

Preoperative evaluation of the adult patient undergoing non-cardiac surgery: guidelines from the European Society of Anaesthesiology

Stefan De Hert, Georgina Imberger, John Carlisle, Pierre Diemunsch, Gerhard Fritsch, Iain Moppett, Maurizio Solca, Sven Staender, Frank Wappler and Andrew Smith, the Task Force on Preoperative Evaluation of the Adult Noncardiac Surgery Patient of the European Society of Anaesthesiology

The purpose of these guidelines on the preoperative evaluation of the adult non-cardiac surgery patient is to present recommendations based on available relevant clinical evidence. The ultimate aims of preoperative evaluation are two-fold. First, we aim to identify those patients for whom the perioperative period may constitute an increased risk of morbidity and mortality, aside from the risks associated with the underlying disease. Second, this should help us to design perioperative strategies that aim to reduce additional perioperative risks. Very few well performed randomised studies on the topic are available and many recommendations rely heavily on expert opinion and are adapted specifically to the healthcare systems in individual countries. This report aims to provide an overview of current knowledge on the subject with an assessment of the quality of the evidence in order to allow anaesthetists all over Europe to integrate – wherever possible – this knowledge into daily patient care. The Guidelines Committee of the European Society of Anaesthesiology (ESA) formed a task force with

members of subcommittees of scientific subcommittees and individual members of the ESA. Electronic databases were searched from the year 2000 until July 2010 without language restrictions. These searches produced 15 425 abstracts. Relevant systematic reviews with meta-analyses, randomised controlled trials, cohort studies, case–control studies and cross-sectional surveys were selected. The Scottish Intercollegiate Guidelines Network grading system was used to assess the level of evidence and to grade recommendations. The final draft guideline was posted on the ESA website for 4 weeks and the link was sent to all ESA members, individual or national (thus including most European national anaesthesia societies). Comments were collated and the guidelines amended as appropriate. When the final draft was complete, the Guidelines Committee and ESA Board ratified the guidelines. *Eur J Anaesthesiol* 2011;28:684–722

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PREAMBLE

The purpose of these guidelines is to present recommendations based on available relevant clinical evidence on the topic. The information comes not only from high-quality randomised clinical trials or meta-analyses but also from cohort studies and even expert opinion statements. Ultimately, these recommendations should

help physicians in the decision making in their clinical practice.

Clinical practice over Europe varies widely. The way in which healthcare services are organised and specific national jurisprudence may have a significant impact on how this scientific evidence will be implemented in the various European countries, despite the availability of the same scientific information. For instance, a Dutch study in 4540 adult surgical patients suggested that trained nurses were perfectly capable of assessing the preoperative health status of surgical patients as compared with anaesthesiologists, thereby providing scientific basis for a potential place for nurses in the preoperative assessment of patients.¹ Yet, in a number of European countries nurses are not legally allowed to perform preoperative evaluations of patients. Hence, this particular scientific information might result in a recommendation

From the Department of Anaesthesiology, Ghent University Hospital, Ghent University, Ghent, Belgium (SDH), Cochrane Anaesthesia Review Group, Rigshospitalet, Copenhagen, Denmark (GI), Department of Anaesthesia and Peri-operative Medicine, Torbay Hospital, Torquay, Devon, UK (JC), Service d'Anesthésie Réanimation Chirurgicale, Hôpital de Haute-pierre, University Hospital of Strasbourg, Strasbourg, France (PD), Department of Anaesthesiology, Peri-operative Medicine and Intensive Care Medicine, Paracelsus Medical University, Salzburg, Austria (GF), Division of Anaesthesia and Intensive Care, University of Nottingham, Nottingham, UK (IM), Department of Anaesthesiology, Azienda Ospedaliera di Melegnano, Milan, Italy (MS), Department of Anaesthesiology and Intensive Care, Spital Männedorf, Männedorf, Switzerland (SS), Department of Anaesthesiology and Operative Intensive Care Medicine, University Hospital Witten/Herdecke, Cologne, Germany (FW) and Department of Anaesthesiology, University of Lancaster, Lancaster, UK (AS)

Correspondence to Stefan De Hert, MD, PhD, Professor of Anaesthesiology, Department of Anaesthesiology, Ghent University Hospital, Ghent University, De Pintelaan 185, B-9000 Ghent, Belgium
Tel: +32 9 332 3281; fax: +32 9 332 4987; e-mail: stefan.dehert@ugent.be

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to include nurses in the preoperative assessment in some countries, whereas in other countries local legislation might preclude such an approach.

The European Society of Anaesthesiology (ESA) is committed to the production of high-quality, evidence-based clinical guidelines and recommendations. The Guidelines Committee of the ESA defines the topics to be examined which are then referred to specific Task Forces. These Task Forces refine the questions and propose guidelines based on their critical appraisal of the available literature.

Several European national anaesthesiology societies have already produced local recommendations concerning preoperative evaluation of the adult non-cardiac surgery patients. Following a request by the ESA to all European national societies, national guidelines and recommendations from Austria, Belgium, the Czech Republic, Finland, the Netherlands, Norway, Slovenia, Sweden and UK were made available to the Task Force.

Very few well performed randomised studies on the topic are available and many recommendations in these reports rely heavily on expert opinion and are adapted specifically to the healthcare systems in the individual countries. This report aims to provide an overview of current knowledge on the subject with an assessment of the quality of the evidence in order to allow anaesthesiologists all over Europe to integrate – wherever possible – this knowledge in daily patient care.

The potential legal implications may be an area of concern.² It cannot be overemphasised that guidelines may not be appropriate for all clinical situations. The decision whether or not to follow a recommendation from a guideline must be made by the responsible physician on an individual basis, taking into account both the specific conditions of the patient and the available resources. Therefore, deviations from guidelines for specific reasons remain possible and certainly should not be interpreted as a basis for claims of negligence.

The ESA Guidelines Committee selected the system for assessing levels of evidence and grading recommendations proposed by the Scottish Intercollegiate Guidelines Network (SIGN), as outlined in Tables 1 and 2. This selection was made because this system provides a thorough categorisation of levels of evidence, including an assessment of quality and also includes observational studies.

The ESA Guidelines Committee supervises and coordinates the preparation of new guidelines. Once the document was finalised, it was submitted to outside specialists for review and comments. The document was then revised and finally approved by the ESA Guidelines Committee and the ESA board. After final approval, the ESA is responsible for the publication of the guidelines. A regular update of the guidelines is planned.

Table 1 Levels of evidence

1++	High-quality meta-analyses Systematic reviews of RCTs RCTs with a very low risk of bias
1+	Well conducted meta-analyses Systematic reviews of RCTs RCTs with a low risk of bias
1–	Meta-analyses systematic reviews of RCTs RCTs with a high risk of bias
2++	High-quality systematic reviews of case-control or cohort studies High-quality case-control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well conducted case-control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2–	Case-control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytical studies (case reports, case series, etc.)
4	Expert opinion

RCT, randomised clinical trial.

INTRODUCTION

The present guidelines deal with the preoperative evaluation of the adult patient undergoing elective, non-cardiac surgery. The ultimate aims of this evaluation are two-fold. First is the identification of those patients for whom the perioperative period may constitute an increased risk of morbidity and mortality, aside from the risks associated with the underlying disease. Second, this identification should help to design perioperative strategies that aim to reduce additional perioperative risks.

A wide variety of surgical procedures need collaboration with anaesthesiology. As surgical techniques become increasingly complex, the physical fitness required of patients as well as the surgical impact on perioperative risk increases. Surgical risk may vary tremendously, depending on duration of procedure, estimated blood-loss, estimated fluid shifts and anatomical region.^{3–6} Cardiac risk has been described by a three-part classification that distinguishes between low-risk, intermediate-risk and high-risk procedures according to the AHA/ACC

Table 2 Grades of recommendation

A	At least one meta-analysis, systematic review of RCTs or RCT rated as 1++ and directly applicable to the target population or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population and with an overall consistency of results
B	A body of evidence including studies rated as 2++, directly applicable to the target population and with an overall consistency of results or extrapolated evidence from studies rated as 1++ or 1+
C	A body of evidence including studies rated as 2+, directly applicable to the target population and with an overall consistency of results or extrapolated evidence from studies rated as 2++
D	Evidence level 3 or 4 or extrapolated evidence from studies rated as 2+

RCT, randomised clinical trial.

guideline and the guideline of the European Society of Cardiology (ESC).⁷⁻⁹ Therefore, in order to stratify overall perioperative risk, it is essential to consider the nature and duration of a surgical procedure.

Risk factors are, therefore, not only patient-related and surgery-related but are also organisation-related. Not all of these can be covered by recommendations. In addition, reliable clinical evidence on many issues is scarce and of low quality or even absent. Therefore, wherever possible, recommendations will be provided on the basis of the best available evidence and when this is not possible, the recent available evidence will be summarised.

The task force addressed the following fundamental questions:

How should a preoperative consultation clinic be organised?

This organisational aspect is addressed by assessing the evidence regarding the following questions:

How, when and by whom should patients be evaluated preoperatively?

This first part of this question assessed the evidence about the different tools available that help to screen patients preoperatively such as paper or website questionnaire to be completed by patients, interview by a nurse or a physician and others.

The background for the second part of the question was concerned with optimisation of the patient's condition when risk factors are present. This implies that patients should be seen sufficiently in advance to allow for measures to be instituted. This question assessed the information and evidence about whether timing of the preoperative assessment affects outcome.

The third part of the question evaluated the evidence regarding the qualifications necessary to perform the preoperative evaluation: nurse, family physician/general practitioner, anaesthesiologist or others?

How should a preoperative assessment of a patient be performed?

We decided to apply a stepwise approach using a number of successive questions; for each question, the best available evidence was sought and assessed for quality. This practical aspect is addressed by assessing the evidence about the available information on the following issues:

Specific clinical conditions in which the patients should undergo more extensive testing

Every patient should be checked for specific conditions that might interfere with anaesthesia and surgery and which should be evaluated further and potentially treated. Uncommon diseases and endocrinological disorders other than diabetes were not included in the present

overview because these represent specific entities in which specialised diagnosis, treatment and advice on perioperative support and treatment are always indicated.

Pregnancy was deliberately not included in the present guidelines, as it represents a specific entity with its own associated physiological changes, possible co-morbidities and potential risks that deserve separate guidelines.

The following conditions/factors were assessed:

- Cardiovascular disease
- Respiratory disease, smoking and obstructive sleep apnoea syndrome (OSAS)
- Renal disease
- Diabetes mellitus
- Obesity
- Coagulation disorders
- Anaemia and preoperative blood conservation strategies
- The elderly
- Alcohol misuse and addiction
- Allergy

How to manage the following concurrent medication:

- Antithrombotic therapy and locoregional anaesthesia
- Herbal medication
- Psychotropic medications
- Perioperative bridging of anticoagulation therapy

Preoperative testing

This part provides recommendations on the preoperative tests to use.

Airway evaluation

This part discusses the modalities for preoperative airway evaluation.

Patient information

This part discusses the evidence concerning possible ways to inform the patient about the operation.

A number of these questions have been addressed recently by other task forces and we decided to refer to existing guidelines on specific topics such as preoperative testing guidelines, cardiovascular disease and anticoagulation.

METHODS

Selection of the task force

The Guidelines Committee of the ESA reviewed the fields of expertise of the subcommittees of the Scientific Committee. The committee decided that the following subcommittees were most relevant to preoperative evaluation: Evidence-Based Practice and Quality Improvement; Monitoring and Computing; Respiration; Circulation; Patient Safety and Airway Management. The committee asked the chairs of those subcommittees to nominate one member to join the task force and then

chose the chair of the task force by consensus. ESA members with expertise in preoperative evaluation and guideline development were co-opted onto the task force. In addition, the Cochrane Anaesthesia Review Group provided assistance with literature searching, critical appraisal and methodological advice.

Development of the guidelines

To develop the scope of the guidelines, the Task Force met and defined a series of key clinical questions about how anaesthetic preoperative evaluation should be conducted. These questions formed the basis for subsequent evidence review and the development of recommendations. We assigned a Task Force member to take primary responsibility for each question.

We designed search strategies to search for all the published evidence relevant to the key clinical questions. Search terms were chosen using the PICO (Population, Intervention, Comparison, Outcome) format in consultation with the member of the Task Force responsible for each key clinical question. We searched *Embase* and *MEDLINE*, using *Ovid*, from year 2000 until the present. We did not use language restrictions. The searches were undertaken between January 2010 and July 2010. Full details of each search, including the search terms used, the dates that each search was conducted and the number of abstracts are shown in Appendix 1, <http://links.lww.com/EJA/A22>.

In total, these searches produced 15 425 abstracts. We reviewed these abstracts and selected articles that were relevant to the key clinical questions. Specifically, we selected articles that investigated interventions that may be implemented by an anaesthesiologist in the preoperative period. We mainly included studies conducted in the context of a patient presenting prior to surgery. We included systematic reviews with meta-analyses, randomised controlled trials (RCTs), cohort studies, case-control studies and cross-sectional surveys. We did not include narrative reviews, editorials, case series or case reports.

Our goal was to include all relevant and robust evidence in these guidelines. Therefore, in some cases, we included trials from other sources. We re-conducted some searches, to cover specific clinical questions that emerged from the initial searches. We also considered references from included trials, sometimes leading to the inclusion of trials that had been published prior to 10 years ago. Finally, other trials were sourced from the personal clinical and academic experience of the Task Force members.

The expertise of the Task Force guided the selection of trials to be included, including a subjective assessment of the relevance of a study. Once selected, we reviewed the trials with regard to their quality and applicability. We used the SIGN grading system to assess the level of

evidence and to grade our recommendations.¹⁰ We assigned a level of evidence to each included study and graded our recommendation based on the body of evidence supporting them.

Review process

The final draft guideline underwent a review process previously agreed upon by the ESA Guidelines Committee and the Editor-in-Chief of the *European Journal of Anaesthesiology*. The draft was posted on the ESA website for 4 weeks and the link was sent to all ESA members, individual or national (thus including most European national anaesthesia societies). We invited comments within this 4-week consultation period. We also sent sections of the draft for review to scientific subcommittees members and external experts with specific expertise in these areas.

We collated the comments from all these sources and amended the guidelines as appropriate. When the final draft was complete, the Guidelines Committee and ESA Board ratified the guidelines.

HOW, WHEN AND BY WHOM SHOULD PATIENTS BE EVALUATED PREOPERATIVELY?

Introduction

The original questions ‘how should we screen patients who need to be evaluated preoperatively by the anaesthesiologist’, ‘at what time should the patient be seen preoperatively’ and ‘who should examine the patient’ have been consolidated into a single chapter. These items have many intersecting aspects and common political implications, as they are regulated by different requirements in different countries.

We assessed the best available evidence concerning the following:

- The tools to screen patient history and physical status (such as questionnaires, either paper-based or electronic-based, to be filled by the patient alone or in conjunction with a health professional; interviews by either medical or non-medical health professionals);
- the timing of preoperative assessment (including studies looking at preoperative interventions aimed at improving patient outcome);
- and the professional qualification necessary to perform the preoperative evaluation (nurse, physician assistant, family physician/general practitioner, surgeon, anaesthesia trainee or anaesthesia specialist).

MEDLINE and *Embase* for the period 2000 to May 2010 were searched (a few articles that appeared late in 1999 are also captured). Abstracts from 584 references in *MEDLINE* and 523 in *Embase* were reviewed. Thirty-eight studies were included initially, but only 28 were finally selected for quality and relevance to the topic.

Existing evidence

There exists a variety of methods for preoperative data collection (level of evidence: 3).¹¹ A standardised preoperative questionnaire has been demonstrated to be valid in detecting medically compromised patients in the dental surgery setting (level of evidence: 2+),¹² to possess a high degree of specificity for 12 common comorbid conditions in cataract patients¹³ (level of evidence: 2+) and to be able to detect, coupled with specific confirmatory tests, impaired haemostasis (level of evidence: 2+).¹⁴ However, preoperative questionnaire design is critical and crucial for the rate and accuracy of completion (level of evidence: 2-).¹⁵

As technology has evolved, so preoperative questionnaires have been transferred to computer-based systems or personal digital assistants (PDAs): touch screen computer technology has been demonstrated an accurate and efficient platform for patient self-administered preoperative questionnaires¹⁶ (level of evidence: 1-) and assessment with the help of PDAs has been suggested as being more complete than without (level of evidence: 3).¹⁷ In addition, computer-based self-assessment increases detection rates of alcohol use disorders (AUDs) (level of evidence: 3).¹⁸ However, such disorders deserve a more elaborated preoperative evaluation with additional diagnostic tools (level of evidence: 1-).¹⁹ We found only one contrary study²⁰ (level of evidence: 3) in which a short questionnaire proposed by the Dutch Health Council was not found to be useful in practice.

There is essentially no evidence regarding the effect of timing of preoperative evaluation on patient outcome. There exists a number of studies reporting the effect of preoperative interventions, notably smoking cessation, alcohol abstinence, optimisation of medical condition and weight loss, on outcome. The effects of these interventions are treated in more detail elsewhere, but as these interventions take time to implement, it is logical to infer that evaluation should be carried out with sufficient lead time to promote and implement them.

Particularly, medical optimisation is linked to reduced mortality and morbidity after major vascular surgery (level of evidence: 3),²¹ even if timing is not specified. Smoking cessation has definitely shown to be beneficial (level of evidence: 1+),²² even if an optimal duration has not been identified (level of evidence: 2++),²³ the majority of studies put it between 4 and 8 weeks (level of evidence: 1-,^{24,25} level of evidence: 1+^{26,27}), whereas shorter periods have less (level of evidence: 1-)^{28,29} or nil effect (level of evidence: 1-).³⁰

Short lasting alcohol abstinence (1 week) has not been shown to be beneficial (level of evidence: 2-),³¹ whereas longer (1 month) abstinence has demonstrated positive effects (level of evidence: 1-).³²

Trained nurses and physicians in training have been shown to be equivalent in assessing patients preoperatively, both in adult (level of evidence: 1+)³³ and paediatric (level of evidence: 1+) populations.³⁴ Interobserver reliability estimates between a nurse and an anaesthetist were similar to those previously demonstrated between two anaesthetists (level of evidence: 3).³⁵ Studies on a nurse-based model for screening all outpatients in a university-affiliated tertiary hospital daycare unit have shown good negative predictive value, moderate specificity and variable sensitivity (level of evidence: 2+).^{1,36} The role of the pharmacy can be very helpful in reducing postoperative medication discrepancies with the previous medical regimen (level of evidence: 1-,³⁷ level of evidence: 2-³⁸).

A recent study³⁹ (level of evidence: 3) reported on the questions of whether the same anaesthesiology specialist should evaluate the patient and subsequently provide anaesthesia service to them: although this is the preferred model of scientific and professional anaesthesia organisations throughout the world, and patients frequently request for such an approach, there is very little evidence to support it.

Recommendations

- (1) Preoperative standardised questionnaires may be helpful in improving anaesthesia evaluation in a variety of situations (grade of recommendation: D).
- (2) If a preoperative questionnaire is implemented, great care should be taken in its design (grade of recommendation: D), and a computer-based version should be used whenever possible (grade of recommendation: C).
- (3) Preoperative evaluation should be carried out with sufficient time before the scheduled procedure to allow for the implementation of any advisable preoperative intervention aimed at improving patient outcome (grade of recommendation: D).
- (4) Preoperative assessment should at least be completed by an anaesthetist (grade of recommendation: D), but the screening of patients could be carried out effectively either by trained nurses (grade of recommendation: C) or anaesthesia trainees (grade of recommendation: D).
- (5) A pharmacy personnel member may usefully be included in preoperative assessment, in order to reduce discrepancies in postoperative drug orders (grade of recommendation: C).
- (6) There is insufficient evidence to recommend that the preferred model is that a patient should be seen by the same anaesthetist from preoperative assessment through to anaesthesia administration (grade of recommendation: D).

HOW SHOULD PREOPERATIVE ASSESSMENT BE PERFORMED?

Specific clinical conditions in which the patients should undergo more extensive testing

Cardiovascular disease

Introduction

Perioperative cardiac complications can occur in patients with documented or asymptomatic ischaemic heart disease, ventricular dysfunction and valvular heart disease. It has been estimated that in non-cardiac surgery, major perioperative cardiac events may occur in up to 4% of cardiac patients and 1.4% of an unselected patient population.⁴⁰ Preoperative identification of patients at risk for developing perioperative cardiac problems and possible medical optimisation of the condition may potentially improve outcome.

Existing evidence

In 2007, the American College of Cardiology (ACC) and the American Heart Association (AHA) updated their 2002 guidelines on perioperative cardiovascular evaluation and care for non-cardiac surgery.⁷ This was followed by a new update in 2009 with regard to new insights in perioperative β -blocking therapy following the publication of the POISE study (level of evidence: 1+).^{9,41} Also in 2009, the ESC published guidelines for preoperative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery which were endorsed by the ESA.⁸ A key component in the preoperative assessment is the evaluation of the presence of active or unstable cardiac conditions (see below), surgical risk factors (Table 3), functional capacity of the patient [<4 or >4 metabolic equivalents (METs)] and the presence of cardiac risk factors (see below). The decisions regarding further testing and possible treatment should be taken in close cooperation with the cardiologist.

Active cardiac conditions that necessitate further evaluation and treatment before non-cardiac surgery are as follows:

- (1) Unstable coronary syndromes
 - (a) Unstable or severe angina
 - (b) Recent myocardial infarction (MI) (within 30 days)
- (2) Decompensated heart failure

- (3) Significant arrhythmias
 - (a) High-grade atrioventricular block
 - (b) Symptomatic ventricular arrhythmias
 - (c) Supraventricular arrhythmias with uncontrolled ventricular rate (>100 beats min^{-1} at rest)
 - (d) Symptomatic bradycardia
 - (e) Newly recognised ventricular tachycardia
- (4) Severe valvular disease
 - (a) Severe aortic stenosis (mean pressure gradient >40 mmHg, area <1 cm^2 or symptomatic)
 - (b) Symptomatic mitral stenosis

Clinical risk factors are as follows:

- (1) History of ischaemic myocardial disease
- (2) Current stable or history of heart failure
- (3) History of cerebrovascular disease
- (4) Diabetes (insulin dependent)
- (5) Renal failure (serum creatinine, SCr >2 mg dl^{-1})

We decided to follow the latter guidelines on preoperative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery. For these the reader is referred to the website www.escardio.org/guidelines and/or to either of the articles^{8,42}. With regard to preoperative treatment with β -blockers and statins, it should be noted that these guidelines underscore the importance of carefully titrating the dose which implies that treatment should ideally be started between 30 days and at least 1 week before surgery. Therefore, these guidelines should be interpreted within the constraints of logistics and infrastructure that allow patients to be seen sufficiently far in advance of surgery.

Recommendations

- (1) If active cardiac disease is suspected in a patient scheduled for surgery, the patient should be referred to a cardiologist for assessment and possible treatment (grade of recommendation: D).
- (2) In patients currently taking β -blocking or statin therapy, this treatment should be continued perioperatively (grade of recommendation: A).

Respiratory disease, smoking and obstructive sleep apnoea syndrome

Introduction

Postoperative pulmonary complications are a significant postoperative risk. Most important complications are

Table 3 Surgical risk estimates

High risk (cardiac risk $>5\%$)	Intermediate risk (cardiac risk 1–5%)	Low risk (cardiac risk $<1\%$)
Aortic surgery	Abdominal	Breast
Major vascular surgery	Carotid	Dental
Peripheral vascular surgery	Peripheral arterial angioplasty	Endocrine
	Endovascular aneurysm repair	Eye
	Head and neck surgery	Gynaecological
	Major neurologic/orthopaedic	Reconstructive
	Pulmonary	Minor orthopaedic
	Major urologic	Minor urologic

atelectasis, pneumonia, respiratory failure and exacerbation of chronic lung disease. Established risk factors are age [odds ratio for postoperative pulmonary complications 2.09 (confidence interval, CI 1.70–2.58) for patients aged 60–69 years and 3.04 (CI 2.11–4.39) for ages 70–79, both compared with patients younger than 60 years of age]; chronic obstructive lung disease (odds ratio 1.79, CI 1.44–2.22); cigarette use (odds ratio 1.26, CI 1.01–1.56); congestive heart failure (odds ratio 2.93, CI 1.02–8.43); functional dependence [for total functional dependence, odds ratio 2.51 (CI 1.99–3.15) and for partial dependence, odds ratio 1.64 (CI 1.36–2.01)]; and a higher ASA classification and prolonged duration of surgery (odds ratio 2.14, CI 1.33–3.46).^{43,44}

Additional risk factors (type of surgery, weight loss, cerebral vascular disease, long-term steroid use as well as alcohol use) have been identified and included in a risk index for predicting postoperative pneumonia after major non-cardiac surgery (level of evidence: 2–).⁴⁵

To guide the preoperative evaluation process, the following questions were addressed:

- (1) How should respiratory disease and OSAS be assessed?
- (2) Will optimisation and/or treatment alter outcome and if so, what intervention and at what time should it be done in the presence of respiratory disease, smoking and OSAS?

To answer these questions, *MEDLINE* and *Embase* for the period 2000 to June 2010 were searched: abstracts from 390 references in *MEDLINE* and 490 references in *Embase* were reviewed. All comparative studies investigating an intervention or assessment with regard to preoperative optimisation of respiratory disease were selected. Cardiac surgery studies and studies related to thoracic surgery or lung reduction surgery were excluded.

Existing evidence

How should respiratory disease and obstructive sleep apnoea syndrome be assessed?

Spirometry

Many studies on spirometry and pulmonary function tests relate to lung resection surgery or cardiac surgery and have been published mainly more than 10 years ago; therefore, they have been excluded from this review.

Spirometry has value in diagnosing obstructive lung disease, but it has not been shown to translate into effective risk prediction for individual patients. In addition, there are no data indicating a prohibitive threshold for spirometric values below which the risk for surgery would be unacceptable. Changes in clinical management due to findings from preoperative spirometry were also not reported.⁴⁶

One study (published in 2000) looked at 460 patients who underwent abdominal surgery. The authors reported that a predicted FEV₁ of less than 61%, and a *PaO*₂ less than 9.3 kPa (70 mmHg), the presence of ischaemic heart disease and advanced age, each were independent risk factors for postoperative pulmonary complications (level of evidence: 2–).⁴⁷

Chest radiography

Chest radiographs are ordered frequently as part of a routine preoperative evaluation. The evidence is poor and the related articles again mostly date before 2000 and, therefore, were not addressed in this review. However, chest radiographs are not predictive of postoperative pulmonary complications in a high percentage of patients. A change in management or cancellation of elective surgery was reported in only a fraction of patients.^{48,49}

A meta-analysis in 2006 on the value of routine preoperative testing identified eight studies published between 1980 and 2000 in which the corresponding authors looked at the impact of chest radiographs on a change on perioperative management. In only 3% of the cases in these studies, the chest radiograph influenced the management, even though 23.1% of preoperative chest radiographs in that sample were abnormal (level of evidence: 1+).⁴⁴

In a systematic review from 2005, the diagnostic yield of chest radiographs increased with age. However, most of the abnormalities consisted of chronic disorders such as cardiomegaly and chronic obstructive pulmonary disease (up to 65%). The rate of subsequent investigations was highly variable (4–47%). When further investigations were performed, the proportion of patients who had a change in management was low (10% of investigated patients). Postoperative pulmonary complications were also similar between patients who had preoperative chest radiographs (12.8%) and patients who did not (16%) (level of evidence: 1+).⁵⁰

Assessment of patients with obstructive sleep apnoea syndrome
OSAS has been identified as an independent risk factor for airway management difficulties in the immediate postoperative period.⁴⁴ In a cohort study from 2008, it was demonstrated that patients classified as OSAS risk have more airway-obstructive events postoperatively and more periods of desaturations (*S*po₂ less than 90%) in the first 12 h postoperatively (level of evidence: 2+).⁵¹

Data are scarce regarding the overall pulmonary complication rate. One case–control study with matched patients undergoing hip or knee replacement surgery reported that serious complications after surgery, such as unplanned days in ICU, tracheal reintubations and cardiac events, occurred significantly more often in patients with OSAS (24% compared with 9% of matched control patients) (level of evidence: 2+).⁵² A recent

cohort study also reported that postoperative cardio-respiratory complications were associated with a score indicating the existence of OSAS (level of evidence: 2+).⁵³

OSAS patients have been identified as having a higher risk of difficult airway management (level of evidence: 2+).⁵⁴ The American Society of Anesthesiologists addressed this issue in 2006 with practice guidelines including assessment of patients for possible OSAS before surgery and suggested careful postoperative monitoring for those suspected to be at high risk.⁵⁵ Therefore, the question of how to correctly identify patients with OSAS or at risk for OSAS is of importance.

Of the 25 eligible studies on that topic published between 2000 and June 2010, 10 dealt with measures to correctly identify patients with risk factors for OSAS. The 'gold standard' for diagnosis of sleep apnoea is an overnight sleep study (polysomnography). However, such testing is time consuming, expensive and unsuitable for screening purposes. The literature indicates that the most widely used screening tool for detecting sleep apnoea is the Berlin questionnaire (level of evidence: 2-).^{53,56,57} Overnight pulse oximetry may be an additional alternative to detect sleep apnoea (level of evidence: 2++).⁵⁸

Will optimisation and/or treatment alter outcome and if so, what intervention and at what time should it be done in the presence of respiratory disease, smoking and obstructive sleep apnoea?

Incentive spirometry and chest physical therapy

Most of the relevant studies deal with physical therapy after the operation. Although relevant from a clinical point of view, a systematic review from 2009 could not show a benefit from incentive spirometry on postoperative pulmonary complications after upper abdominal surgery, as the methodological quality of the included studies was only moderate and RCTs were lacking.⁵⁹ When it comes to preoperative optimisation, there are only limited data on possible effects of chest physical therapy or incentive spirometry for optimisation in non-cardiothoracic surgery. In a randomised trial of 50 patients scheduled for laparoscopic cholecystectomy, patients in one group were instructed to carry out incentive spirometry repeatedly for 1 week before surgery, whereas in the control group, incentive spirometry was carried out only during the postoperative period. Lung function tests were recorded at the time of pre-anaesthetic evaluation, on the day before the surgery, postoperatively at 6, 24 and 48 h, and at discharge. Significant improvement in lung function tests were seen at all study time points after preoperative incentive spirometry compared with patients in the control group (level of evidence: 2+).⁶⁰

Nutrition

Patients with severe pulmonary disease and many other causes may present for surgery with a very poor

nutritional status. This may be detrimental for two reasons. First, muscle mass may be diminished. This may lead to an early loss of muscle strength following only a few days of immobilisation or assisted ventilation in ICUs. Second, serum albumin concentrations are often reduced. This can lead to severe problems with oncotic pressure and fluid shifts. A low serum albumin level ($<30\text{ g l}^{-1}$) has been found to be an independent risk factor for postoperative pulmonary complications (level of evidence: 2+).⁶¹ In some cases (urgent or emergency operations), an improvement in the nutritional status is often impossible. In scheduled elective surgery on the contrary, improvements in nutritional status may be of benefit. However, there are only limited and conflicting data in this regard in the non-cardiothoracic surgery literature in the last 10 years under review (level of evidence: 2-).^{62,63}

Smoking cessation

Smoking is a known risk factor for impaired wound-healing and postoperative surgical sites of infection. A RCT of smoking cessation in 120 patients found a significantly reduced incidence of wound-related complications in the intervention (smoking cessation) group (5 vs. 31%, $P=0.001$) (level of evidence: 1-).²³

In 27 eligible studies, 17 articles addressed the issue of preoperative smoking cessation. Aspects such as duration of cessation necessary, methods to motivate cessation and impact on complications were covered. In a RCT (smoking cessation 4 weeks prior surgery vs. control group with no smoking cessation), an intention-to-treat analysis showed that the overall complication rate in the control group was 41% and in the intervention group 21% ($P=0.03$). Relative risk reduction for the primary outcome of any postoperative complication was 49% and number-needed-to-treat was five (95% CI 3–40) (level of evidence: 1-).⁶⁴

The authors of a systematic review from 2006 concluded that 6–8 weeks cessation of smoking has a beneficial effect on complications such as wound healing (level of evidence: 1-).²³ Smoking cessation 4 weeks prior to surgery also has an effect on the overall rate of postoperative complications (level of evidence: 1-).^{27,64} Short-term cessation (2–3 weeks before scheduled surgery) did not show a reduction in overall complications and wound healing in colorectal resection surgery, although this was a small study (level of evidence: 1-).²⁹ Nevertheless, short-term cessation has a beneficial effect on the amount of carboxyhaemoglobin and, therefore, should be recommended in order to improve oxygen transport capacity (level of evidence: 2+).⁶⁵

Different methods to motivate patients to stop smoking have been used. In almost all of the studies, some kind of nicotine replacement therapy was added to letters of recommendations, physician guidance or teaching

programmes. No single method proved to be superior to the others (level of evidence: 1–).⁶⁶

Optimisation in obstructive sleep apnoea syndrome

The goal of preoperative preparation is to improve or optimise an OSAS patient's perioperative physical status which includes preoperative continuous positive airway pressure (CPAP) or bi-level positive airway pressure; preoperative use of oral appliances for mandibular advancement; or preoperative weight loss. There is insufficient literature to evaluate the impact of any of these measures on perioperative outcomes, although expert opinion recommends these interventions (level of evidence: 4).⁵⁵

Recommendations

- (1) Preoperative diagnostic spirometry in non-cardiothoracic patients cannot be recommended to evaluate the risk of postoperative complications (grade of recommendation: D).
- (2) Routine preoperative chest radiographs rarely alter perioperative management of these cases. Therefore, it cannot be recommended on a routine basis (grade of recommendation: B).
- (3) Preoperative chest radiographs have a very limited value in patients older than 70 years with established risk factors (grade of recommendation: A).
- (4) Patients with OSAS should be evaluated carefully for a potential difficult airway and special attention is advised in the immediate postoperative period (grade of recommendation: C).
- (5) Specific questionnaires to diagnose OSAS can be recommended when polysomnography is not available (grade of recommendation: D).
- (6) Use of CPAP perioperatively in patients with OSAS may reduce hypoxic events (grade of recommendation: D).
- (7) Incentive spirometry preoperatively can be of benefit in upper abdominal surgery to avoid postoperative pulmonary complications (grade of recommendation: D).
- (8) Correction of malnutrition may be beneficial (grade of recommendation: D).
- (9) Smoking cessation before surgery is recommended. It must start early (at least 6–8 weeks prior to surgery, 4 weeks at a minimum) (grade of recommendation: B). A short-term cessation is only beneficial to reduce the amount of carboxyhaemoglobin in the blood in heavy smokers (grade of recommendation: D).

Renal disease

Introduction

Postoperative acute kidney injury (AKI) is associated with prolonged hospital stay, increased morbidity and mortality.^{67–69} The identification of patients at risk and their optimised preparation for non-cardiac surgery is of major importance. Patients with impaired renal function

require particular attention from the attending physician, as they are prone to perioperative complications.^{67,70–74} Several co-morbidities such as chronic heart disease, chronic obstructive lung disease, peripheral occlusive vascular disease and obesity have a major influence on the development of AKI^{6,75} and have to be taken into consideration when preparing patients for surgery.

In addition, the type of surgery may influence the outcome of patients with impaired renal function.^{68,72,73,76,77} Patients with pre-existing renal impairment are at risk of complications, particularly when they undergo vascular procedures such as carotid endarterectomy (level of evidence: 2+).^{70,73,76,77} In such cases, the impairment of renal function has direct relationship to severity and number of complications.^{73,76} Although there is conflicting evidence concerning mortality, pre-existing renal impairment can be worsened in patients undergoing endovascular abdominal aneurysm repair.^{67,78,79} Even a moderate preoperative elevation of SCr is associated with adverse outcomes such as complications and death in patients undergoing general surgery (level of evidence: 3).⁷²

In order to define the severity of AKI, the RIFLE classification of the Acute Kidney Injury Network can be applied.⁸⁰ RIFLE is categorised into five risk classes derived from either urine output, increase of SCr or decrease in glomerular filtration rate (GFR), respectively.

Existing evidence

How should the condition be assessed?

The medical history is usually the first step in preoperative assessment of patients scheduled for surgery. For patients at risk of AKI, several co-morbidities are known to be risk factors. Khetarpal *et al.* developed a score that predicts worsening of renal impairment and the incidence of AKI requiring dialysis in a study with prospectively collected data from 75 952 patients. The following risk factors were identified: intraperitoneal surgery (relative risk 3.3, 95% CI 2.4–4.7); moderate renal insufficiency (relative risk 3.2, 95% CI 2.8–3.7); mild renal insufficiency (relative risk 3.1, 95% CI 2.5–3.9); ascites (relative risk 3.0, 95% CI 2.2–4.0); active congestive heart failure (relative risk 2.0, 95% CI 1.4–3.0); emergency surgery (relative risk 1.9, 95% CI 1.5–2.3), age of at least 56 years (relative risk 1.7, 95% CI 1.4–2.2); diabetes requiring insulin therapy (relative risk 1.7, 95% CI 1.3–2.3); hypertension (relative risk 1.5, 95% CI 1.2–1.9); male sex (relative risk 1.4, 95% CI 1.2–1.7); and diabetes requiring oral medication (relative risk 1.3, 95% CI 1.0–1.7). The five preoperative risk classes that can be used for preoperative risk stratification for perioperative AKI are listed in Table 4 (level of evidence: 2++).⁶

SCr is widely used for the assessment of renal function in clinical practice. Although there is evidence of its accuracy to predict adverse renal outcome such as

Table 4 Preoperative risk classes

Risk class	Number of risk factors	Relative risk for the development of AKI (95% CI)
Class I	0–2	
Class II	3	4.0 (2.9–5.4)
Class III	4	8.8 (6.6–11.8)
Class IV	5	16.1 (11.9–21.8)
Class V	6 and more	46.3 (34.2–62.6)

AKI, acute kidney injury; CI, confidence interval. Data from Kheterpal *et al.*⁶

AKI,^{70,71,77,79} it represents an indirect parameter of renal function, as it is influenced by many non-renal factors such as BMI, age and sex. Both GFR and creatinine clearance (CrCl) (either calculated by the formula of Cockcroft and Gault or the MDRD formula) are able to improve the diagnostic accuracy over SCr alone.

MDRD formula⁸¹

$$\text{GFR (ml min}^{-1}\text{)} \times 1.73 \text{ m}^{-2} = 186 \times \text{Scr}^{-1.154} \times \text{age}^{-0.203} \text{ (years)} \times 0.742 \text{ (if female)} \times 1.212 \text{ (if African-American)}$$

Cockcroft and Gault formula⁸²

$$\text{GFR} = (140 - \text{age}) \times (\text{weight in kilograms}) \times 0.85 \text{ (if female)} / (72 \times \text{SCr})$$

GFR is a better predictor of impaired renal function in patients undergoing major surgery when renal disease is still subclinical (level of evidence: 2+).⁸³ In a study of 852 consecutive patients undergoing major vascular surgery, the calculated CrCl according to the Cockcroft and Gault formula was found to be superior to assessing SCr alone.⁸⁴ These findings were confirmed in patients undergoing cardiac surgery.^{85,86}

Future biomarkers

A series of newly developed biomarkers such as neutrophil gelatinase-associated lipocalin (NGAL), cystatin C (CyC), liver-type fatty acid-binding protein, interleukin-18 and kidney injury molecule-1 are gaining importance in clinical settings. NGAL is a marker of tubular stress with an earlier rise in urine than in serum after tubular injury. In cases of worsening renal function, NGAL levels precede the rise of SCr for more than 24 h. NGAL has been investigated only in the setting of cardiac surgery and intensive care patients as yet, but the results of these trials are promising.^{87–92} The level of CyC is determined by glomerular filtration and not by tubular stress. It is not influenced by age, sex, race, muscle mass, infection, liver disease or inflammatory disease unlike SCr.

What intervention should be done by the anaesthesiologist in the presence of the specific condition (and at what time)?

Until now, data on the prophylactic treatment of AKI in patients undergoing non-cardiac surgery have been lacking. There is growing evidence in the field of cardiac

surgery. Several studies have investigated the effects of *N*-acetylcysteine and fenoldapam on the development of postoperative AKI.^{93–98} Only the combination of *N*-acetylcysteine and fenoldapam reduces the decline of renal function after cardiac surgery (level of evidence: 1–).⁹⁴ Two studies concerning preoperative statin therapy and postoperative renal impairment have been identified.^{97,98} Both were retrospective association studies in patients undergoing cardiac surgery. Argalious *et al.*⁹⁸ found no benefit for patients treated with statins in comparison to patients who did not receive statin therapy. In contrast, Virani *et al.*⁹⁷ found a reduction in postoperative renal impairment for patients pretreated with statins. This effect was restricted to the subgroup of patients undergoing isolated coronary artery bypass surgery. Patients having valve surgery or a combination of coronary artery bypass surgery and valve surgery did not benefit. Thus, it remains unclear whether preoperative statin therapy influences postoperative renal function.

Recommendations

- (1) The risk index of Kheterpal *et al.*⁶ is useful for the identification of patients at risk for postoperative renal impairment (grade of recommendation: C).
- (2) Calculated GFR is superior to SCr for the identification of patients with pre-existing renal impairment (grade of recommendation: C).
- (3) Urine output should be monitored carefully throughout the perioperative phase and adequate fluid management provided in order to avoid worsening of pre-existing renal failure for patients at risk for postoperative renal impairment (grade of recommendation: D).

Diabetes mellitus

Introduction

Diabetes mellitus is a common co-morbidity in patients presenting to anaesthetists for elective and emergency surgery. Impaired glucose tolerance, either iatrogenic or as a precursor to formally diagnosed diabetes, is probably more common than formally diagnosed diabetes. Both type 1 (insulin deficiency) and type 2 (insulin resistance) diabetes are well recognised as risk factors for microvascular and macrovascular disease, resulting in end-organ damage, notably to heart, brain and kidneys. Patients with diabetes are more likely to present for surgery than those without.⁹⁹ Furthermore, elevated blood glucose in the perioperative period is a risk factor for surgical site infection¹⁰⁰ and diabetic patients are at greater risk for postoperative heart failure.¹⁰¹ Both type I and II diabetic patients have a higher rate of difficult laryngoscopy than non-diabetic patients.^{102,103}

The following questions, therefore, need to be addressed. First, should the preoperative assessment be used for unselective or targeted screening for the presence of

diabetes/impaired glucose tolerance? Second, what, if any, preoperative assessment of glycaemic control should be undertaken in patients with known diabetes/impaired glucose tolerance? Third, are there any preoperative tests which should be instituted purely on the basis of diabetes/impaired glucose tolerance? And, fourth, are there any particular issues for the known diabetic patient presenting for surgery as an emergency?

We searched *MEDLINE* and *Embase* for the period 2000 to June 2010 and reviewed a total number of 192 abstracts from *MEDLINE* and 250 from *Embase*. There were no randomised controlled studies which assessed different approaches to assessment of the diabetic/potentially hyperglycaemic patient. The search was completed by searching for practice guidelines from the American Diabetic Association, American Heart Association, UK National Institute of Clinical Excellence (NICE), hand searching of reference lists and review of diabetic association websites for relevant referenced statements.

Existing evidence

How should the condition be assessed?

Screening for diabetes/risk of hyperglycaemia can be based on patient history and examinations or investigations of glycaemic control.

Patient history and examination

Certain surgical groups are at higher risk for impaired glycaemic control, notably patients with peripheral vascular disease. Around 20% of patients presenting for vascular surgery will have known diabetes, 10% will have undiagnosed diabetes and 20–25% will have impaired glucose homeostasis when assessed with oral glucose tolerance tests (level of evidence: 2–).^{104–106} The ACC/AHA Practice Guidelines recommend that patients with asymptomatic peripheral arterial disease should be offered diabetes treatment according to national guidelines and that diabetes treatment may be effective in reducing microvascular complications.¹⁰⁷ A cohort study of medical inpatients found multiple hyperglycaemic episodes in 52% of patients taking high-dose corticosteroids (level of evidence: 2–).¹⁰⁸ History-based screening tools have been developed that predict the risk of diabetes or prediabetes¹⁰⁹ (level of evidence: 2–) and these have been developed into online versions that can be undertaken in the clinic setting (<http://www.diabetes.org/diabetes-basics/prevention/diabetes-risk-test>). Risk factors included in this system include age, sex, family history of diabetes, exercise level and obesity.

There is no evidence to support routine testing of non-fasting blood sugars, as a normal result does not rule out impaired glucose homeostasis. There is also no current evidence that supports or refutes screening in these higher risk populations in the secondary care setting. Finding diabetes/impaired glucose tolerance will have

long-term implications for the patient, although these concerns are mainly in the domain of the primary care physician/general practitioner rather than the perioperative care team. The association between abnormal glucose homeostasis and poorer perioperative outcome [summarised in WHO checklist document (http://whqlib.doc.who.int/publications/2009/9789241598552_eng.pdf) and American College of Endocrinology position statement¹¹⁰] (level of evidence: 2–) suggests that some attempt should be made to identify these patients at preoperative assessment.

Clearly different countries have varying degrees of community-based screening. Individual countries may, therefore, consider opportunistic screening of higher risk patients also to be of benefit within the wider healthcare setting.

Assessment of glycaemic control in patients with known diabetes/impaired glucose tolerance

There is no direct evidence which supports an improvement in outcome by testing blood glucose (fasting or random) at preoperative assessment. Many patients will be under review by a diabetic service and will be monitoring their own blood glucose levels. The same holds true for HbA1c or other markers of longer term control.

Preoperative assessment instituted purely on the basis of diabetes/impaired glucose tolerance

Patients with diabetes are well recognised to be at risk of cardiovascular and renal disease. Both of these conditions may be unknown by the patient. Again, without direct evidence of benefit, consensus guidelines such as the UK NICE guidance [www.nice.org.uk/Guidance/CG3] and ACC/AHA practice guidelines^{7,107} suggest that diabetes, particularly in higher risk surgery or in patients with other identified co-morbidities, should prompt some degree of cardiovascular investigation. Diabetic patients should, therefore, be assessed in accordance with the guidelines for assessment of patients at high risk of cardiovascular or renal disease. Diabetic patients are also at higher risk of difficult laryngoscopy,^{102,103} so although there is no direct evidence of improved outcome, careful airway assessment in diabetic patients would seem prudent.

Insulin dependent diabetics are at risk of ketoacidosis if exogenous insulin is not given. They should be identified at preoperative assessment and managed according to local departmental protocols.

Recommendations

- (1) Patients with known diabetes should be managed in accordance with guidelines on the management of patients with known or suspected cardiovascular disease (grade of recommendation: C).
- (2) It is not recommended to test blood sugars routinely at preoperative assessment (grade of recommendation: D).

- (3) Preoperative assessment should include a formal assessment of the risk of a patient having disordered glucose homeostasis (grade of recommendation: C).
- (4) Patients at high risk of disordered glucose homeostasis should be identified as needing specific attention to perioperative glucose control (grade of recommendation: C).
- (5) Patients with long-standing diabetes should undergo careful airway assessment (grade of recommendation: D).

Obesity

Introduction

Obesity is a disease with significantly increasing prevalence over recent decades in all developed countries. It is defined as a BMI of more than 30 kg m^{-2} and morbid obesity as a BMI of more than 35 kg m^{-2} . Super morbid obesity is often categorised as a BMI of more than 50 kg m^{-2} . Obesity has major implications for the anaesthesiologist due to associated alterations in pulmonary and cardiovascular physiology, as well as gastrointestinal functions.¹¹¹ Furthermore, obese patients are at increased risk due to anaesthesia-related procedures, for example endotracheal intubation¹¹² and positioning.¹¹³ Thus, strategies have to be implemented to reduce perioperative risks and to enable safe anaesthesia in these patients.

We searched *MEDLINE* and *Embase* for the period 2000 to June 2010 and reviewed a total number of 704 abstracts from *MEDLINE* and 872 from *Embase*. All comparative studies investigating an assessment or intervention with regard to preoperative optimisation of obese patients were selected. Initially, 50 studies were selected from which 35 were included. We excluded the remaining 15 due to their low relevance to these recommendations. Furthermore, most of the selected publications dealt with obesity surgery, so there is a bias within the included studies.

Existing evidence

How should the condition be assessed?

Obesity is accompanied by co-morbidities such as coronary artery disease, hypertension, OSAS and/or diabetes. Perioperative risk stratification should, therefore, focus on cardiac and pulmonary dysfunction as well as nutrition deficiencies.

Cardiovascular system

Obesity is associated with several risk factors for cardiovascular diseases such as hypertension, diabetes and smoking (level of evidence: 2-).^{114,115} Preoperative ECG studies showed conduction or ST wave abnormalities in 62% and a prolongation of the QT interval in 17% of obese patients (level of evidence: 2-).¹¹⁶ Doppler echocardiography detected hypertrophy of the left ventricular posterior wall in 61% of obese patients without

any consequences on perioperative management, however.¹¹⁶ In that investigation, stress testing using a treadmill was negative in 73% of all patients and in the remaining 27% it was not interpretable. Measurement of cardiorespiratory fitness in 109 obese patients revealed a lower peak $\dot{V}O_2$ in those with a BMI of less than 45 kg m^{-2} compared with patients with higher BMI values (level of evidence: 2-).¹¹⁷ Using dobutamine stress echocardiography, cardiac evaluation showed normal results in 92% of the cases (level of evidence: 2-).¹¹⁸ Thus, the authors questioned the need for routine preoperative stress testing.

Pulmonary function and obstructive sleep apnoea syndrome

Pulmonary function testing showed mild restrictive pulmonary insufficiency in 21% of morbidly obese patients (level of evidence: 2+).¹¹⁹ Patients with a BMI of more than 49 kg m^{-2} showed a higher incidence of dyspnoea, significantly higher P_{aCO_2} levels and a significantly lower vital capacity than patients with a BMI of less than 49 kg m^{-2} (level of evidence: 2-).¹²⁰ Furthermore, obese patients have high prevalence of obstructive and restrictive pulmonary conditions as well as rates of hypoxaemia (level of evidence: 2-).¹¹⁶

OSAS is evident in up to 72% of obese patients,^{121,122} whereas in superobese patients (BMI $> 60 \text{ kg m}^{-2}$) prevalence rises up to 95% (level of evidence: 2-).¹¹⁹ Predictors for OSAS in severely obese patients include sleep apnoea, male sex, higher BMI, age and fasting insulin and glycolysated haemoglobin A_{1c} (level of evidence: 2-).¹²³

Endotracheal intubation

In a prospective study a BMI of more than 30 kg m^{-2} as well as a Mallampati score of at least 2 were associated with an increased risk for difficult laryngoscopy for microscopic endolaryngeal procedures (level of evidence: 2-).¹²⁴ In contrast, in a prospective study in 100 morbidly obese patients (BMI $> 40 \text{ kg m}^{-2}$), obesity itself was not a predictor for tracheal intubation difficulties. However, a Mallampati score of at least 3 as well as a large neck circumference were risk factors for problematic intubation (level of evidence: 2-).¹¹²

Nutritional deficiencies

Diabetes is a common co-morbidity in obese patients with a significantly higher prevalence compared with non-obese patients (level of evidence: 2-).¹²⁵ Furthermore, unrecognised glucose intolerance is a common feature in obese patients with a prevalence of increased HbA_{1c} concentrations between 11.4 and 20.8% (level of evidence: 2-).¹²⁶

In obese patients, prevalence of nutritional deficiencies has been estimated to be as high as 79% (level of evidence: 2-).¹²⁷ The prevalence of preoperative iron deficiency was 35% and 24% for folic acid and ferritin, resulting in a significantly higher prevalence of anaemia

(35.5 vs. 12%) in obese patients undergoing bariatric surgery (level of evidence: 2–).¹²⁸ In a retrospective study in patients planned for laparoscopic bariatric surgery, prevalence of anaemia was also significantly increased in obese patients, however, to a much lesser extent (level of evidence: 2–).¹²⁹

Predictors for adverse outcome

Several factors have been proposed as predictors for an adverse outcome in obese patients. Increasing BMI values are closely correlated with an increasing incidence of perioperative complications in patients undergoing spinal surgery (level of evidence: 2–).¹¹⁵ Especially, superobesity (weight¹³⁰ > 159 kg or a BMI^{114,115} > 50 kg m⁻²) are predictive of adverse outcomes (level of evidence: 2–).

Reduced cardiorespiratory fitness indicated by low $\dot{V}O_2$ levels was associated with increased, short-term complications (renal failure, unstable angina, etc.) after bariatric surgery (level of evidence: 2–).¹¹⁷ Abnormalities on the ECG as well as a FEV₁ less than 80%¹¹⁴ and a reduced vital capacity¹³¹ predict complications after surgery as well (level of evidence: 2–).

An increased neck circumference (>43 cm) is an independent predictor for an increased apnoea–hypopnoea index¹²² or for OSAS (level of evidence: 2–).¹³² Additional risk factors associated with postoperative complications were smoking¹²⁸ and increased age (level of evidence: 2–).¹¹⁶

The mortality risk in bariatric surgery can be assessed by the so-called obesity surgery mortality risk score (OS-MRS). The OS-MRS uses five preoperative variables including BMI of at least 50 kg m⁻², male sex, hypertension, known risk factors for pulmonary embolism and age of at least 45 years. The score has been validated in 4431 consecutive patients and categorisation in defined risk classes enabled risk stratification for mortality (level of evidence: 2–).¹³³

Will optimisation and/or treatment alter outcome?

There are no studies available answering the question whether specific optimisation and/or treatment strategies may have a positive impact on the outcome in obese patients undergoing surgery. Some authors proposed a preoperative reduction of body weight in order to reduce the perioperative complication rates in these patients. However, results of these studies are inconsistent. Two studies found no effects of weight loss on complication frequencies,^{134,135} whereas in a large number of patients undergoing gastric bypass surgery, reduced complication rates were observed (level of evidence: 2–).¹³⁶ Furthermore, it has been suggested on the one hand that preoperative weight loss leads to reduced blood loss perioperatively,¹³⁷ on the other hand a substantially increased blood loss was detected in

patients undergoing pancreaticoduodenectomy (level of evidence: 2–).¹³⁸

The effects of preoperative weight loss on operation times have been investigated. However, results were inconsistent reporting shorter, unchanged and prolonged operation times,^{115,138–140} dependent on the type of surgery (open vs. laparoscopic gastric banding, oesophagectomy, etc.). Furthermore, obese patients may have a higher probability of a shorter length of stay in hospital after weight reduction (level of evidence: 2–).¹⁴¹ Finally, a retrospective analysis found no differences between morbidly (BMI ≥ 40–49.9 kg m⁻²) and superobese (BMI ≥ 50 kg m⁻²) patients regarding outcome parameters such as cardiovascular and/or respiratory complications (level of evidence: 2–).¹⁴²

Reduced cardiorespiratory fitness was associated with increased, short-term complications; thus, it has been proposed to optimise fitness prior to bariatric surgery (level of evidence: 2–).¹⁰⁷ Preoperative polysomnography has also been proposed in patients regardless of symptoms due to the high incidence of sleep-related breathing disorder.¹⁴³ Furthermore, the authors proposed application of CPAP treatment preoperatively; however, whether this prevents hypoxic complications is unproven (level of evidence: 2–).

What intervention (and at what time) should be done by the anaesthesiologist in the presence of the specific condition?

Preoperative assessment of risk factors and clinical evaluation as well as ECG examination is essential in obese patients (level of evidence: 4).¹¹⁶ The prevalence of OSAS is high in obese patients^{121,132}; therefore, clinical evaluation and use of a specific questionnaire (i.e. Berlin or STOP questionnaire) polysomnography^{116,122,144,145} and/or oximetry¹⁴⁶ are recommended for detection of severe OSAS (level of evidence: 4). Furthermore, neck circumference can be measured, as it is an independent predictor (>43 cm) for an apnoea–hypopnoea index of at least 15 (level of evidence: 2–).¹²² For prevention of hypoxic complications, CPAP may be used (level of evidence: 4).¹⁴³ In order to prevent formation of atelectasis during induction of general anaesthesia, application of CPAP of 10 cmH₂O and a F_{iO_2} of 1.0 via facemask were recommended (level of evidence: 2–).¹⁴⁷

Large neck circumferences as well as a high Mallampati score are predictors for a difficult intubation in obese patients. Thus, measurement of both parameters prior to anaesthesia has been recommended (level of evidence: 4).^{112,124}

Exercise tolerance is negatively influenced by obesity; hence, it has been proposed to improve cardiorespiratory fitness preoperatively (level of evidence: 4).^{117,119}

Owing to nutritional deficiencies in obese patients, haemoglobin concentrations may be reduced.^{128,129}

Glucose intolerance is common in obese patients and prevalence of pathological HbA_{1C} concentrations is increased.¹²⁶ Thus, nutrition deficiencies should be detected and corrected prior to anaesthesia (level of evidence: 4).¹²⁷

Recommendations

- (1) Preoperative assessment of obese patients includes at least clinical evaluation, Berlin or STOP questionnaire, ECG, polysomnography and/or oximetry (grade of recommendation: D).
- (2) Laboratory examination is indicated in obese patients in order to detect pathological glucose/HbA_{1C} concentrations and anaemia (grade of recommendation: D).
- (3) Neck circumferences of at least 43 cm as well as a high Mallampati score are predictors for a difficult intubation in obese patients (grade of recommendation: D).
- (4) Use of CPAP perioperatively may reduce hypoxic events in obese patients (grade of recommendation: D).

Coagulation disorders

Introduction

This section addresses the problem of patients with a potential coagulation disorder. This does not include the question of how to screen for coagulation disorders.

Assessment of the bleeding history, including a physical examination, is still considered the best tool for identification of patients with impaired haemostasis and/or an increased risk of bleeding complications during and after surgery. Platelet dysfunctions are the most common defects of haemostasis, occurring in up to 5% of patients undergoing surgery. When a coagulation disorder is suspected based on the patient's history and/or clinical examination, further haematological assessment of the condition is warranted.

MEDLINE and *Embase* for the period 2000 to February 2010 were searched and abstracts from 85 references in *MEDLINE* and 145 in *Embase* were reviewed. All comparative studies investigating an intervention or assessment with regard to preoperative assessment and treatment of coagulation disorders were analysed. From the 11 articles initially selected only three studies were considered to be of sufficient quality and relevant to the specific topic.

Existing evidence

How to identify and assess patients with impaired haemostasis?

A study in 5649 unselected patients was designed to identify impaired haemostasis before surgical interventions.¹⁴ Each patient had to answer a standardised questionnaire concerning bleeding history and specific blood tests [activated partial thromboplastin time, prothrombin

time and platelet counts including platelet function analysis (PFA-100)] were performed routinely in all patients. Bleeding history was positive in 628 patients (11.2%) and impaired haemostasis was verified in 256 (40.8%) of these patients. The vast majority (97.7%) of these were identified with PFA-100 (level of evidence: 2-).

In another small observational study in 30 patients on cyclooxygenase inhibitors undergoing knee replacement surgery, it was observed that prolongation of the preoperative PFA-100 test was associated with an impaired surgeon rating of haemostasis and an increased post-operative drain output. It was suggested that this test might be useful to preoperatively assess coagulation in patients on cyclooxygenase inhibitors (level of evidence: 3).¹⁴⁸

Does preoperative or intraoperative correction of haemostasis decrease perioperative bleeding?

There still is a paucity of information on the potential benefits of prophylactic preoperative correction of acquired and congenital platelet dysfunction capable of causing significant perioperative bleeding in non-cardiac surgery.

In the same patient population as described above, 254 patients were identified preoperatively as having either acquired ($n = 182$) or inherited ($n = 72$) impaired primary haemostasis (platelet dysfunction including von Willebrand disease).¹⁴⁹ Only two patients (0.8%) had a secondary (plasmatic) haemostatic disorder which was treated with fibrinogen concentrate and factor VII concentrate. All patients were initially pre-treated with a 30-min infusion of $0.3 \mu\text{g kg}^{-1}$ desmopressin which resulted in a correction of platelet dysfunction in 90.2% (229 of 254) of patients. It was concluded that preoperative correction of impaired primary haemostasis is possible in nearly all patients affected and (compared to a historical control group) is associated with a reduction of homologous blood transfusions (level of evidence: 2-).

Recommendations

- (1) If coagulation disorders are suspected, the patient should be referred to a haematologist (grade of recommendation: D).
- (2) Preoperative correction of haemostasis decreases perioperative bleeding (grade of recommendation: D).
- (3) Routine use of coagulation tests is not recommended unless there are specific risk factors in the history (grade of recommendation: D).

Anaemia and preoperative blood conservation strategies

Introduction

The presence of low preoperative haemoglobin concentration is reported consistently as a major predictive factor

for perioperative blood transfusion needs and poorer postoperative outcome.^{150–153} Given the risks and costs associated with allogeneic blood transfusion, strategies have been developed for preoperative correction of anaemia and prevention of perioperative blood transfusion needs. When anaemia is suspected based on the patient's history and/or clinical examination, further haematological assessment of the condition is warranted.

MEDLINE and *Embase* for the period 2000 to June 2010 were searched and abstracts from 479 references in *MEDLINE* and 555 in *Embase* were reviewed. All comparative studies investigating an intervention or assessment with regard to preoperative optimisation of anaemia were selected. Initially, 78 studies were included from which only meta-analyses and RCTs were included ($n = 17$).

Existing evidence

Does preoperative iron therapy decrease the incidence of preoperative anaemia and the risk of perioperative red blood cell transfusion?

In a RCT on 45 patients scheduled for colorectal surgery, it was observed that preoperative oral iron supplementation increased preoperative haemoglobin concentrations and decreased the need for transfusion, compared with routine clinical practice (level of evidence: 1–).¹⁵⁴ Another small randomised trial in 50 patients in a similar study population, on the contrary, found no such effect of intravenous iron therapy with no difference in haemoglobin concentration and need for transfusion compared with placebo-treated patients (level of evidence: 1–).¹⁵⁵

In patients with preoperative anaemia due to menorrhagia, administration of intravenous iron sucrose appeared more effective at correcting preoperative anaemia than oral iron therapy, with a similar incidence of tolerable adverse events (level of evidence: 1–).¹⁵⁶ In gynaecological cancer surgery, erythropoietin seemed to be more effective than iron in increasing haemoglobin concentration (level of evidence: 1–).¹⁵⁷ Similarly, in anaemic women scheduled for hysterectomy because of uterine myoma, a greater increase in haemoglobin concentration was observed with the combination treatment of erythropoietin and iron. However, in most cases, monotherapy with iron seemed to be as efficacious as the combination therapy in correcting preoperative anaemia (level of evidence: 1–).¹⁵⁸

Does preoperative erythropoietin therapy decrease the incidence of preoperative anaemia and the risk of perioperative red blood cell transfusion?

Evidence on the use of erythropoietin in the perioperative setting mainly comes from oncologic and orthopaedic surgery. In a meta-analysis of RCTs of erythropoietin vs. placebo or no treatment/standard of care in anaemic

patients undergoing surgery of colorectal cancer, insufficient evidence was found to recommend the perioperative use of erythropoietin. However, it should be noted that with respect to the primary outcome (transfusion), there were only three trials and 210 patients (level of evidence: 1–).¹⁵⁹ In a placebo-controlled RCT in 63 patients undergoing surgery for different types of gastrointestinal cancer, greater haemoglobin concentrations, less need for transfusion, fewer postoperative complications and a better 1-year survival were observed in the groups that were treated preoperatively with erythropoietin and iron compared with the group that was treated with placebo and iron (level of evidence: 1–).¹⁶⁰

In urologic cancer surgery, the use of erythropoietin increased preoperative haematocrit, but had no effect on transfusion rate and postoperative quality of life (level of evidence: 1–),¹⁶¹ whereas in gastric cancer surgery, erythropoietin was associated with reduced blood transfusion requirements (level of evidence: 1–).¹⁶²

Major orthopaedic surgery is often associated with extensive bleeding and need for allogeneic blood transfusion. Several RCTs have evaluated the effects of preoperative erythropoietin administration in this clinical setting and found an improvement in the preoperative haemoglobin concentration with – in most studies – a decreased need for allogeneic blood transfusion (level of evidence: 1–).^{163–170} In a study in 60 female patients undergoing primary hip replacement, erythropoietin was found to be more effective than autologous blood donation as a measure to decrease autologous blood transfusion (level of evidence: 1–).¹⁷¹ In a recent systematic review of studies in patients undergoing hip and knee surgery, it was observed that treatment of preoperative anaemia with iron, with or without erythropoietin, and perioperative cell salvage decreased the need for blood transfusion and may contribute to improved patient outcomes (level of evidence: 1+).¹⁷⁰

Taking all data in the different surgical populations together, it is unclear at the moment whether preoperative administration of erythropoietin does indeed affect the need for blood transfusion.

Other therapies?

Pre-deposit of autologous blood is widely used as a measure to decrease allogeneic blood transfusion. Its routine application, however, has been questioned because it is difficult to organise, is time consuming and may create the risk of preoperative anaemia with the need for subsequent transfusions. A meta-analysis of RCTs evaluated the effect of preoperative autologous blood donation on the need for perioperative allogeneic blood transfusion in elective surgery. Although the different trials showed a reduced need for blood transfusion,

the quality of the available evidence led the authors to summarise that to date there is insufficient evidence to conclude that the benefits of autologous blood donation outweigh the disadvantages, certainly when blood bank requirements have safe standards (level of evidence: 1–).¹⁷¹

Recommendations

- (1) Preoperative iron supplementation may be considered to correct preoperative anaemia (grade of recommendation: D).
- (2) There is insufficient evidence to promote the routine use of preoperative autologous blood donation to reduce perioperative transfusion requirements (grade of recommendation: D).

The elderly

Introduction

The risks of death and morbidity increase with age. For patients to make an informed decision whether to proceed to surgery, they need these risks quantified. Clinicians need to know these risks, and how surgery will temporarily increase them: first, to help patients make decisions and, second, to determine how to use scarce resources such as critical care. Age, however, is not the only variable that determines death and morbidity. Both death and morbidity are also affected by sex, physical fitness and the presence of one or more co-morbidities: heart failure; ischaemic heart disease; transient ischaemic attack (TIA) or stroke; renal failure; brain failure (dementia and delirium); and peripheral arterial disease (see below).^{172–190}

Therefore, preoperative assessment should not use age alone to define patient risk. The term 'elderly' is of little use if it uses age as the only criterion to define risk. This is one of the reasons why we found little evidence to support changing preoperative assessment for the 'elderly' (see below). The arbitrary definitions of 'elderly' by the WHO as above 64 years and by the United Nations as above 59 years are of little practical use. Quality of life and independence deteriorate about 10 years before death, when monthly mortality exceeds one in 600: on average at an age of 68 years for men and 72 years for women. Interventions are better targeted at the 'risky' rather than the 'elderly': patients whose background mortality exceeds a certain threshold, for instance one in 600, rather than people above a certain age.

Five hundred and eighty nine and 873 abstracts were reviewed from searches in *MEDLINE* and *Embase*, respectively, for the period 2000 to February 2010: 38 of these were reviewed as full articles. There was one RCT of protocolised intervention to reduce postoperative delirium in elderly hip fracture patients. Additional observational studies were sought to develop a general assessment of mortality risk.

Existing evidence

How to identify and assess the 'elderly' or the 'risky'?

Each European country records age-specific and sex-specific mortality rates. For instance, current and historical UK mortality can be downloaded as Excel spreadsheets from www.gad.gov.uk. Mortality doubles for every 7-year increase in age. A man is 1.7 times as likely to die as a woman the same age. Whether a patient exceeds the 'risk' threshold, for instance a monthly mortality of one in 600, can be calculated from national average mortality statistics, combined with known co-morbidities. In the long-term, each of the following diagnoses increases mortality by 1.5 times compared with average for a given age and sex: MI; stroke; heart failure; renal failure (creatinine $> 150 \mu\text{mol l}^{-1}$); peripheral arterial disease (see other sections). Two co-morbidities increase long-term mortality by $1.5 \times 1.5 = 2.25$, and so forth. Angina and TIA in the absence of MI and stroke increase mortality 1.2 times. More precise mortality estimates can be calculated by adjusting for physical fitness. Fitness is best measured rather than estimated. If fitness is 1 MET less than expected, mortality is 1.15 times expected, if fitness is 1 MET more than expected, mortality is 0.87 times expected.¹⁹¹ A 2-MET shortfall increases mortality by $1.15 \times 1.15 = 1.32$, a 2-MET excess reduces mortality to $0.87 \times 0.87 = 0.76$. Expected peak METs are as follows:

- $18.4 - (0.16 \times \text{age})$ for men.¹⁹¹
- $14.7 - (0.13 \times \text{age})$ for women.¹⁹²

It is more important to identify higher risk patients before major surgeries, justifying cardiopulmonary exercise testing to measure peak METs.

Observational perioperative studies are consistent with general survival models. In a cohort of 8781 cancer patients, the unadjusted 30-day postoperative mortality was 4.8% in patients aged more than 74 years, 3.5% in 66–74 years, 1.8% in 55–65 years and 1.1% in 40–54 years.¹⁹³ In the derivation and validation of 'E-POSSUM' for colorectal surgery, mortality was 3.2 times more for patients aged 75–84 years and 10.4 times more for patients above 84 compared with patients aged 65–74 years (level of evidence: 2++).¹⁹⁴ The strongest predictors for postoperative mortality and morbidity are preoperative variables – intraoperative variables rarely affect risk.

These observational studies and others also support the association of postoperative morbidity with mortality, as one would expect from the accumulation of morbidities that precedes mortality in the general population. The increase in morbidity from before to after surgery mirrors the increase in mortality: if postoperative mortality is three times preoperative mortality, morbidity will similarly be increased about three times. Interventions that reduce mortality are also likely to reduce morbidity and

vice versa. However, morbidity is usually defined in terms of organ dysfunction, for instance renal dysfunction, or delirium and dementia for the central nervous system (CNS). There may be specific interventions that reduce the development or deterioration of dysfunction in a particular organ without necessarily affecting overall mortality.

Do preoperative interventions reduce postoperative morbidity or mortality?

The only RCT for an intervention to reduce postoperative morbidity in the 'elderly' was allocation of 126 patients aged more than 64 years with proximal femoral fracture (level of evidence: 2++).¹⁹⁵ This was not strictly an RCT of preoperative assessment and care. Participants were allocated to 'usual care' or institution of a care protocol by a geriatrician before surgery or after (within 24 h). Intervention reduced postoperative delirium from 50 to 32%, absolute risk difference to 18% and number-needed-to-treat to six.

There are numerous studies that have looked at reducing risk of postoperative mortality and morbidity in the 'risky' but these are not dealt with here.

Recommendations

- (1) Risk, not age, should be used to trigger increased assessment and preparation. The likelihood of postoperative mortality and morbidity depends upon background risk interacting with the grade of surgery (grade of recommendation: B).
- (2) Perioperative care protocols reduce postoperative delirium in patients with fractured neck of the femur (grade of recommendation: D).

Alcohol misuse and addiction

Introduction

In European countries, the number of alcohol and drug addicted individuals is still increasing¹⁹⁶ and it is believed that about 15% of the population are daily users, 9% are harmful users and about 5% are estimated to be addicted according to the European Commission Health and Consumers Directorate-General (http://ec.europa.eu/health/ph_information/dissemination/echi/echi_11_en.pdf).

AUDs have a negative influence on postoperative outcomes such as higher rates of wound infection, acute withdrawal and organ failure.^{197–199} In order to avoid alcohol-related postoperative complications, reliable diagnostics and early preventive interventions are crucial.

We searched *MEDLINE* and *Embase* for the period 2000 up to the present and retrieved abstracts from 160 references in *MEDLINE* and 219 in *Embase*. We selected all comparative studies investigating preoperative diagnosis of AUDs or interventions against AUD-related perioperative complications. Nine studies met the inclusion criteria. In addition, we added another seven earlier

studies concerning the overall risk of AUDs and substance abuse and diagnostic tests in non-surgical patients in order to present a more comprehensive survey on the topic.

Existing evidence

How should alcohol addiction be assessed preoperatively?

For the detection of harmful alcohol consumption, both biochemical markers and validated questionnaires are used regularly. In the next paragraph, we describe the value of different diagnostic methods for the identification of AUDs.^{200–206}

In a large multicentre cohort study ($n = 1863$) γ -glutamyl transferase (GGT) and carbohydrate-deficient transferrin (CDT) were found to be superior to alanine aminotransferase (ALT) in the detection of high-risk alcohol consumption. CDT had a higher specificity (92%) than the other investigated biomarkers (74 and 90% for GGT and ALT, respectively) in predicting high-risk alcohol consumption (level of evidence: 2+).¹⁹⁸

The comparison of the biomarkers GGT, mean corpuscular volume, CDT, aspartate aminotransferase and ALT in a cross-sectional cohort trial in heavy drinkers ($n = 165$), moderate drinkers ($n = 51$) and abstainers ($n = 35$) showed an improved sensitivity of detection of excessive alcohol consumption by using the combination of GGT and CDT (level of evidence: 2+).²⁰³

For detection of AUDs, the CAGE questionnaire^{201,206} (Cutting down, Annoyance by criticism, Guilty feeling and Eye opener) and the alcohol use disorders identification test (AUDIT) are both in clinical use.²⁰⁷

In a prospective randomised trial, a total of 705 male patients scheduled for tumour surgery of the upper digestive tract were investigated.²⁰⁵ Patients were allocated to one of five groups with different diagnostic strategies. Thirty-four percent of alcohol misusers could be identified by clinical routine tests alone without the use of the questionnaire. The sensitivity increased by adding the CAGE questionnaire (64%), CAGE questionnaire and GGT (80%) and CAGE questionnaire, GGT and CDT (91%) (level of evidence: 1–).

In a prospective cross-sectional cohort study ($n = 1921$), a computer-based self-assessment tool was found to be superior at detecting AUDs compared with common preoperative interviews done by anaesthesiologists in the setting of a preoperative clinic. The detection rate of AUDs based on the anaesthesiologist's assessments was 6.9%, whereas using the computer-based self-assessment questionnaire it was 18.1%. A computer-based self-assessment tool for the detection of illicit substance use (ISU) preoperatively was investigated in another cohort study.¹⁸ In a study of 2938 patients, it appeared that from the 221 patients who reported ISU in the computerised questionnaire, only 68 (30.8%, 95% CI

25.1–37.2) were detected by the assessment of an anaesthesiologist. The detection of AUDs and also the use of other illicit substances such as cannabinoids, cocaine, opioids and amphetamines were investigated in this study (level of evidence: 2+).²⁰⁴

Will optimisation and/or treatment alter outcome and what intervention (and at what time) should be done by the anaesthesiologist in the presence of the specific condition?

In a prospective randomised placebo-controlled trial, a cohort of 865 patients scheduled for orthopaedic surgery was investigated.²⁰⁸ After preoperative screening for AUDs using GGT, CDT and a questionnaire, they were allocated randomly either to receive prophylaxis against acute withdrawal syndrome (AWS) (20-mg diazepam intramuscularly per day for 5 perioperative days) (group B) or placebo (group C). Patients without abnormal test results did not receive any medication perioperatively and served as control group (group A). The occurrence of AWS was three in group A, nine in group B and 29 in group C ($P = 0.001$ group B vs. C) (level of evidence: 1–).

Although one study did not find a significant difference between a preoperative intervention group and a control group in the incidence of postoperative complications in patients with AUDs ($n = 136$) (level of evidence: 2–),²⁰⁹ another study showed that preoperative abstinence for at least 1 month reduced complications (level of evidence: 1–).²¹⁰

Recommendations

- (1) For the preoperative identification of AUDs, a combination of GGT and CDT show the highest sensitivity when using biomarkers only (grade of recommendation: C).
- (2) For the preoperative detection of AUDs, a combination of standardised questionnaires and laboratory tests such as GGT and CDT is superior to the sole use of laboratory tests or using a questionnaire alone (grade of recommendation: C).
- (3) The use of a computerised self-assessment questionnaire is superior to an interview by an anaesthesiologist in the identification of patients with AUDs (grade of recommendation: C).
- (4) Administration of benzodiazepines for 5 perioperative days reduces the incidence of alcohol withdrawal syndrome in patients at risk (grade of recommendation: D).
- (5) Alcohol abstinence for at least 1 month prior to surgery reduces the incidence of AUD-related perioperative complications (grade of recommendation: C).

Allergy

Introduction

The estimated rate of deaths partially and totally related to anaesthesia was 5.4 in 100 000 anaesthetic procedures

performed in 1999 in France (level of evidence: 2+).²¹¹ Allergic reactions were found in 14 or 3% of these cases. One percent of the deviations from standard practice classified as causal to anaesthesia death involved an allergic complication in patients with a known risk for allergic reaction. In a separate report specifically focused on the airway complications in this series, nine deaths were attributed to intraoperative bronchospasm without further mechanistic explanation (level of evidence: 2+).²¹²

Another recent epidemiologic survey of anaesthesia-related mortality in the USA for the period 1999–2005 (anaesthesia mortality risk about one death in 100 000 anaesthesia procedures) found that 42.5% of anaesthesia-related deaths were attributable to adverse effects of anaesthetics in therapeutic use (in addition to the 46.6% attributable to an overdosage of anaesthetics) (level of evidence: 2+).²¹³ This survey gives no more precise information about the specific role of allergy in the anaesthesia mortality.

During anaesthesia and surgery, patients may present with anaphylactoid reactions or specific anaphylactic episodes. The incidence of such immediate hypersensitivity adverse events has been reported to range from one in 13 000²¹⁴ (level of evidence: 3) to up to one in 3180²¹⁵ (level of evidence: 3) anaesthetics in a series in which a systematic follow-up of patients with unexplained reactions was undertaken.

MEDLINE and *Embase* for the period 2000 to May 2010 were searched, and abstracts from 584 references in *MEDLINE* and 523 in *Embase* were reviewed. Seventeen publications were finally selected for quality and relevance to the matter. We also considered references from included publications, sometimes leading to the inclusion of publications that came out prior to 10 years ago. Previous guidelines were also analysed and taken in account.

Existing evidence

According to seven consecutive surveys covering the years 1984–2002²¹⁶ (level of evidence: 2+), the main causal agents of anaesthesia-related allergy are the muscle relaxants (50–81% of the cases with frequent cross-reactions in this very class and with pholcodine and other molecules); latex (0.5–22%); antibiotics (2–15%, mainly the β -lactams); hypnotics (0.8–11%, reactions to midazolam, ketamine and etomidate being very rare); colloid volume substitutes (0.5–5%); and opioids (1.3–3%, morphine being prone to direct histamine release).

Other drug classes involved include NSAIDs, disinfectants, contrast media and dyes, such as Patent Blue and Isosulfan Blue,²¹⁷ and other substances, such as protamine and aprotinin. Amino amide class local anaesthetics are very rarely involved (<0.6%).²¹⁸ No immediate

hypersensitivity has been reported with the inhalation anaesthetics isoflurane, desflurane or sevoflurane.

Symptomatology is of variable severity; hypersensitivity during anaesthesia may lead to death in 3–9% of cases. Four grades of severity have been described by Ring and Messmer²¹⁸ (level of evidence: 4) (Table 5).²¹⁶

Systematic screening for potential allergic risk before anaesthesia

During the pre-anaesthesia evaluation of every patient, it is mandatory to include a systematic search for the potential for hypersensitivity reactions, taking in account the great number of drugs and devices to which the patient may be exposed during the perioperative period. Guidelines have been proposed in the broader frame of the SFAR (*Société Française d'Anesthésie et Réanimation*) guidelines for the prevention of the allergic risk in anaesthesia (level of evidence: 4).²¹⁹ These SFAR guidelines, first published in 2001, have been updated in 2010²²⁰ (level of evidence: 2+) and recently reviewed (level of evidence: 4).

Albeit with some obvious overlap, this anticipatory screening approach (on which this report is based) differs from the retrospective investigation of a suspected anaphylaxis episode having been observed during general or regional anaesthesia. Guidelines concerning such investigation have been published by the same and other groups (http://www.aagbi.org/publications/guidelines/docs/anaphylaxis_2009.pdf and reference²²¹) (level of evidence: 4).

Similarly, other specialist societies have addressed the issue of the prevention of allergic reactions in their own specific field of practice and their conclusions may be of interest to anaesthesiologists. Particularly, guidelines for prophylaxis of generalised contrast medium reactions have been proposed by the European Society of Urogenital Radiology²²² (level of evidence: 4) with a questionnaire to be used when a contrast medium examination is requested (level of evidence: 4).²²³

Patients at risk for preoperative anaphylactic/anaphylactoid immediate hypersensitivity reaction

As no specific treatment has been shown to prevent the occurrence of anaphylaxis, allergy assessment must be

Table 5 Severity scale for quantification of intensity of anaphylactoid reaction

Grade	Symptoms
I	Skin symptoms and/or mild fever reaction
II	Measurable but not life-threatening Cardiovascular reaction (tachycardia, hypotension) Gastrointestinal disturbance (nausea) Respiratory disturbance
III	Shock, life-threatening spasm of smooth muscles (bronchi, uterus, etc.)
IV	Cardiac and/or respiratory arrest

Data from Mertes and Laxenaire.²¹⁶

performed in all high-risk patients in order to ensure proper identification of the responsible substance or group of substances (level of evidence: 4).²²⁴ To identify this high-risk group, the pre-anaesthesia evaluation should include a search for history of documented or possible allergy.

Patients at risk for anaphylactic/anaphylactoid reactions during anaesthesia include (level of evidence: 2+) the following²¹⁵:

- patients with an allergy documented by previous specialised investigation to one of the drugs or products likely to be administered or used;
- patients with a history of symptoms suggesting a possible allergic reaction during a previous anaesthesia;
- patients with a history of clinical symptoms suggesting a possible latex allergy, irrespective of the circumstance (e.g. workers exposed to latex including healthcare providers, patients exposed to prolonged latex urinary catheterisation, patients having undergone multiple surgeries and patients with eczema and contact allergy with rubber and adhesive tape);
- children having had multiple surgeries, particularly those with spina bifida and myelomeningocele in which latex allergy and anaphylactic shock to latex are particularly frequent;
- patients with a history of clinical symptoms suggesting allergy to vegetables, fruits or cereals known to have frequent cross-reactivity with latex (such as kiwi, banana, papaya, avocado, chestnut, buckwheat).

A recent survey suggests that patients in otorhinolaryngology departments may be more at risk for latex allergy (level of evidence: 3).²²⁵

Pre-anaesthetic allergology consultation and testing

No evidence supports routine testing for allergy to anaesthetic drugs in patients with no positive clinical history on careful and thorough pre-anaesthetic interview. The same is true for asthmatic and atopic patients as well as for patients allergic to a substance that will not be administered during the perioperative period. Similar results have been confirmed for the routine latex allergy testing in a paediatric population (level of evidence: 2+).²²⁶

In cases with a positive clinical history, the diagnosis of hypersensitivity to an anaesthesia drug is ideally confirmed by written confirmation of established allergies and the cross-reactions as well as the drugs allowed when planning for a future procedure.

If such a document is lacking in a patient belonging to the risk group for anaphylaxis due to a positive clinical history, the anaesthesiologist should always seek a specialised allergology opinion.

For a scheduled procedure, the anaesthesiologist should pay all possible efforts to check the previous anaesthesia

record in order to give the best clinical information to the allergologist. Usually, the tested drugs include all the drugs administered before the event, latex, and all the muscle relaxants.

Confirmation of the diagnosis of a specific sensitisation is obtained by high serum concentrations of specific immunoglobulin (IgE) or total IgE, intradermal or skin-prick testing or in-vitro testing, with basophile activation test or leukocyte histamine release test, according to the allergologists experience and the local resources.

Negative as well as positive reactions are important in order to plan the proposed anaesthesia protocol and other drugs to be administered during the surgical procedure. Specialised skin testing in surgical patients with a history of allergy to penicillin allows for reduction of the use of vancomycin from 28 to 10% (level of evidence: 2+).²²⁷

Skin tests may become negative after a variable period, so a negative answer does not carry an absolute guarantee of absence of sensitisation to a given drug. The best period to perform the testing is 6 weeks after the clinical event.

The results of the specialised allergology consultation should be sent to the anaesthesiologist and to the surgeon in charge of the patient. A simplified document should be explained and given to the patient.

In addition to the specific positive and negative choices of drugs and equipment based upon the allergology evaluation, non-specific measures such as placement of a medical alert tag on the patients electronic chart, warning labels on the anaesthesia record, paper chart, bed and room door (e.g. use latex-free devices only) may be useful to prevent accidental exposure to a substance identified as dangerous for the patient.

Recommendations

- (1) The pre-anaesthesia evaluation should include a thorough interview for predisposition to allergic risk (grade of recommendation: A).
- (2) Patients at risk for anaphylactic/anaphylactoid reactions during surgical anaesthesia include the following:
 - patients with a documented allergy to one of the drugs or products likely to be used;
 - patients with a history of possible allergic reaction during a previous anaesthesia;
 - patients with a history of possible latex allergy, irrespective of the circumstance;
 - children having had multiple surgeries, particularly those with spina bifida and myelomeningocele;
 - patients with a history suggesting allergy to vegetables, fruits or cereals known to have frequent cross-reactivity with latex (grade of recommendation: B).

- (3) In patients with a positive clinical history, the anaesthesiologist should seek a specialised allergy opinion and evaluation when feasible in order to guide their choices (negative as well as positive) for the anaesthesia protocol and other drugs (grade of recommendation: C).
- (4) Negative skin tests do not guarantee the absence of sensitisation to a given substance, as they may become negative with time (grade of recommendation: A).
- (5) The results of the pre-anaesthesia allergy evaluation should be made visible to all the care providers as well as to the patient (grade of recommendation: D).

How to deal with the following concurrent medication?

Antithrombotic therapy and locoregional anaesthesia

This topic has been the subject of separate guidelines by the Task Force of the ESA and the reader is, therefore, referred to these existing guidelines.²²⁸ Guidelines on the perioperative bridging of anticoagulation therapy are discussed on p. 706.

Herbal medication

Introduction

Herbal 'over-the-counter' drugs have a widespread use in the public; the family physician/general practitioner is unaware of their intake most of the time.²²⁹ As with any other drugs, these herbal drugs also have effects and have side-effects and interact with other drugs or therapies. Increased perioperative bleeding, interaction with oral anticoagulant drugs and hepatotoxicity may occur.

We searched *MEDLINE* and *Embase* for the period 2000 to June 2010 and studies from 76 references in *MEDLINE* and 72 references in *Embase* were reviewed.

Existing evidence

How should we deal with concurrent herbal medication that might interfere with anaesthesia?

Pharmacologic effects, side-effects and interaction of herbal 'over-the-counter' drugs

Garlic, ginseng and ginkgo all can cause bleeding. Garlic and ginseng both are known platelet aggregation inhibitors; garlic acts in a dose-dependent manner. Ginseng also diminishes the effect of vitamin K antagonists (VKAs) and ginkgo is a platelet-activating factor antagonist.²³⁰ The authors of a review recommended that garlic intake should be discontinued at least 7 days prior to surgery, ginseng should be stopped at least 24h and ginkgo at least 36h (level of evidence: 3).²³¹

Another herbal drug that is often used is St John's wort (*Hypericum perforatum*). This is known to induce cytochrome (CYP) P4503A4 and CYP 2C9. This led to a decrease of 49% in blood cyclosporine concentrations in 45 organ transplant recipients. St John's wort also

interacts with other drugs relevant to anaesthesia including alfentanil, midazolam, lidocaine, calcium channel blockers and serotonin receptor antagonists. Hypericin (the active substance of St John's wort) has a median elimination half-life of 43.1 h. It is, therefore, recommended to discontinue this drug at least 5 days prior to surgery (level of evidence: 3).²³¹ Taking the half-life of St John's wort into account, stopping this drug even 5–9 days prior to intervention could be justified (3 to 5 times the half life).

Valerian is an herb used for the treatment of insomnia. Its action appears to be mediated through modulation of γ -aminobutyric acid neurotransmission and receptor function. AWSs with abrupt discontinuation resembles benzodiazepine withdrawal and can be treated with benzodiazepines should withdrawal symptoms develop during the perioperative period. It, therefore, may be prudent to taper the dose of valerian over several weeks before surgery (level of evidence: 3).²³²

Traditional Chinese herbal medicines (TCHMs) are used increasingly worldwide, because patients assume that these are effective and have only a few side-effects. However, there are considerable risks of adverse events and relevant interactions with other medications. For example, kavalactones are used as sedatives and anxiolytics and can cause hypotension, prolonged sedation and a decreased renal blood flow. Furthermore, it has been shown that the risk of adverse events (e.g. hypertension, hypotension, delayed emergence) perioperatively is increased significantly in patients taking TCHMs (level of evidence: 2+).²³²

Public use of herbal 'over-the-counter' drugs

In a questionnaire study among patients undergoing elective surgery, 57% of the respondents admitted to using herbal medicine. Echinacea (48%), aloe vera (30%), ginseng (28%), garlic (27%) and ginkgo biloba (22%) were the most common. Herbal medicine usage was significantly higher among patients undergoing a gynaecologic procedure (odds ratio 1.68, 95% CI 1.29–2.18) (level of evidence: 2–).²³³ Women and patients aged 40–70 years were most likely to be taking a herbal product (level of evidence: 2–).^{234,235}

Transparency of the use of herbal 'over-the-counter' drugs

A cross-sectional survey of practice and policies within anaesthetic departments in the UK showed that 98.3% of departments did not have a specific section for documenting herbal medicine use and only 15.7% of the departments that held pre-assessment clinics asked patients routinely about herbal medicine use (level of evidence: 2–).²³⁶

The family physician/general practitioner is involved in the use of these complementary and alternative drugs in only 43% of patients (level of evidence: 2–).²³⁷ Patients

themselves did not inform the anaesthesiologist before surgery regarding their use of herbal drugs in 56.4% (level of evidence: 2–).²³⁶

Recommendations

- (1) Patients should be asked explicitly about their intake of herbal drugs, particularly those that may cause increased bleeding in the perioperative period or that have other unwanted interaction/side-effects (grade of recommendation: C) (of note, other 'over-the-counter' drugs may also have an important impact on platelet function like, for example, analgesics, anti-inflammatory drugs or drugs taken for a common cold).
- (2) Herbal medicines should be discontinued 2 weeks prior to surgery (grade of recommendation: D).
- (3) There is no evidence to postpone elective surgery, but for high-risk surgery in 'closed compartments' such as neurosurgery on the brain, a postponement of elective cases might be considered when patients take herbal drugs such as ginseng, garlic and ginkgo until the day of surgery (grade of recommendation: D).

Psychotropic medication

Introduction

Prescription of psychotropic drugs in the general population has increased in recent years. Epidemiological studies have reported that antidepressants are the most commonly prescribed medications (14.6%) followed by statins (13.9%) and β -blockers (10.6%).²³⁸ Antipsychotic medication has several implications for the anaesthesiologist, including interaction of the psychotropic drugs with other medications, the decision whether to continue or to stop administration of those drugs, potential withdrawal problems and acute or long-term relapse of psychiatric morbidity.²³⁹ Thus, recommendations for management of psychotropic drug during the perioperative period are desirable.

MEDLINE and *Embase* were searched for the period 2000 to June 2010. A total number of 198 abstracts from *MEDLINE* and 584 from *Embase* were reviewed. All comparative studies investigating an assessment or intervention with regard to preoperative optimisation of patients using psychotropic medications were selected. A total number of 11 studies/publications were included.

Existing Evidence

Psychotropic Drugs

There are five relevant groups of psychotropic drugs which will be considered: tricyclic antidepressants (TCAs), selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors (MAOIs), lithium and TCHMs.

Tricyclic antidepressants

TCAs act by presynaptic inhibition of the uptake of norepinephrine and serotonin as well as by blocking

postsynaptic cholinergic, histaminergic and α_1 -adrenergic receptors (level of evidence: 4).²⁴⁰ All TCAs lower the seizure threshold and exhibit several effects on the cardiac conduction system. The main side-effects of TCAs are potentiation of sympathomimetic effects of epinephrine and norepinephrine, resulting in hypertensive crisis. Conversely, the effects of norepinephrine can be reduced in patients with chronic TCA treatment. Discontinuation of treatment with TCAs can lead to cholinergic symptoms (gastrointestinal symptoms, etc.), movement disorders and cardiac arrhythmia. Furthermore, the relapse rate has been estimated to be two to four times higher in the year after discontinuation compared with those patients who continue treatment.²⁴¹

Selective serotonin reuptake inhibitors

SSRIs are increasingly used for antidepressant therapy in developed countries. They increase extracellular levels of serotonin by inhibiting its reuptake into the presynaptic cell. Relevant side-effects are due to serotonergic potentiation with gastrointestinal symptoms, headache, agitation and so on. Overdose of SSRIs or a combination of these with MAOIs or serotonergic TCAs can lead to a serotonin syndrome which is characterised by hyperthermia, hypertension, neuromotor as well as cognitive behavioural dysfunction. Withdrawal of SSRIs may induce a variety of different symptoms such as psychosis, agitation, dizziness, palpitations and much more.

Monoamine oxidase inhibitors

MAOIs inhibit the metabolic breakdown of serotonin and norepinephrine by the MAO enzyme, leading to an increase in these hormones at the receptor site. Older substances (tranylcypromine, phenelzine) irreversibly inhibit MAO, whereas the newer preparation moclobemide is a reversible inhibitor with a half-life of 1 to 3 h.

Owing to their pharmacological properties, MAOIs have effects on blood pressure and on the CNS. The effects on blood pressure can be enhanced in combination with analgesics (e.g. pethidine). Sympathomimetics, especially indirectly acting sympathomimetic agents such as ephedrine, can produce severe hypertensive crisis.

Acute withdrawal of classical MAOIs can induce a severe syndrome, including serious depression, suicidality, paranoid delusions and so on. Withdrawal syndromes after discontinuation of reversible MAOIs are in contrast rarely observed and can be reversed within 12–18 h.

Lithium

Lithium is used as a mood stabiliser in patients with bipolar disorders. It has a narrow therapeutic index; thus, intoxication is a frequent and life-threatening complication of chronic treatment (level of evidence: 4).²³⁹ Signs

of intoxication are gastrointestinal and CNS symptoms as well as ECG changes. There seems to be no withdrawal effect after abrupt discontinuation of lithium administration. However, the risk of recurrence of the depression and total affective relapse is very high, especially in the period immediately after discontinuation (level of evidence: 4).²⁴²

What interactions must be considered in the presence of prescribed antipsychotic medication in the perioperative period?

The pharmacological properties of TCAs on the cardiac conduction system as well as an increased sensitivity to sympathomimetic stimulation lead to an increased cardiovascular risk in these patients (level of evidence: 4).²⁴⁰ Thus, on the one hand preoperative evaluation has to focus on the cardiovascular system (ECG, etc.). On the other hand, there is an increased risk during anaesthesia due to interaction with other medications. Thus, sympathomimetics should be avoided (e.g. as adjunct to local anaesthetics). Furthermore, due to metabolism via the CYP P450 system, interactions with a variety of drugs (antibiotics, analgesics, etc.) are possible (level of evidence: 4).²⁴⁰ Through this pathway, TCAs may also potentiate the effects of hypnotics, opioids and volatile anaesthetics.

Two studies investigated whether antipsychotic medication should be continued or not in the perioperative period. In the first trial, it was shown that discontinuation resulted in higher rates of postoperative confusion.²⁴² Thus, the authors recommended continuation of medication in order to prevent postoperative complications (level of evidence: 1–). Another randomised study showed that discontinuation of antidepressants did not increase the incidences of hypotension and cardiac arrhythmia during anaesthesia, but symptoms of depression and confusion were more common compared with patients who continued taking their antidepressants (level of evidence: 1–).²⁴³

SSRIs are metabolised by the CYP P450 system and some of these molecules or their metabolites are potent inhibitors of the same CYP system isoenzymes.²⁴⁴ This can lead to increased levels and at least toxic effects of SSRIs and/or other medications which are combined with these. The most dangerous combinations are SSRIs with MAOIs or serotonergic TCAs such as clomipramine. Also the combination of SSRI with pethidine, pentazocine and tramadol can result in a serotonergic syndrome.

Two relevant interactions have been described in patients under chronic treatment with MAOIs undergoing anaesthesia. First, administration of pethidine, pentazocine and dextrometorphan block presynaptic uptake of serotonin and may induce an excitatory reaction due to central serotonergic overactivity (level of

evidence: 4).²⁴⁵ A mental depressive type of reaction is supposed to be related to an inhibition of hepatic microsomal enzymes, leading to accumulation of anaesthetics.

Second, use of indirectly acting sympathomimetic drugs induces release of norepinephrine from intracellular stores which may result in a hypertensive crisis. Thus, these preparations are contraindicated and, if required, direct-acting sympathomimetics should be used (level of evidence: 4).²⁴⁰

Lithium shows some interactions with analgesics and anaesthetics which have to be taken into account. NSAIDs can increase serum levels of lithium by diminishing lithium excretion and/or increased re-absorption in the kidneys which might induce toxic lithium levels (level of evidence: 4).²⁴⁶ Angiotensin-converting enzyme inhibitors, thiazide diuretics and metronidazole can also increase lithium serum levels (level of evidence: 4).²⁴⁰ Furthermore, interactions with non-depolarising (e.g. pancuronium) as well as depolarising muscle relaxants have been described, leading to a prolongation of neuromuscular blockade (level of evidence: 4).²⁴⁰

Thermoregulation is often impaired in patients with psychiatric disorders receiving antipsychotic drugs. Compared with control patients without medication, those chronically treated with antipsychotic agents have a significantly lower core temperature during anaesthesia, but the incidence of post-anaesthetic shivering was not increased (level of evidence: 2+).²⁴⁷

Recommendations

- (1) Patients chronically treated with TCAs should undergo cardiac evaluation prior to anaesthesia (grade of recommendation: D).
- (2) Antidepressant treatment for chronically depressed patients should not be discontinued prior to anaesthesia (grade of recommendation: B).
- (3) Discontinuation of SSRI treatment perioperatively is not recommended (grade of recommendation: D).
- (4) Irreversible MAOIs should be discontinued at least 2 weeks prior to anaesthesia. In order to avoid relapse of underlying disease, medication should be changed to reversible MAOIs (grade of recommendation: D).
- (5) The incidence of postoperative confusion is significantly higher in schizophrenic patients if medication was discontinued prior to surgery. Thus, antipsychotic medication should be continued in patients with chronic schizophrenia perioperatively (grade of recommendation: B).
- (6) Lithium administration should be discontinued 72 h prior to surgery. It can be restarted if the patient has normal ranges of electrolytes, is haemodynamically stable and able to eat and drink. Blood levels of lithium should be controlled within 1 week (grade of recommendation: D).

- (7) In patients undergoing minor surgery under local anaesthesia, continuation of lithium therapy can be considered (grade of recommendation: D).

Perioperative bridging of anticoagulation therapy

Introduction

The management of patients who require temporary interruption of an anticoagulation therapy with VKAs because of surgery or other invasive procedures is an important topic in everyday anaesthetic practice.

Bridging anticoagulation refers to the administration of unfractionated heparin (UFH) or low molecular weight heparin (LMWH) in therapeutic dose for the period before and after surgery, during which time VKA therapy has potentially to be interrupted. 'Bridging' minimises the period that patients are not receiving therapeutic dose anticoagulation and, therefore, is intended to minimise the risk of potentially devastating thromboembolic events, such as stroke or prosthetic heart valve thrombosis. Although the risk for thromboembolic events during temporary VKA interruption is considered relatively low (<3%), these events can have major consequences. Thrombosis of a mechanical heart valve is fatal in 15% of patients, and embolic stroke results in major disability or death in 70% of patients.²⁴⁸

We searched *MEDLINE* and *Embase* for the period 2000 to June 2010 and abstracts from 348 references in *MEDLINE* and 401 in *Embase* were reviewed.

Existing evidence

How should we deal with patients under oral anticoagulation who need to have surgery?

Principally, this question has been addressed by an evidence-based clinical practice guideline of the American College of Chest Physicians in 2008 (level of evidence: 1–).²⁴⁹ Since that time, the relevant literature focused mainly on the following questions:

Is it safe to use low molecular weight heparin instead of unfractionated heparin for 'bridging' in high-risk patients?

We found one cohort study comparing these two regimens, published after the publication date of the corresponding clinical guidelines article in 2008. The authors extracted data from a large, observational, prospective, multicentre registry in the USA and Canada (named 'REGIMEN') that prospectively enrolled consecutive patients on long-term oral anticoagulation therapy who required 'bridging' for an elective surgical procedure from 1 July 2002 to 31 December 2003. They enrolled finally 142 patients (UFH, $n=73$; LMWH, $n=172$) with mechanical heart valves. Major adverse event rates (5.5 vs. 10.3%, $P=0.23$) and major bleeds (4.2 vs. 8.8%, $P=0.17$) were similar in the LMWH and UFH groups, respectively. Limitations of the study are the relative small number of cases and the fact that no

matching of cases in this retrospective analysis was possible (level of evidence: 2+).²⁵⁰

The authors conclude that a large prospective RCT is needed to correctly answer the question of safety with one of these approaches for 'bridging'. In this review, we did not find an RCT on that question until June 2010.

What is the adherence to (compliance with) the guidelines on 'bridging' of the American College of Chest Physicians published in 2008?

A cohort study on patients receiving long-term anti-coagulation who need to undergo a minor outpatient intervention showed that a brief (≤ 5 days) perioperative interruption of warfarin therapy was associated with a low risk of thromboembolism (level of evidence: 2-).²⁵¹ Another study reported data from 14 patients at high risk for cardioembolic cerebral infarctions with warfarin cessation-related cerebral infarcts in a retrospective cohort study. They concluded that all of these events were avoidable, if the guidelines had been followed appropriately (level of evidence: 2+).²⁵²

A study from 2010 reported on a wide variation of anti-coagulation management after an invasive procedure between different hospitals that was not explained by the clinical characteristics of patients alone (level of evidence: 2-).²⁵³

A similar finding with a wide range of approaches to 'bridging' was reported in a cross-sectional study from Canada in patients on oral anticoagulation undergoing cardiac rhythm device surgery (level of evidence: 2-).²⁵⁴

Can 'bridging' be avoided in different surgical procedures?

Studies addressing this question have mainly been performed in low-risk and superficial surgery. In cataract surgery for example, continuation of warfarin therapy only led to minor problems with postoperative bleeding (level of evidence: 2+).²⁵⁵

Similar results have been reported for minor soft tissue procedures²⁵⁶ (level of evidence: 2+) and for the implantation of cardiac rhythm devices (level of evidence: 2+).²⁵⁷

Even for total knee arthroplasty, an article from 2010 reported on the safe continuation of warfarin throughout the entire perioperative period in these cases (level of evidence: 2-).²⁵⁸

Recommendations

- (1) In high-risk patients under oral anticoagulation, a bridging management for the perioperative period is highly recommended in accordance with existing clinical guidelines (grade of recommendation: A).
- (2) In minor surgical procedures such as cataract or minor soft tissue surgery, continuation of warfarin therapy

should be considered instead of instituting bridging therapy (grade of recommendation: C).

Which preoperative tests should be ordered?

This question is extensively addressed in the existing guidelines on the use of preoperative tests for elective surgery from the NICE. The reader is, therefore, referred to these guidelines (<http://www.nice.org.uk/Guidance/CG3>).

How should the airway be evaluated?

A comprehensive review of the topic can be found in Appendix 2 (<http://links.lww.com/EJA/A22>).

Introduction

The search for predictive signs for difficult airway management aims at the prevention of the occurrence of an unexpected difficulty and eventually the death of a patient impossible to intubate and impossible to ventilate. During the period 1999–2005, failed or difficult intubation caused 2.3%, that is 50 of the 2211, anaesthesia-related deaths in the USA (level of evidence: 2+).²¹³

The entire scope of this topic including the definition of what is a difficult intubation has undergone profound modifications, as the general acceptance of the supraglottic airway devices and the widespread introduction of videolaryngoscopes. In this context, the usual predictive signs for difficult intubation look old fashioned. Moreover, these clinical predictors are almost all predictors for difficult laryngoscopy and not for difficult intubation. Nevertheless, they remain of interest in 2011, as direct laryngoscopy is still the worldwide gold standard for intubation and difficult laryngoscopy is an acceptable surrogate for difficult intubation in which no subglottic obstacle is present. On the contrary, validated predictive signs, specific for difficult videolaryngoscopy and difficult laryngeal mask placement, are lacking so far.

Prediction of difficult facemask ventilation (DMV) was unduly disregarded until this century but is of utmost importance, as facemask ventilation represents the ultimate step to maintain proper oxygenation of the anaesthetised patient when attempts at instrumental airway control have failed.

Screening for high-risk situations using simple clinical signs, albeit not sufficient on its own, is crucial in order to be prepared to apply first-line prevention using validated tools or their combination (level of evidence: 3),²⁵⁹ thereby avoiding the stress and risk of a surprise situation.

A bibliographic search was conducted between January and July 2010 and involved *Embase* and *MEDLINE*, using *Ovid*, from the year 2000 until present. Full details, including the search terms used, the dates that the search was conducted and the number of abstracts, are shown in the appendix, <http://links.lww.com/EJA/A22>.

We reviewed these abstracts and finally selected 38 articles that were relevant to the clinical questions. We included systematic reviews with meta-analyses, RCTs, cohort studies and case-control studies. We also considered references from included trials, sometimes leading to the inclusion of studies that were published prior to 10 years ago. Finally previous guidelines were also analysed and taken in account.

Existing evidence: criteria for difficult facemask ventilation and impossible mask ventilation

The first prospective study specifically devoted to the prediction of DMV was published in 2000 (level of evidence: 2+).²⁶⁰ DMV was found in 75 patients out of a cohort of 1502 (5%). A multivariate analysis showed five criteria to be independent factors for a DMV in this population of adults undergoing scheduled general surgery: age older than 55 years; BMI more than 26 kg m⁻²; presence of a beard; lack of teeth; and history of snoring. The presence of two of these factors predicts DMV with a sensitivity of 72% and a specificity of 73%. In the absence of these factors, the patient is very likely to be easy to ventilate (negative predictive value: 98%). The risk for difficult intubation is four times higher in the presence of risk for DMV.

In 2006, Kheterpal *et al.*²⁶¹ addressed the question of the DMV in a series of 22 660 patients. The authors described four grades of difficulty and their respective incidences in the setting of a general anaesthesia with or without muscle relaxant (level of evidence: 2++).

Grade 1 MV	77.4%	Ventilated by mask
Grade 2 MV	21.1%	Ventilated by mask with oral airway/adjutant
Grade 3 MV	1.4%	Difficult ventilation, that is inadequate, unstable or requiring two providers
Grade 4 MV	0.16%	Unable to ventilate by mask

The incidence of grade 3 or 4 associated with difficult intubation was 0.37%. Multivariate regression analysis identified the several independent predictors for DMV (Table 6).²⁵⁹

Patients with two and three points in the predictor scale had a grade 3 MV incidence of respectively nearly 10 and 20 times the baseline incidence of 0.26% for patients with zero risk factors.

Table 6 The independent predictors of difficult intubation

Predictors for grade 3 mask ventilation	Predictors for grade 4 mask ventilation	Predictors for grade 3 or 4 mask ventilation combined with difficult intubation
BMI ≥ 30 kg m⁻²	Snoring	BMI ≥ 30 kg m ⁻²
Jaw protrusion severely limited	Thyromental distance < 6 cm	Jaw protrusion limited or severely limited
Snoring		Snoring
Beard		Thick/obese neck anatomy
Mallampati classification 3 or 4		Sleep apnoea
Age ≥ 57 years		

Data from Greib *et al.*²⁵⁹

The importance of the mandibular protrusion test in predicting DMV and DMV combined with difficult intubation is stressed. A beard is the only easily modifiable risk factor for DMV (grade 3 MV). Patients should be informed of this risk, especially when other risk factors for DMV are present and shaving may be recommended before the procedure.

Conditions such as the presence of a pharyngostomy or orbital exenteration with a communication between the orbit and the rhinopharynx represent exceptional causes of DMV (level of evidence: 3).²⁶² They are generally obvious at the patient's examination.

A study devoted to impossible mask ventilation confirmed the incidence of grade 4 MV to be 0.15% in a series of 53 041 patients (level of evidence: 2++).²⁶³ The five independent predictors of impossible mask ventilation were neck radiation changes; male sex; sleep apnoea; Mallampati class 3 or 4; and presence of a beard; the relative weights of these predictors being, respectively, of 6, 4, 3, 2 and 2. Patients with three or four risk factors demonstrated odds ratio of 8.9 and 25.9, respectively, for impossible mask ventilation when compared with patients with no risk factors.

Existing evidence: criteria for difficult intubation

We lack predictive criteria for difficult intubation that are simple, rapid, affordable, reliable, 100% sensitive and specific, and that have good positive and negative predictive values. Most proposed assessments include common points or variable approaches to the same criteria (e.g. neck extension and sternomental distance). The most useful screening tests are described and a more comprehensive list is available in Appendix 2, <http://links.lww.com/EJA/A22>.

Screening tests

Mallampati classification

The Mallampati classification is established when the patient is awake, either sitting or standing and has been validated in the supine position (level of evidence: 2-).²⁶⁴

The correlation with the Cormack and Lehane grades is not very reliable for Mallampati classifications 2 and 3. However, there is a good correlation between the

observance of a classification 1 and a grade I laryngoscopy. Likewise, a classification 4 is generally associated with a grade III or IV (level of evidence: 2-).²⁶⁵

The insufficiency of the Mallampati classification has been specifically shown for obese patients. It remains useful in this population (BMI $\geq 40 \text{ kg m}^{-2}$) only when performed with the patient's craniocervical junction extended rather than neutral and if the patient is diabetic (level of evidence: 2+).¹⁰³ These data indicate that this classification should no longer be considered individually capable of predicting the laryngoscopic view with precision (level of evidence: 4).²⁶⁶

A recent study reported that the Mallampati classification other than 1 and the Mallampati classification of 4 were two of the five easily evaluable bedside criteria from a simplified risk score for difficult airway. The other items were a mouth opening of less than 4 cm, a history of difficult intubation and the presence of upper front teeth (level of evidence: 2-).²⁶⁷

El-Ganzouri score

Similar to the Wilson score (see appendix, <http://links.lww.com/EJA/A22>), the El-Ganzouri score takes into account the body weight, head and neck mobility, mouth opening, possibility of subluxation of the jaw, in addition to the thyromental distance, Mallampati classification and history of difficult intubation. A value of 4 or more has a better predictive value for difficult laryngoscopy than a Mallampati classification superior to 2 (level of evidence: 2+).²⁶⁸ It was derived from the study of 10 507 patients of whom 5.1% are grade III and 1% are grade IV according to Cormack and Lehane.

Recently, the El-Ganzouri score has been shown to be of particular interest when laryngoscopy is performed with the GlideScope videolaryngoscope rather than with a conventional direct Macintosh laryngoscope. In this setting, the score was considered as a decisional tool by the authors (level of evidence: 2-) (Table 7).²⁶⁹

The upper lip bite test (ULBT) consists of three classes: class I, the lower incisors can bite the upper lip, making the mucosa of the upper lip totally invisible; class II, the same biting manoeuvre reveals a partially visible upper lip mucosa; and class III, the lower incisors fail to bite the

upper lip. In the initial series, the ULBT class III was a better predictor for difficult intubation than a Mallampati classification of at least 2 (level of evidence: 2-).²⁷⁰ Its value has been disputed²⁷¹ (level of evidence: 2+) and a prospective evaluation in 6882 consecutive patients showed the ULBT to be a poor predictor of difficult laryngoscopy when used as the single bedside screening test in a North American patient population (level of evidence: 2+).²⁷² Like the Mallampati classification, it has to be used as a part of a multimodal evaluation for difficult intubation. The combination of the ULBT with the thyromental distance (threshold: 6.5 cm) and inter-incisor distance (i.e. mouth opening; threshold: 4.5 cm) is easy to perform and more reliable as a predictor for difficult intubation (level of evidence: 2+).²⁷³ Of particular interest, the ULB seems to be of value as a predictor for difficult intubation with GlideScope videolaryngoscopy (level of evidence: 2-).²⁷⁴

Practical evaluation

Benumof²⁷⁵ grouped together 11 main elements of the physical examination and the criteria that must be met in order to indicate that intubation will not be difficult (level of evidence: 4). This evaluation uses the most relevant elements of the main tests or scores proposed at the time the list was set up. It is carried out easily and quickly and requires no specific equipment. Additional elements are obtained by questioning the patient and studying previous anaesthesia reports, keeping in mind that intubation difficulty can vary in the same patient from one procedure to another, and even only a few hours apart (level of evidence: 3).²⁷⁶

A criterion that is pathologic to the point of establishing the diagnosis of an impossible intubation on its own is rare. Usually, the probability of a difficult intubation is backed up by several, converging elements. The reliability of the assessment increases with the number of criteria that are considered (level of evidence: 4) (Table 8).^{273,275}

It has been proposed that the ideal combination includes three airway tests: mouth opening, chin protrusion and atlanto-occipital extension. This preference is based on a multi-variable analysis of predictive criteria, in an observational study of 461 patients of whom 38 had a difficult intubation (level of evidence: 2-).²⁷⁷ Similarly, combining the Mallampati classification 3 or 4 with either a thyromental distance of less than 6.5 cm or a sternomental distance of less than 12.5 cm has been shown to increase the specificity and positive predictive values of the screening to 100% with a negative predictive value maintained at 93% (level of evidence: 2-).²⁷⁸

These results were confirmed in a meta-analysis of 35 studies of screening tests, where the most useful bedside test for prediction of difficult intubation was found to be the combination of the Mallampati

Table 7 The El-Ganzouri score

Criteria	Scores		
	0	1	2
Weight, kg	<90	90–110	>110
Head and neck mobility, degrees	<90	90 ± 10	<80
Mouth opening, cm	≥4	<4	
Subluxation, >0	Possible	Not possible	
Thyromental distance, cm	>6.5	6–6.5	<6
Mallampati classification	1	2	3
History of DI	No	Possible	Established

DI, difficult intubation.

Table 8 Main elements of the examination to detect difficult intubation

Eleven elements of the examination	Criteria in favour of an easy intubation
Length of the upper incisors	Short incisors (qualitative evaluation)
Involuntary anterior overriding of the maxillary teeth on the mandibular teeth (retrognathism)	No overriding of the maxillary teeth on the mandibular teeth.
Voluntary protrusion of the mandibular teeth anterior to the maxillary teeth	Anterior protrusion of the mandibular teeth relative to the maxillary teeth (subluxation of the TMJ)
Interincisor distance (mouth opening)	Over 3 cm
Mallampati classification (sitting position)	1 or 2
Configuration of the palate	Should not appear very narrow or highly arched
Thyromental distance (mandibular space)	5 or 3 cm fingerbreadths
Mandibular space compliance	Qualitative palpation of normal resilience/softness
Length of neck	Not a short neck (qualitative evaluation)
Thickness of neck	Not a thick neck (qualitative evaluation)
Range of motion of head and neck	Neck flexed 35° on chest and head extended 80° on the neck (i.e. sniffing position)

The 11 items are presented in logical order, superiorly to inferiorly (teeth followed by mouth and then neck); no element is sufficient on its own. TMJ, temporomandibular joint. Adapted from Khan *et al.*²⁷³

classification with thyromental distance (ROC AUC of 0.84) (*level of evidence: 1+*).²⁷⁹

Para-clinical examinations for systematic detection of difficult intubation

No para-clinical test can be advocated in the routine pre-anaesthesia airway evaluation. Indirect laryngoscopy is predictive of a similar direct laryngoscopy view (level of evidence: 2).²⁸⁰ This examination may not be possible to perform in certain patients, including 15% who have a strong gag reflex, and others who cannot sit up or who refuse it. The combination of clinical and radiological criteria proposed by Naguib *et al.*²⁸¹ is interesting from a retrospective point of view, but cannot be systematically applied as a detection tool (level of evidence: 2-).

High-risk groups

Intubation is generally considered more difficult in pregnant women and in otolaryngology (ENT)²⁸² (level of evidence: 4) and trauma patients. Contradictory data have been reported, however, notably in obstetrics (level of evidence: 3).²⁸³

Certain pathologies are associated with increased risk of airway difficulty. Among the most common of these is diabetes. The positive 'prayer sign' is patients' inability to press their palms together completely without a gap remaining between opposed palms and fingers and is a marker for probable general ligament rigidity (stiff joint or stiff man syndrome). When present, difficult intubation should be anticipated. A variant of the prayer sign test is a palm print study of the patient's dominant hand (level of evidence: 2+).²⁸⁴

Acromegaly is also considered a risk factor. Difficult intubation occurs in about 10% of patients with this disease (level of evidence: 3).²⁸⁵ Difficult intubation is more common in obese than in lean patients, with a difficult intubation rate of 15.5% in obese patients (BMI > 35 kg m⁻²) compared with 2.2% in lean patients (BMI < 30 kg m⁻²) (level of evidence: 2+).²⁸⁶

In general, problems linked to tongue piercing, congenital disease, rheumatic conditions, local pathology and history of trauma are easily identified during physical examination or by questioning the patient.

Cowden syndrome, lingual papillomatosis and angioedemas can also be formidable pitfalls (level of evidence: 3).²⁸⁷

Weighted approach of the predictive factors: towards a quantitative clinical index for difficult intubation

In 1988, Arné *et al.*²⁸⁸ developed a clinical index that obtains predictive scores with a sensitivity and specificity of 94 and 96% in general surgery, 90 and 93% in ENT non-cancer surgery and 92 and 66% in ENT cancer surgery, respectively. The defined index was validated in a prospective study ($n = 1090$) after being established in an initial study ($n = 1200$).

The statistical analysis based on 1200 observations was used to assign point values to each of the considered factors in proportion to regression coefficients representing the relative weight of each predictive intubation difficulty factor which was validated in the second prospective study of 1090 patients (level of evidence: 2++) (Table 9).²⁸⁸

More recently, Naguib *et al.*²⁸⁹ validated an equation to predict difficult intubation. The prediction (I) was determined by the following formula:

$$I = 0.2262 - 0.4621 \times \text{thyromental distance} + 2.5516 \times \text{Mallampati score} - 1.1461 \times \text{interincisor distance} + 0.0433 \times \text{height},$$

in which the thyromental distance, interincisor gap and height were measured in centimetres and Mallampati score was 0 or 1. Using this equation for predicting difficult intubation, laryngoscopy and tracheal intubation would be easy if the numerical value (I) in the equation is less than zero (i.e. negative), but difficult if the numerical value (I) is more than zero (i.e. positive) (level of evidence: 2+).

Table 9 Points for the different variables that predict difficult intubation

Criteria	Simplified value	
History of DI	10	With 11 as the threshold value for this index, the test gave the following results: sensitivity, 93%; specificity, 93%; PPV, 34%; NPV, 99%; difficult intubation, 3.8% General population Validation study, $n = 1090$
Predisposing pathologies	5	
Respiratory symptoms (such as snoring, etc.)	3	
MO >5 cm or subluxation >0	0	
3.5 cm < MO < 5 cm and subluxation = 0	3	
MO < 3.5 cm and subluxation < 0	13	
Thyromental distance < 6.5 cm	4	
Mobility of head and neck > 100°	0	
Mobility of head and neck 80–100°	2	
Mobility of head and neck < 80°	5	
Mallampati classification 1	0	
Mallampati classification 2	2	
Mallampati classification 3	6	
Mallampati classification 4	8	
Maximum total	48	

DI, difficult intubation; MO, ; NPV, ; PPV, .

Opinions concerning the usefulness of this type of index are sometimes very negative (level of evidence: 4).²⁹⁰ Nevertheless, they introduce a relative weight for the different criteria and may play a justifiable role in the evaluation of situations that are neither obviously easy nor obviously difficult.

Conclusion

Predictive tests of difficult intubation are plentiful. None is perfect. The reproducibility of the tests from one observer to another is inconsistent as it is across age, sex²⁹¹ (level of evidence: 3) and ethnic groups. There is a perceived association in the literature between foreseeing difficulty and preventing death due to impossible intubation. As our final goal is the latter, we should direct our efforts towards the management of difficult intubation as much as towards detecting it and education in airway management is of paramount importance.^{292,293}

Recommendations

- (1) Screening for DMV and difficult intubation should be conducted, whenever feasible, in all patients potentially requiring airway management for anaesthesia as well as in the ICU. This screening includes a history of medical conditions, surgical operations, history of difficult airway management and, if available, examination of previous anaesthetic records. The screening has to be documented in the patients' chart (grade of recommendation: A).
- (2) No single predictive sign for difficult airway management is sufficient by itself and the pre-anaesthesia assessment needs the combination of different validated evaluation criteria (grade of recommendation: A).
- (3) Potential for DMV should be evaluated and relies on the presence of two or more of the following factors:

- BMI of at least 30 kg m^{-2} ; jaw protrusion severely limited; snoring; beard; Mallampati classification 3 or 4; and age at least 57 years (grade of recommendation: C).
- (4) Potential for impossible mask ventilation should be evaluated and relies on the presence of three or more of the following factors: neck radiation changes; male sex; OSA; Mallampati class 3 or 4; and presence of a beard (grade of recommendation: D).
- (5) Systematic multimodal screening for difficult intubation should include the Mallampati classification, the thyromental distance, the mouth opening or interincisor distance and the ULBT (grade of recommendation: A).
- (6) Particular attention to the evaluation for possible difficult intubation should be paid in certain medical conditions such as obesity, OSAS, diabetes, fixed cervical spine, ENT pathologies and preeclampsia. Neck circumference of more than 45 cm is another warning sign (grade of recommendation: D).
- (7) Difficult videolaryngoscopy is difficult to predict, as only a few studies have addressed this question so far (grade of recommendation: D).

How should the patient be informed about perioperative risks?

Introduction

Patients have moral and legal rights to be informed about what is going to happen to them. Although the process of obtaining consent for anaesthesia and surgery varies between countries, a common principle is that the patient should understand enough about the risks and benefits of the proposed procedures in order to make an informed decision. In addition, anaesthetists think that providing information may have beneficial effects on patient anxiety, satisfaction with care and possibly compliance with therapy or instructions.²⁹⁴ Two related questions,

therefore, arise. First, what information is needed and/or wanted by the patient? Second, how should this information be presented to the patient?

MEDLINE and *Embase* for the period 2000 up to June 2010 were searched and abstracts from 967 references in *MEDLINE* and 841 in *Embase* were reviewed. Hand searching of relevant reference lists complemented the searches, including relevant systematic reviews.^{295,296} The number of articles directly investigating anaesthesia as opposed to surgery is small, and so some extrapolation is necessary.

Existing evidence

What information do patients want or need?

Cohort studies suggest that patients are generally satisfied with the amount of information they receive prior to anaesthesia, regardless of how much they are actually given (level of evidence: 2–).^{297,298} When given the choice, patients tend to want more rather than less (level of evidence: 2–),²⁹⁹ but the choice is not uniform: a minority want minimal information and about equal numbers want ‘standard’ or ‘full disclosure’ (level of evidence: 2–).³⁰⁰

There are differences between individuals in how much information is desired, some of which may be cultural, age or sex based or situational (fathers vs. mothers) (level of evidence: 2+).^{301–305} There is limited evidence from non-anaesthetic studies that anxiety *per se* does not influence the amount of information that patients wish to receive (level of evidence: 2–).³⁰⁶

How should information be presented to the patient?

Broadly there are three complementary choices available to the anaesthetist regarding the medium of communication: oral, written or some form of audio–visual presentation (video or computer-based).

Verbal information

Randomised trials of preoperative information have all used some sort of verbal/face-to-face patient/anaesthetologist interaction as the control group, so there are no studies which really address the question of whether verbal/oral information is beneficial. There is some evidence that a structured approach to patient education may improve understanding of anaesthetic requirements such as nil by mouth (level of evidence: 1–).³⁰⁷ Conversely, two trials found that structured preoperative patient-controlled analgesia education did not affect patient outcome (level of evidence: 1–).^{308,309}

Media-based information was assessed formally in 2003 by Lee *et al.*²⁹⁶ At that time, they found 15 RCTs of media-based information (written or video), covering general anaesthesia (nine RCTs), regional anaesthesia (two RCTs) and pain management (four RCTs).

Written information

The available studies suggest that written information supplementing a personal consultation is probably beneficial with regard to satisfaction (level of evidence: 2–),^{310,311} knowledge (level of evidence: 2+),³¹² reduction in anxiety (level of evidence: 1–),³¹³ (level of evidence: 2–)³¹¹ and participation in decision making (level of evidence: 1–).³¹⁴ Others have found no effect on anxiety (level of evidence: 1–),^{315,316} or mixed effects (level of evidence: 3),³¹⁷ and no effect on satisfaction (level of evidence: 1–)³¹⁵ (level of evidence: 2–).³¹⁸

Multimedia information

More recent work has focussed on the use of video clips or computer-based information. Done and Lee³¹⁹ found an improvement in knowledge prior to ambulatory surgery with pre-anaesthetic video (level of evidence: 1–), particularly with regard to knowledge of risks. The meta-analysis by Lee *et al.*²⁹⁶ concluded that video information reduced state of anxiety. More recently, Jjala *et al.*³²⁰ (level of evidence: 1–) found a reduction in anxiety prior to regional anaesthesia with a video-based technique; Snyder-Ramos *et al.*³¹⁵ showed superior information gain with video and consultation compared with just a face-to-face consultation or consultation with written information (level of evidence: 1–); Salzwedel *et al.*³²¹ found benefits in information gain, but no effect on anxiety with video-assisted risk information (level of evidence: 1–); and Hering *et al.*³²² (level of evidence: 2–) demonstrated benefits on anxiety and satisfaction with a web-based approach. The magnitude of these effects on anxiety is relatively small, so the clinical relevance is not clear.

Within each of these media, the question of how to present relative risks and benefits arises. There are insights from the psychological literature regarding this, but little direct evidence in favour of one approach over another. Although not directly derived from anaesthesia-related studies, people prefer risks to be given as numerical estimates rather than qualitative terms (rare, common, etc., even when these are defined) (summarising level of evidence: 2+).³²³

Recommendations

- (1) The amount of information given to the patient should be based on what they wish to know (grade of recommendation: C).
- (2) Written information can be safely used to supplement direct consultations (grade of recommendation: A).
- (3) Written information should not be used in place of direct consultations (grade of recommendation: C).
- (4) Patients prefer to be given numerical estimates of risk (grade of recommendation: C).
- (5) Written and video information are effective methods of providing information (grade of recommendation: A).

- (6) Written and video information are effective methods of reducing anxiety, but the clinical effect is small (grade of recommendation: A).

CONCLUSION

These recommendations addressed two main questions: how should a preoperative consultation clinic be organised and how should preoperative assessment of a patient be performed?

To address these questions, the relevant literature of the last 10 years was screened and the evidence was evaluated in order to provide – whenever possible – graded recommendations on different topics. We took a systematic approach to searching for available evidence and this information was interpreted by experts in the field in order to form guidelines. This is different from a systematic review which, by definition, is a review that uses a systematic approach by gathering evidence to answer a specific clinical question. Such an approach was judged not to be appropriate for the present guidelines, as the issue of preoperative evaluation of the adult non-cardiac surgery patient covers an enormous breadth, probably containing several hundred specific questions that would need to be analysed.

It was striking to note that despite the huge amount of information available from the initial *PubMed* and *Embase* search (see Appendix 1, <http://links.lww.com/EJA/A22>) only a minority was of sufficient scientific quality to be used for making recommendations and guidelines. Many recommendations, therefore, are basically expert opinion, because of the lack of sufficient sound evidence-based information.

We are aware of the fact that the present recommendations cover only a part of the questions relevant to preoperative evaluation of the patient. Specifically, uncommon diseases, specific medications and treatment strategies have deliberately not been included for two reasons. First, the available scientific evidence upon which to base possible recommendations is even more scant than the evidence for the more common issues addressed in the present guidelines. Second, such a detailed approach including all possible diseases and medications would have yielded an enormous document that would lose its usefulness in daily clinical practice. For these specific situations, the global recommendation is to rely on specialist advice and screen the literature for case reports and/or case series providing information on how to deal with specific rare specific cases.

The present guidelines aim to provide assistance for preoperative evaluation of the adult patient by giving

recommendations on some of the most frequently encountered questions in a preoperative evaluation clinic. These recommendations are based on a summary (and grading) of the most recent evidence on the different topics addressed which should allow the reader to interpret this evidence and make – if necessary – their own ‘expert opinion’. The present guidelines are not intended to replace possible national guidelines, although we hope that they may help to develop a unified approach among the different European countries in the future. Instead, the Task Force aimed to summarise the recent scientific background to address different important issues in the preoperative evaluation of patients that should help each European anaesthesiologist in their daily practice. It is beyond doubt that the present recommendations will be the subject of regular re-evaluation with the advent of new evidence and with the continuous feedback we welcome.

Finally, the observation that well designed and sufficiently powered RCTs are lacking on many issues concerning the preoperative evaluation prompts us to plead for initiatives to also address these important questions and to initiate studies on the subject.

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SUMMARY OF RECOMMENDATIONS

How, when and by whom should patients be evaluated preoperatively?

- (1) Preoperative standardised questionnaires may be helpful in improving anaesthesia evaluation in a variety of situations (grade of recommendation: D).
- (2) If a preoperative questionnaire is implemented, great care should be taken in its design (grade of recommendation: D), and a computer-based version should be used whenever possible (grade of recommendation: C).
- (3) Preoperative evaluation should be carried out with sufficient time before the scheduled procedure to allow for the implementation of any advisable preoperative intervention aimed at improving patient outcome (grade of recommendation: D).
- (4) Preoperative assessment should be completed by an anaesthetist (grade of recommendation: D), but the screening of patients could be carried out effectively by either trained nurses (grade of recommendation: C) or anaesthesia trainees (grade of recommendation: D).
- (5) A pharmacy personnel member may usefully be included in the preoperative assessment in order to reduce discrepancies in postoperative drug orders (grade of recommendation: C).
- (6) There is insufficient evidence to recommend that the preferred model is that a patient should be seen by the same anaesthetist from preoperative assessment through to anaesthesia administration (grade of recommendation: D).

How should preoperative assessment be performed?

Specific clinical conditions in which the patients should undergo more extensive testing

Cardiovascular disease

See the guidelines of the ESC for preoperative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery which were endorsed by the ESA (www.escardio.org/guidelines).^{7,42}

- (1) If active cardiac disease is suspected in a patient scheduled for surgery, the patient should be referred to a cardiologist for assessment and possible treatment (grade of recommendation: D).
- (2) In patients currently taking β -blocking or statin therapy, this treatment should be continued perioperatively (grade of recommendation: A).

Respiratory disease, smoking and obstructive sleep apnoea syndrome

- (1) Preoperative diagnostic spirometry in non-cardiothoracic patients cannot be recommended to evaluate the risk of postoperative complications (grade of recommendation: D).
- (2) Routine preoperative chest radiographs rarely alter the perioperative management of these cases. Therefore, it cannot be recommended on a routine basis (grade of recommendation: B).
- (3) Preoperative chest radiographs have a very limited value in patients older than 70 years with established risk factors (grade of recommendation: A).
- (4) Patients with OSAS should be evaluated carefully for a potential difficult airway and special attention is advised in the immediate postoperative period (grade of recommendation: C).
- (5) Specific questionnaires to diagnose OSAS can be recommended when polysomnography is not available (grade of recommendation: D).

- (6) Use of CPAP perioperatively in patients with OSAS may reduce hypoxic events (grade of recommendation: D).
- (7) Incentive spirometry preoperatively can be of benefit in upper abdominal surgery to avoid postoperative pulmonary complications (grade of recommendation: D).
- (8) Correction of malnutrition may be beneficial (grade of recommendation: D).
- (9) Smoking cessation before surgery is recommended. It must start early (at least 6–8 weeks prior surgery, 4 weeks at a minimum) (grade of recommendation: B). A short-term cessation is only beneficial to reduce the amount of carboxyhaemoglobin in the blood in heavy smokers (grade of recommendation: D).

Renal disease

- (1) The risk index of Kheterpal *et al.*⁶ is useful for the identification of patients at risk for postoperative renal impairment (grade of recommendation: C).
- (2) Calculated GFR is superior to SCr for the identification of patients with pre-existing renal impairment (grade of recommendation: C).
- (3) Urine output should be monitored carefully throughout the perioperative phase and adequate fluid management provided in order to avoid worsening of pre-existing renal failure for patients at risk for postoperative renal impairment (grade of recommendation: D).

Diabetes mellitus

- (1) Patients with known diabetes should be managed in accordance with guidelines on the management of patients with known or suspected cardiovascular disease (grade of recommendation: C).
- (2) It is not recommended to test blood sugars routinely at preoperative assessment (grade of recommendation: D).
- (3) Preoperative assessment should include a formal assessment of the risk of a patient having disordered glucose homeostasis (grade of recommendation: C).
- (4) Patients at high risk of disordered glucose homeostasis should be identified as needing specific attention to perioperative glucose control (grade of recommendation: C).
- (5) Patients with long-standing diabetes should undergo careful airway assessment (grade of recommendation: D).

Obesity

- (1) Preoperative assessment of obese patients includes at least clinical evaluation, Berlin or STOP questionnaire, ECG, polysomnography and/or oximetry (grade of recommendation: D).
- (2) Laboratory examination is indicated in obese patients in order to detect pathological glucose/HbA_{1C} concentrations and anaemia (grade of recommendation: D).
- (3) Neck circumferences of at least 43 cm as well as a high Mallampati score are predictors for a difficult intubation in obese patients (grade of recommendation: D).
- (4) Use of CPAP perioperatively may reduce hypoxic events in obese patients (grade of recommendation: D).

Coagulation disorders

- (1) If coagulation disorders are suspected, the patient should be referred to a haematologist (grade of recommendation: D).
- (2) Preoperative correction of haemostasis decreases perioperative bleeding (grade of recommendation: D).
- (3) Routine use of coagulation tests is not recommended unless there are specific risk factors in the history (grade of recommendation: D).

Anaemia and preoperative blood conservation strategies

- (1) Preoperative iron supplementation may be considered to correct preoperative anaemia (grade of recommendation: D).
- (2) There is insufficient evidence to promote the routine use of preoperative autologous blood donation to reduce perioperative transfusion requirements (grade of recommendation: D).

The elderly

- (1) Risk, not age, should be used to trigger increased assessment and preparation. The likelihood of postoperative mortality and morbidity depends upon background risk interacting with the grade of surgery (grade of recommendation: B).
- (2) Perioperative care protocols reduce postoperative delirium in patients with fractured neck of femurs (grade of recommendation: D).

Alcohol misuse and addiction

- (1) For the preoperative identification of AUDs, a combination of GGT and CDT show the highest sensitivity when using biomarkers only (grade of recommendation: C).
- (2) For the preoperative detection of AUDs, a combination of standardised questionnaires and laboratory tests such as GGT and CDT is superior to the sole use of laboratory tests or use of a questionnaire alone (grade of recommendation: C).
- (3) The use of a computerised self-assessment questionnaire is superior to interview by an anaesthesiologist in the identification of patients with AUDs (grade of recommendation: C).
- (4) Administration of benzodiazepines for 5 perioperative days reduces the incidence of alcohol withdrawal syndrome in patients at risk (grade of recommendation: D).
- (5) Alcohol abstinence for at least 1 month prior to surgery reduces the incidence of AUDs-related perioperative complications (grade of recommendation: C).

Allergy

- (1) The pre-anaesthesia evaluation should include a thorough interview for predisposition to allergic risk (grade of recommendation: A).
- (2) Patients at risk for anaphylactic/anaphylactoid reactions during surgical anaesthesia include the following:
 - patients with a documented allergy to one of the drugs or products likely to be used;
 - patients with a history of possible allergic reaction during a previous anaesthesia;
 - patients with a history of possible latex allergy, irrespective of the circumstance;
 - children having had multiple surgeries, particularly those with spina bifida and myelomeningocele;
 - patients with a history suggesting allergy to vegetables, fruits or cereals known for frequent cross-reactivity with latex (grade of recommendation: B).
- (3) In patients with a positive clinical history, the anaesthesiologist should seek a specialised allergy opinion and evaluation when feasible, in order to guide their choices (negative as well as positive) for the anaesthesia protocol and other drugs (grade of recommendation: C).
- (4) Negative skin tests do not guarantee the absence of sensitisation to a given substance, as they may become negative with time (grade of recommendation: A).
- (5) The results of the pre-anaesthesia allergy evaluation should be made visible to all the care providers as well as to the patient (grade of recommendation: D).

How to deal with the following concurrent medication**Antithrombotic therapy and locoregional anaesthesia**

This topic has been the subject of a separate guidelines Task Force of the ESA and the reader is, therefore, referred to these existing guidelines.²²⁶

Herbal medication

- (1) Patients should be asked explicitly about the intake of herbal drugs, particularly those that may cause increased bleeding in the perioperative period or that have other unwanted interaction/side-effect (grade of recommendation: C) (of note, other 'over-the-counter' drugs may also have in important impact on platelet function such as, for example, analgesics, anti-inflammatory drugs and drugs taken for a common cold).
- (2) Herbal medicines should be discontinued 2 weeks prior to surgery (grade of recommendation: D).
- (3) There is no evidence to postpone elective surgery, but for high-risk surgery in 'closed compartments' such as neurosurgery on the brain, a postponement of elective cases might be considered when patients take herbal drugs such as ginseng, garlic and ginkgo until the day of surgery (grade of recommendation: D).

Psychotropic medication

- (1) Patients chronically treated with TCAs should undergo cardiac evaluation prior to anaesthesia (grade of recommendation: D).
- (2) Antidepressant treatment for chronically depressed patients should not be discontinued prior to anaesthesia (grade of recommendation: B).
- (3) Discontinuation of SSRI treatment perioperatively is not recommended (grade of recommendation: D).
- (4) Irreversible MAOIs should be discontinued at least 2 weeks prior to anaesthesia. In order to avoid relapse of underlying disease, medication should be changed to reversible MAOIs (grade of recommendation: D).
- (5) The incidence of postoperative confusion is significantly higher in schizophrenic patients if medication was discontinued prior to surgery. Thus, antipsychotic medication should be continued in patients with chronic schizophrenia perioperatively (grade of recommendation: B).
- (6) Lithium administration should be discontinued 72 h prior to surgery. It can be restarted if the patient has normal ranges of electrolytes, is haemodynamically stable and is able to eat and drink. Blood levels of lithium should be controlled within 1 week (grade of recommendation: D).
- (7) In patients undergoing minor surgery under local anaesthesia, continuation of lithium therapy can be considered (grade of recommendation: D).

Perioperative bridging of anticoagulation therapy

- (1) In high-risk patients under oral anticoagulation, a bridging management for the perioperative period is highly recommended in accordance with the existing clinical guidelines (grade of recommendation: A).
- (2) In minor surgical procedures such as cataract or minor soft tissue surgery, continuation of warfarin therapy should be considered instead of instituting bridging therapy (grade of recommendation: C).

Which preoperative tests should be ordered?

This question is extensively addressed in the existing guidelines on the use of preoperative tests for elective surgery from the NICE.

The reader is, therefore, referred to these guidelines at <http://www.nice.org.uk/Guidance/CG3>.

How should the airway be evaluated?

- (1) Screening for DMV and difficult intubation should be conducted, whenever feasible, in all patients potentially requiring airway management for anaesthesia as well as in the ICU. This screening includes a history of medical conditions, surgical operations, history of difficult airway management and, if available, examination of previous anaesthetic records. The screening must be documented in the patients' chart (grade of recommendation: A).
- (2) No single predictive sign for difficult airway management is sufficient by itself and the pre-anaesthesia assessment needs the combination of different validated evaluation criteria (grade of recommendation: A).
- (3) Potential for DMV should be evaluated and relies on the presence of two or more of the following factors: BMI of at least 30 kg m⁻²; jaw protrusion severely limited; snoring; beard; Mallampati classification 3 or 4; and age at least 57 years (grade of recommendation: C).
- (4) Potential for impossible mask ventilation should be evaluated and relies on the presence of three or more of the following factors: neck radiation changes; male sex; OSA; Mallampati classification 3 or 4; and presence of a beard (grade of recommendation: D).
- (5) Systematic multimodal screening for difficult intubation should include the Mallampati classification, the thyromental distance, the mouth opening or interincisor distance and the ULBT (grade of recommendation: A).
- (6) Particular attention to the evaluation for possible difficult intubation should be paid in certain medical conditions such as obesity, OSA, diabetes, fixed cervical spine, ENT pathologies and preeclampsia. Neck circumference of more than 45 cm is another warning sign (grade of recommendation: D).
- (7) Difficult videolaryngoscopy is difficult to predict, as only few studies have addressed this question so far (grade of recommendation: D).

How should the patient be informed about perioperative risks?

- (1) The amount of information given to the patient should be based on what they wish to know (grade of recommendation: C).
- (2) Written information can be safely used to supplement direct consultations (grade of recommendation: A).
- (3) Written information should not be used in place of direct consultations (grade of recommendation: C).
- (4) Patients prefer to be given numerical estimates of risk (grade of recommendation: C).
- (5) Written and video information are effective methods of providing information (grade of recommendation: A).
- (6) Written and video information are effective methods of reducing anxiety, but the clinical effect is small (grade of recommendation: A).

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