Perioperative Care of the Orthopedic Patient

C. Ronald MacKenzie
Charles N. Cornell
Stavros G. Memtsoudis
Editors

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This book is dedicated to
~~Philip Wilson, Jeremiah Barondess, and Paul Heerdt~~
Mentors and Role Models All

Foreword

Over the last half-century, millions of patients worldwide have benefitted from significant advances in orthopedic care. These benefits have allowed patients to live longer lives, with less pain and greater mobility. Innovations in surgical techniques, perioperative medicine, and anesthesia practice over this time period have helped facilitate this progress. As a consequence of these advances, orthopedic surgical procedures are increasingly extended to a wider range of patients, including the elderly and those with significant medical comorbidities. The opportunities provided by these life-changing procedures, together with the growing need for a multidisciplinary approach to assure optimal outcomes, have stimulated the development of the new clinical and academic discipline that is comprehensively described in this volume.

The perioperative care of patients presenting for orthopedic surgery requires a team approach, a model of the delivery of care that is coordinated and optimized by a physician-directed, multidisciplinary group working together throughout the perioperative continuum. The process begins with the decision to perform surgery and requires preparation of the patient and an optimization of their general medical condition. Intraoperatively, the most current anesthetic and surgical techniques are utilized to minimize complications and to support the patient's ability to recover from the trauma of surgery. Postoperatively, a seamless transition of care from the recovery room, occasionally the intensive care unit, and then to the hospital floors is achieved by minimizing pain, maximizing the patient's ability to rehabilitate, and ensuring that postoperative medical care mitigates the impact of preexisting comorbidities. This entire continuum is carried out in a safe, cost-efficient, and patient-centered manner. Perioperative care at Hospital for Special Surgery is premised on these principles.

Our model of care, presented comprehensively in this book, is responsible for an unparalleled surgical, medical, and anesthesiologic record of success. However, as an innovative domain of surgical practice, advances in orthopedics will continue to challenge those engaged in perioperative care far into the future. Those challenges will drive the refinement of our current system of collaborative care to increasingly incorporate evidence-based approaches and innovative research to achieve the highest level of quality and outcomes for all patients. The expert contributions to this book, brought together by Drs. MacKenzie, Cornell, and Memtsoudis, provide a roadmap by which the challenges of the future can be met.

New York, NY

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Mary K. Crow
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Preface

Arthritis is the leading cause of disability in the adult US population. Twenty-one percent of adults report physician-diagnosed arthritis, a prevalence projected to increase markedly for the foreseeable future. As conditions for which surgery is often required, the arthritides, in their various presentations, will continue to fuel the need for surgical intervention for years to come. Further societal demographics underscore the importance of these projections, especially for elderly patient populations, since the elderly are not only the fastest growing segment of western society, but arthritis as a disease category reaches its peak in older populations. Even today, this is the demographic group that already accounts for the majority of such procedures, particularly total joint arthroplasty.

Medical management in the setting of surgery is a relatively new consultative arena, one spurred on in contemporary times by the aging patient population, a rising prevalence of complex chronic disease, and an ever-expanding surgical armamentarium. Nowhere has the confluence of these forces been more evident than in orthopedic surgery, a highly innovative field, the advances of which continue to enhance the functional capacity and quality of life of patients across the entire span of life.

Although a number of comprehensive textbooks pertaining to perioperative medicine are currently available, none focus exclusively and comprehensively on the patient undergoing orthopedic surgery. The format of this book was developed with several purposes in mind. A primary goal was the development of the first published comprehensive overview of the challenges presented by the orthopedic surgical environment; as such, the book covers most of the relevant domains of orthopedic surgery. A second ambition was to provide an overview of the innovative and sometimes unique approaches to anesthesia in this patient population. A third objective was a presentation of a general approach to the preoperative evaluation of patients, while the fourth and final aim was to offer an up-to-date review of the disease-specific challenges to the care of patients undergoing surgery, maintaining a particular focus on orthopedic procedures whenever possible. In order to achieve these goals, the book is divided into five primary sections: (1) Preoperative Considerations; (2) Anesthesiologic Management; (3) Medical Management in Specific Clinical Settings; (4) Specific Perioperative Problems in Orthopedic Surgery; (5) Role of Allied Services. The book closes with a chapter providing a number of cases and clinical vignettes illustrating the challenges of caring for patients in the orthopedic surgical setting.

A word about us and our institution also seems appropriate. Hospital for Special Surgery is one of the world's premier hospitals devoted to orthopedic and rheumatologic care, its functions are supported by 140 inpatient beds, over 60 recovery room/acute carebeds, and 35 in- and outpatient operating rooms. A full complement of orthopedic subspecialties is backed by the Department of Medicine, Rheumatology, and Perioperative Medicine as well as a 57 member Department of Anesthesiology. Fourteen thousand inpatient and a comparable number of outpatient orthopedic procedures generate over 13,000 preoperative consultations annually. Given this extensive experience, we felt the time was right to contribute in a comprehensive and multidisciplinary way our collective approach to perioperative orthopedic care. The editors, whose tenures at HSS date back 30 years, feel well positioned to lead this effort.

Much has changed from the days during which most of our surgery was conducted on an inpatient basis, all patients admitted (and usually evaluated medically for the first time) the day before their procedure; 5–7 days of postoperative care and rehabilitation generally followed, even after routine total joint arthroplasty. Indeed, the modernization of care, driven though it was by outside forces and unwelcome in its time, has forced greater efficiencies in care, promoted (not stifled) innovation, and lowered cost, while minimizing patient exposure to the hospital environment—all outcomes for the better.

In closing, the editors want to express their gratitude first to the contributors to this book. As a "ground-up" endeavor, we appreciate your efforts, diligence, and particularly your patience. Thanks is also extended to Liz Corra, our development editor at Springer for her encouragement and endurance. Finally, a word to our readers, ultimately the judges of this effort: we hope you find this reference useful in your daily striving to provide the best possible care for patients. While we take full responsibility for its content, we recognize there may be shortcomings and even important omissions in this first edition. Thus, at a time when knowledge and innovation are advancing medical care on a daily basis, we invite commentary and constructive criticism from the broader perioperative and surgical community. Future editions can only benefit from such collective wisdom.

New York, NY

C. Ronald MacKenzie
Charles N. Cornell
Stavros G. Memtsoudis

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Part I

Preoperative Considerations

General Principles and Practices of Perioperative Medicine

1

C. Ronald MacKenzie

Objectives

- To review the rationale for the preoperative medical evaluation.
- To review the goals of the preoperative medical evaluation.
- To review the literature pertaining to the efficacy of preoperative medical evaluation.

Key Points

- Medical evaluation of a patient prior to surgery remains a widespread clinical practice.
- Such consultation is supported by clinical investigation, growing literature, and national conferences.
- The principles and practices of perioperative medicine have been evolving, influenced by the quality movement of the last 15 years.
- An orderly structure for the preoperative evaluation includes: the identification of the nature, severity, and degree of control of all comorbid conditions that may impact perioperative decision-making; the optimization of treatment of all active medical problems; the assessment of anesthesia and surgery-associated risk; education of patients and families concerning the perioperative experience; and motivation of the patient to commit to preoperative preventive practices.

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Introduction

Growing numbers of patients of ever increasing age and often advanced medical conditions undergo surgery annually. Owing to advances in surgical technique as well as advances in the understanding of perioperative medicine, patients of much greater complexity are being considered suitable surgical candidates. Nowhere is this confluence of developments greater than in the field of Orthopedics where advances in total joint arthroplasty, spine, and trauma-related surgery have expanded the indications for surgery and pushed the boundaries of perioperative care. As such a familiarity with the literature pertaining to medical care in the perioperative setting is required for those who provide care to the orthopedic patient undergoing surgery [1–5].

This chapter reviews the clinical domain and literature pertaining to the perioperative medical evaluation emphasizing, where appropriate, the patient undergoing orthopedic procedures. A stepwise approach to the preoperative consultation and the assessment of perioperative risk is presented supported by the literature pertaining to perioperative evaluation and care.

Preoperative Consultation

As a consequence of medical advances as well as the impact of financial and resource constraints on the medical system at large, a substantial trend toward the performance of surgery in the ambulatory setting has evolved in the recent decades. Indeed, the percentage of all surgical procedures performed on an outpatient basis in the USA rose from 20 % in 1982 to 60 % in 1995, a trend particularly relevant to the arthroscopic techniques of orthopedic surgery [6, 7]. Amongst the benefits of these developments has been the opportunity to move the preoperative medical evaluation to the outpatient arena as well, often weeks prior to the surgical

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date. This change in practice allows sufficient time for discourse with other physicians' involved in the patient's care, for supplementary consultation and investigation, and the institution of therapy directed at optimizing the patient's medical status prior to the contemplated surgery. Practiced in this manner, the preoperative evaluation becomes a focal point of communication between all professionals involved in caring for the patient, enhancing the deliberative and collaborative nature of the consultative process and ultimately the patient's care. While the boundaries of such consultation may vary, influenced by patient and surgery-related factors, a growing literature pertaining to perioperative medicine supports various core principles that underlie effective medical consultation in this setting.

Depending on the setting and institutional approach to perioperative care, the preoperative consultation may be conducted by an MD (Internist, Medical Subspecialist, Hospitalist, or Anesthesiologist) or by physician extenders (Nurse Practitioners, Physician Assistants) under MD supervision. Owing to the complexity of medicine, especially the growth in pharmacology, challenges of the elderly with their comorbidities and restricted physiologic reserve, and productivity and reimbursement pressures that keep surgeons in the operating room (as opposed to rounding on the floors), surgeons are desirous of a more involved consultant [8]. This may take the form of a more active participation in the patient's care (ordering rather than recommending medications), adopting a comanagement strategy for the patient's postoperative care, or in some instances assuming full responsibility for the patient after completion of the surgery. Regardless of the institutional model, communication between the referring and consulting physicians remains essential to the provision of optimal perioperative care. Evolving from earlier guidelines regarding effective consultation [9], a recent conceptual revision stressed such considerations as determining the customer, establishing the urgency, gathering your own information, being brief, being specific and talking to the referring physician, establishing contingency plans, establishing one's turf, teaching with tact, talking with the primary physicians, and providing follow-up [8]. While each of these tenants is central to the whole, the first priority is to insure clarity regarding the question asked, as a lack of transparency about the stimulus for the consultation is sure to get the process off on the wrong foot.

Given its essential purpose, consultation as a practice is the provision of advice regarding diagnosis and management. In the context of general medical care, it affords an opportunity to initiate or modify treatment whether primary or secondary (preventive). Although the goals may be of shorter term in the preoperative setting, such consultations can still be most complex, taxing the knowledge and skill of the medical consultant and anesthesiologist alike. Further, the role of the preoperative medical consultant may subsume even broader responsibilities, going beyond the evaluation of the patient's current medical status. Additional responsibilities, especially germane in the preoperative setting, include the estimation of the patient's risk for surgery, decisions regarding the need for additional testing prior to surgery, and the preoperative optimization of the patient's medical condition, the purpose of which is to reduce the risk of postoperative complications [10]. Further, in the domain of orthopedics, the assessment of bone quality is a new and increasingly appreciated preoperative consideration, highly relevant in the setting of spine and hip surgery. This emerging topic is extensively reviewed in Chap 25.

The success of this process therefore depends on a number of elements including a thorough knowledge of those illnesses which impact upon surgical outcome, an understanding of the surgical procedure and anesthetic strategies that might be employed, and an integration of a management plan across the range of physicians and other professional staff who will be caring for the patient [10]. Implicit is the need for effective communication, as the consultant's clinical judgment will impact outcome only if the recommendations are conveyed and then implemented effectively.

Finally a word about the concept of surgical "clearance" is in order. Though widely ensconced in the clinical vernacular, this notion has been decried by the perioperative medical community citing its lack of specification and that the term "cleared" implies that patients will not experience postoperative complications, a sequel that can never be guaranteed [10]. As you will see shortly, the term "optimized for surgery" is more appropriate and better aligned with the goals of preoperative consultation. What are these goals and how do we approach them?

Goals of the Preoperative Medical Consultation

The goals of the preoperative medical evaluation are as follows:

- Identification of the nature, severity, and degree of control of all *comorbid conditions* that may affect perioperative clinical decision-making and medical care;
- *Optimization* of the treatment of all active medical problems;
- Assessment of anesthesia and surgery-associated *risk* (magnitude and type);

- *Education* of patients and families concerning the perioperative experience;
- Motivation of the patient to commit to preoperative *preventive* practices.

Identification of Conditions That Affect Postoperative Outcome

The needs of the patient in the perioperative context depend on a number of considerations notably age, comorbidity, functional capacity, and the type of anesthesia and surgery to be performed. A complete medical history and physical examination constitutes the bedrock preoperative evaluation providing a clinically relevant framework upon which informed decisions concerning the value of additional ancillary testing can be premised. The focus and content of the preoperative history does differ from general medical practice, however. For instance the indication for any type of surgery is an essential component, as the perioperative risk will vary with the magnitude and urgency of the procedure. Patients should also be asked about their prior experience with surgery and anesthesia. Further, the presence, severity, and stability of all comorbid conditions should be established. In the setting of orthopedic procedures, particularly lower extremity arthroplasty, a patient (or family history) of thromboembolic phenomenon may denote the patient at heightened risk for this well-recognized complication of these procedures. Also relevant to this consideration is the association of various connective tissue diseases with antiphospholipid antibodies, a disorder of (hyper) coagulation that places patients at high thrombotic risk after surgery. This condition presents significant management challenges in the perioperative setting and is reviewed elsewhere (Chap. 20). The use of tobacco, alcohol, and other drugs should also be documented, as should the patient's allergic history. All prescription and over-the-counter medications, including the use of herbs and supplements, should be recorded with their dosages and dosing schedules, as decisions need to be made concerning which therapies should be continued (and which should not) prior to surgery. In addition to a traditional review of systems, certain anesthesia related checks are also important: these include airway problems and a history of snoring, daytime sleepiness, and hypertension which, if present in the morbidly obese patient, suggest the presence of sleep apnea, a medical problem underappreciated both in the general and perioperative settings (Chap. 5).

An understanding of specific intraoperative events and practices associated with the range of orthopedic procedures cannot be overemphasized when performing preoperative evaluations and may help avoid delays and cancellations on the day of surgery. For example the simple knowledge of positioning practices may alert the examiner to evaluate the patency of potential femoral vascular grafts, ventriculoperitoneal shunts and the accessibility of implanted cardiac defibrillators in the prone or lateral position as is utilized for spine and hip procedures, respectively. Further, an appreciation of factors like expected blood loss and specialized ventilation strategies such as one-lung ventilation, will allow for a better assessment of the impact of such an approach on various organs and the ability for any given patient to tolerate such interventions. Lastly, consideration of anesthetic practices for specific procedures (i.e., neuraxial versus general approaches) and their physiologic impact, such as effects on cardiac preload and afterload, should be taken into account when evaluating patients with specific diseases. The effect of prone positioning on positive pressure ventilation may be another example to consider specifically in the obese patient. Thorough evaluation of a patient's possible spinal pathology, including the extent and type of prior back fusions, may avoid confusion on the day of surgery when a neuraxial technique is planned for lower extremity arthroplasty. In selected patients a preoperative consultation with an anesthesiologist may be indicated as to more accurately assess the compatibility of a patient's pathophysiology with an anticipated surgical and anesthetic approach.

Last there has been considerable interest in the estimation of the patient's functional capacity, a surrogate for cardiopulmonary fitness, in the prediction of postoperative outcome [11, 12]. Exercise capacity, quantified in metabolic equivalents (METS), can be easily estimated according to the ability to perform simple everyday tasks of living [10]. Patients with functional limitations so determined have been shown to be at risk for postoperative complications [10]. Although often cited as an easily measured predictor of surgical outcome, the applicability of such assessments is restricted in orthopedic populations. Owing to the disability associated with chronic arthritis, painful joint conditions preclude most of the activities that make up the METS-based methodology, thus limiting its applicability in the orthopedic patient.

The physical examination confirms and often amplifies information obtained from the medical history. In the preoperative context, the examination should focus on patient characteristics known to adversely impact upon postoperative course. In addition to the vital signs, body mass index (BMI) should be calculated (Wt/Ht) as not only this parameter is associated with the development of various chronic diseases but obesity is also an important independent risk factor for surgery and highly correlated with the underappreciated condition, sleep apnea syndrome. Careful auscultation of the heart is important as the presence of third and fourth

heart sounds may indicate left ventricular dysfunction or incipient congestive heart failure while cardiac murmurs imply the presence of valvular heart disease. Depending on the nature and severity of the valvular anomaly, valvular heart disease may compromise cardiac function at times of physiological stress such as surgery. Obesity, large neck circumference, and hypertension predict obstructive sleep apnea; obesity is also associated with insulin resistance and thus diabetes mellitus.

The benefit of preoperative laboratory testing has been examined in many studies and its benefit (or lack thereof) continues to be widely debated. Several comprehensive reviews pertaining to the commonly performed preoperative studies have been published. Should the determinants of such testing be disease-related or procedure-related? Is the common practice of screening laboratory panels justified in the preoperative setting? With respect to testing when there are no clinical indications, less than 1 % of such testing has been shown to provide useful information [13]; indeed, there is evidence that overall this approach may actually be harmful [14]. Not surprisingly, preoperative diagnostic tests ordered as a consequence of a finding uncovered on history and physical examination are more likely to be abnormal [15]; of particular importance is the previously abnormal result that is associated with new or persistent abnormalities [16]. Finally there is the economics of such testing. Although not extensively examined, one study relevant to the orthopedic population, examined the costs associated with routine urinalysis, prior to knee arthroscopy; $1.5 million dollars were spent in order to prevent a single urinary tract infection [17].

In response to observations from clinical practice and a literature that fails to demonstrate benefit, support from experienced perioperative clinicians for the global or "shotgun" approach to preoperative testing has waned in recent years [18]. The establishment of guidelines, the effect of which was to reduce preoperative testing, has been shown to have several advantages These include the standardization of practice, improved efficiency, and a substantial reduction in costs; further, these benefits occur with no adverse effect on outcome [19, 20]. Indeed, studies involving healthy patients undergoing minor procedures (i.e., cataract extraction), routine preoperative laboratory testing appears completely unnecessary [21–23]. Although definitive studies in an orthopedic population have not been conducted, a restrictive preoperative testing model might also apply to many of the minor or regional orthopedic procedures (i.e., hand and foot surgery, arthroscopy). Nonetheless, old practices "die hard" and what appears to be excessive preoperative testing remain a widespread practice. Further, depending on the patient and the nature and magnitude of the surgery, a number of investigations may be considered appropriate and are still commonly performed on patients prior to major surgical procedures.

Optimization of Conditions That May Affect Postoperative Outcome

Patient related factors, specifically existing medical comorbidities, are now viewed as the most important determinant of postoperative outcome. Part III and Part II of this book presents a comprehensive overview of the perioperative management across the spectrum of chronic medical conditions encountered in orthopedic patients. Optimization of the treatment of these conditions is an important goal of the preoperative evaluation. Common examples of this practice includes the control of blood pressure in the patient with hypertension, the resolution of bronchospasm in the asthmatic, the achievement of satisfactory glucose control in the diabetic, electrolyte abnormalities (often medication-induced) and heart rate control in patients with coronary artery disease. Unfortunately, for many relevant conditions (i.e., obesity, smoking practices), time constraints and patient compliance impose substantial obstacles.

In practice, the process of optimization generally involves medication adjustments. Medications may be started, discontinued, or their dosages changed, before or on the day of surgery. Further, because perioperative care is a dynamic process, medication adjustments are often required after the surgical procedure as well. The medications involved encompass the entire pharmacopeia, including complementary and alternative therapies. Of note are such pharmacological categories as antihypertensive agents (including beta-blockers), antiarrhythmic agents, statin drugs, bronchodilators, insulin and oral hypoglycemic agents, drugs with effects on coagulation, antidepressants, and analgesics. For example, angiotensin enzyme (ACE) inhibitors and angiotensin receptor antagonists (ARA) are common antihypertensive agents and thus frequently encountered in the preoperative setting. Such medications, which are often combined with a diuretic, are associated with significant hypotension in association with anesthesia and should be held on the day of surgery [24, 25]. Particularly relevant to orthopedic populations are corticosteroids and the disease-modifying agents (DMARDs), drugs commonly employed in the treatment of connective tissue disease (Chap. 10). Other such disease related optimization strategies are dealt with in the individual chapters comprising Part III and Part II of the book.

A decision to hold medication prior to or on the morning of surgery must balance the potential adverse influences of those medications in the short term (in the setting of anesthesia and surgery) versus their long-term indications and

Table 1.1 (A) Medications commonly discontinued several days before surgery. (B) Medications commonly withheld on morning of surgery (Used with permission from Rosenbaum SH, Silverman DG. The Value of Preoperative Assessment. In Newman MF, Fleisher LA, Fink MP (eds): Perioperative Medicine: Managing for Outcome. Philadelphia: Saunders/Elsevier; 2008:41–42)

Medication	Special considerations and comments
(A) Medications commonly discontinued several days before surgery	
Tricyclic antidepressants	Continue for severe depression
Monoamine oxidase inhibitors (MAOIs)	Continue if severe condition (use MAOI-safe anesthetic that avoids meperidine)
Metformin	May stop 24–48 h to decrease risk of lactic acidosis
Birth control pills, estrogen replacement, tamoxifen	Prolonged risk of thromboembolism, especially after major oncologic and orthopedic surgery. Decision by surgeon or oncologist
Aspirin, clopidogrel (Plavix), cliostazol (Pletal), dipyridamole (Persantine)	May continue in patients with critical need for antithrombotic therapy and/or low risk of significant surgical bleeding. Duration of effect of cilostazol and dipyridamole < clopidogrel, aspirin, and ticlidopine. However, if major concern about intraoperative bleeding, stop for up to 10 days
Warfarin (Anticoagulants)	Generally stop for 2–5 days. If high risk of thromboembolism, may replace with heparin or low-molecular-weight heparin
Nonsteroidal anti-inflammatory drugs	May continue for severe inflammatory disorder
Cyclooxygenase type 2 inhibitors	May continue to avoid flare-up (despite potential thrombosis or delayed healing)
Fish oil, vitamin E (>250 U/day), and many herbal medicinals	Potential multisystem (anticoagulant, cardiovascular) effects. Standard vitamins acceptable
(B) Medications commonly withheld on the morning of surgery	
ACE inhibitors, angiotensin receptor blockers	Continue if refractory hypertension, fragile aneurysm, severe congestive heart failure (CHF), valvular insufficiency
Diuretics	May continue for CHF
Phosphodiesterase-5 inhibitors	May predispose to hypotension
Lithium	Interacts with anesthetic agents
Bupropion, trazodone	Predispose to exaggerated sympathetic response
Disulfiram (Antabuse)	Affects metabolism (e.g., phenytoin, warfarin).
Alendronate sodium (Fosamax)	Causes transient esophageal irritation
Particulate antacids	Cause pneumonitis if aspirated
Oral hypoglycemics	Risk of hypoglycemia in fasting patient
Long-acting insulin (no available IV access—e.g., day-of-surgery admission)	May also decrease dose night before surgery if patient is prone to morning hypoglycemia. Initiate tighter control when IV access available
Rapidly acting insulin	Administer preoperatively only if hyperglycemia
Insulin pump	Withhold bolus; may continue basal rate.
Pyridostigmine (for myasthenia gravis)	May complicate use of neuromuscular blocking drugs. Continue if risk of severe weakness or dysphagia
Low-molecular-weight heparin (enoxaparin)	Can replace warfarin; typically withhold for 12–24 h

benefits. Such decisions must be made on an individual basis. Table 1.1 summarizes these considerations across a range of common medications.

The Assessment of Perioperative Risk

The determinants of perioperative risk fall into four categories [26]. The first and least discussed in the perioperative literature involves various system-related phenomena, including the hospital–institutional model of perioperative care (general vs subspecialty, inpatient vs outpatient, comanagement methodologies), approaches to staffing (nursing, physician assistants, hospitalists), and the role of information systems, all of which are important determinant of outcome. This, the domain of the Quality Improvement movement, is discussed in Chap. 30. The second category of risk relates to anesthetic management and includes such factors as choice of anesthesia (regional vs general), monitoring techniques, airway considerations and the approach to postoperative pain control, topics covered in Part III and Part II of this book. The third includes the surgery-mediated risks, while the fourth category subsumes those influences arising as a consequence of existing medical comorbidity. The impact of preexisting medical conditions on postoperative complications is a subject about which an extensive literature now exists. Indeed, medical comorbidity is now viewed as the primary determinant of adverse surgical outcome. Apropos of this point an early study is illustrative. Of 599,548 anesthetics, perioperative death was

proportionately attributed to anesthesiological practices (1/2,680), the surgeon (1/420) and patient comorbidity (1/95) [27]. This, the first paper to feature the key role played by patient comorbidity in surgical outcome, was buttressed by a second report in which patient-related comorbidity was the major contributor to the mortality in 485,850 of surgical procedures [28].

The identification of the factors that may alter the risk associated with surgery has, until recently, been the purview of the anesthesiologist. Surgical practice has, however, changed. An ever-aging patient population, with an increasing burden of medical comorbidity, is now considered as a suitable candidate for surgical intervention. Such patient-related characteristics, coupled with the technical evolution of surgical practice, now require the input other clinical disciplines, specifically internal medicine or the medical subspecialists, professionals who by necessity have entered the perioperative arena and now play a key collaborative role.

The concept of preoperative risk assessment was ushered into to clinical practice by the anesthesiologists, who in the 1940s became interested in postoperative outcome [29]. Discouraged at first by the complexity of the problem, investigators initially regarded the challenge as too daunting owing to such problems as the magnitude of the data required, practice variation, and to the lack of agreement regarding key definitions and terms. Early investigators did, however, develop a scale for the assessment of the patient's state of health prior to surgery. Indeed, the *American Society of Anesthesiologists (ASA) Physical Status Scale* has proven amongst the most durable tools of clinical medicine [30]. Employed for decades in the setting of anesthesia and surgery, the ASA scale has high correlation with a patient's postoperative course. Five levels of risk based on the presence of a systemic disturbance (illness or comorbidity) are defined with the associated surgical mortality in parentheses: I absent (0.2 %), II mild (0.5 %), III severe/non-incapacitating (1.9 %), or IV incapacitating/threat to life (4.9 %), and V moribund/survival $<$24 h without surgery (NA); the sub-designation E, denotes emergency surgery which doubles the risk [31]. First proposed in 1941 [29], a revision of the scale remains in virtual universal use to this day [32]. Although criticized for the vagueness of its criteria, it has proven an extraordinarily durable assessment tool. The search for more robust prediction methodologies has continues, however, and considerable success has been achieved in the assessment of cardiac risk specifically.

As discussed earlier the primary purpose of the preoperative medical evaluation is the identification of patients who are at higher risk for postoperative complications. While the standard history and physical examination remain the principle screening method for the detection of conditions likely to affect surgical outcome, rating systems have been developed to identify patients who are most likely to develop postoperative complications.

A sentinel example is the landmark work of Goldman on cardiac risk in patients undergoing noncardiac surgery [33]. The Goldman *Cardiac Risk Index*, a tool well known in the perioperative community, has undergone extensive study and subsequent revision yielding the *Revised Cardiac Risk Index* (Table 1.2) [34–36]. This is likely the next most employed scoring system developed to date, second only to the ASA scale previously discussed. In this index one point is assigned for each of the six independent factors associated with major cardiac complications in patients undergoing surgery. The incidence of such complications in patients with zero, one, two, or three risk factors was 0.4, 0.9, 7, and 11 % in a validation cohort [30]. Owing to its simplicity the index remains highly popular. Cardiac risk assessment has been taken to even higher levels with the American College of Cardiology/American Heart Association guidelines for perioperative cardiovascular evaluation in noncardiac surgery [37]. Integrating patient and surgical factors, the ACC/AHA algorithms assess patients' risk for postoperative cardiac events and then go further, guiding decision-making through the identification of patients who should undergo more extensive cardiac evaluation preoperatively and those who might benefit from risk factor modification prior to surgery. This approach is fully discussed and in Chap. 11. Further, other prediction tools have been developed. These include indices for pulmonary complications, specifically respiratory failure [38] and pneumonia [39]; a useful prediction tool for postoperative hepatic failure (MELD Score) is also in widespread use [40, 41].

The search for more global indicators of risk nonetheless continues. Investigators at the John Hopkins Medical Center have developed a surgical risk index, fashioned after the ASA scale, focused on the magnitude (invasiveness) of the surgery and anticipated blood loss. This system is limited by its failure to incorporate patient related factors. Alternatively Canadian investigators have proposed a risk classification that combines patient comorbidity and surgical severity [42]. Along these lines a more elaborate effort is that of Holt and Silverman who propose a *resilience* score for organ systems compromised by an underlying disease process [43]. In this methodology an overall resilience score for a given organ system is derived by adding the standard ASA class to a surgical complexity score (rated 1–5). The maximal score is therefore 10 and, the higher the score, the more likely that a given organ system will suffer injury or fail in the setting of a surgical stress. Individual scores for each organ system assigned a score of $\geq$3 are then added and reflect the impact of multisystem disease. Finally there is the methodology developed by the National Surgical Quality Improvement Program (NSQIP), whose risk calculator provides patient-specific risk estimates across a range of surgical procedures

Table 1.2 Independent predictors of major cardiac complications and estimation of risk with revised cardiac risk index

Revised cardiac risk index (RCRI[a])	
High-risk surgery[b]	
Ischemic heart disease[c]	
History of congestive heart failure	
Insulin therapy for diabetes	
Preoperative serum creatinine >2.0 mg/dL	
Risk of major perioperative cardiac event[d] based on predictors in the RCRI[e]	
No. of risk factors	*Risk of cardiac event, % (95 % CI)*
0	0.4 (0.1–0.8)
1	1.0 (0.5–1.4)
2	2.4 (1.3–3.5)
>3	5.4 (2.8–7.9)

Used with permission from Ashton, JN, Hatton KW, Flynn JD. PerioperativeBeta-Blockade in Patients Undergoing Noncardiac Surgery. Orthopedics 2010; 22(7): 488–491

CI confidence interval

[a]Lee TH, Marcantonio ER, Mangione CM, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. Circulation. 1999; 100(10):1043–1049

[b]Includes vascular surgery and any open intraperitoneal or intrathoracic procedures

[c]History of myocardial infarction or a positive exercise test, current complaint of chest pain considered secondary to myocardial ischemia, use of nitrate therapy, or ECG with pathological Q-waves

[d]Includes cardiac death, nonfatal myocardial infarction, and nonfatal cardiac arrest

[e]Devereaux PJ, Goldman L, Cook DJ, Gilbert K, Leslie K, Guyatt GH. Perioperative cardiac events in patients undergoing noncardiac surgery: a review of the magnitude of the problem, the pathophysiology of the events and methods to estimate and communicate risk. CMAJ. 2005; 173(6):627–634

and is available via the web (www.riskcalculator.facs.org/Home/About/). While of significant interest, more work needs to be done utilizing these global preoperative predictors in order to determine their utility in diverse surgical populations.

Patient Education and Preventive Practices

Patient education and the introduction of preventive practices represent the final goals of the preoperative evaluation. At our institution, preoperative classes are conducted daily for all patients scheduled for total hip and knee arthroplasty as well as those who are to undergo spinal surgery. These sessions review the entire inpatient and postoperative experience associated with these major orthopedic procedures. Supplemented by a comprehensive guide given to each patient, the classes provide an opportunity for patients and their family members to ask questions of the trained nursing educational leaders about the entire perioperative experience. Studies have been conducted in the orthopedic setting, demonstrating a number of benefits of such educational practices; these include a reduction in surgery-associated anxiety and pain [44] as well as a reduction in length of stay [45].

Arising logically from the educational ethos, the implementation of preventive measures has long been an aspirational element of the preoperative assessment. While the range of putative deterrent interventions and the clinical settings in which they might apply remains poorly characterized, there are few data substantiating the role and effectiveness of such approaches. Smoking cessation has received the most attention, in part because it is a sound health promoting recommendation in general. Nonetheless, the termination of cigarette smoking is often not practical, as smoking cessation needs to take place many weeks prior to the procedure, generally well before the preoperative consultation takes place. In the realm of orthopedic surgery, however, the opportunity to implement effective prevention is enhanced by the often, elective nature of the procedure. Weight loss is another important target for prevention, as obesity is not uncommon in the orthopedic setting. Indeed, obesity remains a relevant issue with respect to such concerns as prosthetic longevity in the setting of total hip and knee arthroplasty and the long-term results from spinal surgery; obesity as a medical problem remains a major societal challenge fraught with well-known challenges.

Efficacy of Preoperative Consultation

Until recently the efficacy of preoperative assessment has essentially been assumed [46, 47], justified by the aging and increasing complexity of modern-day surgical patients. The anticipated benefits of consultation in the preoperative setting include the documentation of comorbid disease, to optimize such preexisting conditions through the selective performance of additional investigations and timely referral for subspecialty consultation, the initiation of interventions intended to reduce risk, to anticipate the postoperative needs of the patient, and to defer and occasionally cancel surgery [48]. Studies examining a number of aspects of the preoperative consultation including their impact on such adverse outcomes as day of surgery cancellations [49, 50], duration of hospitalization [36, 51], and hospital costs [37, 52] and on patient anxiety [38]. Such studies have focused on quality concerns and the financial impact of preoperative consultation, but there are other important considerations. For example patient satisfaction is favorably influenced by the preoperative evaluation. In one study patients rated meeting with the anesthesiologist preoperatively a higher priority than that of obtaining information on pain relief, methods of anesthesia, and discussion concerning potential complications of surgery [53].

Data concerning the quality of the preoperative consultation have been published. Observations from the Australian Incident Monitoring Study (AIMS) shed light on this issue [54]. In this study 11 % of preoperative assessments were considered either inadequate or incorrect; 3.1 % of all adverse postoperative events were judged a direct result of these flawed practices. Amongst those patients experiencing postoperative complications, the morbidity was considered major and only 5 % of such events were considered unpreventable. Another study, of anesthetic-related deaths, further develops this theme. Thirty-nine percent (53/135) of such deaths involved suboptimal preoperative assessment and management [55].

The aforementioned entrenchment of the preoperative consultation has occurred despite a lack of evidence to support its widespread acceptance. One randomized trial of preoperative medical consultation showed little benefit on postoperative outcome or on quality of care [56]. In another study of 1,282 patients undergoing surgery, preoperative consultation resulted in no improvement in quality of care indicators (glucose in the diabetic, DVT prophylaxis, DVT) [57]. Two recent studies have examined the impact of preoperative consultation on a macro level [58, 59]. In these cohort studies Wijeysundera et al. utilized population-based databases to examine the impact of preoperative anesthesia and medical consultation on a large surgical population (270,000 patients) undergoing a broad range of major procedures. In addition to mortality and length of stay, a number of process-related phenomena were assessed in order to judge how preoperative consultation might influence differentials in outcome.

While modest differences were found according to whether the preoperative consultation was performed by an anesthesiologist or by a medically trained physician, several themes emerged from these reports. First, over the 10-year period (1994–2003) of the study, the rate of preoperative consultation increased from 19 to 53 %. Presumably reflecting a perceived benefit of consultation on the part of the referring surgeons, the withdrawal to the operating room by the surgical community is also likely responsible. Amongst the medical consultations, the majority (94.2 %) were performed in the outpatient setting, generally about 2 weeks before the surgery. Consultation was associated with higher rates of preoperative testing, the preoperative use (new) of beta-blockers and statin drugs, and preoperative cardiac interventions suggesting an active engagement in decision-making by the preoperative physicians. In terms of benefit, however, the results were disappointing. Regardless of who performed the consultation (anesthesiologist vs medical physician), no reduction in mortality could be shown; indeed, patients undergoing preoperative medical consultation had a modest increase in 1-year mortality. Length of stay was also longer (+0.67 days) in patients who underwent medical consultation (though −0.35 days shorter in those who saw an anesthesiologist prior to surgery). Given the support and general belief in the practice of preoperative consultation, these results were surprising, and the authors posit a number of potential explanations for their findings. These include the association of consultation with an apparent decrease in the use of epidural anesthesia, the higher use of beta-blockers (now believed to increase the rate of stroke after surgery), and the fact that the study population did not include patients whose surgery had been cancelled, nor were those undergoing urgent-emergent procedures considered. In addition, perhaps those surgeons who felt comfortable managing medical comorbidities on their own provided superior perioperative care, thus diluting the impact of the preoperative consultation.

So what additional approaches to care might be of incremental benefit? In addressing this question, Weed brings us back to one of the foundational elements of effective consultation, that is, communication [60]. Citing Chassin, a leader in the quality movement, Weeds shows that the "beneficial effect of process" emphasizes how the achievement of optimal outcomes (i.e., postoperative complications) is inextricably a function of the process used to deliver medical care. Thus, the preoperative consultation in itself is not sufficient. Success requires the fastidious attention to the implementation of the preoperative recommendations. Comanagement, a strategy of perioperative care that emphasizes the active participation of the medical consultant, may provide an effective template [61–63]. However, the experience with this model in the orthopedic and other surgical settings has been mixed and generated commentary of a cautionary nature [64].

Nonetheless, it seems unlikely that such qualifications represent significant offsets to the major conclusions of these influential studies. While surgeons, anesthesiologists, and internists alike continue to believe in preoperative evaluation, belief alone may not be enough. In an era of evidence-based medicine, these observations challenge the perioperative community to demonstrate the efficacy of their practices.

Summary

The medical evaluation of a patient prior to surgery remains a widespread clinical practice. Although, as discussed previously, the overall utility of such assessments remains to be demonstrated, the enduring and widespread support for such consultation is supported by clinical investigation and

growing literature, even national conferences. Owing to this widespread acceptance, the underpinning of perioperative medicine, its principles and practices, is evolving influenced by the quality movement of the last 15 years. This chapter provides a general overview and approach to the patient in the perioperative setting and offers a template not only for this book but for clinical practice as well.

Summary Bullet Points

- The preoperative medical evaluation offers an important opportunity for communication between all professionals involved in the care of the surgical patient.
- The term surgical "clearance" should be replaced by the notion of preoperative "optimization" for surgery.
- The goals of the preoperative evaluation include the evaluation and optimization of patient comorbidity, the assessment of surgical risk, and to provide an opportunity for patient education and the implementation of preventive practices.
- The practice of the preoperative medical evaluation remains an unproven medical intervention.

References

1. Newman MF, Fleisher LA, Fink MP. Perioperative medicine: managing for outcome. Philadelphia, PA: Saunders Elsevier; 2008.
2. Cohn SL, Smetana GW, Weed HG. Perioperative medicine: just the facts. New York, NY: McGraw-Hill; 2006.
3. Sweitzer BJ. Preoperative assessment and management. Philadelphia, PA: Wolters Kluwer Lippincott Williams & Wilkins; 2008.
4. MacKenzie CR, Sharrock N. Perioperative care of the patient with rheumatic disease. In: Paget S, Gibofsky A, Beary JF, et al., editors. Manual of rheumatology and outpatient orthopedic disorders: diagnosis and treatment. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.
5. MacKenzie CR, Sharrock NE. Perioperative medical considerations in patients with rheumatoid arthritis. Rheum Clin N Am. 1998;24:1–17.
6. Schirmer B. Ambulatory surgery. Philadelphia, PA: WB Saunders; 1998.
7. MacKenzie CR, Mandle LA, Reyes C, et al. Are ambulatory surgical patients as health as we think? Using a self-reported health status questionnaire to identify unsuspected medical comorbidities. HSSJ. 2006;2:121–6.
8. Salerno SM, Hurst FP, Halvorson S, et al. Principles of effective consultation: an update for the 21st-century consultant. Arch Intern Med. 2007;167:271–5.
9. Goldman L, Lee T, Rudd P. Ten commandments for effective consultation. Arch Intern Med. 1983;143:1753–5.
10. Cohn S. Preoperative medical consultation. Med Clin N Am. 2003;87:1.
11. Hlatky MA, Boineay RE, Higginbotham MB, et al. A brief, self-administered questionnaire to determine functional capacity (the Duke Activity Status Index). Am J Cardiol. 1989;64:651–4.
12. Fleisher LA, Beckman JA, Borwn KA, et al (2007) ACC/AHA guidelines for perioperative cardiovascular evaluation and care for noncardiac surgery. J Am Coll Cardiol 50:e159–241. http://www.acc.org
13. Blery C, Szatan M, Fourgeaux B, et al. Evaluation of a protocol for selective ordering of preoperative tests. Lancet. 1986;18:139–41.
14. Apfelbaum JL. Preoperative evaluation, laboratory screening, and selection of adult surgical outpatients in the 1990s. Anesth Rev. 1990;17 Suppl 2:4–12.
15. Charpak Y, Blery C, Chastang C, et al. Usefulness of selectively ordered preoperative tests. Med Care. 1988;36:95–104.
16. Macpherson DS, Snow R, Logren RP. Preoperative screening: value of previous tests. Ann Intern Med. 1990;113:969–73.
17. Lawrence VA, Ganfi A, Gross M. The unproven utility of the preoperative urinalysis: economic evaluation. J Clin Epidemiol. 1989;42:1185–92.
18. Smetana GW, Macpherson DS. The case against routine preoperative laboratory testing. Med Clin N Am. 2003;87:7–40.
19. Mancuso CA. Impact of new guidelines on physician's ordering of preoperative tests. J Gen Intern Med. 1999;14:166–72.
20. Narr BJ, Hansen TR, Warner MA. Preoperative laboratory screening in healthy Mayo patients: cost-effective elimination tests and unchanged outcomes. Mayo Clin Proc. 1991;66:155–9.
21. Narr BJ, Warner ME, Schroeder DR, et al. Outcomes of patients with no laboratory assessment before anesthesia and a surgical procedure. Mayo Clin Proc. 1997;72:505–9.
22. Schein OD, Katz J, Bass ED, et al. The value of routine preoperative medical testing before cataract surgery. N Engl J Med. 2000;343:168–75.
23. Roizen MF. More preoperative assessment by physicians and less by laboratory tests. N Engl J Med. 2000;342:204–5.
24. Railton CJ, Wolpin J, Lam-McCulloch J, et al. Renin-angiotensin blockade is associated with increased mortality after vascular surgery. Can J Anesth. 2010;89:736–44.
25. Goodman SM, Krauser D, MacKenzie CR, et al. Cardiac arrest during total hip arthroplasty in a patient on an angiotensin receptor antagonist. HSSJ. 2012;8(2):175–83.
26. Tung A. Risk reduction and risk assessment. In: Sweitzer BJ, editor. Preoperative assessment and management. 2nd ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2008.
27. Beecher HA, Todd DP. A study of the deaths associated with anesthesia and surgery: based on a study of 599,548 anesthesias in ten institutions 1948-1942. Ann Surg. 1954;140:2–34.
28. Lunn J, Devlin HB. Lessons from the confidential enquiry into perioperative deaths in three NHS regions. Lancet. 1987;330:1384–6.
29. Saklad M. Grading of patients for surgical procedures. Anesthesiology. 1941;2:281–4.
30. www.asahq.org/clinical/physicalstatus.htm.
31. Prause G, Ratzenhofer-Comenda B, Pierer G, et al. Can ASA grade or Goldman's cardiac risk index predict peri-operative mortality? A study of 16,227 patients. Anaesthesia. 1997;52:203–6.
32. Keats AS, The ASA. Classification of physical status - a recapitulation. Anesthesiology. 1978;49:233.
33. Goldman L, Caldera DL, Nussbaum SR, et al. Multifactorial index of cardiac risk in noncardiac surgical procedures. N Engl J Med. 1977;297:845–50.
34. Detsky A, Abrams H, McLaughlin J, et al. Predicting cardiac complications in patients undergoing non-cardiac surgery. J Gen Intern Med. 1986;1:211–9.

35. Eagle KA, Coley CM, Newell JB, et al. Combining clinical and thallium data optimizes preoperative assessment of cardiac risk before major vascular surgery. Ann Int Med. 1989;110:859–66.
36. Lee HT, Marcantonio ER, Mangione CM, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. Circulation. 1999;100:1043–9.
37. Fleisher LA, Beckman JA, Brown KA, et al. ACC?AHA guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery. J Am Coll Cardiol. 2007;50:e159–241.
38. Arozullah AM, Daley J, Henderson WG, et al. Multifactorial risk index for predicting postoperative respiratory failure in men after major noncardiac surgery. The National Veterans Administration Surgical Quality Improvement Program. Ann Surg. 2000;232:242–53.
39. Arozullah AM, Khuri SF, Henderson WG, et al. Development and validation of a multifactorial risk index for predicting postoperative pneumonia after major noncardiac surgery. Ann Int Med. 2001;135:847–57.
40. Costa BP, Sousa FC, Serodio M, et al. Value of MELD and MELD-based indices in surgical risk evaluation of cirrhotic patients: retrospective analysis of 190 cases. World J Surg. 2009;33:1711–9.
41. www.unos.org
42. Pasternak LR. Risk assessment in ambulatory surgery: challenges and new trends. Can J Anaesth. 2004;51:R4.
43. Holt N, Silverman DG. Modeling perioperative risk: can numbers speak louder than words. Anesthesiol Clin N Am. 2006;24:427–59.
44. Giraudet-Le Quintrec HS, Coste J, Vastel L, et al. Positive effect of patient education for hip surgery: a randomized trial. Clin Ortho Rel Res. 2003;414:112–20.
45. Jones S, Alnaib M, Kokkinakis M, et al. Pre-operative patient education reduces length of stay after knee joint arthroplasty. Ann R Coll Surg Eng. 2011;93(1):71–5.
46. American Society of Anesthesiologist Task Force on Preanestheisa Evaluation. Practice advisory for preanesthesia evaluation: a report by the American Society of Anesthesiologist Task Force on Preanestheisa Evaluation. Anesthesiology. 2002;96:485–96.
47. Cohn SL, Macpherson DS. Overview of the principles of medical consultation. In: Rose ED, editor. UpToDate. Wellesley, MA: UpToDate; 2005.
48. Wijeysundera DN. Preoperative consultations by anesthesiologists. Curr Opin Anesthesiol. 2011;24:326–30.
49. Ferschl MB, Tung A, Sweitzer B, et al. Preoperative clinic visits reduce operating room cancellations and delays. Anesthesiology. 2005;103(4):855–9.
50. van Klei WA, Moons KG, Rutten CL, et al. The effect of outpatient preoperative evaluation of hospital inpatients on cancellation of surgery and length of hospital stay. Anesth Anal. 2002;94(3):644–9.
51. Pollard JB, Garnerin P, Dalman RL. Use of outpatient preoperative evaluation to decrease length of stay for vascular surgery. Anesth Analg. 1997;85(6):1307–11.
52. Ferschl MB, Tung A, Sweitzer BJ, et al. Economic impact of a preoperative clinic on operating room efficiency. Anesthesiology. 2005;103:855–9.
53. Lonsdale M, Hutchison GL. Patient's desire for information about anesthesia: Scottish and Canadian attitudes. Anesthesiology. 1991;46:410–2.
54. Kluger MT, Tham EJ, Coleman NA, et al. Inadequate preoperative evaluation and preparation: a review of 197 reports from the Australian incident monitoring study. Anaesthesia. 2000;55:1173–8.
55. Davis NJ, editor. Anaestheia-related mortality in Australia 1994-1996. Melbourne, VIC: Capital Press; 1999.
56. Macpherson DS, Lofgren RP. Outpatient internal medicine preoperative evaluation: a randomized clinical trial. Med Care. 1994;32(5):498–507.
57. Auerbach AD, Rasic MA, Sehgal N, et al. Opportunity missed Medical consultation, resource use, and quality of care of patients undergoing major surgery. Arch Int Med. 2007;167(21):2338–44.
58. Wijeysundera DN, Austin PC, Beattie WS, et al. A population-based study of anesthesia consultation before major noncardiac surgery. JAMA. 2009;169(6):595–602.
59. Wijeysundera DN, Austin PC, Beattie WS, et al. Outcomes and processes of care related to preoperative medical consultation. Arch Int Med. 2010;170(15):1365–74.
60. Weed HG. Outcomes of preoperative medical consultation. JAMA. 2011;171(4):367–8.
61. Macpherson DS, Parenti C, Nee J, et al. An internist joins the surgery service: does comanagement make a difference? J Gen Intern Med. 1994;9(8):440–4.
62. Huddleston JM, Long KH, Naessens JM, et al. Hospitalist-orthopedic team trial investigators: medical and surgical comanagement after elective hip and knee arthroplasty: a randomized, controlled trial. Ann Int Med. 2004;141(1):28–38.
63. Phy MP, Vanness DJ, Melton III LJ, et al. Effects of a hospitalist model on elderly patients with hip fracture. Arch Int Med. 2005;165(7):796–801.
64. O'Malley PG. Internal medicine comanagement of surgical patients: can we afford to do this? Arch Intern Med. 2010;170(22):1965–6.

The Prevalence of Disabling Musculoskeletal Conditions and the Demand for Orthopedic Surgery in the Twenty-First Century

2

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Objectives

- To document the prevalence of musculoskeletal diseases which require hospitalization and often surgical treatment.
- To present the typical outcomes of surgical treatment of musculoskeletal conditions.
- To present the risk and incidence of complications associated with surgical care of musculoskeletal conditions.

Key Points

- The majority of hospitalizations and indications for surgery for musculoskeletal conditions result from degenerative diseases of the spine and major lower extremity joints
- Spinal surgery, which follows careful selection criteria, typically results in pain relief, improved function, and improved quality of life which is maintained over long term periods of observation.
- Complications following spinal surgery are affected by age of the patient, anatomic location of disease and the surgical approach. Older patients with preexisting comorbidities, posterior approaches to the cervical spine and anterior approaches to the thoracolumbar spine are associated with higher risks of postoperative complications.
- Rapid growth in the demand for total hip and total knee arthroplasty has occurred over the past decade reflecting aging of the population as well as the success and safety of these procedures.
- Morbidity and mortality following total hip replacement (THR) and total knee replacement (TKR) are rare and the incidence of complications and death has decreased over time. Thromboembolic events have been reduced with adoption of routine prophylaxis protocols.
- Myocardial infarction occurs in approximately 3 % of patients and stroke in 0.5 % and patients over 70 years of age appear to be at greater risk.

Introduction

Musculoskeletal conditions are among the most disabling and costly conditions affecting the American population. As the US population rapidly ages, musculoskeletal impairments will increase. By the year 2030, the number of individuals in America over the age of 65 will double, with people above 85 years of age constituting the fastest growing segment of our society [1]. Similar demographic changes are predicted for Europe. Bone and joint disorders account for more than one half of reported conditions in people over the age of 50 and are the most common cause of pain and disability.

The economic impact of musculoskeletal disease is enormous. The projection of direct costs of the medical care required to treat musculoskeletal conditions from 2002 to 2004 was $510 billion, or 4.6 % of our nation's gross domestic product (GDP). Indirect costs resulting from lost wages due to inability to perform ones job added another $331 billion, or 3.1 % of GDP [1]. Advances in the care of patients with musculoskeletal diseases that mitigate the long term suffering and economic impact of these conditions and help these patients return to full and active

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