as the best available predictors.[135,137] Further tests should include upper airway inspection (Mallampati static – Mallampati in phonation, visible masses, scars, edentulous), thyromental distance, cervical motion[18,136,140–147] and neck circumference.[140]

The minimum set of tests as best available predictors for difficult mask ventilation should include an evaluation of the airway,[138] with particular emphasis on surgery/radiation in the neck, body mass index (BMI) (increased BMI and/or neck circumference),[147] Mallampati test (static/phonation), upper airway inspection (presence of full beard, visible masses, scars, edentulous).[140,148–151] Recent evidence highlights the need to incorporate any history of snoring and the STOP-BANG questionnaire into perioperative airway management assessments, given the underestimation of undiagnosed obstructive sleep apnoea (OSA) in surgical populations and limited awareness of the impact of OSA on airway management.[140,150,152]

A minimum set of tests for the prediction of difficult video laryngoscopy cannot be recommended because of a lack of specific studies. Based on a performance study[153] and as a secondary finding of a systematic review,[136] the minimum set of tests may include airway history (with particular emphasis on neck radiation or neck surgery, previous difficult/failed direct laryngoscopy), inter-incisor distance, upper airway inspection (thyromental distance, Mallampati test, crowded mouth), cervical motion and experience in the institution.[153,154] A recent study proposed the definition of a model to predict difficult airway alerts after video laryngoscopy in adults with anticipated difficult airways,[155] which may address the future use of preprocedural (awake) video laryngoscopy to assess the potential of difficult airway management.

The minimum set of tests for difficult insertion of a supraglottic airway device cannot be recommended because of lack of specific studies: based on sparse evidence, the minimum set of tests may include airway history (with particular emphasis on presence or history of glottic/subglottic pathology, neck surgery/radiation), inter-incisor distance, airway inspection (thyromental distance, Mallampati test, crowded mouth) cervical motion and planned avoidance of neuromuscular blocking agents.[142,156,157]

The minimum set of tests for emergency front-of-neck access (eFONA) cannot be recommended because of a lack of specific studies: based on sparse evidence, the minimum set of tests may include airway history (with particular emphasis on the presence or history of glottic/subglottic pathology, neck surgery/radiation, anatomical abnormalities), cervical motion and neck circumference.[140,158]

The minimum set of tests for extubation difficulty, as part of the perioperative airway management, cannot be recommended because of a lack of specific studies; based on sparse evidence, the minimum set of tests may include airway history, difficult airway management during the actual intubation, airway-conflict surgery (i.e. maxillofacial, ENT, tracheal) or risk of postextubation complications (e.g. cervical vascular, cervical orthopaedic, thyroid surgery, prolonged robotic surgery). Any difficult intubation, either previous or actual, must be considered a predictor of difficult extubation.[159]

Specific clinical situations (i.e. pregnancy, OSA) or specific diseases (i.e. obesity, thyroid surgery, cervical surgery) may introduce specific features highlighting the need for specific tests or different temporal patterns for their performance. Pregnancy implies an evolutive adaptation in the woman's body, including airway changes during pregnancy and delivery, so airway evaluation should be performed early in pregnancy and re-evaluated close to delivery.[160]

Thyroid surgery and long-lasting inflammatory disease represent specific situations where adhesions limit trachea–laryngeal motility and dislodgeability. In contrast, previous surgery and/or radiation may interfere with many airway manoeuvres. A large goitre may result in reduced tracheal motility or its deviation. Some authors call for specific tests (e.g. neck circumference to thyromental distance ratio)[161] or the need for preprocedural airway endoscopy.[139] Still, there is insufficient evidence to provide any recommendation. The literature suggests particular care in performing a comprehensive and multitested airway evaluation.[162]

Obesity represents a risk factor for perioperative airway complications, including airway management. In these patients, particular care must be devoted to difficult ventilation and eFONA risks before difficult laryngoscopy issues. Special care should be employed in performing a comprehensive and multitested airway evaluation, with specific emphasis on Mallampati, BMI, neck circumference and history/diagnosis of OSA,[140] including the STOP-BANG questionnaire and/or drug-induced sleep endoscopy (DISE), preprocedural airway flexible endoscopy and polysomnography.[152] Adequate postprocedure level of care planning should be set before the procedure.[162]

Airway management implies multiple tasks and depends upon many factors: while the patient's anatomical features and underlying physiopathological status are important, these should not underestimate the importance of the available devices, the operational setting, individual practitioner skills and the availability of expert help. Apart from anatomical features, the recent literature depicts the role of a 'physiologically difficult airway', referring to co-existing comorbidities, which may worsen hypoxaemia effects, reduce tolerance to apnoea or desaturation and abolish consciousness and airway-protective reflexes.[163] Teamwork and planning, communication and the so-called human factor play a pivotal role in airway management,[164] especially when difficulties are encountered; hence, the availability of team experts on multiple devices and the location where airway management has to be performed may influence the occurrence of complications and outcomes.[131,165]

We must move away from the concept of the 'Prediction of a difficult airway' towards a new paradigm, the 'planning of airway management' for easy, or predicted or unpredicted difficult airways. Such an approach reflects the unique perspective that we must first aim for oxygenation rather than intubation *per se*.[166] With this perspective, we can introduce the concept of a 'context-sensitive' difficult airway. Hence, we suggest that anatomical predictive tests must be considered in the context of eventual comorbidities and resulting physiopathological status, and planning must be arranged considering operational context, the availability of devices and external help. Such an approach must be multileveled, focused on each step of airway management (ventilation, intubation, supraglottic device placement, eFONA performance) and, rather than aiming to identify the anatomical level of difficulty expected to be found preprocedurally, should address the strategy of suppressing or maintaining spontaneous breathing, plan extubation strategies and postprocedural level of care (perioperative airway management).

In recent years, different bedside technologies have become more affordable and available to improve the performance of predictive tests for difficult airway management, including imaging, physical and virtual endoscopy and ultrasound.

Many articles have been published regarding using ultrasounds as a tool to increase the sensitivity and specificity of conventional airway evaluation tests. Despite some specific measurements, such as distance from skin to epiglottis, showing interesting correlations with difficult laryngoscopy,[167] a recent systematic review confirms that ultrasound may discriminate between easy and difficult laryngoscopy. Still, given the high variability of the measurements explored, there is not enough evidence to include their routine use as ancillary tests to support the prediction of a difficult airway.[168]

The literature is inconsistent but primarily reports the use of conventional chest X-rays and CT scans with references to the neck (tumours, goitre) and tracheobronchial pathology (stenosis, anatomical abnormalities). Evidence is needed to include their routine use as ancillary tests to support the prediction of difficult airways.

Many studies have reported on preprocedural endoscopy, which has recently been included in the ASA guidelines as a preoperative diagnostic tool to optimise airway

management strategies.[139] Remarkably, nasal endoscopy has been suggested in cases of a suggestive airway history, known as anatomical or neoplastic deformations, OSA and tracheobronchial pathology. Nevertheless, there is no evidence to include their routine use as ancillary tests to support the prediction of difficult airways.[169]

Virtual endoscopy is a recent technique that may provide valuable data when substituting conventional flexible endoscopy.[170] Despite the available literature addressing its use, no evidence supports the prediction of difficult airways by including its routine use as an ancillary test.

Airway management may require uncomfortable, complex and sometimes invasive procedures, sometimes performed in awake or mildly sedated patients. Different procedures may be scheduled for advanced airway management or particularly complex airways; hence, the patient should be completely and adequately informed, and consent should be acquired and documented.[138,171]

Given the importance of a difficult airway history and its correlation with an actual difficult airway, the occurrence of a difficult airway, whether expected or not, and the performance of advanced airway management technique should always be reported in the patient's record and an ad hoc alert should be given to the patient in case of any future need for airway management.[172,173]

Future research

Further and extensive studies are needed to develop adequate predictive tools for videolaryngoscopy. Virtual endoscopy techniques show promise as supportive tools in airway evaluation, and the increasing spread of artificial intelligence and neural networks applications in medicine may allow extensive data manipulation to apply to airway management, as well as introducing new technologies such as voice recognition and facial analysis, and validating available data on a more rigorous methodology on a massive number of patients.

Renal function assessment

Should the patient with established renal dysfunction be tested preoperatively specifically to predict a worsening of their renal function after anaesthesia?

R7.1: In patients with known chronic kidney disease (CKD), we recommend quantifying the estimated glomerular filtration rate (eGFR) and proteinuria before surgery for risk stratification regarding postoperative acute kidney injury (AKI) and worsening of CKD. (1C)

R7.2: We suggest considering NT-Pro BNP testing combined with eGFR to add additional information on risk stratification for postoperative acute kidney injury (AKI) and worsening of CKD. (2C)

Existing evidence and comments

CKD before surgery is associated with a higher postoperative complication rate and mortality.[174,175] Further, postoperative AKI increases postoperative mortality.[176–179] Patients with chronic kidney disease are particularly predisposed to develop postoperative AKI and worsening of CKD.[27] A recent analysis of more than 500 000 patients in the NSQIP database demonstrated that patients with preoperative renal dysfunction, defined by a decreased eGFR (Table 6), had a higher risk of severe postoperative complications and 30-day in-hospital mortality.[174] Also, data from the MBSAQIP database on bariatric surgery showed a significant increase in major morbidity risk and progressive worsening of renal function for each advanced stage of CKD quantified by eGFR.[175]

The occurrence of postoperative AKI is reported to be 1.7% in neurosurgical, 7% in abdominal surgical, 10% in thoracic surgical and up to more than 30% in cardiac surgical patients.[176,177,180] Several recently published studies further describe an association between postoperative AKI and increased postoperative morbidity and mortality in different disciplines. In abdominal surgery, postoperative AKI is associated with a more extended hospital stay, higher rates of all postoperative complications and higher postop 30-day mortality (17.8 *vs.* 2.1%).[176] In patients undergoing lung cancer surgery, postop AKI was also associated with an increased all-over complication rate (35 *vs.* 16%).[179]

Patients with CKD before surgery are at higher risk of developing AKI postsurgery. In 1212 patients undergoing orthopaedic surgery, 30% of those with pre-existing CKD experienced postoperative AKI.[181] Furthermore, postoperative AKI increases the risk of worsening CKD. A recent large retrospective cohort study from Iceland showed that in patients with CKD, postoperative AKI was independently associated with stage progression of CKD within the year following surgery.[27]

Table 6 Estimated glomerular filtration rate values and their corresponding degrees of renal dysfunction according to the National Kidney Foundation's Kidney Disease Outcomes Quality Initiative guidelines

eGFR (ml min^{-1} 1.73 m^{-2})	Degree of renal dysfunction	Risk of postoperative complications	30-Day mortality
≥90	Normal	Minimal	Low
60 to 89	Mildly decreased	Slightly increased	Low
45 to 59	Mildly to moderately decreased	Mildly increased	Moderate
30 to 44	Moderately to severely decreased	Moderately increased	Moderate to high
15 to 29	Severely decreased	Markedly increased	High
<15	Kidney failure	Extremely high	Very high

eGFR, estimated glomerular filtration rate.

Calculating eGFR allows us to assess the degree of renal dysfunction.[182] According to existing data, eGFR is the strongest predictor for postoperative AKI.[183,184] There is preliminary evidence that the serum biomarker NT-Pro BNP alone and in combination with eGFR can add information to the risk of postoperative AKI.[177,179,180,185] The same applies to preoperative serum albumin levels.[178,186] However, consistent prospective data is not yet available in either case, particularly concerning patients with CKD.

There is also increasing evidence, again based on retrospective data, that preoperative urine biomarkers might help to assess the risk for postoperative AKI. In a mixed surgical cohort of more than 150 000 patients with and without known preoperative CKD, a retrospective data analysis showed that preoperative proteinuria indicated probable postoperative AKI.[187] Other cohort studies in mixed surgical populations also point toward the fact that preoperative albuminuria is strongly associated with postoperative AKI and might, therefore, add value to preoperative risk stratification.[188,189]

Future research

Based on this analysis, for further research, we suggest a prospective, multicentre study on the predictive abilities of proteinuria, serum albumin levels and NT-Pro-BNP on the progression of CKD in patients undergoing noncardiac surgery.

Evaluation of coagulation disorders

How should we manage patients undergoing minor/major surgery with acquired/primary coagulation disorders?

R8.1: In elective procedures, we suggest that the perioperative continuation of antithrombotic therapy should be weighed against the bleeding risk of surgery, patient-related factor and the specific antithrombotic medication. (2C)

R8.2: We recommend continuing antiplatelet therapy for 6 months after elective percutaneous intervention and 12 months after an urgent coronary intervention. In the case of drug-coated balloon angioplasty, the duration of dual antiplatelet therapy could vary from a minimum of 1 month to a maximum of 12 months, depending on the status of the disease (stable vs. unstable, chronic vs. acute), the dimension of the occluded vessel, presence of in-stent restenosis, type of stenosed stent and bleeding risk. (1C)

R8.3: We recommend managing anticoagulant medication before an emergency/urgent procedure based on its pharmacokinetic characteristics, reversal agent availability, the patient's renal function and the likelihood of major bleeding (1A)

R8.4: We suggest that the bleeding risk should be balanced with the thrombotic risk to assess the necessity of withdrawing the anticoagulant or antiplatelet therapy. (2C)

R8.5: We suggest that patients with previous percutaneous coronary intervention require a careful risk–benefit assessment to manage perioperative antiplatelet therapy. (2C)

R8.6: We suggest that the preoperative evaluation of patients undergoing NCS should include an educational program for patients and their caregivers on the perioperative handling of their antithrombotic therapy. (2C)

R8.7: We suggest that the perioperative assessment of coagulation status should be implemented through thromboelastometry and thromboelastography in patients with cirrhosis and significant coagulopathy, as well as in a hypercoagulability state with tranexamic acid administration. (2C)

R8.8: In haemophilia patients, pharmacokinetic-guided treatment should be implemented over real body weight-guided treatment to assure an optimal perioperative achievement of the prespecified coagulation factor range (2B)

R8.9: We recommend that patients with haemophilia, von Willebrand disease and factor X deficiency should be managed with a coordinated, multidisciplinary approach to their care. (1C))

Existing evidence and comments

The present update of previous guidelines[1] is focused on the current practice for dealing with acquired coagulation disorders secondary to chronic antithrombotic therapy and genetically inherited coagulation diseases, mainly in the perioperative setting of NCS.

The management of coagulation disorders secondary to chronic administration of antithrombotic medications has been recently revised by the taskforce for Cardiovascular Assessment and Management of patients undergoing NCS of the ESC with the ESAIC endorsement.[190,191] Accordingly, the perioperative handling of antithrombotic medications should consider patient-related factors, bleeding/thrombotic risk of surgery and pharmacokinetics/pharmacodynamic characteristics of the specific drug. Here, we further discuss the perioperative management of antithrombotic therapy in NCS, considering clinical outcomes.

Usually, anticoagulants are prescribed for thrombogenic arrhythmias, native or prosthetic valve disease and venous thromboembolic disease.[192] Anticoagulants are grouped by their mechanism of action: heparins, vitamin K antagonists (VKA) and novel oral anticoagulant (NOAC) drugs. Low-molecular-weight heparin (LMWH) has a predictable response, lower incidence of thrombocytopaenia and a more convenient dosing interval. Unfractionated heparin (UFH) can be fully reversed by protamine. For anticoagulant discontinuation, UFH should be withheld for 4–6 h and LMWH for 12 h (prophylactic dose) to 24 h (therapeutic dose), respectively.[190]

Compared with VKA, NOACs have a more predictable dose response, less drug interactions and fewer side effects. VKA preserve a primary indication in valvular

heart disease. Reversing the effects of VKA implies the administration of vitamin K, prothrombotic complex concentrate and plasma transfusion.[191,193,194]

NOACs have different pharmacokinetic profiles, affected by renal function to various extents.[190] Generally, NOACs should be withheld for 24 h in low-bleeding-risk procedures and 48 h in high-bleeding-risk procedures.[194] A summary of preoperative oral anticoagulants' management is presented in Fig. 1.

Long-term antiplatelet therapy is usually instituted for secondary prevention of stroke, myocardial infarction and peripheral artery occlusion.[195] Aspirin after percutaneous coronary intervention (PCI) leads to a reduction in mortality and myocardial infarction risks.[196] Following PCI, a therapeutic approach combining P2Y12 inhibitors and aspirin is recommended 6 months after an elective procedure and 12 months after an emergency procedure.[197,198] For time-critical procedures, the bleeding risk must be weighed against the thrombotic risk, considering that the closer to the PCI any therapeutic interruption occurs, the higher the cardiovascular risk.[199,200] However, it is necessary to consider the total amount of bleeding and its impact on the clinical outcome.[190]

Several clinical situations present challenges in managing antithrombotic therapy, often combining high-risk clinical conditions with a high-risk surgery. Kubota *et al.*[191] assessed bleeding and thrombotic complications, including 30-day and 90-day Clavien–Dindo complications in laparoscopic nephrectomy/nephroureterectomy and found comparable bleeding and thrombotic outcomes with or without preoperative antithrombotic medications.

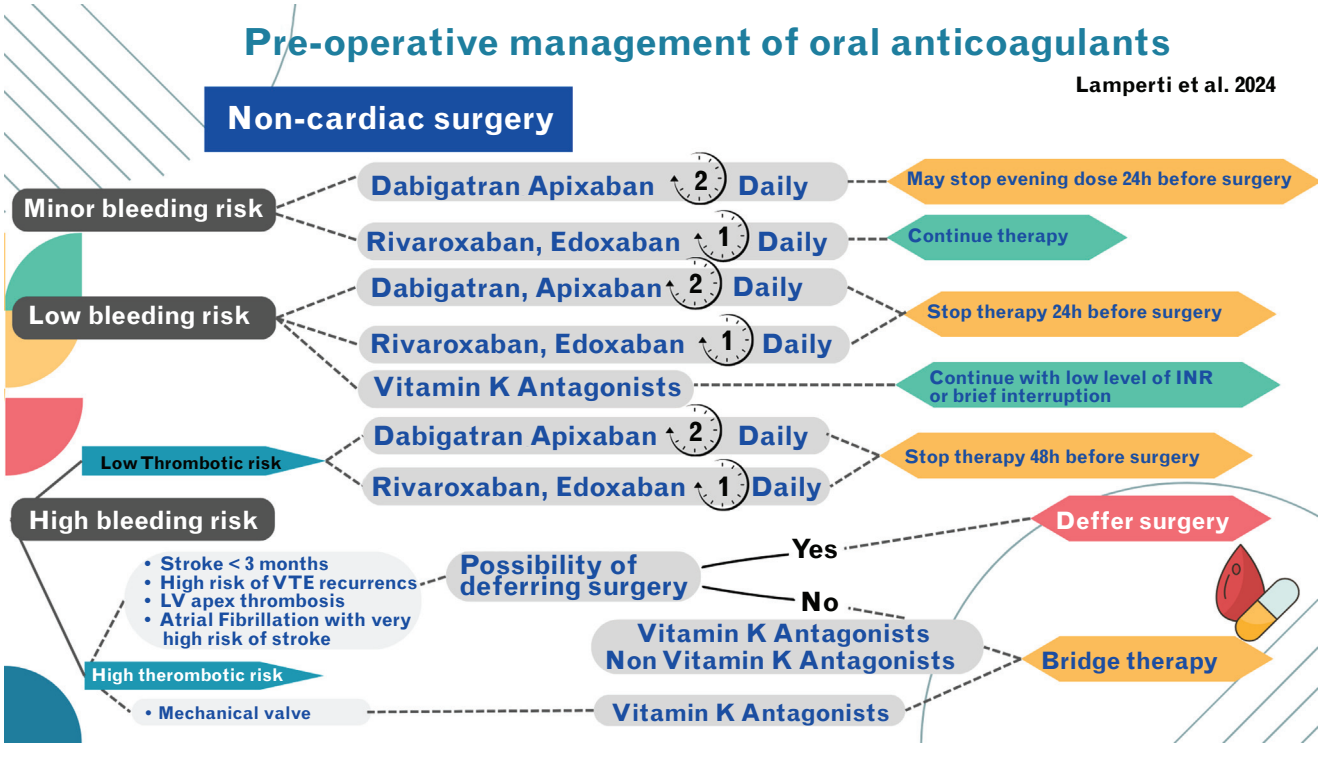
In inguinal and ventral hernia repairs, and laparoscopic cholecystectomies, clopidogrel did not increase bleeding risk.[200] Compared with its discontinuation 1 week before surgery, continuing clopidogrel medication showed similar outcomes in blood loss ($P = 0.49$), procedure time ($P = 0.42$), average change in haematocrit ($P = 0.13$), average length-of-hospital stay ($P = 0.89$), mortality rate, transfusion rates, bleeding-related hospitalisation rate ($P = 0.97$), incidence of myocardial infarction and incidence of stroke.

Perioperative aspirin administration in robotic partial nephrectomy increased the rate of intraoperative and postoperative blood transfusion (4 *vs.* 11%) and 30-day overall postoperative complications occurrence (17 *vs.* 29%) compared with no aspirin.[201]

Conversely, in patients subjected to hepatectomy, the perioperative continuation of aspirin was not associated with an increased risk of severe haemorrhagic events, thromboembolic complications or mortality.[202]

In a small study of 36 patients (36 eyes) on systemic treatment with a NOAC and antiplatelet agents

Fig. 1 Preoperative management of oral anticoagulants.



INR, international normalized ratio; LV, left ventricle; VTE, venous thromboembolism.

undergoing vitreoretinal surgery, no perioperative cases of retrobulbar, suprachoroidal or subretinal haemorrhage were reported.[203] Four eyes (11.1%) had postoperative vitreous cavity haemorrhage and two of these required surgical re-intervention, whereas in the other two, there was a spontaneous recovery.[203]

Clopidogrel continuation in rubber band ligation for internal haemorrhoids did not increase the rate of bleeding complications.[204]

In cervical laminoplasty, compared with no medication, low-dose aspirin did not increase the extent of perioperative bleeding (49 *vs.* 47 ml, $P = 0.389$), the frequency of perioperative blood transfusion (1.4 *vs.* 0%, $P = 0.185$) or the rate of re-intervention for postoperative epidural haematomas (0 *vs.* 3%, $P = 0.541$).[205]

The perioperative continuation of anticoagulant therapy in robot-assisted prostatectomy did not increase bleeding complications and transfusion rates compared with thienopyridine, aspirin monotherapy or no antithrombotic medication.[206]

In lumbar minimally invasive spinal surgery, continuing antiplatelet medications had similar outcomes compared with those who stopped or never used them.[207] Chronic subdural haematoma drainage in patients on antithrombotic therapy showed no difference in recurrence or functional improvement compared with patients without medications.[208]

In knee, hip and spinal surgery, increased aspirin use correlated with reduced perioperative bleeding and cardiovascular events.[209]

Comparing clopidogrel discontinued at least 5 days before major surgery *vs.* clopidogrel administrated within 5 days of the procedure, no differences were found in estimated blood loss, frequency of perioperative transfusion, myocardial infarction incidence, rate of cerebrovascular events, rate of acute visceral or peripheral ischemia, or rate of 30-days mortality.[210] Chronic antiplatelet therapy with aspirin showed the same average estimated blood loss, transfusion rate, and severe complications occurrence compared with no preoperative aspirin treatment.[211]

Low-dose aspirin in laparoscopic inguinal hernia repair had no impact on intraoperative bleeding or postoperative complications.[212]

With chronic or recent administration of antiplatelet agents, antiplatelet medication use within 1 week of lumbar puncture was associated with a 3% incidence of bloody tap and 4% incidence of traumatic tap that cleared. In the group of patients who waited for a lumbar puncture at least 4 weeks after discontinuation of the antiplatelet drug, there was a 5% incidence of bloody or traumatic tap. There was no difference in rates of bleeding between aspirin *vs.* aspirin plus clopidogrel.[213]

Heparin administration for thromboprophylaxis in thoracoscopic major thoracic surgery showed no significant differences whether initiated preoperatively or postoperatively.[214]

Dual antiplatelet therapy (DAPT) interruption in both cardiac surgery and NCS increased the stent thrombosis risk and bleeding complications.[199] Of note, despite DAPT interruption, there was a high rate of bleeding complications, with most cases requiring transfusion therapy.[199]

Perioperative use of low-dose aspirin reduced the risk of a composite outcome (death, fatal and nonfatal myocardial infarction) compared with placebo, with uncertain effects on life-threatening bleeding.[196]

In a cohort of patients with coronary stents undergoing NCS, the management of preoperative antiplatelet therapy was addressed with a focus on the occurrence of adverse events.[215] At the time of preoperative evaluation, 412 (95%) of the scheduled procedures were in patients on some type of antiplatelet drugs. Ninety days after surgery, major adverse cardiac and cerebrovascular events (MACCE) had occurred in 63 (15%) of all the surgical procedures with an all-cause mortality of 3%. The incidence of acute myocardial infarction (AMI) and cardiovascular death was 2.8%, 50% of which were after discharge. MACCE were related to recent myocardial infarction, OR 6.10 (95% CI, 1.20 to 30.93, $P = 0.038$), chronic kidney disease, OR 2.98 (95% CI, 1.73 to 5.13, $P < 0.001$), insulin-dependent diabetes, OR 2.46 (95% CI, 1.31 to 4.61, $P = 0.007$), and the absence of preoperative antiplatelet therapy, OR 2.64 (95% CI, 0.95 to 7.34, $P = 0.149$). Major bleeding events also increased the risk of MACCE, OR 2.6 (95% CI, 1.51 to 4.48, $P < 0.001$).

An algorithm for preoperative DAPT management is presented in Fig. 2.

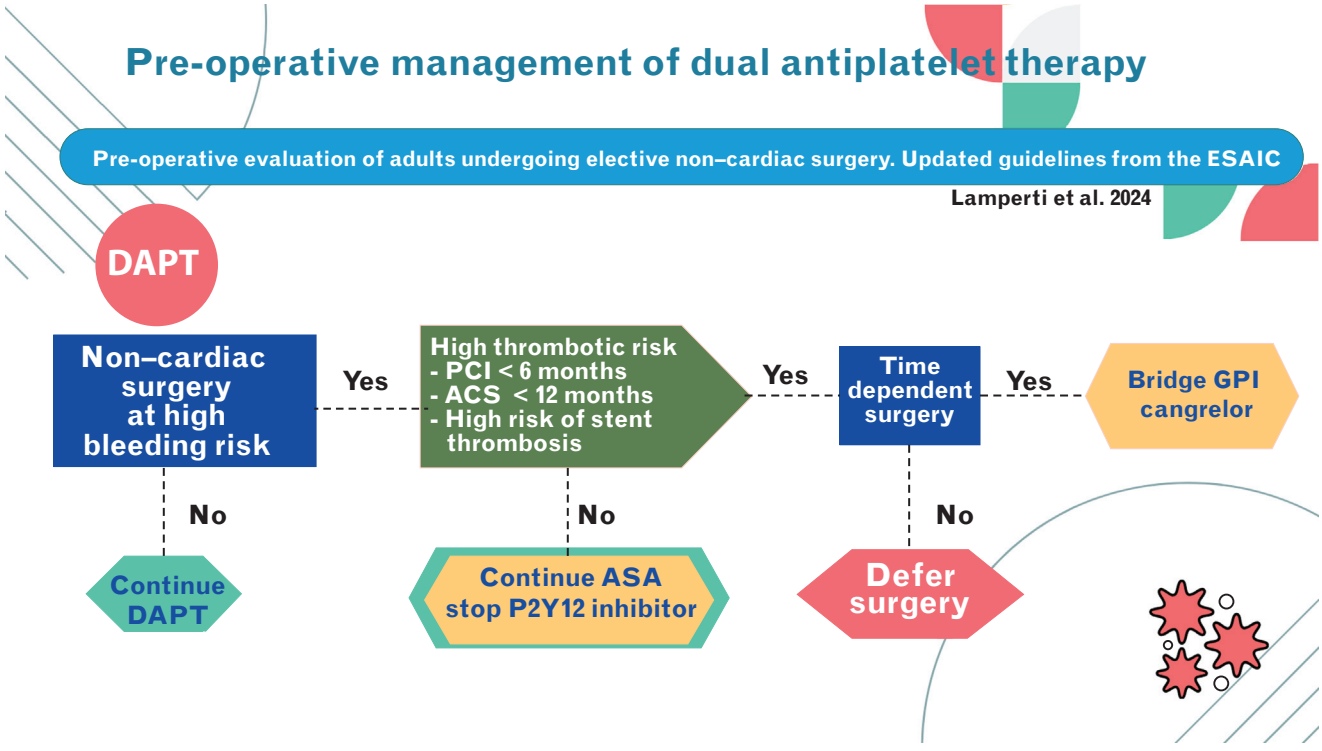
In an observational setting, neither preoperative NOAC nor VKA treatments were associated with increased risk of 30-day postoperative mortality among hip fracture patients. NOAC was associated with slightly increased risk of transfusion.[193] VKA use preoperatively had a similar transfusion rate and 30-day mortality as nonusers.[193] Finally, transfusion and 30-day mortality rates increased in those patients receiving preoperative antiplatelet medications compared with nonusers.

Perioperative continuation of antiplatelet therapy in partial nephrectomy increased bleeding complications, but aspirin alone showed no association with bleeding and transfusion requirements.[216]

In thyroid surgery, perioperative aspirin did not significantly increase intraoperative blood loss or the risk of recurrent laryngeal nerve injury compared with nonusers, but it increased haematoma formation.[217]

Clopidogrel use in lower extremity bypass surgery increased bleeding, complications and mortality.[218] Patients

Fig. 2 Preoperative management of dual-antiplatelet therapy.



ACS, acute coronary syndrome; ASA, acetyl salicylic acid; DAPT, dual antiplatelet therapy; GPI, glicoprotein IIB/IIIA inhibitors; PCI, percutaneous coronary intervention.

undergoing bariatric surgery on anticoagulation medications preoperatively were at a significantly higher risk of absolute 30-day complication rates (8.73 *vs.* 3.36%, $P < 0.001$), bleeding rate (3.78 *vs.* 0.88%, $P < 0.001$), leak rates (0.55 *vs.* 0.41%, $P = 0.021$), cardiac events (0.43 *vs.* 0.06%, $P < 0.001$) and venous thromboembolism (0.68 *vs.* 0.25%, $P < 0.001$).[219]

In the setting of endoscopic colonic mucosal resection, patients receiving anticoagulant medications alone or in combination with antiplatelet drugs showed an increased occurrence of bleeding after polyp removal in comparison with patients without such drug therapy.[220]

In a cohort of 293 dental procedures, a 4% incidence of postoperative bleeding was observed.[221] There was a significant association of postoperative haemorrhage with increased perioperative bleeding ($P = 0.043$) or a combination of anticoagulant and antiplatelet therapy ($P < 0.001$). The chance of postoperative haemorrhage for procedures with increased perioperative bleeding was 8.8 times greater than for procedures without perioperative bleeding. Dental surgery in patients under antithrombotic therapy might be carried out without altering the regimen because of the low risk of perioperative and postoperative bleeding. However, patients with increased perioperative bleeding should be closely followed up because of postoperative complications risk.

Following direct micro-laryngoscopy, chronic antithrombotic therapy led to increased postoperative bleeding compared with no chronic use of antithrombotic medications.[222]

Yang *et al.*[223] evaluated the outcome of patients subjected to surgery for intracranial haemorrhage and using or not using antiplatelet medications. Early postoperative re-haemorrhage was more frequent in the antiplatelet group than in the nonantiplatelet group. In contrast, the volume of postoperative haematoma expansion and mortality rate were similar among the groups. After adjustment for age, early postoperative re-haemorrhage was not affected by preoperative antiplatelet therapy, ischemic stroke history or ventricular haematoma.

A prospective cross-sectional study by Borges *et al.*[224] focused on identifying the risk factors for inadequate management of antiplatelet medications in the perioperative period of NCS. A higher level of schooling or a previous AMI were associated with a higher probability of using a therapy complying with the recommendations in the Brazilian Association of Cardiology (SBC) guidelines.[224]

Thromboelastometry and thromboelastography provide insights into coagulation status and may be useful in the perioperative management of coagulation disorders.

The feasibility of anticoagulant therapy tailoring was addressed during hip and knee arthroplasty.[225] Thromboelastometry effectively detected hypercoagulability conditions and allowed the individualisation of anticoagulants during the perioperative period.

Haemostasis after liver resection is complex and poorly reflected by INR, which should not guide the initiation of chemical thromboprophylaxis in the immediate postoperative period.[226] In patients with cirrhosis and significant coagulopathy (INR >1.8 and platelet count $<50 \times 10^9\,l^{-1}$) undergoing invasive procedures, thromboelastography before surgery reduced the use of blood products without increasing the risk of periprocedural bleeding.[227]

Thromboelastography has been proposed along with conventional laboratory tests to assess the coagulation status following tranexamic acid administration during total hip prosthesis surgery.[228] No differences concerning thromboelastography or conventional laboratory tests were detected between patients receiving tranexamic acid and those not receiving the medication. Tranexamic acid was associated with a reduced total blood loss compared with the group without tranexamic acid. Also, the incidence of blood transfusion and the blood volume transfused were lower with tranexamic acid than in the absence of tranexamic acid.

Recent guidelines address the perioperative management of inherited coagulation diseases, focusing on bleeding risk, clinical monitoring and therapies.[229,230]

Investigations highlight key findings in the context of inherited/genetic coagulation disorders. During major and minor surgical procedures, Chapin *et al.* studied perioperative management in adult patients with haemophilia A, B and von Willebrand disease. The type of procedure and the management (including the use of continuous factor infusion and administration of antifibrinolytics) were reviewed. Adverse outcomes were defined as acute bleeding (<48 h), delayed bleeding (≥48 h), transfusion, inhibitor development and thrombosis. They found similar rates of adverse haematologic outcomes, emphasising the importance of recognising bleeding risks even in minor surgery. Minor procedures, particularly on the oral and genitourinary mucosa, displayed a trend toward delayed bleeding, requiring aggressive treatment. This finding underscores the importance of an interdisciplinary management and procedure-specific guidelines for patients with haemophilia and VWD before even minor invasive procedures.[231]

Escobar *et al.* assessed the safety and efficacy of plasma-derived factor X administration in patients undergoing surgery with mild-to-severe hereditary factor X deficiency. Plasma-derived factor X proved safe and effective for surgery.[232]

In adult and paediatric patients with severe to moderately severe haemophilia B (without a history of factor IX inhibitors) undergoing surgery, the efficacy and safety of recombinant factor IX fusion protein were evaluated.[233] Surgical haemostasis was excellent in 81% of the procedures and good in 23.5%.[233] In major orthopaedic surgery patients,[233] an average of 7 (range 6 to 12) injections of recombinant factor IX fusion protein was required within the time period between the day of surgery and the 14th postoperative day, with a median consumption of 375 IU kg^{-1}. No development of inhibitors or antibodies was described.[233] In a mixed cohort of adult and paediatric patients with severe haemophilia A undergoing surgery, the haemostatic effects of Simoctocog alfa, a fourth-generation recombinant FVIII produced from a human cell line, was evaluated.[234] Therapy was successful for all the minor procedures and 96% of major surgery, with actual blood loss not exceeding expectations. No adverse events or inhibitor development were reported.

Hazendonk *et al.*[235] addressed the perioperative management of patients with haemophilia B. Replacement therapy with factor IXC concentrate was administered to all the patients to achieve the following plasma concentrations: 0.8 to 1.0 IU ml^{-1} on day 1; 0.5 to 0.8 IU ml^{-1} on day 2 to 5 and 0.3 to 0.5 IU ml^{-1} after day 6. The blood levels of factor IX were below and above the predefined targets in 66% of the cases within 24 h of surgery, and in 59% of the cases after 6 days from surgery. Bleeding complications requiring a second surgical look or red blood cell transfusion were reported in 2.7% of the procedures.

In patients with haemophilia A, conventional dosing of factor VIII concentrate based on body weight and crude estimations of clearance led to significant underdosing and overdosing. Depending on postoperative day, 7 to 45% of achieved factor VIII levels were under and 33 to 75% were above predefined target ranges as stated by national guidelines. A potential reduction of factor VIII consumption of 44% would have been attained if factor VIII levels had been maintained within target ranges. Blood group O and major surgery predicted underdosing (OR 6.3, 95% CI, 2.7 to 14.9; OR 3.3, 95% CI, 1.4 to 7.9, respectively). Blood group O was identified as a predictive factor for underdosing, with associated higher bleeding risks. Patients with non-O blood groups were at higher risk of overdosing (OR 1.5, 95% CI, 1.1 to 1.9). Additionally, patients treated with bolus infusions were at higher risk of excessive overdosing (OR 1.8, 95% CI, 1.3 to 2.4). Quality of care and cost-effectiveness can be improved by refining of dosing strategies based on individual patient characteristics such as blood group and mode of infusion.[235]

Voncento, a plasma-derived factor VIII/von Willebrand factor concentrate, was effective and well tolerated for perioperative management in all von Willebrand disease types.[236]

A randomised trial, in patients with moderate-to-severe haemophilia undergoing surgery, compared pharmacokinetic-guided treatment to standard treatment. Although

no significant differences in factor VIII concentrate consumption were observed, pharmacokinetic-guided treatment allowed better optimisation of prespecified factor VIII targets. It offered more accurate perioperative dosing than the standard bodyweight-guided approach.[237]

Future research

Future research in coagulation disorder management during surgery aims to enhance outcomes and refine treatments. Areas of focus include personalised therapeutic approaches, advanced haemostatic agents like gene therapy, perioperative monitoring tools for real-time assessments of coagulation and refining risk stratification models. Investigating the impact of NOAC and direct oral anticoagulants, and exploring multidisciplinary approaches among specialists can optimise perioperative care. A standardised preoperative questionnaire on bleeding risk should be implemented to optimise the patient before surgery and prepare adequate perioperative coagulation monitoring and management. Patient-centred research on quality of life and satisfaction is essential. Advancements in these areas will contribute to safer and more effective perioperative care for individuals with coagulation disorders.

The high-risk patient

How to care for a patient at high risk of postoperative complications but requiring a low-risk procedure?

R9.1: We recommend using frailty testing as an effective tool for predicting postoperative outcomes, especially for assessing the risk of delirium. (1C)

R9.2: We recommend using the Clinical Frailty Scale if the preoperative anaesthesia physical examination reveals the presence of a frailty phenotype. We should ask for evaluation by a geriatrician to improve the cognitive, nutritional and comorbidity status by delaying surgery (time-sensitive or elective procedures) when possible. (1C)

R9.3: We recommend using the Clinical Frailty Scale because of its high feasibility and predictive values. (1C)

Existing evidence and comments

Healthcare systems must face the challenge of providing high-quality care to an ageing population undergoing surgery with comorbidities and increased vulnerability, such as postoperative delirium, whose prevention has already been addressed.[3] Unfortunately, there is no clear definition of low-risk, intermediate-risk, and high-risk patients. CPET can guide the determination of the cardiopulmonary risk constellation. However, the resources for CPET are limited in many countries. In this case, the modified DASI questionnaire with and without peak heart rate response may be a screening tool because of its predictive value for 1-year mortality.[238] Frailty assessment addresses the comprehensive physical conditions of a patient and is therefore essential for clinical risk stratification, surgical planning, care planning and at least shared decision-making. Frailty has various dimensions, such as declines in lean body mass, strength, endurance, balance, walking performance, in association with low activity.[239,240] The ideal preoperative test should address all these issues and be quick and easy to carry out during preoperative risk assessment. Frailty tests can predict 30-day, 90-day and 1-year mortality as well as postoperative complications and length of stay in hospital.[239] However, a systematic review[241] analysed the feasibility and the number of resources needed for testing, but it did not find any general agreement about the best tool for preoperative frailty assessment.

The European Commission has prioritised frailty within the health policy agenda of the majority of the European Union (EU) member states through its 'Joint Action on Frailty Prevention' (ADVANTAGE JA) consortium.[242]

Fried *et al.*[239] describe frailty as a decline in lean body mass, strength, endurance, balance, walking performance and low activity. That means that a frail patient is different from a HRSP, but a frail patient can also be a HRSP with increased mortality, complications and prolonged length of stay.[243]

The American Geriatrics Society and American College of Surgeons National Surgical Quality Improvement Program recommend preoperative evaluation of frail patients to improve their cognitive, nutritional and comorbidity status and to find an ideal time for surgery whenever possible (time-sensitive procedure or elective).[244]

The question of preparing this growing population for common surgical procedures arises. Traditionally, surgical procedures associated with more than 5% cardiac risk are considered high-risk procedures, 1 to 5% as intermediate risk and less than 1% as low risk.[245] Schwarze *et al.*[246] developed a list of 227 surgical procedures with an in-patient mortality of at least 1%, classified as high-risk procedures for older patients.

A systematic review of 12 trials demonstrated that preoperative frailty assessment among gynaecological oncology patients is essential to predict adverse outcomes and tailor a personalised treatment.[241] This review indicates that physicians should expect a prevalence of up to 60% frailty among patients undergoing gynaecological oncology surgery. There was an association of frailty with 30-day postoperative complications (OR 4.16, 95% CI, 1.9 to 11.65, $P = 0.007$), non-home discharge (OR 4.41, 95% CI, 4.09 to 4.76, $P < 0.001$), ICU admission (OR 3.99, 95% CI, 3.76 to 4.24, $P < 0.001$). Due to the various definitions of postoperative mortality in the selected studies (30-day mortality, 90-day mortality and 1-year mortality), the authors of this systematic review did not perform a pooled analysis of the risk of death. Frail patients had elevated mortality rates in all five studies investigating this endpoint.

Unfortunately, the existing evidence regarding the instruments to evaluate frailty is also heterogeneous. A systematic review and meta-analysis analysed 45 studies.[247] Frailty was defined using 35 different instruments and five of these were subjected to meta-analysis: 32 trials investigated the Fried Frailty Phenotype and its modifications, 12 studies analysed the Clinical Frailty Scale, nine trials used the Frailty Index and seven studies used the Edmonton Frailty Scale. The Clinical Frailty Scale was the one most strongly associated with mortality and unfavourable discharge (odds ratio 4.89, 95% CI, 1.83 to 13.05 and odds ratio 6.31, 95% CI, 4.00 to 9.94, respectively). The Edmonton Frail Scale correlated best with the development of postoperative complications (odds ratio 2.93, 95% CI, 1.52 to 5.65). The Fried Frailty Phenotype was the scale best associated with the development of postoperative delirium (odds ratio 3.79, 95% CI, 1.75 to 8.22). The Clinical Frailty Scale had the highest feasibility, followed by the Edmonton Frail Scale and the Frailty Index. Most of the data did not support the feasibility of the Fried Frailty Phenotype in the preoperative setting because this tool needed additional equipment and was more time-consuming (5 to 20 min compared with 44 s for the Clinical Frailty Scale).[247] Table 7 shows the different characteristics of frailty scales.

In a prospective multicentre cohort trial of 645 patients, the Clinical Frailty Scale predicted postoperative outcomes (death or new disability, length of stay, adverse discharge) to the highest degree, followed by Fried Frailty Phenotype and Frailty Index.[248]

In 99 patients, Rabelo *et al.*[249] assessed the feasibility and the predictive value of three screening tools for frailty: The Program of Research to Integrate Services for the Management of Autonomy 7-item questionnaire (PRISMA7), the Timed Up and Go (TUG) and the Clock Drawing Test (CDT). Forty percent of the cohort had positive tests for frailty. All the tests predicted delirium, whereas a combination of the various tests had a positive-predictive value for further complications.[249] The time for performing all three tests sequentially on one patient was an average of 3 min and 35 s (range 2–8 min). No additional equipment was necessary for the tests.

Future research

There is still no agreement on which frailty scale should be used to predict the need for postoperative ICU admission and mortality. Future studies should target developing a comprehensive and simple scale to enable the delivery of appropriate care to very frail patients and optimise those patients preoperatively to minimise failure-to-rescue conditions after surgery.

Optimisation and planning

Role of prehabilitation

How should patients at high risk of postoperative complications (respiratory, cardiac) be prehabilitated (physical therapy, nutrition)?

R10.1: The role of prehabilitation should be established in NCS patients. (2B)

R10.2: Nutritional support before surgery should be considered in NCS patients. (2C)

Existing evidence and comments

Evidence from the available literature needs to be more consistent. For example, Berkel *et al.*[250] randomised 57

Table 7 Comparison between the Clinical Frailty Scale and the Fried Phenotype Scale

Aspect	Clinical Frailty Scale	Fried Phenotype Scale	Edmonton Frailty Scale
Definition	Rates a person's level of frailty based on their overall health, function, and ability to carry out daily activities.	Identifies frailty based on five criteria: weakness, slowness, low physical activity, exhaustion and unintentional weight loss.	Assesses frailty based on nine domains: cognition, general health status, functional independence, social support, medication use, nutrition, mood, continence and functional performance.
Components	Considers factors such as mobility, function, comorbidities, and cognitive status.	Focuses on physical traits and conditions associated with frailty, such as muscle weakness, exhaustion and weight loss.	Evaluates various aspects of health, cognition and functional abilities to assess frailty comprehensively.
Scale range	Ranges from 1 (very fit) to 9 (terminally ill) or 10 (death).	Each criterion is scored as 0 (no impairment) or 1 (impairment), leading to a total score ranging from 0 to 5.	Scores range from 0 (not frail) to 17 (very frail), with higher scores indicating greater frailty.
Clinical application	Widely used in clinical settings to assess overall frailty and guide treatment decisions for older adults.	Often used in research studies and clinical settings to identify frailty and predict adverse health outcomes in older adults.	Commonly used in geriatric practice and research to assess frailty and guide interventions for older adults.
Strengths	Provides a holistic view of an individual's health and function.	Easy to administer and interpret and has been validated in various populations.	Comprehensive assessment covering multiple domains of frailty, allowing for personalised interventions.
Limitations	Subjective assessment that may vary depending on the observer's interpretation.	Does not capture all aspects of frailty, particularly cognitive and psychosocial factors.	Requires more time and resources compared with simpler frailty assessment tools.
Predictive power	Strong predictor of adverse health outcomes, including mortality and hospitalisation.	Strongly associated with future disability, hospitalisation and mortality in older adults.	Predicts adverse outcomes such as hospitalisation, functional decline and mortality in older adults.

colorectal surgery patients into prehabilitation or standard care groups. The rate of postoperative complications was lower in the prehabilitation group (42.9%) than in the usual care group (72.4%), relative risk (RR) 0.59 (95% CI, 0.37 to 0.96, $P = 0.024$). In another RCT, Barberan-Garcia *et al.*[251] randomised 143 patients older than 70 years having major abdominal surgery to either prehabilitation or standard care. Patients in the prehabilitation group had enhanced aerobic capacity, and the incidence of complications in the overall sample of patients was 46%. When stratifying by groups, compared with the standard care group, the prehabilitation group showed a lower rate of complications, 31 *vs.* 62%, respectively ($P = 0.001$). Accordingly, the estimated RR for complications demonstrated that prehabilitation intervention has a protective role for postoperative complications (RR 0.5, 95% CI, 0.3 to 0.8, $P = 0.001$). In contrast, another recent double-blind RCT by McIsaac *et al.*[252] randomised 182 patients older than 60 years and undergoing elective cancer surgery to either home-based exercise prehabilitation, nutritional guidance or standard care. The authors found no significant difference in the primary outcome (6MWT) nor the secondary outcomes, including physical performance, quality of life, disability, length of stay, nonhome discharge and 30-day readmission. Another RCT by Ausania *et al.*[253] randomised 40 patients having pancreaticoduodenectomy to prehabilitation or standard care. The authors observed no difference between the groups in terms of the overall number of complications, or the significant complications.

Gade *et al.*[254] randomised 35 patients to supplementary oral immunonutrition for 7 days before pancreatic surgery *vs.* standard care. The authors found no difference in complications or length of stay between the groups. Fiorindi *et al.*[255] enrolled 61 consecutive patients scheduled for surgery for either Crohn's disease or ulcerative colitis. The nutritional intervention included personalised dietary counselling and oral nutritional supplements whenever necessary. The nutritional intervention improved preoperative body composition, but whether this resulted in fewer postoperative complications remains unclear. In a prospective observational study with a historical cohort as the control group, Mueller *et al.*[256] enrolled 96 patients scheduled for salvage surgery for recurrent head and neck cancer. Fifty-one patients were enrolled in a preoperative immunonutrition group and were compared with 45 patients in a historical cohort. Immunonutrition was associated with a significant reduction in overall complications (35 *vs.* 58%, fully-adjusted odds ratio 0.30 (95% CI, 0.10 to 0.91, $P = 0.034$), and reduced length-of-hospital stay (17 *vs.* 6 days, $P < 0.001$). No differences in mortality or hospital readmission were found.[256] Gilbert *et al.*[257] enrolled 147 patients aged 70 years or older having abdominal surgery in a stepped-wedge cluster-randomised study of five surgical hospitals (some hospitals provided prerehabilitation, some did not). The authors found no benefits of preoperative nutrition counselling or oral nutritional supplement prescription.

Future research

RCTs with adequately sized patient populations are needed to address the potential benefits of prehabilitation on postoperative outcomes. A cost–benefit analysis should consider not only the direct costs related to a reduced hospital stay but also whether there is a better quality of life for the patients after surgery.

Postoperative admission to the intensive care unit

Should all patients with preexisting cardiac disease undergoing elective major surgery be admitted routinely to the intensive care unit postoperatively?

R11.1: We do not recommend routine admission to the ICU for patients with stable cardiac diseases undergoing elective major surgery. Selective access to the ICU in this subset of patients following a multidisciplinary evaluation of the risk-to-benefit ratio might be more appropriate. (1C)

Existing evidence and comments

Patients undergoing major surgical procedures often experience planned admission to the ICU.[258] Approximately 8 to 10% of patients undergoing major surgery are admitted to an ICU, with mortality rates within this group ranging from 1 to 4%.[259,260] An important question currently confronting anaesthetists and surgeons is whether it is necessary to admit HRSPs to the ICU as a routine following elective procedures.

Before surgery, it is essential to provide clear guidelines as to who should have a planned postoperative admission to ICU. This poses a challenge because of inconsistencies in defining major surgery and estimating perioperative risk. Scepticism exists in the literature regarding the necessity of routine ICU admission after elective major NCS because of its associated costs and the absence of robust supporting evidence.[260,261] Additionally, identifying high-risk patients who would benefit from ICU admission remains a significant challenge, leading to problems in resource allocation. This challenge is particularly evident for patients with preexisting cardiac conditions scheduled for elective surgery. Traditionally, anaesthetists and surgeons have seen ICU admission as crucial for reducing postoperative complications and mortality, but supporting evidence, if it exists, needs to be more specific.

Several factors may contribute to the perceived ineffectiveness of ICU admission, particularly in patients with preexisting cardiac conditions. A significant factor is that most of these patients admitted to the ICU immediately postoperatively spend only 24 to 48 h there, while cardiac complications and fatal events tend to occur later in the

hospital stay, often after the patient has been transferred to a general ward.

Furthermore, most elective ICU admissions for cardiac patients primarily involve closely monitoring their cardiorespiratory and metabolic functions, and other organ functions are not monitored.[262] This is partly because surgical procedures are becoming less invasive, and anaesthesia practices continue to advance.

Therefore, alternative organisational models could offer more efficient support to surgical patients with and without preexisting cardiac conditions. They should be based on the infrastructure issues in the hospitals, depending on the quality of care that can be provided on the ward, manpower, monitoring availability, access to escalating care, cost refunds, availability of outreach care and availability of early warning score-alerts. Postoperative 'intermediate care' wards, High Dependency Units and anaesthesia-driven 24-h Post-Anaesthesia Care Units could serve as safe environments for most surgical patients, and patient monitoring could be extended beyond the initial postoperative 24 to 48 h to cover the critical period when late complications such as cardiovascular events and infections are more likely to occur. The use of such 'intermediate' units could significantly reduce ICU costs and, at the same time, identify those later adverse effects missed by a shorter stay in ICU.[263–266]

Future research

Optimising postoperative care for cardiac patients undergoing major NCS involves a comprehensive strategy. Future studies should address which risk prediction models should be developed and how to tailor them explicitly to identify which cardiac patients undergoing major NCS require admission to ICU. These models should consider patient-specific factors, surgical complexity and preoperative cardiac conditions.

Preoperative planning for intraoperative monitoring should be considered to provide immediate feedback on cardiac status during surgery. This information can guide the decision whether a patient should be admitted to the ICU postoperatively.

We should investigate the effectiveness of preoperative optimisation strategies in reducing the need for postoperative ICU admission: these should include medication management, lifestyle interventions and behavioural modifications. In addition, utilising machine learning and artificial intelligence algorithms to analyse a wide range of patient data, including preoperative factors, surgical variables and real-time monitoring data, may predict the need for postoperative ICU care more accurately. Telemedicine and remote monitoring should be considered, to evaluate their role in postoperative care, and whether this will enable early identification of patients who may require ICU admission, even after they have left the operating room.

Use of GLP-1 agonists and sodium-glucose cotransporter-2 inhibitors

Is using GLP-1 agonists or sodium-glucose cotransporter-2 inhibitors changing the perioperative management of patients undergoing procedures requiring sedation/anaesthesia?

R12.1: When a GLP-1 agonist is prescribed as a weekly injection and considering the long half-life of GLP-1 agonists, we recommend pausing GLP-1 agonists at least 1 week before a scheduled procedure requiring sedation/anaesthesia. If these drugs are given for obesity, then 2 weeks (three half-lives) are recommended. (CPS)

R12.2: If the medication is prescribed as daily oral or subcutaneous administration, we recommend pausing GLP-1 agonists on the day of the procedure. (CPS)

R12.3: There is no evidence to show that stopping these medications even 1 week before the procedure will eliminate the risk of delayed gastric emptying, despite following the usual fasting timing for surgery. (CPS)

R12.4: A clear fluid diet should be encouraged 24 h before any procedure in patients taking GLP-1 agonists. (CPS)

R12.5: All patients taking GLP-1 agonists should be considered as at risk of having a full stomach despite a lack of gastrointestinal symptoms. (CPS)

R12.6: Whenever possible, a gastric ultrasound should be performed. If gastric contents are found by ultrasound and these are considered as a high risk for aspiration, patients should be counselled about this risk before deciding to proceed with sedation/general anaesthesia. (CPS)

R12.7: If the procedure is of such urgency that postponement is not desirable, endotracheal intubation by rapid sequence induction/intubation is advised. (CPS)

R12.8: SGLT2 inhibitors (SGLT2i) drugs should be withheld for 3 to 4 days before elective procedures to reduce the risk of euglycemic diabetic ketoacidosis. (CPS)

R12.9: Patients taking SGLT2i medications should consume clear fluids approximately 2 h before the procedure to keep regular hydration. (CPS)

R12.10: Euglycemic diabetic ketoacidosis should be suspected in this category of patients, and blood β-hydroxybutyrate (BOHB) is a functional confirmatory test. (CPS)

R12.11: If a patient taking SGLT2i drugs did not discontinue the medication in time, dehydration caused by bowel preparation for endoscopy can increase the ketone levels, and the patient should be adequately hydrated before leaving the hospital. (CPS)

Existing evidence and comments

Two categories of medications designed initially for diabetes treatment have now found broader applications. GLP-1 agonists and SGLT2i carry significant implications

Table 8 Management of patients on glucagon-like-peptide-1 receptor agonists

Administration frequency	Day before surgery	Day of surgery check blood glucose
Daily basis	Last dose	Stop
Liraglutide s.c. injection *Semaglutide oral* *Lixisenatide s.c. injection* *Exenatide s.c. twice daily*		
Weekly basis	Withhold for a week before the procedure/ surgery (last dose must be given on day 8)	
Dulaglutide s.c. injection *Semaglutide s.c. injection* *Tirzepatide s.c. injection* *Exenatide s.c. injection* *Liraglutide s.c. injection*		

s.c., subcutaneous.

for peri-procedural management. Their management is summarised in Table 8 and Figs. 3 and 4.

GLP-1 agonist medications have gained considerable popularity, not only for managing diabetes but also for facilitating weight loss. Their action in diabetes is to stimulate insulin secretion from pancreatic beta cells resulting in optimised haemoglobin A1, thus reducing the risk for major cardiac events.[267,268] For weight loss, their action is primarily related to both activation of vagal afferent nerves innervating the stomach as well as direct binding to GLP-1 receptors on gastric mucosal cells leading to delayed gastric emptying. This latter effect promotes earlier satiety and reduces food intake. However, these drugs raise concerns because of their delay in gastric emptying,[269] which can lead to the aspiration of solid material, even after prolonged fasting periods. Several case reports have highlighted instances of vomiting and aspiration, identifying these as potential risks for patients undergoing surgical and procedural interventions.[270–272] Despite patients following the available preoperative fasting guidelines,[273,274] there are case reports of patients with delayed gastric emptying even with 18 h of fasting.[270,271] Recent consensus-based guidance from the ASA's Task Force on Preoperative Fasting[275] recommended withholding daily dosed GLP-1 receptor agonists the day of the procedure and weekly dosed formulations a week before, while the Society of Perioperative Assessment and Quality Improvement has also put forward consensus recommendations to withhold GLP-1 receptor agonists on the day of surgery unless there is heightened concern for postoperative gut dysfunction.[276] For patients taking GLP-1 receptor agonists for weight loss, consider withholding the drug at least three half-lives (approximately 88% clearance of the drug) ahead of the planned procedure. For semaglutide, this would be 3 weeks.[277]

There is not sufficient evidence to suggest that the absence of gastrointestinal symptoms (nausea, vomiting

Fig. 3 Preoperative management of glucagon-like-peptide-1 agonists.

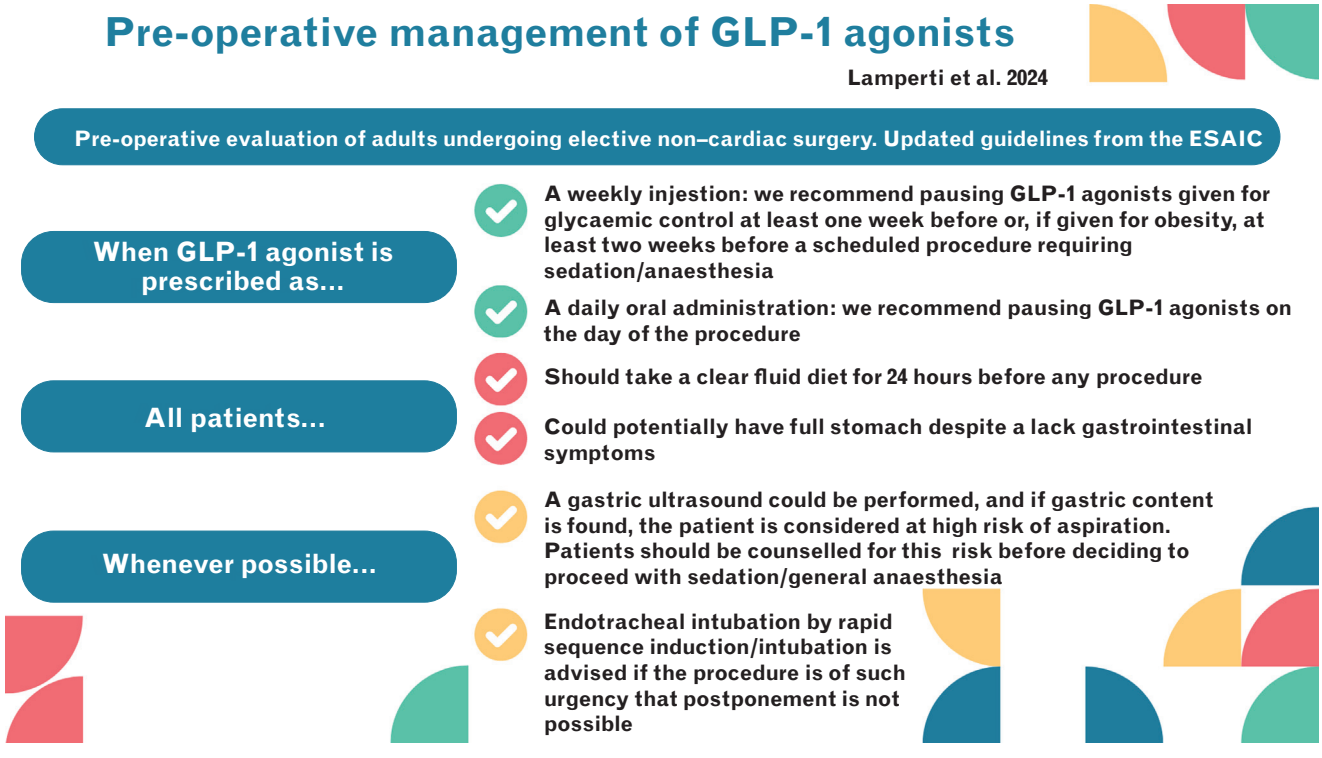
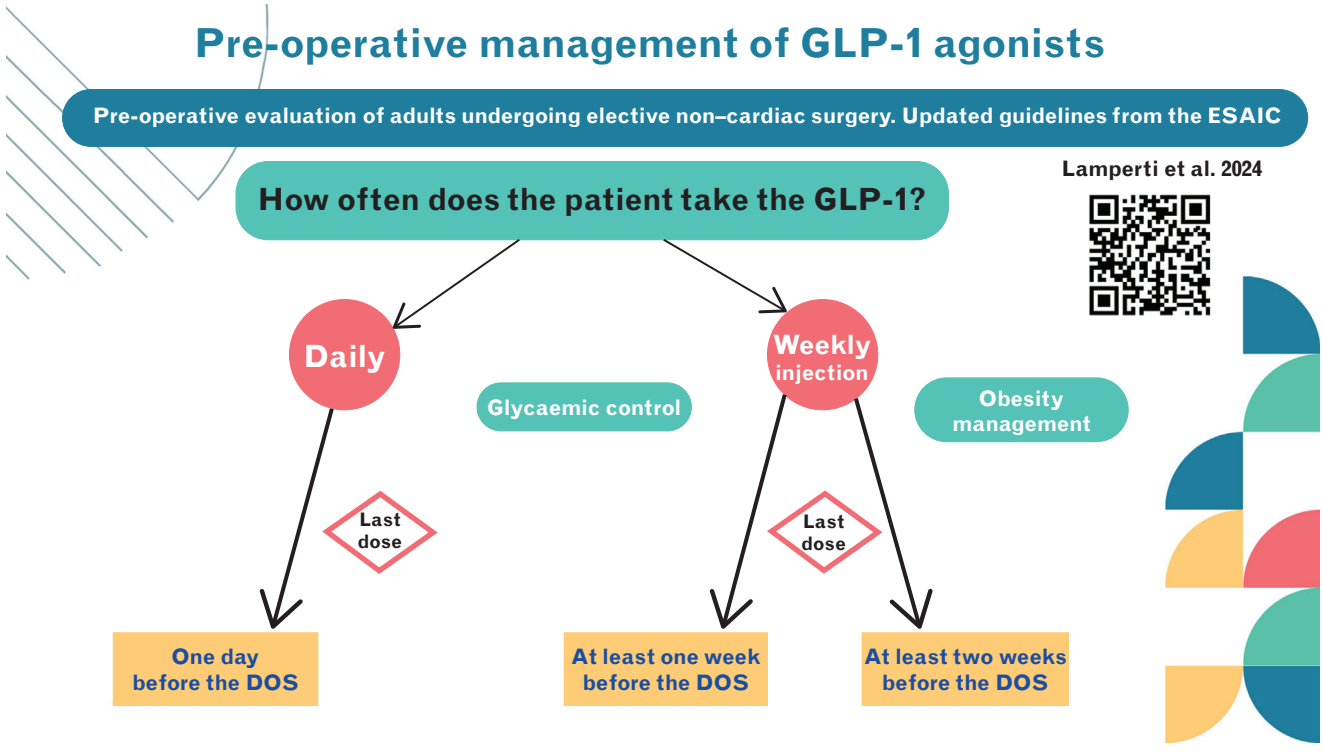


Fig. 4 Schematic diagram of preoperative management of glucagon-like-peptide-1 agonists.



DOS, day of surgery.

and abdominal pain) should be enough to consider the patient who stopped these medications at a reduced risk for a full stomach and possible aspiration; for this reason, the ESAIC taskforce suggests keeping patients on a clear-fluid diet the day before the procedure, and to perform a gastric ultrasound to rule out the presence of solid or excessive fluid content.[278,279] If gastric ultrasound is not possible/available, or there is a need to proceed with emergency surgery/procedure, the patient should be informed regarding the risk of pulmonary aspiration and a rapid sequence induction/intubation should be used.

SGLT2i, often called '-flozin' drugs, work by blocking SGLT2 in the proximal tubule of the kidneys, a mechanism responsible for reabsorbing filtered sodium and glucose. This action has several clinical effects, including reduced blood glucose levels and increased sodium excretion. These drugs are commonly used for managing glucose levels in diabetes, lowering the risk of cardiovascular events in diabetic patients and treating heart failure.

However, alongside their benefits, SGLT2i also pose risks such as genitourinary tract infections, AKI and skeletal fractures. Additionally, they can predispose patients to ketoacidosis, often with blood glucose levels remaining relatively normal, hence the name eDKA.[280] There have been numerous documented instances of eDKA occurring in perioperative patients, highlighting the importance of recognising this as a potential risk factor for individuals undergoing surgical procedures.[281–283] The ESAIC taskforce has formulated a series of CPS to guide the clinician in avoiding eDKA. Patients undergoing bowel preparation for a colonoscopy typically experience an extended period of decreased calorie consumption. The cathartic bowel preparation can result in volume depletion and dehydration, especially when combined with SGLT2i, further exacerbated by reduced insulin doses.[284] These factors increase the risk of DKA even before the stress induced by the procedure itself. Failing to discontinue the SGLT2i 3–4 days before surgery, predisposes the patient to develop eDKA in the perioperative period. In these situations, or in an emergency or unplanned procedure when patients are unlikely to have discontinued their medications, the medical team must decide if the procedure should be postponed or how to manage and monitor the patient if it must proceed.

Depending on the fasting duration, patients may exhibit signs of eDKA even before their scheduled procedure. The anion gap, which can be easily derived from a basic metabolic panel (BMP), is a valuable indicator for detecting underlying acidosis, although it lacks specificity for diagnosing DKA. Despite being less precise than direct pH measurement through arterial blood gas analysis, the

anion gap is favoured as a screening tool for underlying acidosis because it is easily obtained in most hospitals or surgery centres, unlike arterial blood gas samples.

In DKA, elevated levels of circulating ketone bodies contribute to the anion gap, necessitating the demonstration of ketosis for diagnosis. The measurement of blood BOHB, the primary ketone body in DKA, is the preferred method for ketone assessment and is increasingly advocated for diagnosing DKA, particularly in cases of euglycemia.[285,286]

Patients with well documented DKA generally have BOHB concentrations greater than 2 mmol l^{-1}.[287]

Instead of routinely deferring all elective procedures where SGLT2i drugs have not been withheld preoperatively, a clinical protocol has been developed to evaluate additional patient and procedural variables.[288] This protocol aims to stratify the risk of eDKA and permits certain patients to proceed with their scheduled procedures without delay. For individuals with diabetes mellitus taking SGLT2i who present for surgery and have not followed the FDA-recommended period without the medication, a BMP is conducted on the day of surgery to use the anion gap as an initial screening test for underlying acidosis. Should the anion gap exceed 12, their procedure is postponed and a BOHB level is obtained to confirm the presence/absence of DKA: if present then urgent medical intervention is required. If the anion gap is normal (below 12), then additional factors such as the nature of the surgical procedure, anaesthesia requirements, fasting duration, comorbidities and overall diabetic management are considered to identify patients with a low risk of developing DKA.

Low-risk patients may undergo surgery with standard intraoperative monitoring and management of diabetes mellitus, including intraoperative blood glucose checks and insulin administration. Acknowledging the significance of total fasting duration as a risk factor for eDKA, patients must meet the criteria for low risk and have an anticipated total fasting time of less than 12 h by the time surgery begins.[3]

Future research

Because of the increasing number of patients using GLP1 agonists, more evidence is urgently required as to the variability of gastric emptying and when gastric volume should be assessed objectively using gastric ultrasound. Some ongoing trials aim to assess the perioperative gastric volume and content in patients taking GLP1 agonists[289–291] to understand if the current recommendations on withholding these drugs, and the current fasting policies could reduce the risk for aspiration.

There is also a need to define clear protocols for the management of SGLT2i drugs and better understand if the risk of eDKA could have an impact on either intraoperative management because of a hypovolaemic state or on postoperative outcomes due to increased morbidity and mortality.

Final remarks

The current guidelines cover some new topics not previously discussed in the 2018 version,[1] and they aim to provide practical guidance to anaesthetists evaluating patients who should undergo sedation or general anaesthesia for NCS. We decided to include not only the organisational aspect and the clinical assessment according to an organ and disease-based scheme but also how patients should be optimised before surgery and how we should plan the management of new emerging drugs and plan for postoperative admission to ICU in an era of low resources in our ICUs.

These guidelines are not meant to be a systematic review of the literature. Nevertheless, these are evidence-based guidelines, based on the GRADE system, for all European and global physicians on how we should provide the best care during this evaluation process. The aim of the preoperative assessment is not only to evaluate the patient's clinical fitness for a specific procedure but also to include a comprehensive discussion, which we should have with patients or their caregivers on the specific and tailored risks.

The perioperative period is not the period with the highest risk of death for many surgical patients.[292] According to a prospective cohort study on 40 000 patients aged 45 years and older who underwent inpatient NCS at 28 centres in 14 countries, 1.8% died within 30 days of surgery.[292] Only five deaths (0.7%) occurred in the operating room and the remainder (99.3%) occurred after the procedure; 500 deaths (69.9%) occurred after surgery during the index admission to hospital and 210 deaths (29.4%) occurred after discharge from the hospital. Three complications accounted for 44.9% of the deaths: major bleeding, myocardial injury after NCS and sepsis. Given these findings, focusing on the prevention, early identification and management of these three complications holds promise for reducing perioperative mortality. This would mainly happen if we had a better understanding of our patient's status before surgery, and plan when and how we should test the patients and optimise their medical conditions.

Our role as perioperative physicians is to provide a clear risk assessment that patients can understand and follow so that they can use that information to reach an informed decision on the anaesthetic management options. The preoperative anaesthetic assessment is an essential part of the patient's surgical journey that has been shown to reduce patient anxiety.[293]

This guideline has covered some new aspects of the preoperative evaluation, such as frailty and previous or

current infection from COVID-19. Frailty per se is a diminished resistance to stress, such as the surgical insult, and it is of the utmost importance to perform preoperative frailty screening and to have a multidisciplinary approach to the elderly patient to avoid postoperative delirium and neurocognitive decline. The current evidence on the long-term effect of SARS-CoV2 is still not sufficient to provide clear protocols on how to assess the pulmonary, cardiac and neurological sequelae of this disease. However, the extensive retrospective studies conducted on patients affected by moderate symptoms are sufficient to increase our awareness of the timeline when surgery and anaesthesia could be considered sufficiently safe to be undertaken.[130]

This taskforce is also proposing a clinical algorithm for GLP-1 agonists but that requires more data: hopefully, it could confirm our cautious evaluation of gastric emptying and the related recommendations on preoperative fasting.

These guidelines implement and update some aspects covered previously.[1,17] However, some other topics, such as pre-existing chronic pain, patients with pre-existing neurological disorders and the management of patients with continuous intradermal insulin pumps, were not covered and will be included in the future. The primary goal of this document is to guide national societies and institutional committees on how the preoperative evaluation should be conducted, and subsequent management planned to achieve a better outcome for our patients. We will continue to provide the best evidence and update the document promptly or whenever better evidence is available.

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References

1 De Hert S, Staender S, Fritsch G, *et al.* Preoperative evaluation of adults undergoing elective noncardiac surgery: updated guideline from the European Society of Anaesthesiology. *Eur J Anaesthesiol* 2018; **35**:407–465.
2 Kietaibl S, Ferrandis R, Godier A, *et al.* Regional anaesthesia in patients on antithrombotic drugs: Joint ESAIC/ESRA guidelines. *Eur J Anaesthesiol* 2022; **39**:100–132.
3 Aldecoa C, Bettelli G, Bilotta F, *et al.* Update of the European Society of Anaesthesiology and Intensive Care Medicine evidence-based and consensus-based guideline on postoperative delirium in adult patients. *Eur J Anaesthesiol* 2024; **41**:81–108.
4 Lurati Buse G, Bollen Pinto B, Abelha F, *et al.* ESAIC focused guideline for the use of cardiac biomarkers in perioperative risk evaluation. *Eur J Anaesthesiol* 2023; **40**:888–927.
5 Routine preoperative tests for elective surgery: (c) NICE (2016) Routine preoperative tests for elective surgery. *BJU Int* 2018; **121**:12–16.
6 Anaesthetists, R.C.o. A shortage of 1,400 NHS anaesthetists already means that more than one million surgical procedures are delayed every year. 2021 [cited 24 January 2024]. Available at: https://www.rcoa.ac.uk/news/shortage-1400-nhs-anaesthetists-already-means-more-one-million-surgical-procedures-are-delayed#:~:text=Up%20to%20one%20million%20operations,in%20the%20next%20five%20years. [Accessed 28 July 2024].
7 Jalilian L, Cannesson M. Precision medicine in anesthesiology. *Int Anesthesiol Clin* 2020; **58**:17–22.
8 Alekberli T, Alekberli FR, Mimouni C, *et al.* Smart-anesthesia application with artificial intelligence for a preoperative evaluation of patients. *Res Inno in Anesth* 2020; **5**:21–22.
9 Sanders RD, Hughes F, Shaw A, *et al.* Perioperative Quality Initiative consensus statement on preoperative blood pressure, risk and outcomes for elective surgery. *Br J Anaesth* 2019; **122**:552–562.
10 Bose S, Talmor D. Who is a high-risk surgical patient? *Curr Opin Crit Care* 2018; **24**:547–553.
11 Lurati Buse GA, Mauermann E, Ionescu D, *et al.*, MET: Reevaluation for Perioperative Cardiac Risk investigators, European Society of Anaesthesiology and Intensive Care. Risk assessment for major adverse cardiovascular events after noncardiac surgery using self-reported functional capacity: international prospective cohort study. *Br J Anaesth* 2023; **130**:655–665.
12 Dashboard, F.A.E.R.S.P. *Ozempic*. 2024 [cited 25 January 2024].
13 dashboard, F.A.R.S.p. *SGLT2 inhibitors*. 2024 [cited 25 January 2024].
14 Ouzzani M, Hammady H, Fedorowicz Z, *et al.* Rayyan-a web and mobile app for systematic reviews. *Syst Rev* 2016; **5**:210.
15 Anaesthetists, A.o. *Preoperative assessment and patient preparation - the role of the anaesthetist*. 2010 [cited 15 November 2023]. Available at: https://anaesthetists.org/Home/Resources-publications/Guidelines/Preoperative-assessment-and-patient-preparation-the-role-of-the-anaesthetist-2. [Accessed 28 July 2024].
16 De Hert S, Staender S, Fritsch G, *et al.* Preoperative evaluation of the adult patient undergoing noncardiac surgery: guidelines from the European Society of Anaesthesiology. *Eur J Anaesthesiol* 2011; **28**:684–722.
17 Kamdar NV, Huverserian A, Jalilian L, *et al.* Development, implementation, and evaluation of a telemedicine preoperative evaluation initiative at a major academic medical center. *Anesth Analg* 2020; **131**:1647–1656.
18 Committee on Standards and Practice ParametersApfelbaum JL, Connis RT, *et al.* . Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. *Anesthesiology* 2012; **116**:522–538.
19 Economics, A.S.o.A.C.o. *Distinguishing Between a Pre-Anesthesia Evaluation and a Separately Reportable Evaluation and Management Service*. 2020 [cited 24 January 2024]. Available at: https://www.asahq.org/quality-and-practice-management/managing-your-practice/timely-topics-in-payment-and-practice-management/distinguishing-between-a-preanesthesia-evaluation-and-a-separately-reportable-evaluation-and-management-service. [Accessed 28 July 2024].
20 Lan RH, Kamath AF. Does the Timing of pre-operative medical evaluation influence perioperative total hip arthroplasty outcomes? *Open Orthop J* 2017; **11**:195–202.
21 Minto G, Biccard B. Assessment of the high-risk perioperative patient. *Continuing Educ Anaesth Crit Care Pain* 2013; **14**:12–17.
22 Sankar A, Beattie WS, Wijeysundera DN. How can we identify the high-risk patient? *Curr Opin Crit Care* 2015; **21**:328–335.
23 Phillips G, Cameron A, Szakmany T. Defining the high-risk patient. *J Emerg Crit Care Med* 2019; **3**:40.
24 Pearse RM, Holt PJ, Grocott MP. Managing perioperative risk in patients undergoing elective noncardiac surgery. *BMJ* 2011; **343**:d5759.

25 (NCEPOD), N.C.E.i.P.O.a.D. *Knowing the risk. A review of the peri-operative care of surgical patients*. 2011 [cited 24 January 2024]. Available at: https://www.ncepod.org.uk/2011report2/downloads/POC_fullreport.pdf. [Accessed 28 July 2024].
26 Kristoffersen EW, Opsal A, Tveit TO, *et al.* Effectiveness of preanaesthetic assessment clinic: a systematic review of randomised and nonrandomised prospective controlled studies. *BMJ Open* 2022; **12**: e054206.
27 Privratsky JR, Krishnamoorthy V, Raghunathan K, *et al.* Postoperative acute kidney injury is associated with progression of chronic kidney disease independent of severity. *Anesth Analg* 2022; **134**:49–58.
28 Umeno Y, Ishikawa S, Kudoh O, *et al.* Effects of the multidisciplinary preoperative clinic on the incidence of elective surgery cancellation. *J Med Syst* 2022; **46**:95.
29 Epstein RH, Dexter F. Management implications for the perioperative surgical home related to inpatient case cancellations and add-on case scheduling on the day of surgery. *Anesth Analg* 2015; **121**:206–218.
30 Molin C, Rovsing ML, Meyhoff CS. Preoperative anaesthesia triage with a patient-centred system-a prospective clinical study. *Acta Anaesthesiol Scand* 2020; **64**:1446–1452.
31 Liu S, Lu X, Jiang M, *et al.* Preoperative assessment clinics and case cancellations: a prospective study from a large medical center in China. *Ann Transl Med* 2021; **9**:1501.
32 Kamal T, Conway RM, Littlejohn L, *et al.* The role of a multidisciplinary preassessment clinic in reducing mortality after complex orthopaedic surgery. *Ann R Coll Surg Engl* 2011; **93**:149–151.
33 Blitz JD, Kendale SM, Jain SK, *et al.* Preoperative evaluation clinic visit is associated with decreased risk of in-hospital postoperative mortality. *Anesthesiology* 2016; **125**:280–294.
34 Zhang K, Rashid-Kolvear M, Waseem R, *et al.* Virtual preoperative assessment in surgical patients: a systematic review and meta-analysis. *J Clin Anesth* 2021; **75**:110540.
35 Mullen-Fortino M, Rising KL, Duckworth J, *et al.* Presurgical assessment using telemedicine technology: impact on efficiency, effectiveness, and patient experience of care. *Telemed J E Health* 2019; **25**:137–142.
36 O'Shea J, Corbett M, Mahdy S, *et al.* Evaluation of an online preoperative assessment tool. *BMJ Innovations* 2020; **6**:127–131.
37 Applegate RL 2nd, Gildea B, Patchin R, *et al.* Telemedicine preanesthesia evaluation: a randomized pilot trial. *Telemed J E Health* 2013; **19**:211–216.
38 Roberts S, Spain B, Hicks C, *et al.* Telemedicine in the Northern Territory: an assessment of patient perceptions in the preoperative anaesthetic clinic. *Aust J Rural Health* 2015; **23**:136–141.
39 Blanco Vargas D, Faura Messa A, Izquierdo Tugas E, *et al.* Online versus nonstandard face to face preoperative assessment: cost effectiveness. *Rev Esp Anestesiol Reanim* 2012; **59**:350–356.
40 Lozada MJ, Nguyen JT, Abouleish A, *et al.* Patient preference for the preanesthesia evaluation: telephone versus in-office assessment. *J Clin Anesth* 2016; **31**:145–148.
41 Zetterman CV, Sweitzer BJ, Webb B, *et al.* Validation of a virtual preoperative evaluation clinic: a pilot study. *Stud Health Technol Inform* 2011; **163**:737–739.
42 Tam A, Leung A, O'Callaghan C, *et al.* Role of telehealth in perioperative medicine for regional and rural patients in Queensland. *Intern Med J* 2017; **47**:933–937.
43 Goodhart IM, Andrzejowski JC, Jones GL, *et al.* Patient-completed, preoperative web-based anaesthetic assessment questionnaire (electronic Personal Assessment Questionnaire PreOperative): development and validation. *Eur J Anaesthesiol* 2017; **34**:221–228.
44 Wood EW, Strauss RA, Janus C, *et al.* Telemedicine consultations in oral and maxillofacial surgery: a follow-up study. *J Oral Maxillofac Surg* 2016; **74**:262–268.
45 Rollert MK, Strauss RA, Abubaker AO, *et al.* Telemedicine consultations in oral and maxillofacial surgery. *J Oral Maxillofac Surg* 1999; **57**:136–138.
46 Afable MK, Gupte G, Simon SR, *et al.* Innovative use of electronic consultations in preoperative anesthesiology evaluation at VA Medical Centers in New England. *Health Aff (Millwood)* 2018; **37**:275–282.
47 Pearse RM, Moreno RP, Bauer P, *et al.* Mortality after surgery in Europe: a 7 day cohort study. *Lancet* 2012; **380**:1059–1065.
48 Glance LG, Lustik SJ, Hannan EL, *et al.* The Surgical Mortality Probability Model: derivation and validation of a simple risk prediction rule for noncardiac surgery. *Ann Surg* 2012; **255**:696–702.
49 Rafiq A, Sklyar E, Bella JN. Cardiac evaluation and monitoring of patients undergoing noncardiac surgery. *Health Serv Insights* 2017; **9**:1178632916686074.
50 Graham SG. The National Confidential Enquiry into Perioperative Deaths 1990. *Br J Anaesth* 1992; **69**:431–432.
51 Lee TH, Marcantonio ER, Mangione CM, *et al.* Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation* 1999; **100**:1043–1049.
52 Ford MK, Beattie WS, Wijeysundera DN. Systematic review: prediction of perioperative cardiac complications and mortality by the revised cardiac risk index. *Ann Intern Med* 2010; **152**:26–35.
53 Davis FM, Park YJ, Grey SF, *et al.* The clinical impact of cardiology consultation prior to major vascular surgery. *Ann Surg* 2018; **267**:189–195.
54 Nagele P, Brown F, Gage BF, *et al.* High-sensitivity cardiac troponin T in prediction and diagnosis of myocardial infarction and long-term mortality after noncardiac surgery. *Am Heart J* 2013; **166**:325.e1–332.e1.
55 Vernooij LM, van Klei WA, Moons KG, *et al.* The comparative and added prognostic value of biomarkers to the Revised Cardiac Risk Index for preoperative prediction of major adverse cardiac events and all-cause mortality in patients who undergo noncardiac surgery. *Cochrane Database Syst Rev* 2021; **12**:CD013139.
56 Kopec M, Duma A, Helwani MA, *et al.* Improving prediction of postoperative myocardial infarction with high-sensitivity cardiac troponin T and NT-proBNP. *Anesth Analg* 2017; **124**:398–405.
57 Bayes-Genis A, Docherty KF, Petrie MC, *et al.* Practical algorithms for early diagnosis of heart failure and heart stress using NT-proBNP: a clinical consensus statement from the Heart Failure Association of the ESC. *Eur J Heart Fail* 2023; **25**:1891–1898.
58 Tran D. Cardiopulmonary exercise testing. *Methods Mol Biol* 2018; **1735**:285–295.
59 Boujibar F, Gillibert A, Gravier FE, *et al.* Performance at stair-climbing test is associated with postoperative complications after lung resection: a systematic review and meta-analysis. *Thorax* 2020; **75**:791–797.
60 Charloux A, Brunelli A, Bolliger CT, *et al.*, European Respiratory Society and European Society of Thoracic Surgeons Joint Task Force on Fitness for Radical Therapy. Lung function evaluation before surgery in lung cancer patients: how are recent advances put into practice? A survey among members of the European Society of Thoracic Surgeons (ESTS) and of the Thoracic Oncology Section of the European Respiratory Society (ERS). *Interact Cardiovasc Thorac Surg* 2009; **9**:925–931.
61 Brunelli A, Charloux A, Bolliger CT, *et al.*, European Respiratory Society, European Society of Thoracic Surgeons Joint Task Force on Fitness For Radical Therapy. The European Respiratory Society and European Society of Thoracic Surgeons clinical guidelines for evaluating fitness for radical treatment (surgery and chemoradiotherapy) in patients with lung cancer. *Eur J Cardiothorac Surg* 2009; **36**:181–184.
62 Shulman MA, Cuthbertson BH, Wijeysundera DN, *et al.* Using the 6-min walk test to predict disability-free survival after major surgery. *Br J Anaesth* 2019; **122**:111–119.
63 Rodriguez M. Stair-climbing test: beyond the height. *Thorax* 2020; **75**:716.
64 Biccard BM. Relationship between the inability to climb two flights of stairs and outcome after major noncardiac surgery: implications for the preoperative assessment of functional capacity. *Anaesthesia* 2005; **60**:588–593.
65 Wijeysundera DN, Pearse RM, Shulman MA, *et al.* Assessment of functional capacity before major noncardiac surgery: an international, prospective cohort study. *Lancet* 2018; **391**:2631–2640.
66 Wijeysundera DN, Beattie WS, Hillis GS, *et al.* Integration of the Duke Activity Status Index into preoperative risk evaluation: a multicentre prospective cohort study. *Br J Anaesth* 2020; **124**:261–270.
67 Kusunose K, Torii Y, Yamada H, *et al.* Association of echocardiography before major elective non-cardiac surgery with improved postoperative outcomes - possible implications for patient care. *Circ J* 2019; **83**:2512–2519.
68 Shillcutt SK, Walsh DP, Thomas WR, *et al.* The implementation of a preoperative transthoracic echocardiography consult service by anesthesiologists. *Anesth Analg* 2017; **125**:1479–1481.
69 Meier I, Vogt AP, Meineri M, *et al.* Point-of-care ultrasound in the preoperative setting. *Best Pract Res Clin Anaesthesiol* 2020; **34**:315–324.
70 Chang JS, Ravi B, Jenkinson RJ, *et al.* Impact of preoperative echocardiography on surgical delays and outcomes among adults with hip fracture. *Bone Joint J* 2021; **103-b**:271–278.
71 Barber RL, Fletcher SN. A review of echocardiography in anaesthetic and peri-operative practice. Part 1: impact and utility. *Anaesthesia* 2014; **69**:764–776.
72 Sharma V, Fletcher SN. A review of echocardiography in anaesthetic and peri-operative practice. Part 2: training and accreditation. *Anaesthesia* 2014; **69**:919–927.
73 Hindricks G, Potpara T, Dagres N, *et al.*, ESC Scientific Document Group. 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for

Cardio-Thoracic Surgery (EACTS): the Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. *Eur Heart J* 2021; **42**:373–498.

74 Keeling D, Tait RC, Watson H, *et al.* Peri-operative management of anticoagulation and antiplatelet therapy. *Br J Haematol* 2016; **175**:602–613.

75 Neelankavil JP, Thompson A, Mahajan A. Change of pace: an update on the perioperative management of cardiovascular implantable electronic devices (CIEDs). *APSF Newsletter* 2020; **35**:92–93.

76 Bernstein AD, Daubert JC, Fletcher RD, *et al.* The revised NASPE/BPEG generic code for antibradycardia, adaptive-rate, and multisite pacing. North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group. *Pacing Clin Electrophysiol* 2002; **25**:260–264.

77 American Society of Anesthesiology. Practice advisory for the perioperative management of patients with cardiac implantable electronic devices: pacemakers and implantable cardioverter-defibrillators: an updated report by the American Society of Anesthesiologists Task Force on perioperative management of patients with cardiac implantable electronic devices. *Anesthesiology* 2011; **114**:247–261.

78 Indik JH, Gimbel JR, Abe H, *et al.* 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices. *Heart Rhythm* 2017; **14**: e97–e153.

79 Streckenbach S, Lai Y, Bas H, *et al.* Starting an anesthesia-based perioperative device management service: a practical guide to training anesthesiologists. *J Cardiothorac Vasc Anesth* 2021; **35**:1006–1017.

80 Thomas H, Plummer C, Wright IJ, *et al.* Guidelines for the peri-operative management of people with cardiac implantable electronic devices: guidelines from the British Heart Rhythm Society. *Anaesthesia* 2022; **77**:808–817.

81 Stuhlinger M, Burri H, Vernooy K, *et al.* EHRA consensus on prevention and management of interference due to medical procedures in patients with cardiac implantable electronic devices. *Europace* 2022; **24**:1512–1537.

82 Song P, Rooke GA. Fundamental electrophysiology principles related to perioperative management of cardiovascular implantable electronic devices. *J Cardiothorac Vasc Anesth* 2024; **38**:361–370.

83 Yokoshima T, Honma H, Kusama Y, *et al.* Improved stratification of perioperative cardiac risk in patients undergoing noncardiac surgery using new indices of dobutamine stress echocardiography. *J Cardiol* 2004; **44**:101–111.

84 Go G, Davies KT, O'Callaghan C, *et al.* Negative predictive value of dobutamine stress echocardiography for perioperative risk stratification in patients with cardiac risk factors and reduced exercise capacity undergoing noncardiac surgery. *Intern Med J* 2017; **47**:1376–1384.

85 Shulman MA, Myles PS, Chan MT, *et al.* Measurement of disability-free survival after surgery. *Anesthesiology* 2015; **122**:524–536.

86 Ustun TB, Chatterji S, Kostanjsek N, *et al.*, WHO/NIH Joint Project. Developing the World Health Organization Disability Assessment Schedule 2.0. *Bull World Health Organ* 2010; **88**:815–823.

87 Wijeysundera DN, Beattie WS, Karkouti K, *et al.* Association of echocardiography before major elective noncardiac surgery with postoperative survival and length of hospital stay: population based cohort study. *BMJ* 2011; **342**:d3695.

88 Levitan EB, Graham LA, Valle JA, *et al.* Preoperative echocardiography among patients with coronary artery disease in the United States Veterans Affairs healthcare system: a retrospective cohort study. *BMC Cardiovasc Disord* 2016; **16**:173.

89 Canty DJ, Heiberg J, Yang Y, *et al.* Pilot multicentre randomised trial of the impact of preoperative focused cardiac ultrasound on mortality and morbidity in patients having surgery for femoral neck fractures (ECHONOF-2 pilot). *Anaesthesia* 2018; **73**:428–437.

90 Li X, Chen J, Gu C, *et al.* The impact on 30-day mortality from a brief focused ultrasound-guided management protocol immediately before emergency noncardiac surgery in critically ill patients: a multicenter randomized controlled trial. *J Cardiothorac Vasc Anesth* 2022; **36**:1100–1110.

91 Pallesen J, Bhavsar R, Fjølner J, *et al.* The effects of preoperative focused cardiac ultrasound in high-risk patients: A randomised controlled trial (PREOPFOCUS). *Acta Anaesthesiol Scand* 2022; **66**:1174–1184.

92 Registry, A.N.Z.C.T. Look before you Leap: a randomized controlled trial of the impact on length of hospital stay of ECHOcardiography Goal-directed Ultrasound Informed Decision-making for Elderly patients undergoing emergency noncardiac surgery - the ECHOGUIDE III trial. 2019 [cited 2 February 2024]. Available at: https://www.anzctr.org.au/TrialSearch.aspx#&&conditionCode=&dateOfRegistrationFrom=&interventionDescription=&interventionCodeOperator=OR&primarySponsorType=&gender=&distance=&postcode=&pageSize=20&ageGroup=&recruitmentCountryOperator=OR&recruitmentRegion=&ethicsReview=&countryOfRecruitment=&registry=&searchTxt=ACTRN12619000116123&studyType=&allocationToIntervention=&dateOfRegistrationTo=&recruitmentStatus=&interventionCode=&healthCondition=&healthyVolunteers=&page=1&conditionCategory=&fundingSource=&trialStartDateTo=&trialStartDateFrom=&phase=. [Accessed 28 July 2024].

93 Zhu N, Zhang D, Wang W, *et al.*, China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020; **382**:727–733.

94 George PM, Barratt SL, Condliffe R, *et al.* Respiratory follow-up of patients with COVID-19 pneumonia. *Thorax* 2020; **75**:1009–1016.

95 Evans RA, McAuley H, Harrison EM, *et al.*, PHOSP-COVID Collaborative Group. Physical, cognitive, and mental health impacts of COVID-19 after hospitalisation (PHOSP-COVID): a UK multicentre, prospective cohort study. *Lancet Respir Med* 2021; **9**:1275–1287.

96 Stewart I, Jacob J, George PM, *et al.* Residual lung abnormalities after COVID-19 hospitalization: interim analysis of the UKILD post-COVID-19 study. *Am J Respir Crit Care Med* 2023; **207**:693–703.

97 Cassar MP, Tunnicliffe EM, Petousi N, *et al.* Symptom persistence despite improvement in cardiopulmonary health - insights from longitudinal CMR, CPET and lung function testing post-COVID-19. *EClinicalMedicine* 2021; **41**:101159.

98 Raman B, Cassar MP, Tunnicliffe EM, *et al.* Medium-term effects of SARS-CoV-2 infection on multiple vital organs, exercise capacity, cognition, quality of life and mental health, posthospital discharge. *EClinicalMedicine* 2021; **31**:100683.

99 Khera KD, Blessman JD, Deyo-Svendsen ME, *et al.* Pre-anesthetic medical evaluations: criteria considerations for telemedicine alternatives to face to face visits. *Health Serv Res Manag Epidemiol* 2022; **9**:23333928221074895.

100 Velly L, Gayat E, Quintard H, *et al.* Guidelines: anaesthesia in the context of COVID-19 pandemic. *Anaesth Crit Care Pain Med* 2020; **39**:395–415.

101 Fiorelli S, Menna C, Piccioni F, *et al.* Preoperative SARS-CoV-2 infection screening before thoracic surgery during COVID-19 pandemic: a multicenter retrospective study. *Int J Clin Pract* 2023; **2023**:8993295.

102 Flemming S, Hankir MK, Kusan S, *et al.* Safety of elective abdominal and vascular surgery during the COVID-19 pandemic: a retrospective single-center study. *Eur J Med Res* 2021; **26**:112.

103 COVIDSurg Collaborative. Preoperative nasopharyngeal swab testing and postoperative pulmonary complications in patients undergoing elective surgery during the SARS-CoV-2 pandemic. *Br J Surg* 2021; **108**:88–96.

104 Puylaert CAJ, Scheijmans JCG, Borgstein ABJ, *et al.*, SCOUT study group. Yield of screening for COVID-19 in asymptomatic patients before elective or emergency surgery using chest CT and RT-PCR (SCOUT): multicenter study. *Ann Surg* 2020; **272**:919–924.

105 Ralhan S, Arya RC, Gupta R, *et al.* Cardiothoracic surgery during COVID-19: Our experience with different strategies. *Ann Card Anaesth* 2020; **23**:485–492.

106 Nekkanti SS, Vasudevan Nair S, Parmar V, *et al.* Mandatory preoperative COVID-19 testing for cancer patients-is it justified? *J Surg Oncol* 2020; **122**:1288–1292.

107 Castellvi J, Jerico C, DeMiguel A, *et al.* Impact on clinical practice of the preoperative screening of Covid-19 infection in surgical oncological patients. Prospective cohort study. *Int J Surg Open* 2020; **26**:30–35.

108 Pujol R, Rivas E, Gracia I, *et al.*, Perioperative COVID Group Hospital Clinic. Preoperative triage to detect SARS-CoV-2 infection in surgical patients: lessons learned for resuming surgery. *Surg Today* 2023; **53**:709–717.

109 Nazemi P, Feizabad E, Shokouhi N, *et al.* Importance of preoperative COVID-19 screening test in elective surgeries. *Iran J Microbiol* 2022; **14**:10–14.

110 Patkar S, Voppuru SR, Thiagarajan S, *et al.* Incidence of SARS-CoV-2 infection among asymptomatic patients undergoing preoperative COVID testing prior to cancer surgery: ASPECT study. *J Surg Oncol* 2022; **125**:564–569.

111 Lopes A, Pastore CBP, Deckers P, *et al.* Oncological surgery during the COVID-19 pandemic: effectiveness of preoperative screening and factors associated with postoperative SARS-CoV-2 infection. *Ann Surg Oncol* 2022; **29**:2155–2162.

112 Al-Essa RS, Alkharashi MS. Preoperative universal screening for COVID-19 in patients undergoing ophthalmic surgeries: Experience from a tertiary eye care center in Saudi Arabia. *Saudi J Ophthalmol* 2021; **35**:316–319.

113 Hendrickson NR, Kesler K, DeMik DE, *et al.* Asymptomatic pre-operative COVID-19 screening for essential and elective surgeries: early results of

universal screening at a midwestern academic medical center. *Iowa Orthop J* 2021; **41**:33–38.
114 Baboudjian M, Mhatli M, Bourouina A, *et al.* Is minor surgery safe during the COVID-19 pandemic? A multidisciplinary study. *PLoS One* 2021; **16**: e0251122.
115 Ferrari M, Paderno A, Giannini L, *et al.* COVID-19 screening protocols for preoperative assessment of head and neck cancer patients candidate for elective surgery in the midst of the pandemic: A narrative review with comparison between two Italian institutions. *Oral Oncol* 2021; **112**:105043.
116 de Bock E, Filipe MD, Simmermacher RKJ, *et al.* Meta-analysis of COVID-19 prevalence during preoperative COVID-19 screening in asymptomatic patients. *BMJ Open* 2022; **12**:e058389.
117 Byambasuren O, Cardona M, Bell K, *et al.* Estimating the extent of asymptomatic COVID-19 and its potential for community transmission: Systematic review and meta-analysis. *J Assoc Med Microbiol Infect Dis Can* 2020; **5**:223–234.
118 Prevention, T.C.f.D.C.a. COVID-19 by County. 2023 [cited 26 January 2024]. Available at: https://www.cdc.gov/coronavirus/2019-ncov/your-health/covid-by-county.html. [Accessed 28 July 2024].
119 Hasibi M, Asadollahi-Amin A, Sharifian H, *et al.* The value of spiral chest computed tomography scan in the diagnosis of asymptomatic coronavirus carriers among paranasal sinus and pharynx surgery candidates. *Int Arch Otorhinolaryngol* 2022; **26**:e487–e490.
120 Ai T, Yang Z, Hou H, *et al.* Correlation of chest CT and RT-PCR testing for coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. *Radiology* 2020; **296**:E32–E40.
121 Fang Y, Zhang H, Zhang H, *et al.* Sensitivity of chest CT for COVID-19: comparison to RT-PCR. *Radiology* 2020; **296**:E115–E117.
122 Barrio Piqueras M, Ezponda Casajús##A, Urtasun Iriarte C, *et al.* Low-dose chest CT for preoperative screening for SARS-CoV-2 infection. *Radiologia (Engl Ed)* 2022; **64**:317–323.
123 Barba-Valadez LA, Gallegos-Hernandez JF, Benítez-Martinez AL, *et al.* Chest tomography for COVID-19 screening in head and neck cancer elective surgery. Is it enough? *Gac Med Mex* 2022; **158**:36–40.
124 Gumus T, Kabaoglu ZU, Coskun B, *et al.* Preoperative computerized tomography screening for COVID-19 pneumonia in asymptomatic patients: experiences from two centers. *Jpn J Radiol* 2021; **39**:240–245.
125 Chetan MR, Tsakok MT, Shaw R, *et al.* Chest CT screening for COVID-19 in elective and emergency surgical patients: experience from a UK tertiary centre. *Clin Radiol* 2020; **75**:599–605.
126 Ap Dafydd D, O'Mahony M, Jhanji S, *et al.* The role of CT chest in screening for asymptomatic COVID-19 infection in self-isolating patients prior to elective oncological surgery: findings from a UK Cancer Hub. *Br J Radiol* 2021; **94**:20200994.
127 Knol WG, Thuijs DJFM, Odink AE, *et al.* Preoperative chest computed tomography screening for coronavirus disease 2019 in asymptomatic patients undergoing cardiac surgery. *Semin Thorac Cardiovasc Surg* 2021; **33**:417–424.
128 Callaway M, Harden S, Ramsden W, *et al.* A national UK audit for diagnostic accuracy of preoperative CT chest in emergency and elective surgery during COVID-19 pandemic. *Clin Radiol* 2020; **75**:705–708.
129 COVIDsurg Collaboration. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet* 2020; **396**:27–38.
130 Aziz MF, Schenning K, Koike S, *et al.*, Multicenter Perioperative Outcomes Group Investigators. Perioperative mortality of the COVID-19 recovered patient compared to a matched control: a multicenter retrospective cohort study. *Anesthesiology* 2024; **140**:195–206.
131 Cook TM, Woodall N, Frerk C, Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. *Br J Anaesth* 2011; **106**:617–631.
132 Yentis SM. Predicting difficult intubation–worthwhile exercise or pointless ritual? *Anaesthesia* 2002; **57**:105–109.
133 Rosenblatt WH. Preoperative planning of airway management in critical care patients. *Crit Care Med* 2004; **32 (4 Suppl)**:S186–S192.
134 Pandit JJ, Heidegger T. Putting the 'point' back into the ritual: a binary approach to difficult airway prediction. *Anaesthesia* 2017; **72**:283–288.
135 Detsky ME, Jivraj N, Adhikari NK, *et al.* Will this patient be difficult to intubate?: the rational clinical examination systematic review. *JAMA* 2019; **321**:493–503.
136 Roth D, Pace NL, Lee A, *et al.* Airway physical examination tests for detection of difficult airway management in apparently normal adult patients. *Cochrane Database Syst Rev* 2018; **5**:CD008874.
137 Shiga T, Wajima Z, Inoue T, *et al.* Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. *Anesthesiology* 2005; **103**:429–437.
138 Lundstrøm LH, Muller AM, Rosenstock C, *et al.* A documented previous difficult tracheal intubation as a prognostic test for a subsequent difficult tracheal intubation in adults. *Anaesthesia* 2009; **64**:1081–1088.
139 Apfelbaum JL, Hagberg CA, Connis RT, *et al.* 2022 American Society of Anesthesiologists Practice Guidelines for management of the difficult airway. *Anesthesiology* 2022; **136**:31–81.
140 Petrini F, Di Giacinto I, Cataldo R, *et al.*, Obesity Task Force for the SIAARTI Airway Management Study Group. Perioperative and periprocedural airway management and respiratory safety for the obese patient: 2016 SIAARTI Consensus. *Minerva Anestesiol* 2016; **82**:1314–1335.
141 Xia M, Ma W, Zuo M, *et al.* Expert consensus on difficult airway assessment. *Hepatobiliary Surg Nutr* 2023; **12**:545–566.
142 Baker P. Assessment before airway management. *Anesthesiol Clin* 2015; **33**:257–278.
143 El-Radaideh K, Dheeb E, Shbool H, *et al.* Evaluation of different airway tests to determine difficult intubation in apparently normal adult patients: undergoing surgical procedures. *Patient Saf Surg* 2020; **14**:43.
144 Gupta R, Gupta N, Kumar V, *et al.* El-Ganzouri multivariate risk index based airway management in head and neck cancer patients: a retrospective analysis of 1000 patients in a tertiary care center. *J Anaesthesiol Clin Pharmacol* 2022; **38**:97–103.
145 Min JJ, Kim G, Kim E, *et al.* The diagnostic validity of clinical airway assessments for predicting difficult laryngoscopy using a grey zone approach. *J Int Med Res* 2016; **44**:893–904.
146 Nørskov AK, Wetterslev J, Rosenstock CV, *et al.* Effects of using the simplified airway risk index vs usual airway assessment on unanticipated difficult tracheal intubation - a cluster randomized trial with 64,273 participants. *Br J Anaesth* 2016; **116**:680–689.
147 Vannucci A, Cavallone LF. Bedside predictors of difficult intubation: a systematic review. *Minerva Anestesiol* 2016; **82**:69–83.
148 Hung KC, Chuang MH, Kang FC, *et al.* Prevalence and risk factors of difficult mask ventilation: a systematic review and meta-analysis. *J Clin Anesth* 2023; **90**:111197.
149 Kheterpal S, Martin L, Shanks AM, *et al.* Prediction and outcomes of impossible mask ventilation: a review of 50,000 anesthetics. *Anesthesiology* 2009; **110**:891–897.
150 Lundstrøm LH, Rosenstock CV, Wetterslev J, *et al.* The DIFFMASK score for predicting difficult facemask ventilation: a cohort study of 46,804 patients. *Anaesthesia* 2019; **74**:1267–1276.
151 Nørskov AK, Wetterslev J, Rosenstock CV, *et al.* Prediction of difficult mask ventilation using a systematic assessment of risk factors vs. existing practice - a cluster randomised clinical trial in 94,006 patients. *Anaesthesia* 2017; **72**:296–308.
152 Nagappa M, Wong DT, Cozowicz C. Is obstructive sleep apnea associated with difficult airway? *Evidence from a systematic review and meta-analysis of prospective and retrospective cohort studies* 2018; **13**: e0204904.
153 Aziz MF, Healy D, Kheterpal S, *et al.* Routine clinical practice effectiveness of the Glidescope in difficult airway management: an analysis of 2,004 Glidescope intubations, complications, and failures from two institutions. *PLoS One* 2011; **114**:34–41.
154 Amalric M, Larcher R, Brunot V, *et al.* Impact of videolaryngoscopy expertise on first-attempt intubation success in critically ill patients. *Crit Care Med* 2020; **48**:e889–e896.
155 Kohse EK, Siebert HK. A model to predict difficult airway alerts after videolaryngoscopy in adults with anticipated difficult airways - the VIDIAC score. *Anaesthesia* 2022; **77**:1089–1096.
156 DI Filippo A, Adembri C, Paparella L, *et al.* Risk factors for difficult Laryngeal Mask Airway LMA-Supreme™ (LMAS) placement in adults: a multicentric prospective observational study in an Italian population. *Anaesthesia* 2021; **87**:533–540.
157 Law JA, Broemling N, Cooper RM, *et al.*, Canadian Airway Focus Group. The difficult airway with recommendations for management–part 1–difficult tracheal intubation encountered in an unconscious/induced patient. *Can J Anaesth* 2013; **60**:1089–1118.
158 Corso RM, Sorbello M, Mecugni D, *et al.* Safety and efficacy of Staged Extubation Set in patients with difficult airway: a prospective multicenter study. *Minerva Anestesiol* 2020; **86**:827–834.
159 Sorbello M, Frova G. When the end is really the end? The extubation in the difficult airway patient. *Minerva Anestesiol* 2013; **79**:194–199.
160 Kodali BS, Chandrasekhar S, Bulich LN, *et al.* Airway changes during labor and delivery. *Anesthesiology* 2008; **108**:357–362.

161 De Cassai A, Papaccio F, Betteto G, *et al.* Prediction of difficult tracheal intubations in thyroid surgery. Predictive value of neck circumference to thyromental distance ratio. *PLoS One* 2019; **14**:e0212976.
162 De Cassai A, Boscolo A, Rose K, *et al.* Predictive parameters of difficult intubation in thyroid surgery: a meta-analysis. *Minerva Anestesiol* 2020; **86**:317–326.
163 Myatra SN, Divatia JV, Brewster DJ. The physiologically difficult airway: an emerging concept. *Curr Opin Anaesthesiol* 2022; **35**:115–121.
164 Kelly FE, Frerk C, Bailey CR, *et al.* Human factors in anaesthesia: a narrative review. *Anaesthesia* 2023; **78**:479–490.
165 Huitink JM, Bouwman RA. The myth of the difficult airway: airway management revisited. *Anaesthesia* 2015; **70**:244–249.
166 Sorbello M, Afshari A, De Hert S. Device or target? A paradigm shift in airway management: Implications for guidelines, clinical practice and teaching. *Eur J Anaesthesiol* 2018; **35**:811–814.
167 Falcetta S, Cavallo S, Gabbanelli V, *et al.* Evaluation of two neck ultrasound measurements as predictors of difficult direct laryngoscopy: a prospective observational study. *Eur J Anaesthesiol* 2018; **35**:605–612.
168 Carsetti A, Sorbello M, Adrario E, *et al.* Airway ultrasound as predictor of difficult direct laryngoscopy: a systematic review and meta-analysis. *Anesth Analg* 2022; **134**:740–750.
169 Sasu PB, Pansa JI, Stadlhofer R, *et al.* Nasendoscopy to predict difficult videolaryngoscopy: a multivariable model development study. *J Clin Med* 2023; **12**:3433.
170 Di Rienzo Businco L, Turchio P, Guazzaroni M, *et al.* Virtual versus conventional laryngeal endoscopy. *Ann Otol Rhinol Laryngol* 2006; **115**:182–185.
171 Sajayan A, Nair A, McNarry AF, *et al.* Analysis of a national difficult airway database. *Anaesthesia* 2022; **77**:1081–1088.
172 Chandradeva K, Ghosh SM. Airway alert information following difficult intubations. *Anaesthesia* 2005; **60**:97.
173 Barron FA, Ball DR, Jefferson P, *et al.* 'Airway Alerts'. How UK anaesthetists organise, document and communicate difficult airway management. *Anaesthesia* 2003; **58**:73–77.
174 Liao YC, Chang CC, Chen CY, *et al.* Preoperative renal insufficiency predicts postoperative adverse outcomes in a mixed surgical population: a retrospective matched cohort study using the NSQIP database. *Int J Surg* 2023; **109**:752–759.
175 Edwards MA, Asbun D, Mazzei M. Comparison of eGFR formulas in determining chronic kidney disease stage in bariatric patients and the impact on perioperative outcomes. *Surg Obes Relat Dis* 2021; **17**:1317–1326.
176 Long TE, Helgason D, Helgadottir S, *et al.* Acute kidney injury after abdominal surgery: incidence, risk factors, and outcome. *Anesth Analg* 2016; **122**:1912–1920.
177 Wang C, Gao Y, Tian Y, *et al.* Prediction of acute kidney injury after cardiac surgery from preoperative N-terminal pro-B-type natriuretic peptide. *Br J Anaesth* 2021; **127**:862–870.
178 Kim K, Bang JY, Kim SO, *et al.* Association of preoperative hypoalbuminemia with postoperative acute kidney injury in patients undergoing brain tumor surgery: a retrospective study. *J Neurosurg* 2018; **128**:1115–1122.
179 Cardinale D, Cosentino N, Moltrasio M, *et al.* Acute kidney injury after lung cancer surgery: incidence and clinical relevance, predictors, and role of N-terminal pro B-type natriuretic peptide. *Lung Cancer* 2018; **123**:155–159.
180 Zhao BC, Zhuang PP, Lei SH, *et al.* Preoperative N-terminal pro-B-type natriuretic peptide for prediction of acute kidney injury after noncardiac surgery: a retrospective cohort study. *Eur J Anaesthesiol* 2021; **38**:591–599.
181 Soliman KM, Campbell RC, Fulop T, *et al.* Acute kidney injury in subjects with chronic kidney disease undergoing total joint arthroplasty. *Am J Med Sci* 2019; **358**:45–50.
182 Section 2: AKI definition. *Kidney Int Suppl* 2012; **2**:19–36.
183 Mokhtar AT, Tennankore K, Doucette S, *et al.* Predicting acute kidney injury following nonemergent cardiac surgery: A preoperative scorecard. *J Card Surg* 2021; **36**:2204–2212.
184 Flammia RS, Tufano A, Proietti F, *et al.* Renal surgery for kidney cancer: is preoperative proteinuria a predictor of functional and survival outcomes after surgery? A systematic review of the literature. *Minerva Urol Nephrol* 2022; **74**:255–264.
185 Verwijmeren L, Bosma M, Vernooij LM, *et al.* Associations between preoperative biomarkers and cardiac surgery-associated acute kidney injury in elderly patients: a cohort study. *Anesth Analg* 2021; **133**:570–577.
186 Murashima M, Nishimoto M, Kokubo M, *et al.* Inflammation as a predictor of acute kidney injury and mediator of higher mortality after acute kidney injury in noncardiac surgery. *Sci Rep* 2019; **9**:20260.
187 Wahl TS, Graham LA, Morris MS, *et al.* Association between preoperative proteinuria and postoperative acute kidney injury and readmission. *JAMA Surg* 2018; **153**:e182009.
188 Park S, Lee S, Lee A, *et al.* Preoperative dipstick albuminuria and other urine abnormalities predict acute kidney injury and patient outcomes. *Surgery* 2018; **163**:1178–1185.
189 Sun AJ, Thomas IC, Velaer KN, *et al.* The urine albumin-to-creatinine ratio and kidney function after nephrectomy. *J Urol* 2020; **204**:231–238.
190 Halvorsen S, Mehilli J, Cassese S, *et al.* 2022 ESC Guidelines on cardiovascular assessment and management of patients undergoing noncardiac surgery. *Eur Heart J* 2022; **43**:3826–3924.
191 Kubota M, Matsuoka T, Mine Y, *et al.* Effect of continued perioperative antithrombotic therapy on bleeding outcomes following laparoscopic nephrectomy and nephroureterectomy. *Asian J Endosc Surg* 2023; **16**:7–13.
192 Vivas D, Roldan I, Ferrandis R, *et al.*, Expert reviewers. Perioperative and periprocedural management of antithrombotic therapy: consensus document of SEC, SEDAR, SEACV, SECTCV, AEC, SECPRE, SEPD, SEGO, SEHH, SETH, SEMERGEN, SEMFYC, SEMG, SEMICYUC, SEMI, SEMES, SEPAR, SENEC, SEO, SEPA, SERVEI, SECOT and AEU. *Rev Esp Cardiol (Engl Ed)* 2018; **71**:553–564.
193 Chai-Adisaksopha C, Hillis C, Siegal DM, *et al.* Prothrombin complex concentrates versus fresh frozen plasma for warfarin reversal. A systematic review and meta-analysis. *Thromb Haemost* 2016; **116**:879–890.
194 Daugaard C, Pedersen AB, Kristensen NR, *et al.* Preoperative antithrombotic therapy and risk of blood transfusion and mortality following hip fracture surgery: a Danish nationwide cohort study. *Osteoporos Int* 2019; **30**:583–591.
195 Piepoli MF, Hoes AW, Agewall S, *et al.* 2016 European guidelines on cardiovascular disease prevention in clinical practice. The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts. Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation. *G Ital Cardiol (Rome)* 2017; **18**:547–612.
196 Graham MM, Sessler DI, Parlow JL, *et al.* Aspirin in patients with previous percutaneous coronary intervention undergoing noncardiac surgery. *Ann Intern Med* 2018; **168**:237–244.
197 Collet JP, Thiele H, Barbato E, *et al.* 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Rev Esp Cardiol (Engl Ed)* 2021; **74**:544.
198 Kedhi E, Fabris E, van der Ent M, *et al.* Six months versus 12 months dual antiplatelet therapy after drug-eluting stent implantation in ST-elevation myocardial infarction (DAPT-STEMI): randomised, multicentre, noninferiority trial. *BMJ* 2018; **363**:k3793.
199 Dargham BB, Baskar A, Tejani I, *et al.* Intravenous antiplatelet therapy bridging in patients undergoing cardiac or non-cardiac surgery following percutaneous coronary intervention. *Cardiovasc Revasc Med* 2019; **20**:805–811.
200 Chu EW, Chernoguz A, Divino CM. The evaluation of clopidogrel use in perioperative general surgery patients: a prospective randomized controlled trial. *Am J Surg* 2016; **211**:1019–1025.
201 Delto JC, Fleishman A, Chang P, *et al.* Perioperative aspirin use is associated with bleeding complications during robotic partial nephrectomy. *J Urol* 2022; **207**:277–283.
202 Gelli M, Allard MA, Farges O, *et al.*, Association de Chirurgie Hépato-Biliaire et de Transplantation (ACHBT) French Hepatectomy Study Group. Use of aspirin and bleeding-related complications after hepatic resection. *Br J Surg* 2018; **105**:429–438.
203 Grand MG, Walia HS. Hemorrhagic risk of vitreoretinal surgery in patients maintained on novel oral anticoagulant therapy. *Retina* 2016; **36**:299–304.
204 Hite N, Klinger AL, Miller P, *et al.* Clopidogrel bisulfate (Plavix) does not increase bleeding complications in patients undergoing rubber band ligation for symptomatic hemorrhoids. *J Surg Res* 2018; **229**:230–233.
205 Inoue T, Mizutamari M, Hatake K. Safety of continuous low-dose aspirin therapy for cervical laminoplasty. *Spine Surg Relat Res* 2022; **6**:240–246.
206 Kubota M, Matsuoka T, Yamasaki T, *et al.* Effect of continued perioperative anticoagulant therapy on bleeding outcomes following robot-assisted radical prostatectomy. *Urology* 2021; **148**:151–158.
207 Kulkarni AG, Patel J, Khandge A, *et al.* The practice of continuation of antiplatelet therapy during the perioperative period in lumbar minimally invasive spine surgery (MISS): how different is the morbidity in this scenario? *Spine* 2020; **45**:673–678.
208 Poon MTC, Rea C, Kolias AG, *et al.* Influence of antiplatelet and anticoagulant drug use on outcomes after chronic subdural hematoma drainage. *J Neurotrauma* 2021; **38**:1177–1184.

209 Smilowitz NR, Oberweis BS, Nukala S, *et al.* Perioperative antiplatelet therapy and cardiovascular outcomes in patients undergoing joint and spine surgery. *J Clin Anesth* 2016; **35**:163–169.
210 Strosberg DS, Corbey T, Henry JC, *et al.* Preoperative antiplatelet use does not increase incidence of bleeding after major operations. *Surgery* 2016; **160**:968–976.
211 Wessels F, Kriegmair MC, Oehme A, *et al.* Radical cystectomy under continuous antiplatelet therapy with acetylsalicylic acid. *Eur J Surg Oncol* 2019; **45**:1260–1265.
212 Yan Z, Liu Y, Ruze R, *et al.* Continuation of low-dose acetylsalicylic acid during perioperative period of laparoscopic inguinal hernia repair is safe: results of a prospective clinical trial. *Hernia* 2019; **23**:1141–1148.
213 Lee PW, Levy M. Risk of hematoma from aspirin or clopidogrel owing to lumbar puncture. *Mayo Clin Proc* 2019; **94**:1552–1555.
214 Deng HY, Shi CL, Li G, *et al.* The safety profile of preoperative administration of heparin for thromboprophylaxis in Chinese patients intended for thoracoscopic major thoracic surgery: a pilot randomized controlled study. *J Thorac Dis* 2017; **9**:1065–1072.
215 Rodriguez A, Guilera N, Mases A, *et al.*, REGISTRESTENTS group. Management of antiplatelet therapy in patients with coronary stents undergoing noncardiac surgery: association with adverse events. *Br J Anaesth* 2018; **120**:67–76.
216 Ito T, Derweesh IH, Ginzburg S, *et al.* Perioperative outcomes following partial nephrectomy performed on patients remaining on antiplatelet therapy. *J Urol* 2017; **197**:31–36.
217 Raggio BS, Barton BM, Kandil E, *et al.* Association of continued preoperative aspirin use and bleeding complications in patients undergoing thyroid surgery. *JAMA Otolaryngol Head Neck Surg* 2018; **144**:335–341.
218 Jones DW, SchermerhornF ML. Brooke BS, *et al.* Perioperative clopidogrel is associated with increased bleeding and blood transfusion at the time of lower extremity bypass. *J Vasc Surg* 2017; **65**:1719.e1–1728.e1.
219 Modasi A, Dang JT, Afraz S, *et al.* Bariatric surgery outcomes in patients on preoperative therapeutic anticoagulation: an analysis of the 2015 to 2017 MBSAQIP. *Obes Surg* 2019; **29**:3432–3442.
220 Ono S, Ishikawa M, Matsuda K, *et al.* Clinical impact of the perioperative management of oral anticoagulants in bleeding after colonic endoscopic mucosal resection. *BMC Gastroenterol* 2019; **19**:206.
221 Rocha AL, Souza AF, Martins MAP, *et al.* Oral surgery in patients under antithrombotic therapy: perioperative bleeding as a significant risk factor for postoperative hemorrhage. *Blood Coagul Fibrinolysis* 2018; **29**:97–103.
222 Saba ES, Higgins MK, Heyes R, *et al.* Is continued perioperative antithrombotic therapy safe when performing direct microlaryngoscopy? *Laryngoscope* 2020; **130**:2853–2858.
223 Yang J, Liu Q, Mo S, *et al.* The effect of preoperative antiplatelet therapy on early postoperative rehemorrhage and outcomes in patients with spontaneous intracranial hematoma. *Front Aging Neurosci* 2021; **13**:681998.
224 Borges J, Almeida PA, Nascimento MMGD, *et al.* Factors associated with inadequate management of antiplatelet agents in perioperative period of non-cardiac surgeries. *Arq Bras Cardiol* 2018; **111**:596–604.
225 Wang C, Liu Q, Sun L, *et al.* Application of thrombelastography in primary total knee and total hip replacement: a prospective 87 patients study. *Blood Coagul Fibrinolysis* 2019; **30**:281–290.
226 Oo J, Allen M, Loveday BPT, *et al.* Coagulation in liver surgery: an observational haemostatic profile and thromboelastography study. *ANZ J Surg* 2020; **90**:1112–1118.
227 De Pietri L, Bianchini M, Montalti R, *et al.* Thrombelastography-guided blood product use before invasive procedures in cirrhosis with severe coagulopathy: a randomized, controlled trial. *Hepatology* 2016; **63**:566–573.
228 Zhang XC, Sun MJ, Pan S, *et al.* Intravenous administration of tranexamic acid in total hip arthroplasty does not change the blood coagulopathy: a prospective thrombelastography analysis. *J Orthop Surg (Hong Kong)* 2020; **28**:2309499020959516.
229 Connell NT, Flood VH, Brignardello-Petersen R, *et al.* ASH ISTH NHF WFH 2021 guidelines on the management of von Willebrand disease. *Blood Adv* 2021; **5**:301–325.
230 Srivastava A, Santagostino E, Dougall A, *et al.*, WFH Guidelines for the Management of Hemophilia panelists and co-authors. WFH guidelines for the management of hemophilia, 3rd edition. *Haemophilia* 2020; **26 (Suppl 6)**:1–158.
231 Chapin J, Bamme J, Hsu F, *et al.* Outcomes in patients with hemophilia and von Willebrand disease undergoing invasive or surgical procedures. *Clin Appl Thromb Hemost* 2017; **23**:148–154.
232 Escobar MA, Auerswald G, Austin S, *et al.* Experience of a new high-purity factor X concentrate in subjects with hereditary factor X deficiency undergoing surgery. *Haemophilia* 2016; **22**:713–720.
233 Negrier C, Abdul Karim F, Lepatan LM, *et al.* Efficacy and safety of long-acting recombinant fusion protein linking factor IX with albumin in haemophilia B patients undergoing surgery. *Haemophilia* 2016; **22**: e259–e266.
234 Zozulya N, Kessler CM, Klukowska A, *et al.* Efficacy and safety of Nuwiq ((R)) (human-cl rhFVIII) in patients with severe haemophilia A undergoing surgical procedures. *Haemophilia* 2018; **24**:70–76.
235 Hazendonk HC, Lock J, Mathot RA, *et al.* Perioperative treatment of hemophilia A patients: blood group O patients are at risk of bleeding complications. *J Thromb Haemost* 2016; **14**:468–478.
236 Rugeri L, d'Oiron R, harroche A, *et al.* Effectiveness and safety of hFVIII/VWF concentrate (Voncento((R))) in patients with inherited von Willebrand disease requiring surgical procedures: the OPALE multicentre observational study. *Blood Transfus* 2021; **19**:152–157.
237 van Moort I, Preijers T, Bukkems LH, *et al.*, OPTI-CLOT study group. Perioperative pharmacokinetic-guided factor VIII concentrate dosing in haemophilia (OPTI-CLOT trial): an open-label, multicentre, randomised, controlled trial. *Lancet Haematol* 2021; **8**:e492–e502.
238 Riedel B, Li MH, Lee CHA, *et al.*, METS Study Investigators. A simplified (modified) Duke Activity Status Index (M-DASI) to characterise functional capacity: a secondary analysis of the Measurement of Exercise Tolerance before Surgery (METS) study. *Br J Anaesth* 2021; **126**:181–190.
239 Fried LP, Tangen CM, Walston J, *et al.*, Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 2001; **56**:M146–M156.
240 Lin HS, Watts JN, Peel NM, *et al.* Frailty and postoperative outcomes in older surgical patients: a systematic review. *BMC Geriatr* 2016; **16**:157.
241 Di Donato V, Caruso G, Bogani G, *et al.* Preoperative frailty assessment in patients undergoing gynecologic oncology surgery: a systematic review. *Gynecol Oncol* 2021; **161**:11–19.
242 Roller-Wirnsberger R, Lindner S, Liew A, *et al.* European Collaborative and Interprofessional Capability Framework for Prevention and Management of Frailty-a consensus process supported by the Joint Action for Frailty Prevention (ADVANTAGE) and the European Geriatric Medicine Society (EuGMS). *Aging Clin Exp Res* 2020; **32**:561–570.
243 Chow WB, Rosenthal RA, Merkow RP, *et al.*, American College of Surgeons National Surgical Quality Improvement Program, American Geriatrics Society. Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. *J Am Coll Surg* 2012; **215**:453–466.
244 Shulman MA, Wallace S, Gilbert A, *et al.* Predicting death or disability after surgery in the older adult. *Anesthesiology* 2023; **139**:420–431.
245 Eagle KA, Rihal CS, Mickel MC, *et al.* Cardiac risk of noncardiac surgery: influence of coronary disease and type of surgery in 3368 operations. CASS Investigators and University of Michigan Heart Care Program. Coronary Artery Surgery Study. *Circulation* 1997; **96**:1882–1887.
246 Schwarze ML, Barnato AE, Rathouz PJ, *et al.* Development of a list of high-risk operations for patients 65 years and older. *JAMA Surg* 2015; **150**:325–331.
247 Aucoin SD, Hao M, Sohi R, *et al.* Accuracy and feasibility of clinically applied frailty instruments before surgery: a systematic review and meta-analysis. *Anesthesiology* 2020; **133**:78–95.
248 McIsaac DI, Harris EP, Hladkowicz E, *et al.* Prospective comparison of preoperative predictive performance between 3 leading frailty instruments. *Anesth Analg* 2020; **131**:263–272.
249 Rabelo LG, Bjornsdottir A, Jonsdottir AB, *et al.* Frailty assessment tools and associated postoperative outcomes in older patients undergoing elective surgery: a prospective pilot study. *Acta Anaesthesiol Scand* 2023; **67**:150–158.
250 Berkel AEM, Bongers BC, Kotte H, *et al.* Effects of community-based exercise prehabilitation for patients scheduled for colorectal surgery with high risk for postoperative complications: results of a randomized clinical trial. *Ann Surg* 2022; **275**:e299–e306.
251 Barberan-Garcia A, Ubre M, Roca J, *et al.* Personalised prehabilitation in high-risk patients undergoing elective major abdominal surgery: a randomized blinded controlled trial. *Ann Surg* 2018; **267**:50–56.
252 McIsaac DI, Hladkowicz E, Bryson GL, *et al.* Home-based prehabilitation with exercise to improve postoperative recovery for older adults with frailty having cancer surgery: the PREHAB randomised clinical trial. *Br J Anaesth* 2022; **129**:41–48.
253 Ausania F, Senra P, Melendez R, *et al.* Prehabilitation in patients undergoing pancreaticoduodenectomy: a randomized controlled trial. *Rev Esp Enferm Dig* 2019; **111**:603–608.
254 Gade J, Levring T, Hillingsø JG, *et al.* The effect of preoperative oral immunonutrition on complications and length of hospital stay after elective surgery for pancreatic cancer–a randomized controlled trial. *Nutr Cancer* 2016; **68**:225–233.

255 Fiorindi C, Cuffaro F, Piemonte G, *et al.* Effect of long-lasting nutritional prehabilitation on postoperative outcome in elective surgery for IBD. *Clin Nutr* 2021; **40**:928–935.
256 Mueller SA, Mayer C, Bojaxhiu B, *et al.* Effect of preoperative immunonutrition on complications after salvage surgery in head and neck cancer. *J Otolaryngol Head Neck Surg* 2019; **48**:25.
257 Gilbert T, Bernard L, Alexandre M, *et al.*, Anc Working Group. Impact of a geriatric intervention to improve screening and management of undernutrition in older patients undergoing surgery for colorectal cancer: results of the ANC Stepped-Wedge Trial. *Nutrients* 2021; **13**:2347.
258 Zampieri FG, Lone NI, Bagshaw SM. Admission to intensive care unit after major surgery. *Intensive Care Med* 2023; **49**:575–578.
259 Wunsch H, Gershengorn HB, Cooke CR, *et al.* Use of intensive care services for medicare beneficiaries undergoing major surgical procedures. *Anesthesiology* 2016; **124**:899–907.
260 Ohbe H, Matsui H, Kumazawa R, *et al.* Postoperative ICU admission following major elective surgery: a nationwide inpatient database study. *Eur J Anaesthesiol* 2022; **39**:436–444.
261 Kahan BC, Koulenti D, Arvaniti K, *et al.*, International Surgical Outcomes Study (ISOS) group. Critical care admission following elective surgery was not associated with survival benefit: prospective analysis of data from 27 countries. *Intensive Care Med* 2017; **43**:971–979.
262 Gillies MA, Harrison EM, Pearse RM, *et al.* Intensive care utilization and outcomes after high-risk surgery in Scotland: a population-based cohort study. *Br J Anaesth* 2017; **118**:123–131.
263 Reuter S, Schmalfeldt B, Haas SA, *et al.* Impact of introducing a PACU24 concept on the perioperative outcome of patients with advanced ovarian cancer treated with cytoreductive surgery. *Geburtshilfe Frauenheilkd* 2023; **83**:1022–1030.
264 Labmayr V, Rief M, Reinbacher P, *et al.* Simplified pain management including fentanyl TTS in PACU patients with hip fracture surgery to improve patients' well being: a double-blind randomized trial. *J Perianesth Nurs* 2023; **19**:461–467.
265 Skovbye M, Mølgaard J, Rasmussen SM, *et al.* The association between vital signs abnormalities during postanaesthesia care unit stay and deterioration in the general ward following major abdominal cancer surgery assessed by continuous wireless monitoring. *Crit Care Resusc* 2022; **24**:330–340.
266 Ludbrook G, Grocott MPW, Heyman K, *et al.* Outcomes of postoperative overnight high-acuity care in medium-risk patients undergoing elective and unplanned noncardiac surgery. *JAMA Surg* 2023; **158**:701–708.
267 Holst JJ, Orskov C. The incretin approach for diabetes treatment: modulation of islet hormone release by GLP-1 agonism. *Diabetes* 2004; **53 Suppl 3**:S197–204.
268 Trujillo J. Safety and tolerability of once-weekly GLP-1 receptor agonists in type 2 diabetes. *J Clin Pharm Ther* 2020; **45 Suppl 1**:43–60.
269 Urva S, Coskun T, Loghin C, *et al.* The novel dual glucose-dependent insulinotropic polypeptide and glucagon-like peptide-1 (GLP-1) receptor agonist tirzepatide transiently delays gastric emptying similarly to selective long-acting GLP-1 receptor agonists. *Diabetes Obes Metab* 2020; **22**:1886–1891.
270 Klein SR, Hobai IA. Semaglutide, delayed gastric emptying, and intraoperative pulmonary aspiration: a case report. *Can J Anaesth* 2023; **70**:1394–1396.
271 Silveira SQ, da Silva LM, de Campos Vieira Abib A, *et al.* Relationship between perioperative semaglutide use and residual gastric content: a retrospective analysis of patients undergoing elective upper endoscopy. *J Clin Anesth* 2023; **87**:111091.
272 Wilson PR, Bridges KH, Wilson SH. Particulate gastric contents in patients prescribed glucagon-like peptide 1 receptor agonists after appropriate perioperative fasting: a report of 2 cases. *A A Pract* 2023; **17**: e01712.
273 Pfeifer KJ. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Task Force on Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration. *Anesthesiology* 2017; **126**:376–393.
274 Smith I, Kranke P, Murat I, *et al.*, European Society of Anaesthesiology. Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. *Eur J Anaesthesiol* 2011; **28**:556–569.
275 Girish PJ, Abdelmalak BB, Weigal WA, *et al.*, American Society of Anesthesiologists (ASA) Task Force on Preoperative Fasting. *American Society of Anesthesiologists consensus-based guidance on preoperative management of patients (adults and children) on glucagon-like peptide-1 (GLP-1) receptor agonists* 2023; [cited 6 February 2024].
276 Pfeifer KJ, Selzer A, Mendez CE, *et al.* Preoperative management of endocrine, hormonal, and urologic medications: Society for Perioperative Assessment and Quality Improvement (SPAQI) Consensus Statement. *Mayo Clin Proc* 2021; **96**:1655–1669.
277 Parkman HP, Rim DS, Anolik JR, *et al.* Glucagonlike peptide-1 receptor agonists: the good, the bad, and the ugly-benefits for glucose control and weight loss with side effects of delaying gastric emptying. *J Nucl Med Technol* 2024; **52**:3–7.
278 Giron-Arango L, Perlas A. Point-of-care gastric ultrasound to identify a full stomach on a diabetic patient taking a glucagon-like peptide 1 receptor agonist. *A A Pract* 2024; **18**:e01751.
279 El-Boghdadly K, Wojcikiewicz T, Perlas A. Perioperative point-of-care gastric ultrasound. *BJA Educ* 2019; **19**:219–226.
280 AD Society. Periprocedural diabetic ketoacidoss (DKA) with SGLT2 inhibitor use. 2020 [cited 6 February 2024]
281 Pujara S, Ioachimescu A. Prolonged ketosis in a patient with euglycemic diabetic ketoacidosis secondary to dapagliflozin. *J Investig Med High Impact Case Rep* 2017; **5**:2324709617710040.
282 Wang KM, Isom RT. SGLT2 inhibitor-induced euglycemic diabetic ketoacidosis: a case report. *Kidney Med* 2020; **2**:218–221.
283 Thiruvenkatarajan V, Meyer EJ, Nanjappa N, *et al.* Perioperative diabetic ketoacidosis associated with sodium-glucose co-transporter-2 inhibitors: a systematic review. *Br J Anaesth* 2019; **123**:27–36.
284 Meyer EJ, Thiruvenkatarajan V, Jesudason D. Sodium-glucose cotransporter type 2 inhibitors: managing the small but critical risk of diabetic ketoacidosis. *Med J Aust* 2021; **214**:93.e1–93.e1.
285 Kilpatrick ES, Butler AE, Ostlundh L, *et al.* Controversies around the measurement of blood ketones to diagnose and manage diabetic ketoacidosis. *Diabetes Care* 2022; **45**:267–272.
286 Tremblay ES, Millington K, Monuteaux MC, *et al.* Plasma beta-hydroxybutyrate for the diagnosis of diabetic ketoacidosis in the emergency department. *Pediatr Emerg Care* 2021; **37**:e1345–e1350.
287 Sacks DB, Bruns DE, Goldstein DE, *et al.* Guidelines and recommendations for laboratory analysis in the diagnosis and management of diabetes mellitus. *Clin Chem* 2011; **57**:e1–e47.
288 Raiten JM, Morlok A, D'Ambrosia S, *et al.* Perioperative management of patients receiving sodium-glucose cotransporter 2 inhibitors: development of a clinical guideline at a large academic medical center. *J Cardiothorac Vasc Anesth* 2024; **38**:57–66.
289 Panzer O. Gastric ultrasound assessment for patients taking GLP1 agonists. 2023 [cited 6 February 2024]; ClinicalTrials.gov Identifier: NCT06003985]. Available at: https://classic.clinicaltrials.gov/ct2/show/NCT06003985.
290 Sen S. Gastric ultrasound assessment for preoperative prandial state of patients taking glucagon-like peptide-1 receptor agonists. 2023 [cited 6 February 2024]
291 Wolla, C. Effects of GLP-1 agonists on gastric volume. 2023 [cited 6 February 2024]. Available at: https://classic.clinicaltrials.gov/ct2/show/NCT05854979?cond=GLP1+agonist+and+gastric+ultrasound&draw=2&rank=4.
292 Vascular Events in Noncardiac Surgery Patients Cohort Evaluation (VISION) Study InvestigatorsSpence J, LeManach Y, *et al.* . Association between complications and death within 30 days after noncardiac surgery. *CMAJ* 2019; **191**:E830–E837.
293 Egbert LD, Battit G, Turndorf H, *et al.* The value of the preoperative visit by an anesthetist. A study of doctor-patient rapport. *JAMA* 1963; **185**:553–555.