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Anaesthesia for the Elderly Patient

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FREDERIQUE SERVIN

SECOND EDITION · SECOND EDITION · 2

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SECOND EDITION

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Preface to the second edition

In the nearly 10 years since we wrote the first edition of this book, the predictions about the effect an ageing population would have on society, states, and medicine are now clearly present across the world. The challenges of providing the best care to these vulnerable individuals and paying for that care are central to policy making and planning of most national governments, as well as in health care institutions and medical bodies. Many models are being proposed; however, none yet appears without serious flaws.

It remains true that, at present, the elderly consume a disproportionate share of health care provision, but when delivered well, health care maintains their independence in society, and that more than balances the alternative cost of providing personal care to dependent patients, their relatives, carers, and the state. It is also worth remembering that they have contributed to national healthcare funds for their entire working lives.

There has been an increase in the number and quality of research papers in anaesthesia and critical care relating to or including elderly patients, as well as a handful of major textbooks on the subject. Preventing cognitive decline is of the highest priority, with dementia care in the UK costing more than £26 billion/year. Research funding bodies have therefore given priority to research into cognitive dysfunction, and major collaborations are starting to unravel possible mechanisms for its causation. National audits of outcome are more widespread, for instance, those for fractured neck of the femur and colorectal surgery, and the results are informing government policy making.

In response to this, we have updated all of the book's chapters, some of which have been completely rewritten. For example, we added a new chapter on non-theatre-based anaesthesia. Yet we aimed to retain the principle of the first edition: namely, to present current information on the care of the elderly anaesthetic patient, in an accessible and easy to understand format. As before, we hope this readily accessible source of information will support anaesthetists, intensivists, and other clinicians caring for elderly patients. We hope it will generate their enthusiasm to read further and develop into leaders in this highly rewarding field of practice.

Chris Dodds
Chandra M. Kumar
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Preface to the first edition

For the first time in recorded history, there are more people over the age of 65 years than under the age of 16. Associated with this is an increased longevity resulting in more people than ever reaching their ninth decade or more. These people are much more likely to need access to the highest-quality healthcare. Unfortunately, they also suffer the highest rate of complications, including death. In some, this is part of an end-of-life process, but for others, this precipitates them into many years of dependence on others, including admission into nursing care despite full independence before becoming ill.

The challenges that elderly patients pose to anaesthetists and intensivists are greater than for any other group of patients, and yet the entire field remains one of the most poorly researched aspects of medical care.

The aim of this handbook is to provide rapid access to information that will help clinical staff understand some of the problems that occur in caring for the elderly patient. Basic physiological changes and the pharmacological variations with age-ing inform the later chapters on the common areas where elderly patients are most likely to present. There are chapters dealing with the commonly occurring presentations of elderly patients, such as emergency surgery and elective ortho-paedic, urological, abdominal, and neurological surgery.

A brief review of ethics and current law relating to the elderly and anaesthesia has been included to help with understanding the issues of capacity and consent, both of which are areas where the elderly are more likely than younger patients are to require careful assessment and management.

It is hoped that this handbook will not only provide this information in an acces-sible format but also encourage readers to seek more information on the care of elderly patients, and indeed research into their needs so that we can improve the delivery of effective care for them.

Chris Dodds

Definitions, social trends, and epidemiology

KEY POINTS

- The proportion of the elderly in the population is increasing.
- There are now more people over the age of 65 than under the age of 16.
- Aged economies (where more capital is spent on elderly than on younger groups) will quadruple in the next 40 years
- Dependency increases with advancing age.
- The social and financial costs of dependency are staggeringly large.
- Elderly cohorts differ markedly—research has a 'sell-by' date.
- Social changes, such as independent living, have a major influence of health care provision.
- Life expectancy is increasing.
- Technological advances will need to play a major part in the delivery of care to the elderly.
- Anaesthesia has an important role in maintaining independence.

1.1 Social influences

The changes in population demography are relatively uniform across the world, but these are for differing reasons. Demographic studies show a proportionate increase in the number of the elderly and a decline in numbers of the younger members of society. This may be due to either a prolonged survival or a falling birth rate in the so-called developed countries or a loss of young adults from infectious disease or warfare in other countries. This loss of the 'earning classes' has a great effect on the finances available to support the health care requirements of an ageing population. It is usually described as a dependency ratio, where the population over retirement age (usually over 65 years of age) is factored against the group in active employment (usually 18–64 years of age) (Fig. 1.1).

A more useful ratio is that of the population with a less than 15-years life expectancy against all those over 20 with a greater than 15-years life expectancy, the Prospective Old Age Dependency Ratio (Fig. 1.2)

The proportion of 'old' (over 60) and 'oldest old' (over 80) will nearly double over the next 40 years (Table 1.1). The only realistic future is for those over

Fig. 1.1 Conventional old-age dependency ration as projected for 2030

Reproduced from European demographic data sheet 2012. Vienna Institute of Demography, Vienna 2012.
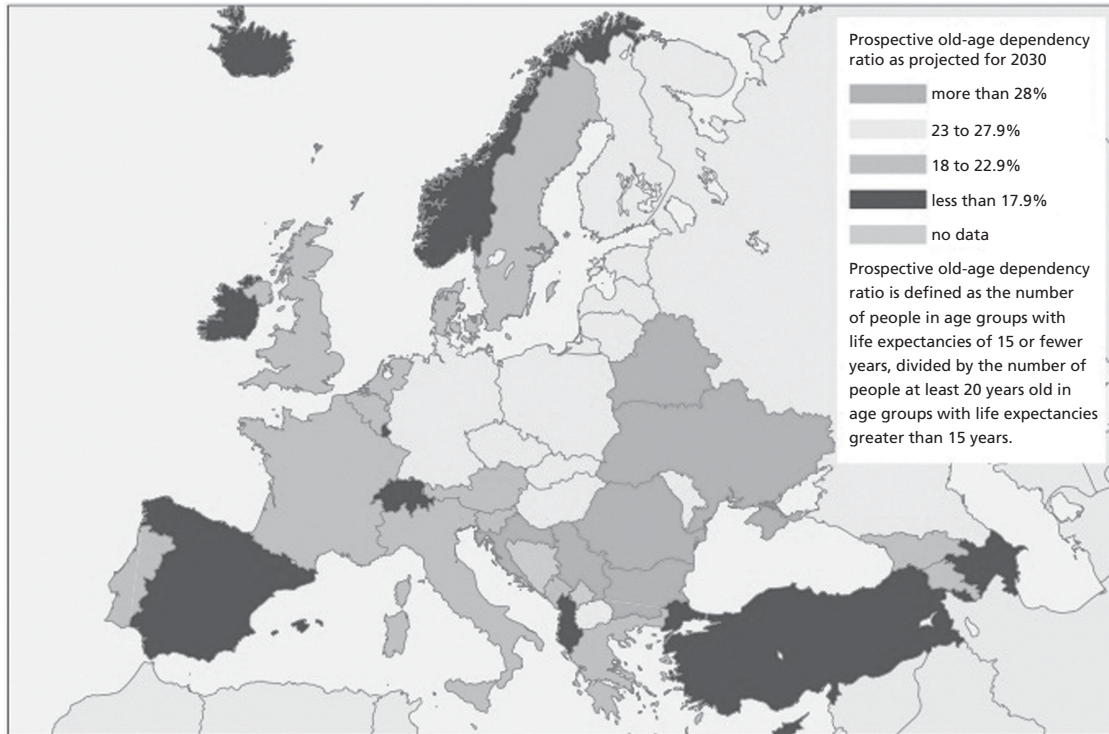
Fig. 1.2 Perspective old-age dependency ration as projected for 2030

Reproduced from European demographic data sheet 2012., Vienna Institute of Demography, Vienna 2012.

Table 1.1 Global ageing indicators		
Life expectancy	2011/12	2050 projection
Life expectancy at birth by sex (men/women)	67.1/71.6	73.2/78.0
Life expectancy at 60 by sex (men/women)	18.5/21.6	20.9/24.2
Life expectancy at 80 by sex (men/women)	7.1/8.5	8.3/9.8
Population		
Number of persons aged 60+	809,742,889	2,031,337,100
Number of persons aged 80+	114,479,616	402,467,303
Number of persons aged 100+	316,600	3,224,400
Percentage of persons aged 60+	11.5	21.8
Percentage of persons aged 80+	1.6	4.3
Sex ratio: number of men aged 60+ per 100 women aged 60+	83.7	86.4

Reproduced from Ageing in the Twenty-First Century, 'Setting the Scene', Copyright © United Nations Population Fund (UNFPA) and HelpAge International, 2012.. Data from UNDESA, Population Division (2012). Prepared by the Population and Development Section on the basis of data from UNDESA, World Population Prospects. The 2010 Revision (New York, 2011) and UNDEA, World Population Ageing and Development, 2012 Wall Chart (2012 forthcoming) www.unpopulation.org, and UNDESA, Population Diversion, World Population Ageing: Profiles of Ageing, 2011 (New York, 2011), CD-ROM

the current retirement age to remain in employment for longer. This will partly compensate for the increasing cost of healthcare provision, but it emphasizes the necessity to maintain these elderly people as independent and healthy.

Migration, both internal and international, is a further social influence. The elderly may move to rural areas for retirement just as younger people leave for urban areas (See Fig. 1.3). At a local level, this may lead to great regional instability in the ability to fund the infrastructure necessary to maintain that population: roads, emergency services, and hospitals, for instance.

The loss of an individual's independence (Fig. 1.4), causes difficulties for those who may also need to be cared for after injury or illness. Several generations may be affected, as older parents require care at the same time as young children. Loss of earnings may be inevitable as increasing dependency outstrips the local provision of free home-based care, further limiting care options. For most families the cost of nursing care far exceeds the state provided funding.

The properties of the 'elderly' also change from one cohort to the next because of differences in nutrition or exposure to infection, for example. These differences make direct extrapolation of data from one group to the next difficult. There is effectively a 'sell-by' date on these studies.

What information is available on the impact of major surgery in the elderly patient population suggests that they have outcomes that are less favourable and
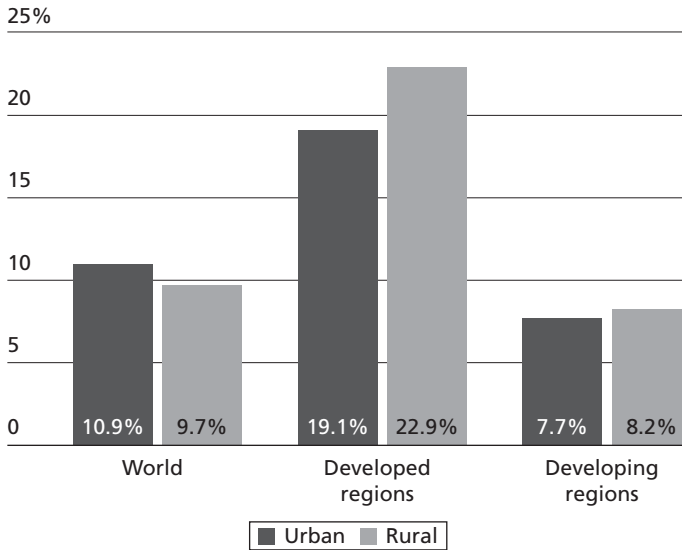
Fig. 1.3 Percentage of the population aged 60 or over in rural and urban areas in 2005

more complications compared with younger groups. Recovery is also prolonged, and it may not allow a return to their previous level of activity. Dependency increases with age, and it is estimated that more than 60% of the elderly will be dependent during the last year of life. The cost to carers in the UK is estimated to be £36 billion/year in direct and indirect costs.

Many of the interventions necessary during surgery, anaesthesia, and intensive care that are apparently well tolerated by younger patients cause significant problems in the elderly. These range from the minor (communication difficulties in terminology) to the major (cognitive impairment or loss of independence).

Progressive variation in the pathophysiological make-up of patients is associated with getting older (see Chapter 2). They become increasingly individualized in their responses to challenges. This means that the delivery of a standard pattern of care often has unpredictable results.

Legislation in the UK in the form of the Mental Capacity Act 2005 defines mechanisms for dealing with informed consent and legal capacity in patients with impaired cognition. The full effect of these measures is still developing, although there is much useful information on the Department of Justice website. http://www.justice.gov.uk/downloads/publications/moj/2010/Memorandum-Justice-Select-Committee.pdf

Men

Women

■ Living with spouse only   ■ Living alone
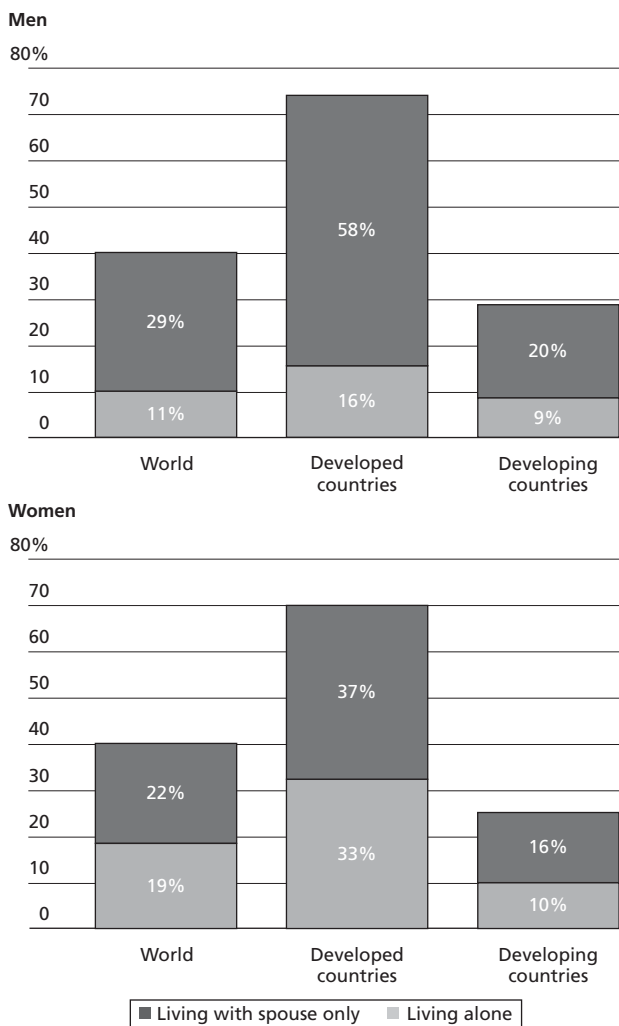
Fig. 1.4 Percentage of people aged 60 or over living independently (alone or with a spouse only), latest available data

Reproduced from *Ageing in the Twenty-First Century*, 'Setting the Scene', Copyright UNFPA. Data from UNDESA, World Population Ageing 2011 (2012; forthcoming) based on the UNDESA Population Division medium projection scenario World Population Prospects. The 2010 Revision

Note: the group of "developed countries" corresponds to the " more developed regions" of the World Population Prospects: The 2010 Revision, and the group "developing countries" corresponds to the "Less developed regions" of the same publication.
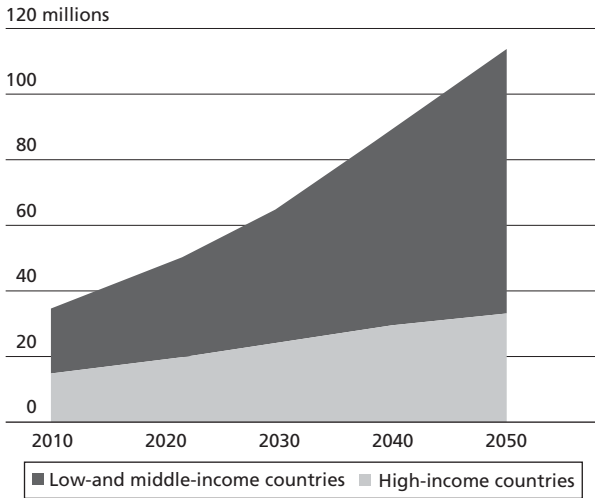
Fig. 1.5 Growth in numbers of people with dementia in high-, middle-, and low-income countries

Reprinted from *Dementia: A Public Health Priority*, p 19. Copyright (2012) with permission from World Health Organisation and Alzheimer's Diseases International

There are over 250,000 Powers of Attorney registered in the UK.

The predicted fourfold increase in numbers of patients with Alzheimer's disease by 2050 worldwide means that we will face this problem much more frequently, especially in acute situations (Fig. 1.5).

1.2 Recent advances

Basic science research into the causes of ageing are leading some exponents to the belief that longevity could be increased to over 1000 years—a race of 'immortals' being developed as we identify genetic influences involved in malignancy, predisposition to disease, and ageing itself. We do not appear to have reached that stage yet, but it is clearly a possibility (Fig. 1.6).

Further, preoperative assessment at some time distant from surgery has become established, but it has problems with detecting acute changes in the elderly, and it provides only a limited ability to improve the condition of the patient if a problem is detected close to the time of surgery. Specific testing protocols for major surgery using markers of performance, such as the move of cardiopulmonary exercise testing, from being a largely cardiology-based investigation, into anaesthetic screening, are showing some promise in risk stratification, as are the benefits of graded exercise programmes.

Anaesthesia in the elderly
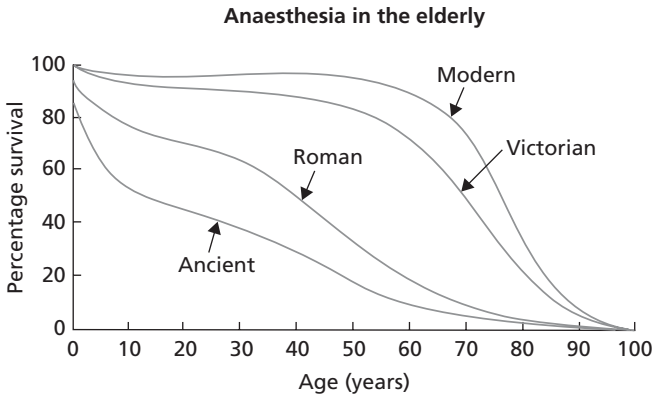
Fig. 1.6 Survival curves over time

Reproduced from Davenport H.T., Anaesthesia and the aged patient. Copyright (1988), with permission from John Wiley & Sons.

At another level, the growing understanding that the impact of injury has on astrocytes and microglial cells and the role of the inflammatory response to surgery is starting to illuminate the possible processes that may lead to devastating but unpredictable postoperative cognitive dysfunction. At the same time, there is also a debate developing on whether volatile or intravenous anaesthetic agents provide benefits or pose risks to patients.

Clinically, there have been advances in our understanding of perioperative management that may make for better outcomes in the elderly. For instance, tight glycaemic control during the perioperative period improves outcomes and reduces complication rates after surgery.

1.3 Novel procedures

Improvement in the success rates of experimental surgery for stem cell implantation means that it is likely to be of clinical utility within the next few years. The potential to restore or maintain function in degenerative diseases has huge cost implications for the state and for families. They range from chondrocyte resurfacing in major joints instead of prosthetic replacement, replacement myocardium to repair damage caused by infarction, or stereotactic neurosurgical placement of stem cells into the brain to replace key cell lines, such as dopaminergic neurones for Parkinson's disease or cholinergic neurones for dementia.

The ability to maintain independence alone makes these attempts worthwhile. However, given the cost benefit to both the patient and the state, these are not going to be inexpensive procedures.

Interventional radiology has been the fastest growing speciality in medicine. It has revolutionized many procedures that were once solely the domain of the

surgeon (see Chapter 13). Interventional cardiology has largely replaced coronary artery bypass surgery as first-line management of coronary arterial stenosis. The same technology could allow direct injection of chemotherapy directly into the arterial supply of tumours rather than the whole patient, thus reducing operative surgery for malignancy.

Further, newer drugs are changing the face of disease presentation. Statins have deferred the onset of ischaemic heart disease, but not the process—this will mean an increasingly large number of elderly patients presenting with heart disease as a new problem. This will have an effect on our screening of patients, as they will rightly say they have no cardiovascular disease but will have organ-specific disease, as well as the normal changes of ageing.

1.4 Risk indices

One of the most common methods used to try to quantitate the likelihood of a particular operation being of benefit to a patient, or of assessing the risks (morbidity or death), is a calculation of a 'risk index'. The most common method used to test the discriminating power of an index is the 'receiver operating characteristic' curve. This plots true-positive predictions (sensitivity) against false-positive predictions (specificity). The nearer to unity the area under the curve is, the better model it is. Values above 0.704 are clinically acceptable, whereas pure chance gives a value of 0.5 (Fig. 1.7).

These indices have been developed in many countries and can be used in such areas as intensive care medicine (Apache III), major vascular surgery, and even in day-case surgery. They all have problems in common. The development of a risk index for one population is rarely so predictive in another group because of genetic and environmental impacts related to each group. Extrapolation of a group data set into individual patient outcome is also of limited value. Even large-scale, multivariate indices, such as those used in risk stratification for cardiac (euroSCORE) or colorectal carcinoma surgery (CR-POSSUM), are of limited predictive value in absolute terms.

1.5 Health care and political issues

Within each health care system, there are limits on the funding available, and the differing priorities are given to that available money. Some of the influences will be related to geographical or social concerns: for example, the need for long-distance transfers in remote country areas or the political aspirations of the government. However, keeping pace with developments in medical practice across the broad range of specialities is impossible through state provision alone.

One aspect of this is the 'lag time' where funding to support clearly identified methods of reducing complications rarely follows immediately. Yet the longer it takes for their implementation, the more patients and their carers will suffer avoidable increases in dependency. These methods range from such simple
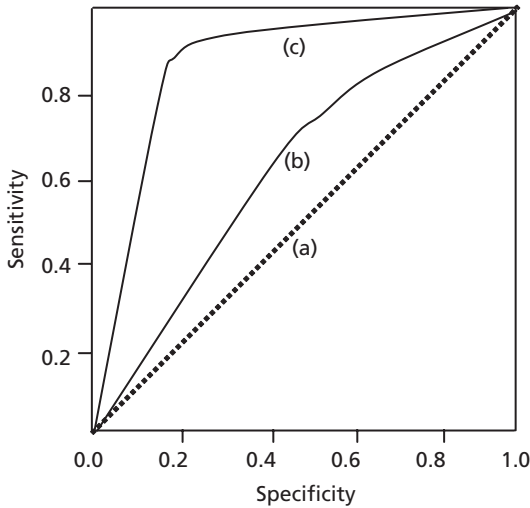
(a) = area under the curve of 0.5 and a discrimination that
        is no better than chance
(b) = small area under the curve and a poor discrimination
(c) = large area under the curve and a good discrimination

Fig. 1.7 The receiver operating characteristic (ROC) curve

techniques such as active warming or the close control of fluid balance to the provision of an appropriate number of high-dependency beds. This funding inertia alone is likely actually to cost society more than the initial capital investment to deliver these provisions.

There is a drive across the world to increase the proportion of surgery performed as day-care or limited-stay surgery because it is believed to reduce complications, deliver financial savings, and improve patient satisfaction. Initially the scope of surgery offered was limited, and it often is offered to relatively young patients. During the past decade, there has been an increase in the complexity of surgery being performed as a 'day case', and limitations related to age have largely disappeared.

Recently, concerns have arisen that day-case surgery is not without problems. In particular, poor pain relief and cognitive dysfunction persist after such surgery. It is likely that complications related to the extent of surgery and the triggered stress responses will occur regardless of the place of care for that patient. Where these are managed within an acute hospital, they can be treated rapidly, but if they occur in the community, they may be less likely to be identified and treated

quickly. Pain relief after intermediate complexity surgery is rarely well provided, yet this has a major influence on subsequent complications such as chest infections and cognitive performance.

The costs of providing health care increases year on year, and all systems operate a rationing system. They vary from an explicit definition of state provision with increasing enhancement of medication, facilities, investigations, and the like, with funding from personal health insurance or direct self-funding. Others have increased private investment to maintain services. Still others maintain an arbitrary provision of services dependent on local or national taxation, and some have entirely independent health provision. All variations have the potential to discriminate unfairly against the elderly. Even the market place jargon of health economics, such as 'quality adjusted life years' (QUALYS), makes detrimental assumptions about the quality of life of older patients, especially given the weighting that longer life expectancy gives.

State funding for all aspects of health care are being challenged by the escalating costs of new procedures and therapeutic agents. Changes in management are nearly always more expensive than those now regarded as less useful. Many countries are committed to maintaining the provision of emergency or acute care but are starting to create shared-cost care for procedures that are elective, such as hip replacements. Whether this is by the introduction of semiprivate hospitals providing subsidized care or by directly funded private hospitals varies from country to country.

Where these have been in place for years, there is little effect on the elderly, but when these are introduced *de novo*, they cause hardship for the retired population of that country. This is because, usually, the elderly will not have the financial resources to meet these new demands. Moreover, the elderly are often excluded from subscribing to medical health insurance because of the chronic nature of the conditions leading to such elective surgery.

Another issue in these new systems is that they are often advantageously placed to offer surgery or investigations to the fittest, least-complicated groups. They limit provision to the chronically ill or those with complex histories because they do not provide the resources, of an intensive care unit, for instance, which are necessary for the safe care of those patients. This further disadvantages the state provider because it has to continue to deliver care for the complex patients (usually elderly) without the financial buffer of straightforward cases. The divergence in cost per case is then used against the state system to demonstrate how much more effective the new system is.

It is highly unlikely that routine, straightforward elective surgery will continue to be provided by state funding.

1.6 Patient changes

The current cohort of proto-aged, the 'baby-boomers', are much more demanding and better informed compared with previous generations of elderly patients.

The knowledge base on which medical professionalism has been based for centuries is now readily available. Now, information overload rather than ignorance is the danger.

Media coverage of all new developments fuels this process, and combined with the surfeit of information, it leads to an unrealistic degree of expectation for care provision. This is further aggravated by the TV medical dramas that show recovery from injuries or medical disasters that in real life are far more commonly lethal.

The combination of these influences will mean that the patient/doctor relationship in the future will have to combine acting as an expert adviser on one hand and an access point to health care that may be only partly state funded for routine care on the other.

Face-to-face consultations may become less common as access to investigations and imaging will be available by direct booking, and the interpretation of these findings may be by experts in other parts of the world. Robot-based medical history taking and diagnostic evaluations are already being used, and it may only be a matter of time before interventional medicine and surgery do not require human physical contact.

1.7 Summary

The elderly are vulnerable to the stresses of injury, surgery, and anaesthesia, which may profoundly affect their quality of life, as well as its length. Understanding the changes in society and the imperatives that an ageing population places on governments is vital if we are to protect and preserve the independence and well-being of our elderly patients.

FURTHER READING

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Pathophysiological changes of ageing and their relevance to anaesthesia

KEY POINTS
• Organ function declines at an average rate of 1% a year from the age of 40.
• Behavioural influences (choosing not to drink, for instance) have to be considered.
• Atrial fibrillation (AF) is the default rhythm for the elderly.
• Closing volume lies within tidal ventilation when supine after the age of 65.
• Muscles are no longer 'vessel rich'.
• Autonomic dysfunction may be occult and should be sought.
• Renal homeostasis is reduced in both speed and degree of compensation to water and solute loads.

2.1 Introduction

Ageing is a balance between gradual maturation and senescence, which is the process by which the capacity for cell division and for growth and function are lost over time, ultimately leading to death. The changes that occur with ageing can be categorized as those that result from ageing itself and those that result from diseases, lifestyle, and exposures. 'Normal ageing' describes the changes attributed to ageing itself, but these are often associated with common complex diseases and functional impairments. However, this complex impairment is hard to define because people age very differently. Some develop disease with impaired organs, whereas others seem to escape disease altogether. 'Healthy ageing' refers to a process by which the deleterious effects are minimized, preserving function until senescence makes continued life impossible. People who age successfully avoid experiencing many of the undesirable effects of ageing, and, whether they have a disease or not, they both physically and mentally functional. The physiopathology of ageing has been extensively researched, and this summary focuses on the consequences of the ageing process that are important in anaesthesia and intensive care.

2.2 Molecular basis of ageing

Ageing is associated with a progressive increase in somatic mutations, which accumulate in the cells in a tissue-specific manner. Those mutations lead to genomic instability, which in turn increases the risk of cancer. Not all individuals or genomes are equal, and some genomes are more resistant than other are to ageing. Some changes have been clearly identified.

2.2.1 Summation over time of DNA alterations leading to genome instability

Accumulating DNA damage may become detrimental to physiologic cell function, and, ultimately, lead either to malignancy or to cellular death and loss of tissue. Over a lifetime, the normal subject develops many DNA errors, and these are recognized and removed by highly specialized DNA-repair systems. It is a huge challenge for future science to promote and maintain this reparative function into old age. However, other mechanisms are necessary to explain a more or less fixed life span and a rather uniform evolution towards senescence.

2.2.2 Epigenetic alterations leading to changes in the expression of genes

Epigenetic alterations are changes in gene expression, which can be transmitted but do not modify a DNA sequence, and are thus potentially reversible. For example, a DNA sequence can be modified by the adjunction of a methyl radical to the DNA bases, by a mutation or a virus, and become unable to express itself. This DNA methylation status is progressively lost during ageing, and this may promote age-related diseases.

2.2.3 Telomeric shortening in somatic cells

Human somatic cells can duplicate only a limited number of times, and current research is trying to identify the biological clock that governs this phenomenon. A protective hood, the telomere, which is eroded at each cell division, covers the extremities of the chromosomes. When this telomere is too short, the essential sequences of the chromosome are exposed, leading to cell damage and death. The telomeres of patients suffering from progeria are very short. The introduction into somatic cells of a telomerase, one of the enzymes in charge of telomere regeneration, provides them with the ability to divide *ad infinitum* without signs of cell senescence or loss of function.

2.2.4 Oxidative and specifically mitochondrial lesions

Mitochondria, which produce most of the cell energy, contain their own genome, distinct from the nuclear DNA, and that does not have the same repair capacities. This leads to microlesions within the mitochondrial genomes and numerous senescence traits are believed to be due to the resulting mitochondrial dysfunction.

To summarize, senescence is largely due to a progressive loss of functional cells, and resultant declining efficiency in organs. This progressive loss occurs at variable rates in individual patients and their organ systems. Functional reserve is the difference between the basal level of organ function at rest and the maximum level of organ function that can be achieved in response to increased demand, such as during exercise or in response to surgical stress. Functional reserve is generally reduced in elderly patients, leading to increased morbidity and mortality. This is made worse if the condition requiring surgery or the procedure itself further reduces this failing physiological reserve.

Decreased functional reserve is difficult to detect. Patients may have limited mobility and as a result are unable to exert themselves. These patients usually are unaware that they could suffer from breathlessness or angina, but they may have significant underlying and undetected ischaemic cardiac disease.

2.3 Impact of senescence on organ function

2.3.1 Basal metabolic rate and thermoregulation

Basal metabolic rate is reduced by about 1% per year, from the age of 30. Consequently, thermogenesis is also reduced. In the elderly, peripheral vascular changes lead to an important increase in caloric loss linked to anaesthesia-induced vasodilatation. The threshold for thermoregulatory vasoconstriction is lower in elderly than in young patients, and shivering occurs at lower body temperatures specifically during regional anaesthesia. Therefore, the caloric debt of elderly patients is dramatically increased at the end of surgery, with numerous deleterious effects: increase in oxygen demand during recovery when hypoxemia is frequent, delayed recovery of consciousness and of airway protective reflexes, hypovolaemia unmasked by rewarming, and increased protein catabolism during the first postoperative days as compared with normothermic patients. The cardiovascular response to passive percutaneous rewarming is less efficient with advancing age because the redistribution of blood supply to the skin is reduced and rewarming is thus slower.

Age-related changes occur in all organs (see Fig. 2.1), but the reduction is especially relevant in the cardiovascular, respiratory, renal, and central nervous system. It is important to understand these changes because they largely determine the outcome of surgical procedures under both general and regional anaesthesia.

2.3.2 Cardiovascular system

With age, the heart can atrophy, remain unchanged, or develop moderate or marked hypertrophy. Atrophy usually coincides with various wasting diseases, and it is not observed during ageing in healthy persons. The cardiac mass increases by approximately 1–1.5 g every year. There is an age-related modest increase in the left ventricular (LV) wall thickness, even in patients free of cardiovascular disease
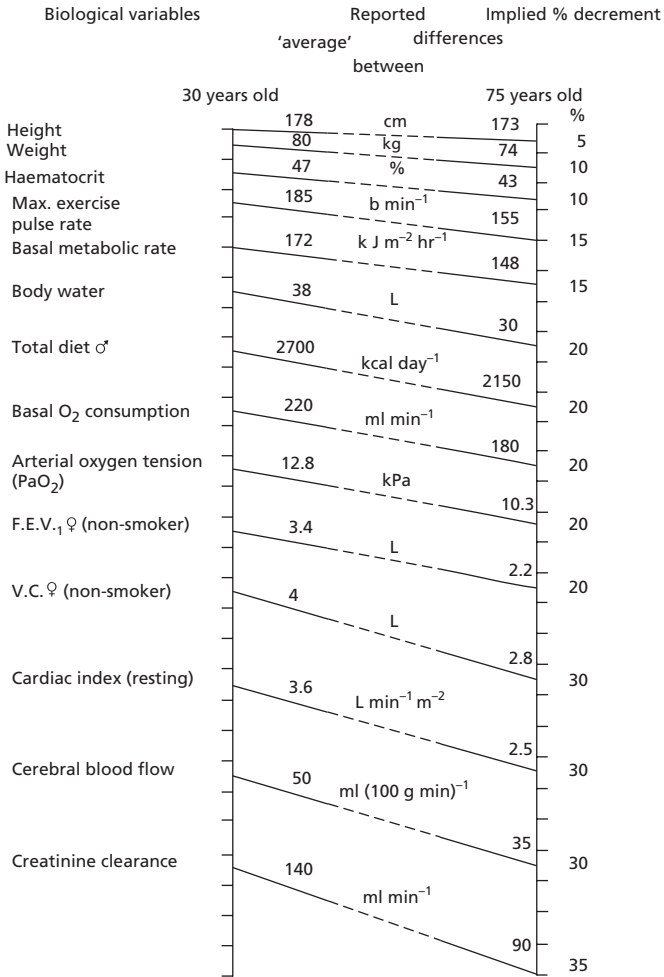
Fig. 2.1 Biological measurement related to age

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or hypertension. Studies that have excluded subjects with hypertension, however, show consistent increases in LV wall thickness in conjunction with reduced diastolic compliance, and the stimulus for hypertrophy may be an increased afterload imposed on the LV by an age-related decline in aortic compliance. All types of hypertrophy are associated with various degrees of increased deposition of

CHAPTER 2

collagen, which may further reduce diastolic compliance. The amount of fibrous tissue within the myocardium increases with age, but it does not contribute appreciably to cardiac mass.

The valvular structures are affected by ageing that is manifested by thickening of the aortic and mitral leaflets and a gradual increase in the circumference of all four cardiac valves. Frequently, the mitral and aortic valves are the sites of ectopic calcification that results from degeneration of the collagen content. Calcification of the mitral apparatus is common in elderly patients, particularly in women and patients with systemic hypertension or diabetes mellitus. Mild degrees of mitral regurgitation (MR) are common, but clinically significant MR is much less common. A 12-fold increase in the incidence of AF is seen, and conduction defects frequently occur as well. Histological changes detected in the vasculature include increased intimal thickness, elastin fragmentation, and increased collagen content of the arterial wall. The resultant decrease in compliance reduces distensibility and causes a measurable increase in pulsed-wave velocity. In the presence of atherosclerotic disease, these findings are accentuated, and they may explain the age-related increases in LV wall thickness.

Peak contractile force of the myocardium remains unimpaired in the ageing myocardium, but the duration of contraction is prolonged. This may be due to diminished calcium uptake by the myofibrillar sarcoplasmic reticulum. The Frank–Starling length–tension relationship remains unchanged in the senescent heart, although the augmentation of contractility by cardiac glycosides and β-adrenergic stimulation is blunted in the senescent myocardium.

Ischaemic heart disease is common and is exacerbated by smoking and conditions such as hypercholesterolaemia, hypertension, and type 2 diabetes mellitus, and obesity can all contribute to the development of atherosclerosis. This results in a less compliant arterial tree, increased systemic vascular resistance, and systemic hypertension leading to LV hypertrophy, reduced ventricular compliance and contractility, and, eventually, reduced cardiac output.

The resting cardiac index (cardiac output per unit of time [L min^{-1}], measured while seated and divided by body surface area [m^2]) is not reduced in healthy older men who have been rigorously screened to exclude occult heart disease and who live independently in the community. However, in older women, resting cardiac output decreases slightly because neither end-diastolic volume nor stroke volume increases to compensate for the modest reduction in heart rate. Stroke volume decreases; systole time is prolonged; and, with a decrease in ventricular contractility, cardiac output and its reserve decline. Despite this, the average arterial pressure rises with an increase in the systolic and a slight drop in the diastolic pressures. The mean arterial pressure remains unchanged. Peripheral vascular resistance increases progressively. Progressive coronary arterial sclerosis leads to a reduction in maximal coronary artery blood flow. Vessel walls become less compliant as smooth muscle is reduced and collagen replaces elastin. Major vessels become stretched and distended, damaging the endothelium and baroreceptors, leading to a labile blood pressure. Importantly, any increase

in intrathoracic pressure, passively or actively, causes proportionately greater decreases in blood pressure with little or no rebound elevation. With age, the supine resting heart rate does not change in healthy men; however, the heart rate while seated decreases slightly in men and women. Spontaneous variations in heart rate during a 24-hour period decrease in men without coronary artery disease, as do variations in the sinus rate with respiration. The intrinsic sinus rate (i.e. measured after sympathetic and parasympathetic blockade) decreases significantly with age. Cardiac output increases by increasing stroke volume rather than increasing heart rate. There is reduction in vasomotor tone; both vagal and sympathetic influences are minimized. Degenerative vasomotor control precipitates syncope in the presence of decreased cardiac output or peripheral resistance. Postural hypotension can be spontaneous or an effect of drugs. The reduced cardiac output compromises blood flow to the kidneys and brain. The resting ejection fraction is not reduced in healthy older men and women. Resting stroke volume increases slightly in older men (commensurately with the slightly larger end-diastolic volume) and remains constant in older women. Autoregulation of blood flow to these organs is impaired in the elderly; hence, the kidneys and brain are more prone to perioperative ischaemia.

Atrial pacemaker cells decline in number and fall to approximately 10% of the adolescent value by age 70. This makes AF the 'default' rhythm for the elderly. Myofibrils enlarge but become less numerous. Collagen and fat replace a substantial volume of the muscle mass. Deposits of amyloid and subendocardial calcification impair conduction in the ventricle. This combined with a reduction in pacemaker cells make the elderly prone to arrhythmias. The fast ventricular rate in AF leads to poor and variable diastolic filling and a reduced cardiac output that is not tolerated well in an elderly patient. If AF is shown to cause haemodynamic instability, cardioversion should be considered before anaesthesia to control the heart rate to <100 min^{-1}.

Ageing affects aerobic capacity and cardiovascular performance during exercise. Peak exercise capacity and peak oxygen (O_2) consumption decrease with age, but inter-individual variation is substantial. Aerobic capacity decreases by 50% between the ages of 20 and 80 because maximum cardiac output decreases by 25%, and peripheral O_2 utilization decreases because of age-associated reductions in muscle mass and strength. During all levels of exercise, the older heart, on average, pumps blood from a larger filling volume. However, stroke volume in older persons does not exceed that in younger persons, because the end-systolic volume in older persons remains larger than it does in younger persons. Consequently, the ejection fraction does not increase as much in response to an increase in end-diastolic volume. Thus, although the stroke volume during exercise is maintained at the same level in older persons as in younger persons, the Frank–Starling mechanism is blunted with age. These changes result from a combination of age-associated factors, including augmented vascular and cardiac components of afterload, reduced maximal intrinsic myocardial contractility, and reduced augmentation of contractility by β-adrenergic stimulation.

The activity of the sympathetic nervous system seems to increase with age, as suggested by higher blood levels of norepinephrine and epinephrine in older than in younger persons during any effort. Because levels of norepinephrine and epinephrine are higher, more β-adrenergic receptors on cardiac and vascular cell surfaces are occupied. The result is a desensitization of β-adrenergic receptors, thereby causing a down regulation of associated intracellular signalling pathways.

The physiological response to stress such as hypovolaemia may be blunted due to reduced baroreceptor sensitivity and autonomic function. This may be significant if the patient is also taking β-blockers or angiotensin-converting enzyme (ACE) inhibitors. A normal response to exercise in young patients is increased heart rate and ejection fraction. This response is blunted in elderly patients because of decreased reactivity of β-receptors, and the ejection fraction may even fall further. Maximum cardiac output and, hence, functional cardiac reserve decreases as age increases.

The elderly have reduced haemoglobin and haematocrit, as well as reduced marrow iron stores. They can suffer from anaemia following even trivial haemorrhage. However, blood transfusion is not without problems. It is considered only once other serious causes of anaemia are excluded or functional limitation is present.

Other haematological changes include reduced cellular immune response because of thymic atrophy and a reduction in the number of T cells. Lymphocytosis within the marrow results in susceptibility to proliferative disorders and infections.

2.3.3 Respiratory system

Ventilatory responses to hypoxia, hypercarbia, and mechanical stress diminish with ageing because peripheral and central chemoreceptor responses diminish, as does the integration of central nervous system pathways. Ageing also decreases neural output to the respiratory muscles and lower chest wall, and this reduces lung mechanical efficiency. These reductions increase the risk of developing hypoxia and hypercapnia if the elderly acquire disorders that decrease oxygen levels. The respiratory adverse effects of benzodiazepines, opioids, and volatile anaesthetic agents are exaggerated.

Reduced height and calcification of the vertebral column lead to a barrel chest appearance. The diaphragm is flattened; intercostal muscles are weak; and the chest wall is rigid. These not only increase the work of breathing but also reduce its efficiency. In the presence of a disorder that requires sustained increases in ventilation, it predisposes the elderly to hypoxaemia and hypercapnia, thus possibly to the need for mechanical or assisted ventilation. The chest and lung compliances change, and the chest becomes less compliant. Changes in compliance are primarily responsible for age-related decreases in ventilation and the corresponding decrease in gas distribution that result from the collapse of small airways. Cellular changes also occur in the lung parenchyma. Elastic recoil of the lungs is reduced, increasing the lung volume at end expiration, which in turn increases the residual volume (see Fig. 2.2). The intra-alveolar pressure generated by the
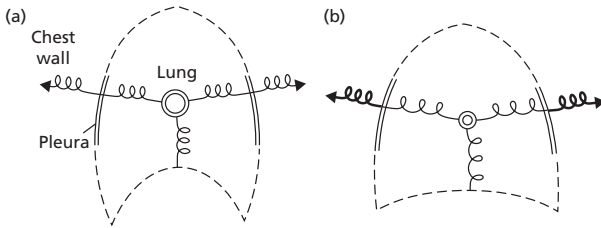
Fig. 2.2 Lung volume and elastic recoil in (a) normal healthy volunteer and (b) elderly patient, in the latter showing increased lung volume and reduced elastic recoil resulting in reduced compliance and decreased ventilation

Reproduced from Davenport H.T, *Anaesthesia and the aged patient*. Copyright (1988) with permission from John Wiley & Sons.

elastic recoil of the lungs prevents airway collapse. Loss of elastic recoil results in collapse of poorly supported peripheral airways, resulting in decreased flow at low lung volumes. Airway collapse, increasing dependence on the diaphragm and abdominal muscles, and reduced vital capacity all produce an uneven distribution of ventilation, without change in tidal volume at rest. The upper airway becomes increasingly unstable during inspiration, and this is most marked during sleep. There is a progressive increase in the number of episodes of airway collapse and arterial oxyhaemoglobin desaturations during sleep with advancing age. Snoring (partial upper-airway obstruction) is almost universal. Silent aspiration is common. This is partly due to the fall in sensitivity of the cough reflexes—a seven-fold reduction—and partly due to increased oesophageal reflux with ageing. The increasingly negative intrathoracic pressure necessary to overcome the high resistance of the upper airway further aggravates these problems.

Total lung capacity is relatively unchanged (Fig. 2.3). The volume at which small dependent airways start to close (closing capacity) increases with age. Change in the relationship between functional residual capacity and closing capacity causes an increased ventilation perfusion mismatch. There is a parallel decrease in the vital capacity. Widening of the airways together with an increase in the size of the alveolar ducts increases the anatomical dead space. Reduction in elastic fibres in these ducts may explain why airway closure occurs at resting functional residual capacity. This premature closure of the airways further contributes to increases in residual volume. By the mean age of 65, not all the airways are opened during tidal breathing in the sitting position. Atelectasis and potentially a complicating pneumonia are more likely to develop in the elderly, particularly when lying in bed for a prolonged period.

Increases in pulmonary vascular resistance and pulmonary artery pressure occur with age and may be secondary to decreases in cross-sectional area of the pulmonary capillary bed. The alveolar–arterial oxygen tension-difference increases, causing a gradual decrease in the partial pressure of oxygen in arterial
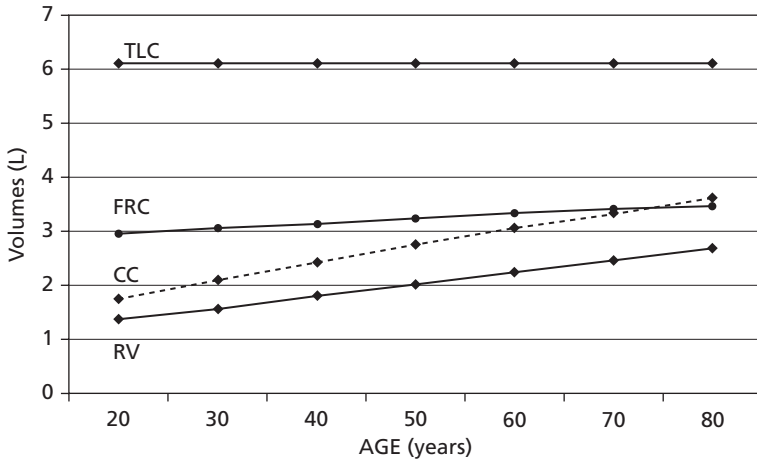
Fig. 2.3 Effects of ageing Total lung capacity remains unchanged; closing capacity increases with age; vital capacity decreases with age; and residual volume increases. Lung volumes for a normal male (height 1.7 m) at different ages. CC: closing capacity; FRC: functional residual capacity; RV: residual volume; TLC: total lung capacity.

blood (PaO_2). The maximum oxygen consumption describes the body's ability to deliver maximally oxygen to the tissues, and this gradually declines with the passing of each decade because of reduction in maximal heart rate, muscle mass, and cardiovascular deconditioning associated with lower levels of physical activity or from changes in cardiovascular function. The $PaCO_2$ usually remains unchanged. Diffusing capacity declines gradually with every decade after adulthood because of decreased alveolar-capillary surface area caused by inflammation-induced destruction of capillary containing alveolar walls. The loss of alveolar-capillary surface area decreases venous oxygenation, particularly under condition of high pulmonary blood flow (see Fig. 2.4). Fibrous replacement of the muscular arterial media and reduction in the number of capillaries increases the pulmonary vascular resistance and shunting.

Any alteration in the control of respiration, lung structure, mechanics, and pulmonary blood flow predispose elderly patients to perioperative complications. Atelectasis, pulmonary embolism, and chest infections are all more common in elderly patients, particularly following abdominal or thoracic surgery. Progressive weakness of intercostal and accessory muscles reduces the ability to cough
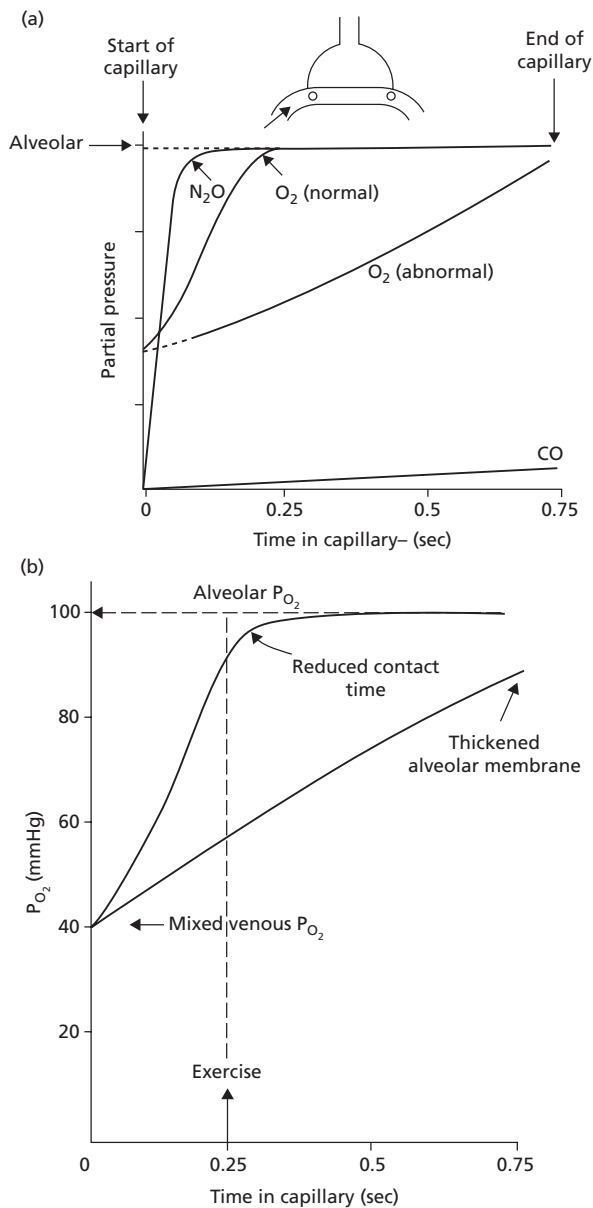
Fig. 2.4 The effect on oxygenation caused by (a) changes in anaemia or with abnormal haemoglobins and (b) effects of diffusion and capillary transit time

Maximal pulmonary blood flow and, therefore, perfusion are lowered. The additional oxygen demand caused by increased activity induces increased ventilation in the presence of a diminished maximum breathing capacity. This leads to dyspnoea in the absence of underlying pulmonary disease.

forcibly. The rate of mucociliary transport declines with ageing. The bronchial mucosa degenerate because of impaired blood supply, and the cilia are ineffective in keeping the small airways clear, particularly in smokers. Cellular immunity declines with ageing. Dysphagia and other swallowing difficulties and impaired oesophageal motility occur more often in the elderly and increase the risk of aspiration and chest infection. Early mobilization and good analgesia following abdominal surgery help reduce lung atelectasis and collapse.

2.4 Renal function

Renal function does not deteriorate in everyone with age; in some, it remains relatively unchanged; in others, it deteriorates only slightly; and in still others, there is a more substantial decline. Pragmatically, renal function must be considered reduced in elderly patients who are admitted as an emergency.

Renal mass may decrease as much as 30% by the age of 80. Loss of mass is most prominent in the renal cortex and co-relates with a decreased number of functioning glomeruli. Alongside the renal cortical loss, there is a reduction in function of the juxtaglomerular bodies, essential for renin and aldosterone production, and the peritubular epithelial cells responsible for erythropoietin (EPO) production. EPO is generated in response to hypoxia and triggers red cell production, but this hypoxic feedback is reduced in the elderly.

There is a failure of the countercurrent gradients in the loop of Henle. Ageing also affects the collecting system, and prostate disease in men and urinary incontinence in women will have complex effects on the behaviour of the patient. Active, self-imposed fluid restriction is quite common as an attempt to limit the effect of these conditions, especially if bed-bound in an acute hospital environment.

Renal blood flow decreases by about 10% per decade because of a decrease in the reno-vascular bed. Cortical blood flow decreases, but medullary flow is preserved. Vascular changes may initiate this deterioration. As renal blood flow is reduced, glomerular filtration and concentrating ability decline linearly at about 1% per annum from 30 to 80 years. The decrease in glomerular filtration rate is measured by creatinine clearance. Glomerular filtration rate and creatinine clearance decrease with age, but the serum creatinine remains relatively unchanged. This is because muscle bulk also decreases with age, resulting in reduced creatinine production. Therefore, serum creatinine level is a poor predictor of renal function in the elderly. Large acid or alkali loads can overwhelm the ability of the kidney to maintain acid–base homeostasis.

Tubular function is also impaired with reduced renal concentrating ability and reduced free-water clearance. Diverticula appear in the distal nephron, reaching a peak of about three per tubule by age 90. These diverticula may become retention cysts. The renal clearance of excreted drugs is reduced, and fluid balance is more critical as responses to both fluid loading and dehydration are impaired. Renal function may deteriorate rapidly in hypovolaemic patients, particularly those taking non-steroidal anti-inflammatory drugs (NSAIDs) or

ACE inhibitors. Close monitoring of hourly urine output after major surgery should be routine.

2.5 Fluid and electrolyte balance

Renal capacity to conserve sodium is decreased. With ageing, there is nephron loss and a consequent increase in the osmotic load per nephron. Renin levels are decreased in both basal and stimulated states. As a result of the changes in renin, aldosterone levels are decreased. This age-related decrease in renin and aldosterone levels contributes to the development of various fluid and electrolyte abnormalities. Elderly patients have the tendency to lose sodium because of poor dietary habits. There is a decrease in angiotensin II production, which results from lack of renin stimulation, and this leads to the impairment of tubular concentrating ability. There is a decreased thirst response. Inadequate salt intake and impaired thirst response lead to dehydration and sodium depletion. Generally, there is no change in serum sodium, potassium, hydrogen ion concentration, or circulating blood volume with age, but adaptive mechanisms may be impaired. Therefore, acute illness is often complicated by derangements in fluid and electrolytes balance.

Elderly patients with or without cardiovascular disease are at increased risk from rapid volume expansion. They are less able to excrete an elevated salt load requiring a longer time to re-establish balance. These changes may be due to decreased glomerular filtration rate and decreased baroreceptor reflex sensitivity. Potassium handling and renal excretion of potassium is altered with age. The tendency towards hyperkalaemia is enhanced by acidosis because the ageing kidney is slow to correct an increase in acid load, resulting in prolonged depression of serum pH and a shift of potassium out of cells. All of these factors lead to increased serum potassium. Dehydration with altered electrolytes is common when fluid intake is limited and insensible loss is increased.

2.6 Nervous system

In the absence of neurological disease, intellectual performance tends to be unchanged until at least the age of 80, but tasks may take longer to perform. Verbal skills are well maintained until the age of 70, after which some healthy elderly gradually develop a reduction in vocabulary and tend to make semantic errors. The elderly with neurological disease are especially susceptible to the action of many anaesthetic drugs.

An age-related decline in central nervous system function is common. The causes of this decline include cerebrovascular disease, changes in hormone levels, and neuronal damage induced by oxidative stress, as well as a generalized progressive loss of cells. Brain weight declines about 10%, and the area of the cerebral ventricles relative to the entire brain may decrease three to four times. Plasticity at the nerve cell level involves compensatory lengthening and production

of dendrites in remaining nerve cells to offset the age-related gradual deterioration and loss of nerve cells. New connections in the dendritic tree may compensate for the fewer nerve cells. Other compensatory changes occur when the brain is damaged (the non-dominant hemisphere may compensate when speech centres in the dominant hemisphere are damaged leading to gradual improvement in speech function). Other motor systems may compensate when large areas of cerebellum are destroyed by injury, vascular disease, or tumour. Compensatory mechanisms are more effective in higher centres. The ability to compensate after any damage in the spinal cord declines with age.

Confusion is more common, both before and after surgery. Cognitive impairment increases with ageing, and dementia may affect up to 20% of patients over the age of 80. Dementia should be diagnosed only by formal testing and, ideally, by experts in geriatric psychology. It is not a diagnosis to be made lightly because it has a 50% life expectancy of fewer than 5 years—similar to most malignant carcinomas. Attention span falls, factual recall becomes impaired, and repeated explanations are necessary. Mental impairment is present in up to 5% of the population and is associated with illiteracy. Changes in cognitive function are multifactorial. Of the octogenarians, 20% have some degree of dementia, but this diagnosis should be made only when other causes have been excluded. Causes of confusion or delirium include hypoxia, infection, drug toxicity, electrolyte abnormalities, hypoperfusion, hypotension, hypothyroidism, constipation, and impaired sight or hearing.

Autonomic dysfunction is prevalent in the ageing population, and it may result in labile blood pressure and perioperative arrhythmias. The baroreceptor reflex may be attenuated, leading to postural hypotension and a decrease in blood pressure during anaesthesia, particularly during induction of anaesthesia, especially if hypovolaemic. Impaired temperature regulation and delayed gastric emptying may also occur. A rapid-sequence induction is desirable in such cases.

Temperature regulation is impaired in the ageing population, and there is a reduction in physiological compensatory mechanisms such as shivering. Hunger and thirst centres are down regulated, and antidiuretic hormone is less effective, making the elderly vulnerable to dehydration and malnutrition. The peripheral nervous system declines in a similar manner. Nerve conduction velocity decreases, and appreciation of pain reduces. The elderly generally do not complain about pain, although they suffer as much as younger patients do.

Cerebral blood supply is reduced by 20% on an average because of atheroma or sclerosis. Vertebrobasilar insufficiency is common. Decreases are greater in certain areas of the brain (prefrontal area) and are greater in the grey matter than in the white matter. Flexion or extension of the neck can compromise cerebral oxygen delivery. Osteoporosis and laxity of ligaments is common in old age, and care should be exercised during induction of anaesthesia.

Free radicals (atoms or molecules with unpaired electron) that are produced normally during metabolism accumulate with age and may have a toxic

effect on nerve cells. With a generalized progressive loss of cells, there are losses of neurotransmitter systems such as active nuclei of the cholinergic and dopaminergic systems. Cholinergic receptors and catecholamine levels usually decrease. The loss in function that this causes is masked by the degree of reserve that exists; it is estimated that a loss of 70%–80% of dopaminergic function is necessary before symptoms are seen in patients with Parkinson disease. There is an increase in monoamine oxidase levels. When this increase is inhibited by monoamine oxidase inhibitors, the onset of disability in patients with Parkinson disease may be forestalled. The apoptosis that occurs in neuronal cells with ageing may be exacerbated by stress responses, especially the rises in cortisol.

2.7 Hepatic system

Liver mass decreases with age, although this appears to be due to the reduced metabolic rate in the elderly. This also reduces hepatic blood flow by about 10% per decade. There may be a decreased capacity to metabolize drugs. This decreased metabolic activity and reduced hepatic blood flow alters the pharmacokinetic and pharmacodynamics of many drugs used during anaesthesia (see Chapter 3).

2.8 Endocrine system

The ageing process is associated with glucose intolerance. This intolerance is due to many factors, including insulin resistance, dysregulation of insulin secretion, alterations in insulin receptor number, or post-receptor defects. The incidence of diabetes is increased in the elderly, and may be seen in up to 25% of patients aged over 80 years. Diabetics frequently have cardiovascular, renal, neurological, and visual impairment and require control of blood glucose levels during the perioperative period. The metabolic clearance rate of thyroid hormone decreases with age. With an intact hypothalamic–pituitary thyroid axis, thyroxine levels are maintained in the normal range. Yet, with thyroid disease, when exogenous thyroxine is administered, the replacement dose must be reduced to account for the change in clearance. There is a decreased oestrogen production, a notable alteration in bone metabolism, and increased incidence of osteoporosis.

2.9 Nutrition

Malnutrition is common in the elderly and is associated with increased morbidity and mortality. Nutritional supplementation is generally advocated to reduce the length of hospital stay and postoperative complications. Oral protein supplementation is advised in those with significant malnutrition.

2.10 Musculoskeletal system

Arthritis is almost universal in the elderly, and this will limit their ability to exercise.

Degenerative diseases of all types affect the elderly. This may limit exercise tolerance; hence, it is difficult to assess fitness. This may mask a falling exercise tolerance owing to cardiorespiratory failure. It also leads to severe pain after surgery if there has been an excessive manipulation under anaesthesia. Osteoporosis and ligament laxity make epidural and spinal anaesthesia technically difficult. These patients are prone to fractures or dislocation of joints (including the cervical spine) while anaesthetised. Care should be taken with patient movement and intraoperative positioning because vigorous movements of the patient or pressure over joints may lead to fracture or dislocation. Vulnerable pressure points should be well padded.

2.11 Vision

Visual acuity may decrease because of changes in the retina or neural element. Blindness affects nearly 30% of the elderly, largely related to cataracts and glaucoma, and it may make understanding written material such as consent forms and visual analogue pain scales very difficult. Diminished tear production and secretion lead to dry eyes, thus predisposing corneal damage.

2.12 Hearing

Deafness is more common and may be severe in about 35% of elderly patients. There are changes in both the peripheral and central auditory systems in elderly patients. A loss of hearing pure tones, especially in higher frequencies, is more pronounced, and this can interfere with both hearing and understanding speech. Brain stem changes may lead to difficulty in hearing and localizing sounds in noisy environments. Cortical changes may lead to problems with difficult speech and language.

Both visual and hearing problems present difficulties in obtaining valid informed consent, and all efforts to present important information in a way the patient can perceive is imperative before any debate about legal competency can begin

2.13 Summary

An increasing elderly population and advances in surgical technology present many challenges to anaesthetists. Many elderly patients are likely to undergo surgery. Increased age and pre-existing illness both increase the incidence of complications. Signs and symptoms are often masked by limitation of movement and lack of exercise because of the pain of arthritis. A successful outcome depends on meticulous attention to preoperative assessment and an intelligent choice of

suitable anaesthetic techniques. Therefore, the opportunity to improve physiological function before surgery, where applicable, should never be missed. To provide safe and effective anaesthesia, an understanding of the limitations of physiological function in the elderly is of paramount importance.

FURTHER READING

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CHAPTER 2

Anaesthetic pharmacology in the elderly

KEY POINTS
• Initial distribution of drugs is often impaired.
• Protein binding is less efficient.
• Excretion of water-soluble drugs or metabolites is reduced.
• Clearance of highly extracted drugs decreases with liver blood flow.
• Inter-individual variability increases with age.
• Titration to effect is mandatory.
• Always favour the shortest acting and easiest to titrate drugs.

Perioperative anaesthetic complications in the elderly are mainly due to overdosing during induction of general anaesthesia, haemodynamic instability throughout the procedure and undetected aspiration of gastric content in the post-anaesthetic care unit (PACU) owing to poor recovery. Only a thorough knowledge of the changes induced by ageing on the pharmacology of anaesthetic drugs will allow optimization of the whole course of anaesthesia and recovery.

3.1 Changes induced by ageing on the pharmacology of anaesthetic drugs

3.1.1 Pharmacokinetics

3.1.1.1 *Distribution*

In the elderly, a reduction in lean body mass and total body water, as well as an increase in fat, modify drug distribution. Those changes are more important in males than in females. The volume of distribution at steady state of highly lipid-soluble drugs is markedly increased in aged individuals, lowering their plasma concentration and delaying their elimination. On the contrary, drugs that are less lipid soluble (morphine) have a smaller volume of distribution in the elderly, and their elimination time is reduced in this population.

The so-called greater sensitivity of aged patients to the action of many drugs is in some cases related to a reduction in the initial volume of distribution or of the initial distribution clearance. In elderly patients, compared with younger ones, the same dose will generate a markedly higher plasma concentration and thus a greater pharmacological effect.

Plasma albumin concentration tends to decrease with age, and even if the albumin plasma concentration remains normal, structural protein changes may lead to a reduced efficiency in albumin binding sites. Moreover, many chronically administered drugs that are seemingly not dangerous may compete with the anaesthetic agents on those sites and thus increase their unbound fraction. On the contrary, alpha$_1$-acid-glycoprotein (which links basic drugs such as opioids) concentration is increased in many situations, such as inflammation or cancer, which are frequently present in the elderly.

3.1.1.2 *Elimination*

3.1.1.2.1 Hepatic metabolism

Up to about 50 years of age, the liver represents a constant fraction of total body weight (around 2.5%). After 50 years of age, this proportion is progressively reduced to reach only 1.6% at 90 years. Liver blood flow also decreases with age, about 0.3% to 1.5% every year. Thus, at 65 years, the liver blood flow has reduced by an average 40% of its value at 25 years. The elimination clearance of highly extracted drugs (e.g. etomidate, ketamine, flumazenil, morphine, fentanyl, sufentanil, naloxone, and lidocaine) is thereby reduced in the aged population.

Hepatic drugs metabolism is achieved through two major processes: phase I (oxidation, reduction, and hydrolysis) and phase II (acetylation and conjugation) reactions. Phase I reactions are mainly carried out by microsomal monooxygenases, which include the P450 cytochromes (CYP450). The majority of studies agree that ageing does not modify liver metabolizing capacities when phase II reactions are activated. For example, the intrinsic clearance of conjugated agents is not modified, but their elimination clearance will usually be reduced because it depends on hepatic blood flow.

Changes over time in phase I reactions are more controversial. Age does not appear as an independent covariate for the mean clearance value, but it increases the inter-individual variability of this parameter.

3.1.1.2.2 Renal excretion

Ageing and associated diseases frequently impair glomerular filtration rate. However, reduced creatinine synthesis may lead to low plasma creatinine levels even in the presence of renal dysfunction. Thus, glomerular filtration rate should always be estimated in this population (Cockcroft-Gault or MDRD formulas). Most anaesthetic agents are lipid soluble, thus they are filtered by the glomeruli and immediately undergo a complete tubular reabsorption, which precludes their

renal elimination. The kidney will excrete only their more hydro-soluble metabolites. Some metabolites (e.g. morphine-6-glucuronide) are pharmacologically active, and their retention may prolong the pharmacological effect of the native compound because of decreased renal function. Similarly, some muscle relaxants are eliminated at least in part through the kidneys. Their clearance will be reduced in the elderly.

3.1.2 Transfer to the effect site

Modelling studies based on the observation of differences between the time course of effect of numerous drugs and the evolution of their plasma concentration have led to the establishment of an 'effect site concentration', closely related to the time course of effect and which can be calculated from the plasma concentration via a transfer rate constant. Frequently, in the elderly, the transfer of anaesthetic drugs from the plasma to the biophase is delayed. This may explain a delayed onset and a delayed recovery even when pharmacokinetics is not modified by ageing.

3.1.3 Pharmacodynamics

The central nervous system is the target of nearly all anaesthetic agents, and consequently all changes over time in this system will directly influence the handling of anaesthetic drugs in the elderly population. The main effects of age on the central nervous system are

- *an overall depletion in neurotransmitters* (catecholamines, dopamine, tyrosine, and serotonin) and
- *a selective attrition of cortical neurons*, with a general reduction in the density of neurons, leading to the disappearance of about 30% of the cerebral mass by the age of 80. The cerebral blood flow undergoes a similar reduction, as does the cerebral oxygen consumption.

3.2 Influence of age on the pharmacology of specific anaesthetic drugs

3.2.1 Hypnotics

Intravenous hypnotics have little in common as far as biochemistry, or pharmacokinetics, is concerned (see Box 3.1). Most interfere with the gamma aminobutyric acid (GABA) receptor, albeit at different binding sites. Although all intravenous hypnotics can be used for induction of anaesthesia, only propofol is commonly used for maintenance. Apart from etomidate, all have haemodynamic effects that are markedly increased in the elderly.

Volatile halogenated hypnotics have very similar pharmacodynamic effects. However, these differ in their pharmacokinetics.

Box 3.1 Summary box, hypnotics

- Reduce induction doses of thiopental, propofol, and etomidate and titrate to effect.
- Dramatically reduce midazolam doses.
- Haemodynamic consequences are both enhanced and delayed in propofol induction.
- Propofol decrement time is not prolonged.
- MAC of all volatile agents decreases with age.

3.2.1.1 *Thiopental*

Many studies have demonstrated a reduction in thiopental requirements for induction of anaesthesia in elderly patients as compared with the requirements for young adults. Thiopental induction dose should be reduced in the elderly largely because of pharmacokinetic changes altering the initial distribution of the drug. Thiopental should always be administered slowly in the elderly, so much so that even when all the factors known to influence the size of the induction dose are considered, a pronounced inter-individual variability still exists, which makes it necessary to adjust the dose according to the observed effect in every single patient.

3.2.1.2 *Propofol*

Propofol has become one of the most popular hypnotic agents for induction, as well as for maintenance of anaesthesia. Nevertheless, in the aged population, its use has been limited owing to its haemodynamic effects. In as early as 1986, it was observed that, in the elderly, the doses necessary to obtain a loss of consciousness were lower, and the incidence of apnoeas and hypotension was increased, as compared with younger patients.

Age-related changes in propofol pharmacokinetics include alterations in initial distribution (decreased initial volume and/or impaired rapid inter-compartment clearance) leading to higher plasma concentrations and an increased effect of the same induction dose and a reduction in elimination clearance mainly because of a decrease in hepatic blood flow buffered by extra hepatic metabolism. On the contrary, propofol elimination is not delayed in the elderly. When administering propofol as a target controlled infusion (TCI) for induction and maintenance of anaesthesia in the elderly, which improves propofol safety profile in this population, it is important to ascertain that the model implemented in the TCI device includes age as a covariate (Fig. 3.1).

Pharmacodynamic studies have shown that the concentration–effect relationship was only moderately modified in the elderly, whereas the transfer time to the effect site remains unchanged.
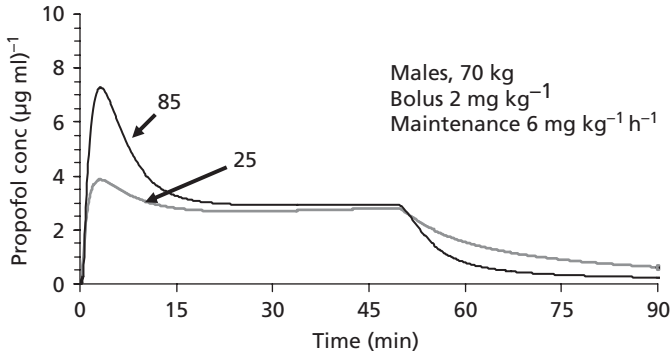
Fig. 3.1 Comparison of the time course of action of propofol effect-site concentration when the same dosage regimen is applied to a 25-year-old and to an 85-year-old

With the same induction dose, the peak concentration is almost doubled in the elderly, but elimination is not delayed (The author has performed the simulation with Schnider's parameters set using pkpdtools (www.pkpdtools.com)).

Propofol is a potent vasodilator, and numerous publications have outlined the risk of hypotension when using this drug in elderly patients. Thus, for the same hypnotic effect, the haemodynamic effect will be increased and delayed in the elderly when compared with young subjects. It is, therefore, particularly important to titrate propofol to effect in order to give only the required dose and no more. TCI may help. As far as drug interactions are concerned, the addition of opioids to propofol for induction of anaesthesia does not allow any important reduction in the propofol dose, but it potentates the drop in systolic blood pressure and may lead to major hypotension in the absence of adrenergic stimuli.

3.2.1.3 *Etomidate*

Haemodynamic stability is a major advantage of etomidate, and this feature makes it very popular among anaesthetists for induction of anaesthesia in elderly patients. Despite this fact, very few studies about etomidate pharmacology in the elderly are available. The decreased etomidate dose requirement in the elderly is mainly due to changes in etomidate pharmacokinetics rather than altered brain responsiveness. The initial etomidate volume of distribution decreases significantly with increasing age (by 42% between age 22 and 80), yielding a higher initial blood concentration in the elderly following any given dose. Etomidate clearance also decreases with age, following the reduction in liver blood flow. However, the consequences of an overdose are limited, except for short procedures in which it may lead to delayed recovery. The safety of etomidate as an induction agent in the emergency ward has recently been questioned because of its inhibition of

cortisol synthesis. New etomidate analogues with less effect on 11β-hydroxylase function are currently under investigation.

3.2.1.4 *Ketamine*

Ketamine is an N-methyl D-aspartate (NMDA) receptor inhibitor that provides a dissociative anaesthesia. It has been used extensively in the past to induce general anaesthesia, but its use had nearly disappeared in developed countries owing to frightening emergence reactions. However, like other NMDA inhibitors, ketamine stimulates endogenous catecholamines release and thus usually provides a good hemodynamic stability at induction of anaesthesia. When etomidate safety was questioned, ketamine was proposed as a replacement in haemodynamically compromised patients, including the elderly. However, adequate comparative studies are lacking. Combinations of propofol and ketamine in various proportions (Ketofol) are currently under investigation.

3.2.1.5 *Midazolam*

Midazolam is a benzodiazepine with an intermediate clearance that is dependent both on hepatic blood flow and on the intrinsic clearance, and it has a short elimination half-life (around 2 hours).

In daily practice, it is well recognized that the dose of any benzodiazepine required for achieving a specific sedative or hypnotic endpoint in most elderly patients is smaller than that required in younger patients. Factors, such as midazolam central compartment volume, plasma protein binding, and volume of distribution, that could influence the induction dose requirement are not affected, or only slightly affected, by the ageing process. These results suggest that the lower doses needed in the elderly are mainly attributable to pharmacodynamic changes, and profound alterations in the midazolam concentration–effect relationship have been demonstrated in the elderly. Midazolam should be used with extreme caution, if at all, for premedication and conscious sedation in this population because doses as low as 0.5 mg may be responsible for apnoea. A new, very short acting and thus very easy to titrate benzodiazepine is currently under investigation (Remimazolam). As for all benzodiazepines, the effective doses will be drastically reduced in the elderly.

3.2.1.6 *Volatile agents*

Ageing reduces the Minimum alveolar concentration (MAC) of all volatile anaesthetic agents (Fig. 3.2).

Sevoflurane may be used to induce anaesthesia in the elderly, with a good haemodynamic stability, probably because of a progressive induction when compared with a bolus dose of intravenous drug.

Even if clinical studies are currently controversial, the preconditioning ability of volatile agents to myocardial, brain, or kidney hypoxia may be of interest in this population.
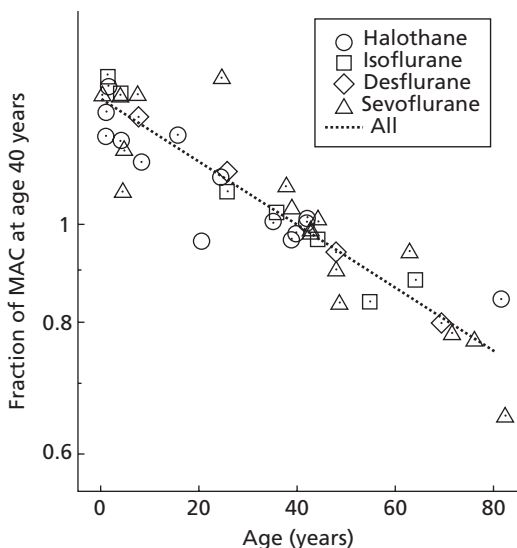
Fig. 3.2 Reduction in MAC for volatile agents as a function of age

Desflurane is the least lipid soluble of all volatile halogenated agents, and as such, it is the easiest to titrate and the most rapidly eliminated agent. It is, therefore, a drug of choice in the elderly. In the presence of opioids, no deleterious sympathetic stimulation is observed, and this drug, like sevoflurane, is associated with good haemodynamic stability.

3.2.1.7 *Nitrous oxide*

Nitrous oxide, a very common adjuvant of many general anaesthetics, should be used with caution if at all in the elderly. The drug decreases myocardial contractility and at the same time induces a stimulation of endogenous catecholamines. Most of the time, the haemodynamic consequences are minimal. Nevertheless, specifically in elderly patients with a cardiac condition, the use of nitrous oxide may lead to severe hypotension. This cause should be explored when at the beginning of maintenance an unexplained hypotension is observed.

3.2.2 Opioids

Ever since 1971, the need for reducing morphine dose with increasing age has been outlined. Opioids are currently used in the vast majority of surgical patients and a poor understanding of their pharmacology may lead to serious

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Box 3.2 Summary box, opioids

- Pharmacokinetic changes have very few clinical consequences.
- Increased central nervous system sensitivity indicates the need for reducing the opioid concentrations by 50%.
- Titration to effect is best achieved with remifentanil TCI.
- In the postoperative period, morphine titration to effect can be improved by PCA.

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haemodynamic or adverse respiratory events specifically in the elderly (see Box 3.2).

3.2.2.1 *Fentanyl*

Despite the worldwide use of this agent in elderly patients, fentanyl pharmacology has not been extensively studied in this population. Fentanyl is lipid soluble, with a large volume of distribution at steady state and a high clearance dependent on liver blood flow. Whatever the pharmacokinetic alterations, they do not induce important changes in fentanyl plasma concentrations. Bjorkman, using a physiological model, has been able to demonstrate that after a bolus dose, the difference in a simulated plasma peak concentration was less than 3% when a 35-year-old individual was compared with a 90-year-old individual. He also stated that the reduction in clearance (liver blood flow) with age should induce a prolonged fentanyl elimination half-life in the aged.

Nevertheless, clinical studies have clearly outlined the need to reduce fentanyl doses with increasing age. As with all other opioids, this is due to a marked increase in sensitivity to the fentanyl drug effect in the elderly. These pharmacodynamic changes suggest that fentanyl doses should be decreased by 50% in aged patients.

3.2.2.2 *Alfentanil*

Alfentanil pharmacokinetics differ from that of other piperidine derivatives in that its rather low clearance is dependent both on liver blood flow and on hepatic enzyme activity. As such, it varies with the status of its metabolizing enzymes, CYP 450. Thus, alfentanil clearance is reduced by co-administered drugs (i.e. erythromycin), but it may be increased by enzyme inducers and is subject to pharmacogenetic modulation and hormonal impregnation influence. All these factors will blunt the effect of ageing on alfentanil pharmacokinetics, and the results of the studies will depend highly on the population involved because the number of patients in these pharmacokinetics studies is usually low. This explains the discrepancies between the different approaches to alfentanil pharmacokinetics in the elderly. It seems that alfentanil pharmacokinetics do not depend on gender in younger patients but that ageing (menopause?) leads to a reduction in alfentanil clearance in women but not in men.

Alfentanil doses, as with fentanyl doses, should be reduced by about 50% in the elderly, mostly for pharmacodynamic reasons.

3.2.2.3 *Sufentanil*

The influence of age on sufentanil pharmacokinetics has mainly been described in two studies, both of which concluded that sufentanil pharmacokinetics parameters were not affected by ageing, with the exception of a reduced initial volume of distribution leading to a higher plasma peak concentration in elderly patients. Even if we lack data on the pharmacodynamics of sufentanil in the elderly, it seems reasonable to extrapolate those from fentanyl, alfentanil, and morphine and conclude that the sufentanil dose should be reduced by 50% in this population.

3.2.2.4 *Remifentanil*

The influence of ageing on remifentanil behaviour has been described in detail by Minto and others in a population pharmacokinetics/pharmacodynamics model including individuals who are more than 80 years old. Remifentanil pharmacokinetics in elderly individuals is characterized by a decreased initial volume of distribution, resulting in higher initial plasma concentrations following a bolus dose. Concurrently, remifentanil clearance, which is independent from hepatic function and renal blood flow but depends on the number and efficiency of tissue esterases, was decreased by about 30% from age 20 to 80.

The transfer rate from the effect site, k_e0 was reduced with increasing age, hinting at a delayed onset of action. Moreover, the central nervous system is more sensitive to the effect of remifentanil: the concentration required to induce 50% of EEG depression (CE_{50}) in 80-year-old patients was half the concentration required in young adults (Fig. 3.3).
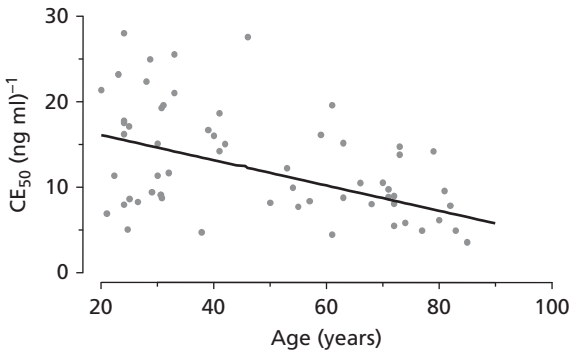

Fig. 3.3 Progressive reduction with age of remifentanil CE50 for EEG effect

Whatever his or her lean body mass, an 80-year-old patient would require approximately half the dose of a 20-year-old to reach the same EEG peak effect. This endpoint would be delayed in the elderly (approximately 1 minute at 20 years and 2 minutes at 80 years). This adjustment in the initial bolus dose is due to pharmacodynamic changes (decreased CE_{50}). The adjustment in bolus dose for age is far more important than the adjustment in bolus dose for body weight.

The infusion rate required to maintain a constant EEG effect in an 80-year-old person is approximately one-third of that required in a 20-year-old. Again, the adjustment for age is far more important than the adjustment for body weight. This reduction in infusion rate is based on both pharmacokinetics (decreased clearance with age) and pharmacodynamics considerations (decreased CE_{50} with age).

Thus, owing to its titrability and absence of lingering effect, remifentanil appears like a very useful drug in elderly patients, provided its dosage is carefully titrated to effect. This can optimally be achieved through a target controlled remifentanil infusion. A recent use of remifentanil TCI in the elderly is for conscious sedation, where easy titration allows rapid handling of respiratory depression. Inadequate understanding of remifentanil pharmacology in the aged patient may lead to dangerous but avoidable haemodynamic depression.

3.2.2.5 *Morphine*

The morphine volume of distribution at steady state in elderly subjects is only half that of younger patients. The difference is due to reductions in both central and peripheral compartments. Plasma clearance is also reduced. These changes in morphine pharmacokinetics are amplified by the retention of active morphine metabolites morphine-3-and morphine-6-glucuronide, owing to the physiological reduction in glomerular filtration rate in the aged. These findings suggest that the reported increased sensitivity of elderly subjects to the analgesic effects of morphine may be due at least in part to altered disposition of the drug.

Morphine pharmacodynamic data are lacking, but considering the results obtained with other opioids, it is recommended to reduce the amount of the first analgesic dose of morphine in the elderly, and to titrate further doses to effect. As often as possible, morphine patient controlled analgesia (PCA) is appropriate in this population.

3.2.3 Muscle relaxants

3.2.3.1 *Clinical findings*

The onset of action of neuromuscular blocking agents (NMBAs) is usually prolonged in the elderly, irrespective of the study drug (See Box 3.3).

The duration of action of maintenance doses of rocuronium and vecuronium is significantly prolonged in the elderly, whereas that of atracurium doses is not. The maintenance infusion rate of mivacurium required to ensure adequate muscle relaxation is lower in elderly patients.

Box 3.3 Muscle relaxants

- Onset is slower, and duration is usually prolonged.
- Atracurium and cisatracurium duration of action are not modified by ageing.
- Inter-individual variability is increased, and monitoring is mandatory.
- Transfer to and from the effect site is delayed.
- Sugammadex reversal (after vecuronium or rocuronium blockade) may be very useful in cardiac patients.
- Ascertain that no residual paralysis is present (T4/T1 ≥ 90%) before sending the patient to the PACU.

Recovery from muscle relaxation is usually delayed in elderly patients. Thus, the recovery index from 25% to 75% recovery of twitch height is increased by 60% (39–62 minutes) for pancuronium, 230% (15–49 minutes) for vecuronium, 62% (13–21 minutes) for rocuronium, and 42% (5.5–7.8 minutes) for mivacurium. On the contrary, recovery from muscle relaxation is not modified by ageing for atracurium and cisatracurium.

3.2.3.2 *Pharmacokinetic changes*

3.2.3.2.1 Steroid compounds

Muscle relaxants with a steroid structure (pancuronium, vecuronium, and rocuronium) are mainly eliminated by the liver through metabolism and biliary excretion, and partially excreted in the urine. They are poorly bound to plasma proteins. These large molecules are highly ionized regardless of pH, which limits their distribution to the extracellular compartment. Consequently, their volume of distribution remains unchanged or slightly decreases with ageing.

Vecuronium is scarcely metabolized, with 40% excreted unchanged in the bile and 30% in the urine. A limited amount of the drug (30%) is deacetylated in the liver with one active metabolite. Because both liver blood flow and glomerular filtration rates are reduced in the elderly, vecuronium clearance is reduced by approximately 30% in this population, without any modification in the volumes of distribution.

The elimination of rocuronium is very similar to that of vecuronium, with approximately 75% eliminated in the bile and 10% in the urine. A little rocuronium undergoes deacetylation, and no significantly active metabolites are produced. Rocuronium clearance is also reduced by 30% in the elderly.

Therefore, usual pharmacokinetic parameters for steroid NMBAs are significantly but moderately modified by ageing, with a trend towards reduction in both clearance (around 30%) and distribution volumes (around 25%). These modifications have been proposed to explain prolonged duration of action, but this prolongation (of at least 60%) appears important when compared with the kinetic changes.

3.2.3.2.2 Benzylisoquinoliniums

The currently available benzylisoquiniliniums include atracurium, mivacurium, and cisatracurium. Atracurium and mivacurium are mixtures of stereoisomers with varying potencies and pharmacokinetics. Atracurium is a mixture of ten isomers, one of them being cisatracurium.

Like steroid NMBAs, benzylisoquinoliniums are big molecules that do not cross lipophilic barriers. Their distribution volumes are, therefore, in the same order of magnitude than that of the steroid compounds. Distribution volumes of benzylisoquinoliniums are slightly enhanced in elderly patients. This may be due to a potential decrease in plasma protein binding in this population, these compounds being more extensively protein bound compared with the steroids.

Metabolism or hydrolysis of benzylisoquinolinium compounds is quite diverse. Atracurium and cisatracurium undergo spontaneous degradation through Hofmann elimination and ester hydrolysis. This process accounts for about 83% of cisatracurium elimination clearance, but only for about 40% of atracurium total elimination clearance. The fraction of atracurium that does not undergo Hofmann elimination is probably metabolized mainly in the liver. If atracurium total elimination clearance is not modified by ageing, its organ clearance is reduced, but this reduction is counterbalanced by an enhancement of non-organ clearance.

The main mivacurium isomers are metabolized by plasma pseudocholinesterases, and the *cis-cis* isomer has a much lower clearance. In a letter to the *British Journal of Anaesthesia*, a decrease in pseudocholinesterase activity in elderly patients when compared with that in younger ones, though the activity remained in the normal range, was reported. This observation, which has not been confirmed by a full paper, might contribute to the reduced *trans-trans* and *cis-trans*-isomers clearances.

3.2.3.3 *Effect site concentration*

Muscle blood flow has been suggested as a factor that influences delivery of drugs to the end plate. Regional blood flows, including muscle blood flow, are reduced in the elderly. Therefore, a more important concentration gradient between the effect site and the plasma in elderly patients may exist, which is illustrated by a lower exit-rate constant k_e0 in the aged. The slow onset and longer duration of action of most NMBAs in elderly patients, poorly explained by the scarce changes in elimination kinetics, might correspond to this phenomenon. When cisatracurium was studied, the time to maximum block was more rapid in young patients than in elderly ones, owing to a reduction in k_e0 with age.

3.2.3.4 *Pharmacodynamics*

So far, all the clinical changes in NMBA behaviour in elderly patients have been explained by pharmacokinetic but not pharmacodynamic alterations. Plasma concentrations corresponding to a fixed degree of paralysis are not modified by ageing, and the concentration–response relationships remain usually unchanged,

suggesting that the ageing process has no influence on the pharmacodynamic component of NMBA behaviour.

3.2.3.5 *NMBA antagonists*

The use of NMBA antagonists such as neostigmine or edrophonium should be widely recommended in the elderly. The onset of action of neostigmine is often delayed; its effects are longer lasting, possibly owing to a reduced elimination with impaired renal function, and thus the dose requirements are increased. The incidence of cardiac dysrhythmias after injection of neostigmine is increased.

Sugammadex is efficient in the elderly, with a reversal time to a Train of Four ratio of 0.9 only slightly prolonged. It can be administered safely to patients with renal or cardiac failure and, therefore, can be an important alternative to neostigmine in cardiac elderly patients where rocuronium has been used for muscle relaxation. Monitoring remains mandatory in all cases.

3.3 **Conclusion**

Ageing induces changes in both the pharmacokinetics and the pharmacodynamics of anaesthetic agents. These changes vary between agents and class, and a detailed knowledge of these variations is necessary to design safely any anaesthetic protocol in this population. As ageing progresses, inter-individual variability increases. Therefore, it is appropriate to choose drugs with a rapid onset and a short duration of action in the aged in order to carefully titrate their doses to the desired effect and avoid unwanted side effects, mainly haemodynamic. The way the drugs are handled in this population is much more important than the choice of the drug alone, and many dosing schemes should be adapted to the patient's age rather than his or her weight.

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Preoperative assessment and preparation of elderly patients undergoing major surgery

KEY POINTS
• Age alone is a poor predictor of surgical risk.
• Patho-physiological age-related changes increase the risks of surgery and anaesthesia.
• Comorbidities increase with age.
• Behavioural adaption (hiding declining function) should be explored.
• Anaesthetic planning for surgery in the elderly is a challenge.
• The aim of preoperative assessment is to risk stratify the patient and the proposed procedure and to identify modifiable factors that can be optimized before surgery.
• The presence of interval delirium or confusion indicates a very high risk of postoperative cognitive impairment.
• Advance directives, where possible before emergency surgery and always for elective surgery, should be documented and followed.
• There may not be time for complete evaluation and correction of risk factors before emergency surgery.
• Lifesaving treatment can proceed without consent.

4.1 Introduction

Even though the number of elderly patients is increasing, the number and range of surgical procedures available is expanding faster. The elderly certainly benefit from the opportunity that surgery may give them, but there is still an old-fashioned and unacceptable view in some practitioners that elderly patients may be 'too high a risk'. The elderly have more perioperative complications than younger patients do, but this is in keeping with the reduced physiological reserve and the comorbidities that are more commonly seen in the elderly. These very factors, functional reserve and comorbidities, demand careful and detailed preoperative assessment and subsequent review for modifiable opportunities to

rationalize and optimize drug therapy, physiological reserve, nutritional status, and social planning.

The preassessment of the elderly patient serves several purposes: to gather information on the patients, their functional ability, and, combined with the known risks of a given surgical procedure in a particular surgeon's hands and to allows a degree of risk assessment that can inform patient consent. It may demonstrate that one procedure has an unacceptable risk of major complications and that a more limited or alternative procedure may achieve most of the benefits for the patient with significantly reduced risk. As important, it should seek modifiable factors that can be optimized before surgery to improve the outcome for the patient. These factors can vary from a medication review including compliance checking, nutritional support, or exercise programmes before surgery. For these reasons, preassessment protocols designed for younger patients are all too often inappropriate to elderly patients. Expertise in assessing the elderly patient is essential to enable appropriate assessment and interpretation of results. This expertise is seldom present in the junior medical or nursing staffs who usually provide the routine preoperative assessment service. Specific approaches tailored to the elderly patient, such as Comprehensive Geriatric Assessment protocols, improve outcomes.

Proactive care of older people undergoing surgery ('POPS') (see Fig. 4.1).

The key aspects that must be assessed, documented, and acted upon include:

- Baseline functional assessment, identification of comorbidities, and looking for previously unidentified disease
- Optimization of any modifiable conditions identified
- Formal cognitive-function testing and recording that can be used to inform capacity to consent
- Identification and recording of the existence of any Advanced Directives, or Lasting Powers of Attorney related to health
- Identification of any need for level 2 or 3 critical care before surgery
- Review of the patient by a multidisciplinary team of anaesthetist, surgeon, and geriatricians
- Identification of specific rehabilitation requirements and their organization before surgery
- Provision for social care interventions at home to facilitate discharge

Clearly, it takes time to implement the optimization of modifiable factors. This may be difficult in emergencies, however, this is not a reason to shortcut the important assessment and documentation processes.

The assessment needs to cover factors related to the patient, the procedure, and the facilities available in the host surgical unit.
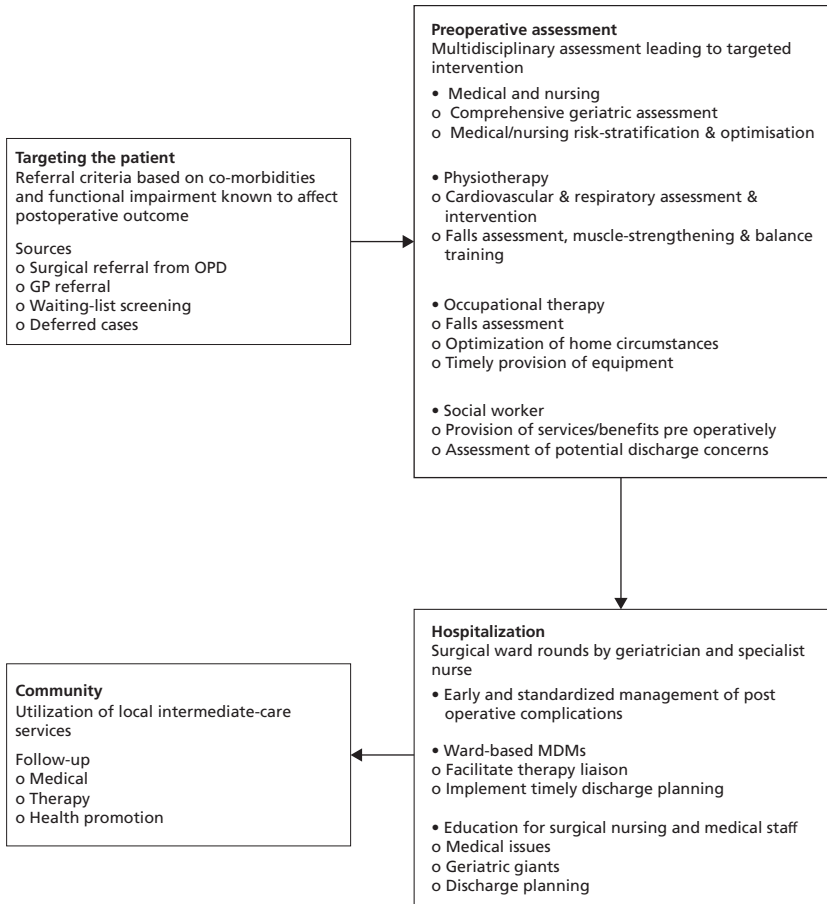
Targeting the patient
Referral criteria based on co-morbidities
and functional impairment known to affect
postoperative outcome

Sources
o Surgical referral from OPD
o GP referral
o Waiting-list screening
o Deferred cases

Preoperative assessment
Multidisciplinary assessment leading to targeted
intervention

• Medical and nursing
o Comprehensive geriatric assessment
o Medical/nursing risk-stratification & optimisation

• Physiotherapy
o Cardiovascular & respiratory assessment &
   intervention
o Falls assessment, muscle-strengthening & balance
   training

• Occupational therapy
o Falls assessment
o Optimization of home circumstances
o Timely provision of equipment

• Social worker
o Provision of services/benefits pre operatively
o Assessment of potential discharge concerns

Hospitalization
Surgical ward rounds by geriatrician and specialist
nurse
• Early and standardized management of post
   operative complications

• Ward-based MDMs
o Facilitate therapy liaison
o Implement timely discharge planning

• Education for surgical nursing and medical staff
o Medical issues
o Geriatric giants
o Discharge planning

Community
Utilization of local intermediate-care
services

Follow-up
o Medical
o Therapy
o Health promotion

Fig. 4.1 Diagram 4.1, a model for proactive care of older people undergoing surgery designing, embedding, evaluating, and funding a comprehensive geriatric assessment service for older elective surgical patients. Danielle Harari, Adrian Hopper, Jugdeep Dhesi, Gordana Babic-Illman, Linda Lockwood, and Finbarr Martin. Age and Ageing 36(2): 190–6. Courtesy of Jugdeep Dhesi.

4.2 The patient

Patient factors include pre-existing diseases, functional reserve, and frailty.

Communication problems can confound preassessment at many levels. Many patients are deaf and in denial, refusing hearing aids and suggestions that they

cannot hear well. The majority have matured in a much more stable local environment than many today and have a fixed local vocabulary that may use identical words or phrases but with markedly differing meanings. Elderly widows or widowers may not have been called by their first name for a decade or more and are likely to fail to respond when addressed by the first name by medical or nursing staff. These are compounded if the language of their residential country differs from their primary tongue. Surprising proportions of elderly have limited literacy and are skilled at disguising this.

Behavioural adaption is one of the hallmarks of an individual's response to reduced function or external threats. The elderly attempt to maintain their dignity at all costs, and the embarrassment present in all hospital procedures and environments, multipatient or mixed-sex wards and hospital gowns, for instance, may lead to significant behavioural changes. This includes fluid restriction, often extreme, if incontinence is present or likely because of reduced mobility from arthritis or other locomotor problems. They will often omit medication such as diuretics for the same reasons. They may blame their current medical state on a new medication and then choose to stop it without informing anyone.

Comorbidities are diseases or medical conditions that are present but are not directly related to the primary surgical diagnosis. The incidence of these increases with advancing age, as does the number present. They have a direct influence on outcome including severe morbidity and mortality, but the more associated complications there are to a comorbidity the greater the risk. Examples could include obesity with associated diabetes or ischaemic heart disease with congestive failure. Patients will usually self-report their comorbidities if they are cognitively intact and are more likely to benefit from practical assessment than research-based tools such as the Index of Coexistent Disease in the clinical setting.

Functional reserve is a useful concept because it encompasses several integrated physiological systems that may be affected by ageing alone or because of organ-specific disease, although it is usually the cardiopulmonary integrated system that is tested. The predicted extent of the surgical stress response with its increased demand for prolonged oxygen uptake and increased catabolism have to be balanced by the patient's ability to mount and maintain these requirements for several days. There have been several attempts to describe a reliable method for quantitating functional reserve, but none has proved entirely useful in the elderly. Metabolic equivalence (METS) has been widely used, with a cut-off of 4 as the boundary between reasonable functional reserve and values below 4 as indicating heightened risk. Unfortunately, patients with movement disorders, poor vision, dementia, or arthritis may be unable to exercise enough to provide a reliable score. There had been an expansion in the use of cardiopulmonary exercise testing (CPEX) from a purely cardiology assessment to be part of the assessment for complex major surgery such as vascular or major abdominal surgery. The use of the anaerobic threshold to risk stratify has proved broadly useful, but it is also of restricted value in those with the same problems that make the use of METS unreliable.

CHAPTER 4

Frailty has been added to the other so-called geriatric giants: intellectual impairment, immobility, instability, incontinence, and iatrogenic disorders. Frailty is recognized as a more generalized failure across the majority of organ systems to the extent that even minor degrees of physiological stress can lead to severe morbidity or death. Its precise definition remains elusive, but it is generally accepted by clinicians that it is this broad collection of reduced physiological reserve across organ systems that results in a loss of independence from even the slightest external stressor. The underlying causes for developing frailty are unclear, but the concept of immunosenescence has a growing evidence base in its support. Several other models of frailty and its identification exist, but the most common in use are those of Fried and of Rockwood. Both have been validated in clinical settings but their approaches differ. Fried uses the presence of three or more of unintended weight loss, weak grip strength, slow walking speed, tiredness, and physical inactivity (including a slow time to 'get up and go' from a chair). Rockwood's uses a deficit model that rates them on a continuous scale and includes items such as symptoms, disease states, biochemistry results, sleep disturbances, and other mental health issues. Other scales incorporate items from both and appear to perform as well in identifying the subgroup of elderly who are frail. A downloadable free app for the Edmonton Frailty Scale by Create Multimedia is available for smartphones. (https://itunes.apple.com/us/app/edmonton-frail-scale/id540317697?mt=8)

Organ-specific assessments are then necessary to try to predict individual organ performance and reserve. Of these, the cognitive, neurological, cardiac, pulmonary, and renal systems are most likely to display age-related decline.

Cognitive function is a fundamental determinant of outcome, and it must be formally assessed in the elderly patient. The two specific disorders that must be recognized are dementia and episodes of delirium. A degree of cognitive impairment affects 10% of those over age 65 and 20% of those over age 80. These changes may be denied by the patient because they may regard them as 'normal for their age', and because of their insidious progress, these changes may not be identified by even close relatives and friends until the patient's social skills fail. Because of the frequency (one in five) and the effect on outcome, all elderly patients should have a recorded assessment of their mental state. Pragmatically, this should be the first assessment performed because it informs the rest of the patient evaluation. This is because if impairment is present, the history taken will be of limited value, and compliance with investigations may be limited. Precisely which tool is used depends on the time available, but the Abbreviated Mental Test can be used in most emergencies, and, if not, simply questioning a carer or relative about any recent changes in the patient's memory may give vital clues. Major elective surgery, however, demands that a comprehensive assessment is made. The Mini-Mental State Evaluation is the most commonly used tool, and it takes about 10 minutes to complete.

If cognitive impairment is identified, it becomes a significant diagnosis with life-threatening consequences. For this reason, the patient must be informed of the

Table 4.1 Examples of predisposing and precipitating factors for postoperative delirium

Predisposing factors	Precipitating factors
Age	Change in environment
Dementia or cognitive impairment	Sleep deprivation
Depression	Loss of sensory aids/clues
History of delirium	Physical restraints
Severe illness or hip fracture	Constipation
Polypharmacy	Urinary retention
Malnutrition/dehydration	Sepsis
Functional dependency	Acute illness (e.g. myocardial infarction)
Sensory impairment	Untreated pain or excess use of

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findings and he or she should be referred to a specialist service for further assessment, confirmation of diagnosis, and potential treatment. In particular, specialist advice should be sought about the patient's capacity to give informed consent. The perioperative risks of postoperative cognitive dysfunction and delirium are greatly increased, and hence, strategies to address these problems, both in theatre and on the ward, need to be put in place before surgery. This should prompt alerting the geriatricians about the patient in perioperative support is needed (see Table 4.1).

The history should include questioning about any episodes of delirium that have been observed in the patient. These may be related to severe infections or drug therapy or may have been present on other hospital admissions. Such episodes are unlikely to be in the medical notes but are much more likely to be in the nursing records. History of delirium episodes is a strong predictor of postoperative delirium, which occurs in up to 60% of hip fracture patients and even 35% of medical admissions. It has an increased mortality and complication rate. As such, prevention strategies should be instituted before surgery, including maintaining day/night routines and sensory support.

Neurological function should be assessed for motor and sensory dysfunction. The commonest disability in the elderly is visual impairment; with deafness second (See Table 4.2). The loss of these special senses limits communication, and this is exacerbated if the host country's language is not the primary language of the patient. Even in competent patients, informed consent may be difficult owing to these communication problems.

CHAPTER 4

Table 4.2 Prevalence of moderate and severe disability in adults aged over 60 years by leading health condition associated with disability, in developed and developing countries		
	Developed countries (millions)	Developing countries (millions)
Visual impairment	15.0	94.2
Hearing loss	18.5	43.9
Osteoarthritis	8.1	19.4
Ischaemic heart disease	2.2	11.9
Dementia	6.2	7.0
Chronic obstructive pulmonary disease	4.8	8.0
Adapted from World Report on Disability, pp.297, Copyright (2011) World Health Organisation.		

Parkinson disease has particular risks in the operative period because these patients are exquisitely sensitive to variations in the circulating levels of their anti-Parkinson medication, and even routine fasting regimens may lead to extreme postoperative rigidity problems. Patients with Parkinson disease are also prone to postural hypotension, requiring care with positioning.

Cardiovascular function is routinely assessed, and investigations are requested in response to identified clinical symptoms. Whilst this is necessary to avoid over investigation in younger patients, a more assertive approach is needed in the elderly. For all intermediate and major surgery, full investigations including blood tests for haematology, renal and liver function, and bone function, as well as an ECG, are required. These may also be indicated in low-risk surgery in those patients over the age of 65 years. The utility of such investigations is in confirming diagnosis and guiding optimization rather than providing risk assessment. Such risk assessment is often performed using the Revised Cardiac Risk Index from Lee et al. (1999). It is valuable in non-cardiac surgery and widely used to decide if a preoperative or perioperative cardiologic intervention will alter outcome.

Ischaemic heart disease becomes more common with increasing age, but it may be asymptomatic in those with limited mobility, through arthritis, blindness, or cognitive impairment. Stress testing may be indicated, induced either by exercise or inotrope infusions. Echocardiography is indicated if valvular dysfunction is suspected. Autonomic function should be assessed, although this can be difficult in practice. Postural hypotension on standing from sitting, or on a tilt table, is indicative of intraoperative haemodynamic instability. Caution in interpreting cardiology recommendations is warranted and should be related to possible cardiovascular stresses not anaesthesia or surgery.

Many elderly patients are on anticoagulants, usually for atrial fibrillation, but increasingly following stenting of coronary arteries. Whilst the risk related to atrial fibrillation may allow discontinuation of anticoagulation for the duration of the surgical period, this is not the case with stents. It remains mandatory to continue with antithrombotics where stents are *in situ*, especially clopidogrel, because the risk of a catastrophic cardiac event or stroke is unacceptably high. If the surgery requires cessation of the anticoagulants it should be deferred for up to a year, despite the age of the patient, if the risk of bleeding is too high for the planned surgery.

Respiratory function becomes progressively limited with age. Closing capacity encroaches into tidal breathing when supine, even in non-smokers, by the age of 65 with the inevitable increase in shunt. Cough reflexes attenuate, and chest wall dynamics become more limited. Pulse oximetry at rest, sitting, and supine, is a useful, simple test. The 6-minute walk and an assessment of walking speed are also of interest from a cardiorespiratory viewpoint.

Sleep apnoea increases with ageing, and the patient may be unaware of its existence especially if living alone. The vast majority of the elderly snore, and this is an indicator of upper-airway collapse during sleep. Overnight pulse oximetry with a review by the local sleep medicine team is often diagnostic. Diagnostic questionnaires such as the STOPBANG are of limited value in screening independent elderly patients, again because of the lack of witnessed sleep.

Renal function reduces with age. Creatinine clearance is more reliable than a single plasma value, but even if normal, it does not indicate good renal function. Homeostasis is limited in both speed of response and extent, and this is difficult to assess before surgery. Hyperosmolarity, commonly seen in nursing home patients may reflect behavioural aspects, or even a limited ability to access fluids. Immobility may place a glass of water well beyond their reach.

Nutritional status must be assessed for all but the minor procedures. Malnutrition is very common in the elderly, and it has a marked impact on outcome, both mortality and morbidity. Clearly, those presenting for gastrointestinal surgery are most obviously at risk and are usually assessed as part of the surgical workup, but the same is true for major orthopaedic, vascular, or neurosurgical practice. As with cognitive function, formal testing is needed, and there are clinically useful tools to clarify the presence of malnutrition, from the undernourished to the obese, and to suggest appropriate management protocols. These include the Malnutrition Universal Screening Tool and the Mini-Nutritional Assessment, both of which perform well in the elderly.

Biochemical screening, for instance, using serum albumin, may identify either malnutrition or an acute-phase reaction if reduced. However, values below 35gl^{-1} predict poor operative outcomes; from the 30-day mortality to significant wound infections. The assessment of levels of vitamins, minerals, and trace elements is not routine, even though they are known to affect outcome. Empirical treatment has demonstrated benefit from, for instance, iron, vitamin B12, and folate for 1 month before elective surgery.

Many nutritional abnormalities require oral supplementation, especially for gastrointestinal problems, but there is not a clear basis for when, what, or how long before surgery. If the oral route is limited, enteral feeding is the next best option. This may also provide a necessary route for maintaining patients' chronic medication during the perioperative period.

The procedure being proposed has to be assessed in terms of the risk/benefit for each individual patient. There are several risk-stratification scoring systems in use. The commonest general system is the ASA (American Society of Anesthesiologists), and it still performs well despite its simplicity. However, it does not reliably predict individual risk because it does not factor in the procedure or the age, sex, or comorbidities of the patient. Most elderly patients fall into the ASA 3 or higher scores, even if otherwise fit and healthy. Another is the Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity (POSSUM) tool, which has been modified, from its original version because of an excessive prediction of death in low-risk groups, into several alternatives such as the Plymouth and Vascular versions (P-possum and V-possum). Currently, they all overestimate risk.

Increasingly, valid outcome data related to surgical units and even individual surgical teams are becoming available. These data, combined with a detailed assessment of the health of the patient, can inform the debate about the benefit and risks of a given procedure. This, in discussion with the patient, should identify any modifiable factors that could be improved before surgery, the exact anaesthetic and surgical management, postoperative care resources, and discharge planning.

Convalescence after surgery is almost without any evidence base, but the oldest old, over 80 years of age, may take up to a year to return to their preoperative status, even if they do benefit from the planned surgery. This is not a reason to limit access to such surgery but a flag to the duration of postoperative care needed in the community afterwards.

4.3 Prehabilitation

The principle aim of preassessment is to identify which of the patients' comorbidities, drug therapy, nutritional status, and/or general physical fitness can be improved to give them the best chance of successful surgery. This has been recently badged as 'prehabilitation' and the term describes an integrated multidisciplinary process where medical, nursing, nutritional, physiotherapy, and social care staff plan a tailored programme for the preoperative, perioperative, postoperative, and community care for that patient. One major change in emphasis is that a clinician with extensive experience of assessing elderly patients, rather than less experienced nursing or junior medical staff, is seen as the lead for the elderly preassessment clinic.

Ideally, the process of seeking to get the patient in the best possible state for surgery should begin when their GP first decides that a surgical opinion is needed, long before attendance in outpatients.

Optimizing some high-risk individual patients before surgery has been practised for a long time and by some units as a programme to reduce hospital stay and fast-track patients' recovery. The elective process usually starts once the patient is reviewed in the hospital outpatient department and listed for surgery. The evidence base for these interventions is still unclear, partly because of small study numbers and limited scope of design. There is more uncertainty related to the frail elderly because no single intervention or programme has demonstrated changes in predicted outcome. The same is not true for other forms of surgery in elderly but not frail patients.

Nutritional supplementation improves outcome in thin patients with femoral neck fractures and gastrointestinal surgery, for instance, but it has less effect on well-built patients. Treating subclinical nutritional anaemia with iron, B12, and folate is routine in some orthopaedic units, and it improves outcome, both for morbidity and mortality.

Exercise training is being investigated for major vascular and orthopaedic surgery and in patients scheduled for surgery after a course of chemotherapy, both before surgery and as targeted physiotherapy after surgery. Early data suggest that some groups improve, but how long the patient needs to exercise and what form of exercise remains to be decided; for example, hip replacement patients benefit from preoperative strengthening exercise, but data for total knee replacement surgery are conflicting.

Social and community planning, as well as early provision of aids where necessary, allow early discharge home, as does the organization of convalescent, supported living care if needed. Close coordination between the GP, district nursing, the hospital unit, and the patient's family are essential.

4.4 Summary

The opportunity that seeing the patient before surgery gives to improve outcome and provide individualized best care has to be taken by senior, experienced clinicians. The increasing data on how optimization and careful perioperative planning can reduce postoperative complications suggests that anaesthesia and critical care can help maintain independence for these vulnerable patients.

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Day-case anaesthesia in the elderly

> **KEY POINTS**
>
> - Ambulatory anaesthesia can be a very good choice in elderly patients, provided a competent adult can escort them home and take care of them.
> - The preoperative anaesthesia assessment should be performed sufficiently ahead of the surgery to allow preparation and adaptation of chronic treatments.
> - Spinal anaesthesia is often associated with delayed discharge when compared with general anaesthesia using short-acting agents.
> - When applicable, local anaesthesia or peripheral nerve block provides long-lasting postoperative analgesia.

1.1 Indications and limitations of day-case anaesthesia in the elderly

Ambulatory surgery or day surgery in the UK is defined as a patient being admitted to hospital for a planned procedure and discharged home on the same calendar day. Ambulatory surgery is now widely accepted as the default position for the vast majority of patients requiring surgery with inpatient stay chosen only by exclusion. There are very few absolute contraindications. Common surgeries encountered in the elderly include ophthalmic surgery, followed by urology, orthopaedics, and other surgical procedures increasingly being undertaken in the ambulatory setting. Ambulatory anaesthesia and surgery, when surgery is compatible with it, can be an excellent choice in very old patients, specifically if they are confused or disorientated because it takes them far from their usual environment for only a short while. In selecting patients, one has to decide if the operation is an appropriate day-case procedure (Table 5.1): is there anything we would do for this patient by admitting him or her overnight that could not be done at home, and are the patient's home circumstances adequate for day-surgery discharge? The scope of day surgery is constantly expanding. Patients with complex medical problems and elderly patients increasingly are being considered for day surgery. After minor surgery, cognitive dysfunction at 7 days is more severe when elderly patients are treated as inpatients rather than as outpatients.

Nevertheless, ambulatory surgery can be considered in elderly patients only if a responsible and reasonably fit adult can escort them home and care for them

Table 5.1 Examples of procedures considered suitable for day-surgery pathways	
Breast surgery	Excision of the breast Simple mastectomy Sentinel node biopsy Axillary clearance
Gynaecology	Operations to manage female incontinence
Urology	Endoscopic resection of prostate (TURP) Resection of prostate by laser
General surgery	Cholecystectomy Repair of a range of hernia
Orthopaedic surgery	Arthroscopic subacromial decompression Bunion operations Dupuytren fasciotomy
ENT	Tympanoplasty Tonsillectomy Septoplasty
Reproduced from *Continuing Education in Anaesthesia Critical Care and Pain*, 14, Quemby DJ and Stocker ME, 'Day surgery development and practice: key factors for a successful Pathway'. Copyright (2014) with permission from Oxford University Press	

until they can resume their normal activities and a suitable locally developed pathway is followed (Fig. 5.1). Some American Society of Anesthesiology (ASA) IV patients are being operated upon in the ambulatory setting, under local anaesthesia safely, mostly cataract surgery or inguinal hernia repair surgery. It is important to bear in mind that not all procedures and patients are suitable for surgery in the day-surgery setting, and some are best undertaken in the in-hospital setting. The spouse does not always fulfil the requirements for safe care at home. Stable ASA physical status III patients will be accepted for ambulatory procedures most of the time, but the medical team must be conscious that the incidence of complications is higher in this population.

1.2 **Preoperative assessment and preparation**

In elderly outpatients, concomitant diseases (e.g., hypertension, ischaemic heart disease, history of strokes, impaired cognitive function, and diabetes mellitus) and chronic medication are the rule rather than the exception. History and physical
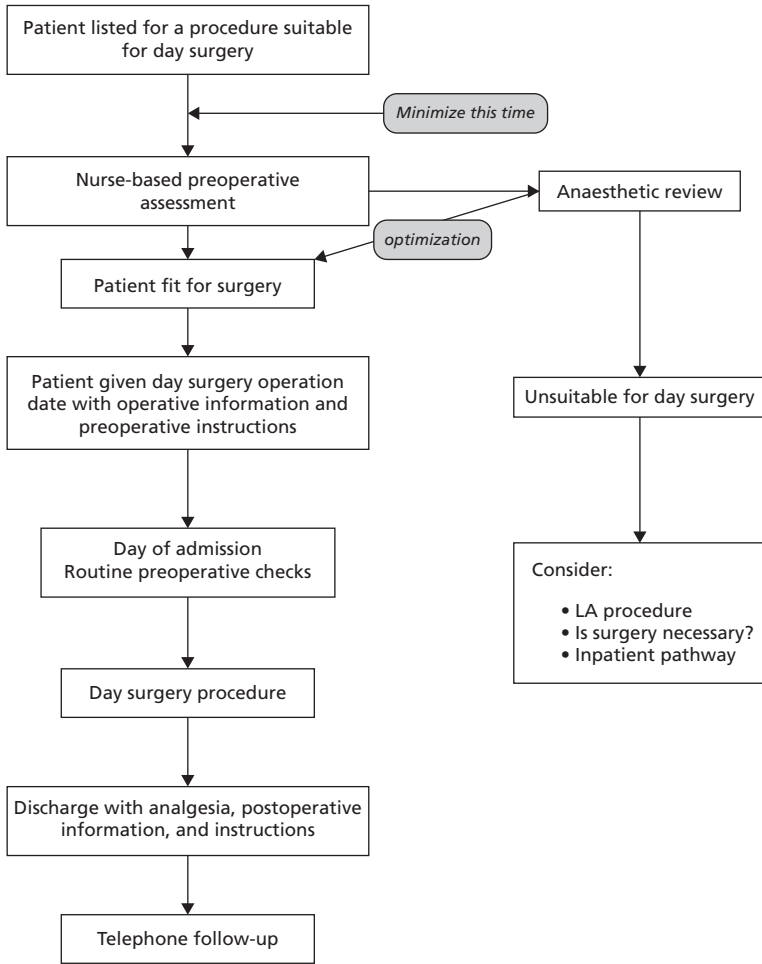
Fig. 5.1 An example of a day-surgery patient pathway

examination will provide the best estimation of the patient's preoperative condition. Screening laboratory tests are no more contributive in the elderly than in the rest of the population. On the contrary, laboratory tests indicated by history and physical examination will provide important information on the status of the

> **Box 5.1** Screening tests to be performed in healthy elderly patients proposed for ambulatory surgery
>
> - Haemoglobin (or haematocrit)
> - Creatinine (estimation of the creatinine clearance)
> - ECG

patient and allow, if appropriate, an adequate preparation for the planned surgical procedure (Box 5.1).

Nevertheless, considering the high frequency of anaemia and renal failure, haemoglobin and creatinine concentrations should be measured even in seemingly healthy patients. The request for chest radiographs is often questionable, especially for minor procedures. However, an electrocardiogram (ECG) should be obtained as a baseline assessment, considering the high frequency of ECG abnormalities in this population. To be efficient, the preoperative assessment by the anaesthetist should be performed early enough before the surgery to allow this preparation and the adaptation of chronic treatments. Successful day-surgery outcomes depend on good preoperative preparation and education of the patients, as well as day-surgery pathways, which provide informed decisions regarding the planned procedures and postoperative care. It is important to identify any medical risk factors that can be optimized before surgery. Preoperative assessment should occur, ideally, as close to the date of the decision to operate as possible and thus give maximum time for optimization of medical conditions, hence reducing the risk of cancellation. This assessment, which should be associated with explanation of the actual course of anaesthesia and surgery and answering any questions that may be caused anxiety, will reassure the patient and reduce the need for drug premedication. Indeed, such premedication may have unreliable effect and duration of action and lead to unexpected hospital admission. The risks of postoperative nausea vomiting (PONV) should be assessed before operation, and prophylactic antiemetics should be given to the patient after stratifying the risks. The routine use of IV fluids can enhance a patient's feeling of well-being and reduce PONV.

1.3 Which anaesthetic protocol should be used?

1.3.1 Conscious sedation

When associated (if appropriate) to local anaesthesia provided by the surgeon, conscious sedation (when applicable) conveys the best chance of rapid recovery and is, therefore, well suited to the ambulatory setting. Nevertheless, it should be used with great caution, taking into account the specificities of pharmacology in the elderly. Appropriate monitoring, similar to those applied during general anaesthesia, should be used. Midazolam is difficult to handle in this population, and it may trigger confusion and difficulties in controlling the patient. The drug of choice

is currently propofol, best administered by effect-site target-controlled infusion (TCI), through a device implemented with a model including age as a covariate, or by patient-controlled sedation. Sedation is usually obtained with targets around 1–2 µg ml^{-1}, but titration to effect should always prevail. A growing interest is emerging now for remifentanil effect-site TCI, which alleviates pain without altering consciousness. However, some precautions are mandatory: close intraoperative monitoring of respiratory rate and pulse oximetry (ideally non-invasive monitoring of $P_{ET}CO_2$), prophylaxis of PONV, and when applicable, administration of analgesics to prevent postoperative pain as soon as induction of sedation or even as a premedication.

1.3.2 Regional anaesthesia

It is important to bear in mind that elderly patients receiving central or peripheral nerve block are at an increased risk of postoperative numbness or nerve injury because nerve fibres are vulnerable to local anaesthetic agents leading to prolonged motor and sensory blockade. Central neuraxial blocks are associated with higher levels of blocks for the same volume of drugs, as well as a higher degree and incidence of hypotension and bradycardia. Peripheral blocks when applicable (e.g., hand or cataract surgery) are a very good choice for the elderly outpatient. They provide excellent postoperative analgesia and rapid 'street fitness'. Even if a consensus is arising as to their use in patients taking aspirin, peripheral blocks should be used with extreme caution if at all in patients undergoing antiplatelet therapy. They remain contraindicated in patients on heparin or anticoagulants. Peripheral blocks of the lower limb are less suited to the ambulatory setting because they may impair the patient's mobility for as long as 24 hours. Central blocks and, specifically, spinal anaesthesia are more controversial in the elderly. Spinal anaesthesia does not provide prolonged postoperative analgesia, so it presents no advantage over general anaesthesia in this respect, and it is frequently associated, especially in male patients, with difficulty in postoperative voiding, which may prolong recovery or even lead to unanticipated hospital admission.

1.3.3 General anaesthesia

The basic principles of day-surgery anaesthesia include rapid onset and offset of anaesthesia with clear-headed emergence, minimal PONV, dizziness, or drowsiness, and rapid return to full cognitive functions.

In these short outpatient procedures, general anaesthesia using the newest hypnotic and analgesic drugs provides excellent intraoperative titrability and rapid clear-headed recovery. The drugs of choice are propofol (consider TCI); desflurane or sevoflurane; and alfentanil or remifentanil (consider TCI). A laryngeal mask is often applicable for airway control. If surgery does not require muscle relaxation, a good method to assess the adequacy of anaesthesia is to use pressure support to ensure adequate ventilation, while allowing monitoring of respiratory rate. General anaesthesia does seem to be associated with increased incidence of postoperative cognitive dysfunction (POCD) owing to the use of

multiple drugs, some of which are potentially delirium inducing, but studies have not been able to prove that general anaesthesia has a higher association with POCD or delirium in comparison with regional anaesthesia. The level of sedation used or the magnitude of postoperative pain and its control are potentially confounding factors and may have affected the results of the studies. The nature of the surgery seems to be a triggering factor for POCD, with major surgery predisposing elderly patients to POCD more commonly compared with minor surgery.

1.4 Postoperative care

Elderly patients, specifically if ASA physical status III, should be submitted to the postanaesthetic care unit after ambulatory surgery. There are some specific aspects of their recovery, one example is that in postoperative analgesia, opioids, which convey a risk of drowsiness precluding rapid discharge, should be avoided. A multimodal approach to pain relief should be adopted for day-surgery patients. Policies should also exist for the rapid management of any postoperative PONV because this can significantly delay discharge.

The patient and/or his/her escort should receive written, as well as oral, instructions about the postoperative period, including a telephone contact number to an experienced clinician or nurse practitioner, in case of unexpected complications.

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Emergency anaesthesia in the elderly

6.1 Introduction

Emergency surgery is comparatively more frequent in the elderly than in younger patients, and it must be performed even in cases where elective surgery might appear unreasonable. Emergency surgery concerns mainly trauma surgery (e.g. fractured femoral neck or broken wrist), emergency intra-abdominal surgery (occlusive syndromes resulting from inguinal hernias or digestive, mainly colic, cancer, and peritonitis), and vascular surgery (acute arterial thrombosis and ruptured aortic aneurysm). It may be delayed by late discovery, and the patient's general condition is often poor, worsened by hypovolaemia and interruption of chronic medication. Pain, infection, hypotension, and metabolic disorders may lead to a confused state even if dementia did not pre-exist. In the absence of family or previous medical record, the patient's medical history may be difficult to elicit. For all of these reasons, the outcome of emergency surgery is poorer than that of elective operations in similar patients. Nevertheless, there are no major differences between old patients undergoing emergency surgery and younger ones. They may suffer from the same traumas, and the overall care is not fundamentally different from what it can be at other ages.

6.2 Preoperative care: conditioning of the elderly patient before emergency surgery

When an elderly patient is proposed for an emergency surgery, an overall assessment of his/her medical condition has to be done in a short period, depending on the nature of the case.

The preanaesthetic assessment of a geriatric patient who has fallen should focus as much on the causes of the fall as on its consequences. Inadvertent chronic medication overdose, vertebrobasilar arterial insufficiency leading to 'drop attack', aortic stenosis, and rhythm abnormalities should be looked for.

The need to stabilize concurrent medical conditions should not unduly delay the surgery. A study on over 290,000 admissions for fractured hips identified that delay in operation was associated with an increased risk of death, even after adjustment for co-morbidity (Khan et al. 2009) (See Fig. 6.1).

When an elderly patient is admitted as an emergency and is delirious, which limits the recording of their medical history and chronic medication, a careful clinical examination and routine investigations such as ECG, blood cell count, and blood chemistry may identify significant factors such as coronary artery disease, aortic stenosis, or anticoagulant therapy, which may modify the perioperative management. Antiplatelet treatment, which is very frequent in this population, can be more difficult to recognize through a rapid screening.
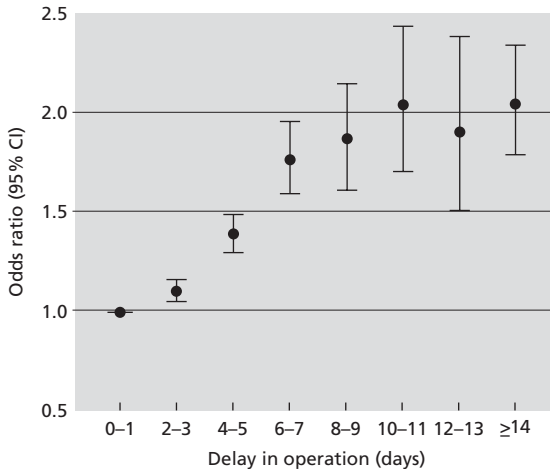
Fig. 6.1 Odds ratio of death within the hospital by operative delay relative to at most a 1-day delay, after adjustment for age, sex, deprivation, type of procedure (fixation and replacement only), and selected comorbidities

Reproduced from Bottle A and Aylin P, The *BMJ*, 332, 'Mortality associated with delay in operation after hip fracture: observational study'. Copyright (2006) with permission from BMJ Publishing Group Ltd.

6.3 Coping with hypovolaemia

Hypovolaemia is very common in elderly patients presented for emergency surgery, even in the absence of bleeding or shock. Their tolerance to hypovolaemia is particularly poor because they have a decreased β-receptor responsiveness, which limits heart rate increases, and they must rely on increased ventricular filling (Frank–Starling law) and stroke volume to maintain an adequate cardiac output. Consequently, any decrease in sympathetic activity induced by general anaesthesia and/or central blockade may trigger profound hypotension. On the contrary, in an aged patient, rapid correction of hypovolaemia in the absence of proper monitoring, may easily lead to overloading, pulmonary oedema, and heart failure. These complications will often be unmasked during the recovery period, when the vasodilatation induced by either general anaesthesia or central blockade wears off. Oesophageal Doppler ultrasonography or continuous estimations of cardiac output through an arterial line may help. In this population, early vasopressor use should be advocated.

There is no clear consensus about transfusion thresholds in the elderly. Nevertheless, considering that the majority of those patients suffer from ischaemic heart disease, and that redistribution of fluids in the postoperative period associated with some blood loss through drains will further lower the haemoglobin concentration, it seems reasonable to maintain an Hb value above 100 g L^{-1} in elderly emergency patients.

6.4 The trauma patient

Traumatic injury in the elderly is most often caused by falls; but they can also be victims of assault, road traffic accidents, or attempted suicide. Because of osteoporosis, loss of muscle mass, and decreased elasticity of connective tissues, the same traumatic force will generate more severe injuries in the elderly than in younger adults.

Fractured neck of the femur remains as the most common injury in the elderly. The cause is usually a fall, and a hip fracture often follows a gradual decline in their physiological status. Identification of the cause for the fall is important because cardiac disorders, stroke, diabetic states, and autonomic dysfunction are common precursors to a fall that profoundly affect anaesthetic and surgical outcome. The long-term mortality of falls is high despite all the efforts and improvements in surgical techniques and anaesthesia care. Numerous studies have attempted to define the best anaesthesia technique in this situation, but no difference in outcome when comparing general and spinal anaesthesia, has ever been demonstrated.

6.5 Emergency laparotomy in the elderly

Intra-abdominal surgical procedures that are most commonly performed as an emergency in elderly patients are complications of colonic cancer (obstruction and perforation), appendicitis, cholecystitis, strangulated groin hernia, and

intestinal infarction. In all cases, mortality is significant (from 15% to 40%), and much more in those over the age or 90 or in cases of acute mesenteric ischaemia owing to metabolic disorders and sepsis. Preconditioning the patient before surgery must not delay the procedure. For example, postponing surgery for more than 24 hours after the onset of symptoms in patients with complete small bowel obstruction dramatically increases the risk of perforation, septic shock, and ultimately death. Elderly patients frequently present late after the onset of symptoms, and they can be misdiagnosed easily, especially if not admitted to an acute surgical facility.

Malignant obstruction is the most frequent cause of emergency large bowel surgery. In about 25% of the cases, the patient will undergo either a Hartmann procedure or formation of a palliative stoma. In elderly frail individuals, this stoma will never be reversed. Colonic stenting has recently been tried with promising results as an alternative to surgery for malignant large bowel obstruction or as a temporary relief allowing delayed surgery in better conditions thus avoiding stoma.

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CHAPTER 6

Anaesthesia for orthopaedic surgery in the elderly

KEY POINTS

- Elderly patients may have significant organ dysfunction.
- Cardiorespiratory, renal, and neurological dysfunctions and arthritis are common.
- Major joint surgery is performed increasingly.
- Preoperative assessment is essential to optimize the disease state.
- Elderly patients may be malnourished.
- There is no single 'best' technique of anaesthesia.
- The use of cement during surgery is associated with intraoperative morbidities.
- Tourniquet use is common during distal bone or joint surgery.
- Sedation is commonly used when a regional technique is in use.
- Deep vein thrombosis (DVT) prophylaxis is necessary in all patients undergoing major joint surgery.
- Antibiotics are routinely used but must be administered before a tourniquet is used.
- Blood loss may be excessive, especially during revision surgery, and measures should be taken to minimize blood loss.
- Regional technique with an opioid provides good analgesia.
- Patient-controlled analgesia (PCA) with an opioid is a good method, but patients may not use it properly because of arthritis or impaired cognitive function.
- Prolonged use of a urinary catheter should be avoided.
- Delirium is common in the elderly, occurring to some degree in the vast majority of patients, and anaesthesia may compound this problem.
- Early mobilization is helpful.

7.1 Introduction

Orthopaedic procedures in the elderly can be broadly divided into emergency and elective operations involving joint replacement, fixation of broken bones, and the endoscopic examination of joints, but there is a huge variety of operations, ranging from minor surgery, such as toenail excision, to massive revision limb and joint salvage in elderly patients. Many of these patients will have some degree of

organ dysfunction. They are likely to suffer from rheumatoid arthritis, ankylosing spondylitis, and other systemic diseases, and they usually receive multiple drugs. Anaesthesia for orthopaedic surgery poses particular challenge to the anaesthetist relating to elderly patients and the procedure. An effective preoperative assessment is of paramount importance. This chapter covers the general principles of anaesthesia relevant to orthopaedic surgery. Preoperative preparation for surgery and anaesthesia; perioperative management, including monitoring and analgesia; and postoperative management, including fluid balance, critical care, and recovery, will be covered.

7.2 Preoperative preparation and assessment

The objective of preoperative assessment is to identify and optimize any disease state. It is important to differentiate between chronic stable disease and deteriorating clinical states that need further specialist input. Concurrent medical therapy can be checked and optimized for the surgical period with appropriate tests arranged at this stage (see Chapter 4). The majority of these patients are likely to be older and have medical problems that are more serious. However, the elective nature of the surgery allows time for a thorough work-up, and effective treatment can be initiated if necessary. A history of hypertension, myocardial infarction, heart failure, cerebrovascular disease, and respiratory disease, as well as renal and hepatic insufficiency, should be sought. Active infection is an absolute contraindication to joint replacement, and any potential source, such as urinary or dental infection, must be treated. Aspirin and non-steroidal anti-inflammatory drugs are the mainstays of analgesic treatment for arthritic patients, and gastritis, anaemia, and platelet dysfunction may occur. Accompanying medical and orthopaedic problems, together with side effects from drug treatment make the rheumatoid patient considerably more difficult to treat. Antihypertensive and other cardiac and respiratory drugs should be administered as normal on the day of surgery.

7.3 Nutritional assessment

Many elderly patients are malnourished with associated hypoproteinaemia; this can adversely affect wound healing and increase the potential of postoperative complications. Aggressive postoperative nutritional protein supplementation in patients hospitalized with hip fractures is associated with weight gain, shorter durations of hospitalization, and reductions in postoperative complications. Most patients can tolerate enteral nutrition within 12–24 hours after surgery. Oral protein supplements should be used in the vast majority of these patients because their intake in the immediate postoperative period may be diminished from baseline. If oral intake is inadequate, nasogastric tube feeding may be effective in improving nitrogen balance and caloric intake.

7.4 Elective surgery

Elective joint replacement for a variety of reasons including osteoarthritis, rheumatoid arthritis, osteoporosis, metastatic lesions and avascular necrosis, is now an established treatment for end-stage joint disease. Since the innovative work of Charnley in the 1960s, on the development of total hip replacement, there have been many advances in design and metallurgy. Because of increased understanding of the biomechanical principles involved in the development of prostheses, and the use of acrylic cement to transmit forces between metal and bone, joint replacement has become increasingly successful. Custom-made prostheses are also increasingly being used and are inserted without the use of cement.

7.4.1 Hip replacement surgery

Total hip arthroplasty presents a challenge (see Box 7.1) because of the age group of the typical patient and their associated comorbidity, the complexity of the nerve supply to the hip and surrounding structures, and the severity of the surgery. Most hip prostheses used are of the cemented variety. The surgery is performed in either supine or in a modified lateral position using sandbags. Surgery involves insertion of an acetabular cup and removal of the femoral head, which is replaced with a femoral component. Polymethylmethacrylate cement is used to fix the cup and femoral components.

There is no single clearly superior technique for either anaesthesia or post-operative analgesia but on balance of risk and benefit, the evidence points to

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Box 7.1 Considerations during hip surgery

- Hip surgery in the elderly is major challenge. It is performed in a supine or modified lateral position.
  - Hip fracture should be fixed as soon as possible to reduce pain and minimize complications because delay can lead to decline in functional status and increased medical problems.
- There is no single clear superior technique of anaesthesia.
  - Regional anaesthesia appears to have marginal benefit.
- Use of cement is common, and it may be associated with morbidity.
  - Cement insertion into the femoral shaft may be accompanied by sudden reduction in end tidal carbon dioxide and decrease in blood pressure.
  - Slowing of the heart rate may occur.
  - The precise cause is not known, but air and fat embolism are considered major contributing factors.
- Prevention of DVT and infection are important.

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regional anaesthesia having some proven benefits over general anaesthesia and systemic opioids and to the benefits of extending regional anaesthesia–based analgesia into the postoperative recovery period. There are advantages and dis-advantages to each technique.

Regional or general anaesthetic techniques, often combined with a variety of peripheral nerve blocks or intrathecal opiate, are the main stay of anaesthesia practice for these cases. Sedation is generally used with regional anaesthesia, which is usually spinal anaesthesia or more rarely epidural technique. The advantages of regional anaesthesia include decreased blood loss, reduced risk of deep venous thrombosis, immediate postoperative analgesia and prolonged postoperative analgesia, early mobilization, decreased risk of respiratory infection, less vomit-ing, and less mental confusion in the elderly. Unfortunately, many surgeons and patients still do not like regional anaesthesia. There are known complications of regional techniques, such as hypotension, headache, and inadequate block, but there are few absolute contraindications to regional techniques even though regional blocks may be sometimes difficult to perform in the elderly.

General anaesthesia may be preferred by the patient, as well as the surgeon because of better cardiovascular stability and control of the airway. However, the disadvantages of general anaesthesia include risks such as slower recovery, slower mobilization, and increased incidence of nausea and vomiting, and postoperative cognitive dysfunction, and increased risk of respiratory infection.

Revision of hip replacement surgery may take several hours; therefore, general anaesthesia is employed. A single-shot regional anaesthesia may not be appropri-ate, but a catheter-based technique is suitable in some patients, although they may become uncomfortable despite the use of sedation.

Application of cement particularly after its insertion into the femoral shaft may be accompanied by a sudden reduction in end tidal carbon dioxide and decrease in blood pressure. Slowing of heart rate may occur, and cardiac arrest is known to occur. It is usually attributed to toxic monomers released as the cement polymer-ises. The incidence was much more frequent when the technique was relatively new. Air embolism (air trapped under the cement forced into the circulation as the prosthesis is pushed into the femoral shaft) was thought to be another rea-son. The technique of filling cement into the shaft from the bottom upwards has reduced the incidence of adverse events, but insertion can still cause embolism of fat, blood clots, or marrow. Intramedullary pressure may increase above the venous pressure, thus leading to embolization of air.

Full cardiovascular monitoring is essential, and a patent intravenous line with free-flowing fluid should always be running.

The current evidence of best practice for hip replacement recommends either a single-shot local anaesthetic spinal with a small dose of fentanyl (20–25 mcg) or morphine (100–200 mcg) or a general anaesthetic with minimal opi-oid use combined with a lumbar plexus block. Both techniques offer a good risk–benefit profile.

CHAPTER 7

7.4.2 Knee replacement surgery

General anaesthesia with opioid analgesia with or without intubation (laryngeal mask airway [LMA]) is an appropriate technique. This method is carried out with the patient supine, and a tourniquet is used. Antibiotics are administered before inflation of the tourniquet. Epidural or spinal anaesthesia with a small dose of intrathecal opiate provides good anaesthesia and postoperative analgesia. Sedation with a small dose of midazolam is usually helpful to relieve the anxiety caused by the noise of sawing and other instrumentation. Thorough attention to haemostasis by the surgeon is required following tourniquet release but before wound closure. When the tourniquet is released, acidic by-products of metabolism are released. These cause hypotension secondary to vasodilatation and negative inotropic effects on cardiac contractility. If the tourniquet is not released until the end of the surgery, the patient, on awakening, can experience pain from this cause alone.

Knee replacement surgery is very painful for the first 12 hours after surgery, and a regional technique has an advantage. The pain can be lessened by combined sciatic and 'three in one' femoral sheath block. Local infiltration of local anaesthetic agent after general anaesthesia is helpful in reducing postoperative pain.

Peripheral blocks (femoral +/− sciatic block) in combination with a general anaesthetic are a practical and effective alternative to spinal or epidural block, and, with fewer side effects and equal analgesic benefit, they are probably the method of choice. Postoperative infusion of local anaesthetic via sciatic and femoral catheters for up to 72 hours may provide excellent analgesia (lowest pain scores and minimum rescue analgesia required); whether this improves outcome remains to be seen. Continuous or patient-controlled infusions of even dilute local anaesthetics and adjuvant drugs can delay return of full motor and proprioceptive function and thus inhibit active rehabilitation at 24 hours. In some countries, peripheral nerve blocks are being replaced by local anaesthesia infiltration and infusions. There is some evidence that femoral nerve blocks may delay mobilization, and nerve blocs can cause significant quadriceps weakness in patients over 80, which may delay mobilization.

The use of a tourniquet is common during some orthopaedic procedures to produce a bloodless field. Effective venous exsanguination is produced by elevating the limb or winding a rubber bandage (Esmarch bandage), followed by inflation of a tourniquet cuff to a pressure sufficient to occlude arterial supply. The tourniquet is inflated and maintained 100 mmHg higher than the systolic blood pressure. Because elderly skin is very friable and muscles and nerves can be damaged, it is important to apply fabric or cotton under the cuff. Prolonged application of tourniquet can lead to electromyographical and histological changes, which are usually reversed after deflation. The products of anaerobic metabolism in the limb are released, and a bolus of acidic and hypercapnic blood is returned to the circulation. This can result in transient cardiovascular and neurological changes. The use of a tourniquet should be avoided in patients with poor peripheral circulation, crush injury, infection, or sickle cell disease.

7.4.3 Shoulder surgery

Major surgical procedures on the shoulder include replacement of joints, open surgery, or repair of joint by arthroscopic approach. Surgery often involves vigorous manipulation of the joint in the semisitting position; hence, the patient's head needs to be supported and protected. For shoulders, the usual position is the 'beach chair' sitting position, which has theoretical disadvantages for cerebral circulation. Anaesthetic techniques vary for shoulder surgery. General anaesthesia techniques vary from intubation with a reinforced tracheal tube and controlled ventilation of the patient to spontaneous ventilation via an armoured LMA in selected patients. Postoperative pain can be relieved by intravenous morphine through a PCA machine. Intermittent or continuous injection of local anaesthetic through a subacromial catheter inserted at the end of surgery is an option for pain relief.

Regional techniques are also employed but must ensure the shoulder is completely blocked. A supraclavicular approach, preferably interscalene, to the brachial plexus, provides excellent intraoperative analgesia, decreased blood loss, and good muscle relaxation for any shoulder operation. Ultrasound-guided interscalene block also provides effective analgesia for shoulder operations and avoids the need for opioids in the immediate postoperative period. As with all regional techniques, this should be performed awake, and complications must be sought for and treated; the commonest include phrenic nerve palsy (this problem may be reduced by using smaller volumes of local anaesthetic), Horner's syndrome, block of the recurrent laryngeal nerve, and transient neuroparexia may occur.

A good regional analgesia technique extending into the postoperative period improves the chances of early postoperative mobilization and physiotherapy for the shoulder joint.

Blood pressure monitors can be used on the nonoperative limb or the leg. If venous access is used on the same limb as the blood pressure cuff, using a nonreturn valve will prevent venous blood filling up the venous cannula when the blood pressure is being recorded. A fully functional intravenous infusion line with remote injection facility should be available.

The patient is positioned in a semisitting position with a sandbag between the shoulders to improve surgical access. The head must be secured, as traction can pull it off the head ring, and dislodgement of the tracheal tube can occur. The eyes should be well padded. All monitoring equipment must be fully functional and electro-cardiogram (ECG) and connectors secured.

7.4.4 Hand and distal arm surgery

Regional anaesthesia is especially suitable for surgery on the hand and arm, provided the duration of surgery is not unduly prolonged. A distal approach, such as axillary brachial plexus block, combined peripheral nerve block or intravenous regional anaesthesia, is the usual technique used. Measures need to be taken to

reduce tourniquet discomfort. If general anaesthesia is required, a simple anaesthetic technique breathing spontaneously using any modern volatile inhalational agent through an LMA is usually satisfactory.

7.4.5 Foot and lower extremity surgery

Operation on the lower leg can be accomplished with peripheral nerve block either at the level of femoral and sciatic nerves or by individual nerve blocks at the level of the knee. However, these blocks are difficult to achieve without the help of an ultrasound machine, and training and experience are essential.

7.4.6 Arthroscopic surgery

Arthroscopic surgery is usually performed in younger patients, but it is also performed in elderly patients for diagnostic purposes. All forms of anaesthesia previously described for shoulder surgery are suitable.

7.5 Emergency surgery

7.5.1 Surgery for hip fracture

Patients who undergo surgery for hip fracture are usually frail and female. A number of publications help in the clinical management of hip fracture patients. Surgery should be planned as soon as possible. There is evidence that delaying surgery may increase morbidity and even mortality. Planning for surgery and optimization is a dynamic process, and no time should be lost in sorting out any medical conditions before surgery. Surgical aims are to fix the fracture as soon as possible, to reduce pain and minimize complications associated with prolonged bed rest. Excessive delay in surgery and delay in weight bearing may lead to decline in functional status and increased medical problems. Early repair of fracture (within 24–48 hours) is associated with a reduction in 1-year mortality and lower incidences of pressure sores, confusion, and fatal pulmonary embolism (PE). However, early repair may not be possible in some patients who have unstable medical conditions in whom the risk of urgent surgery outweighs the risk of delay. Such patients include those with arrhythmia, acute coronary syndromes, cerebrovascular accidents, sepsis, and severe hypoxia. The consensus appears to suggest that their medical status should be stable and optimal, and they should be rehydrated appropriately. Patients might not have had anything to drink for hours or even days. They are monitored carefully while being prepared for surgical intervention, which, if possible, should be performed within 24 hours after admission. Fractures may be repaired by screws, pin, and plate or a prosthetic femoral head may be inserted with or without cement, and intraoperative X-ray imaging may be used. Many centres increasingly perform femoral nerve block or fascia iliac block to provide preoperative analgesia for fractured neck of the femur while the patient is being optimized or while waiting for surgery.

Spinal anaesthesia is usually chosen because it provides rapid anaesthesia. The short-term mortality is considerably less. However, performing a spinal anaesthesia on a patient with a fracture who is in pain may be very difficult. Hypotension may result. The use of low-volume hyperbaric bupivacaine in the sitting position with a fast-running intravenous line is helpful. Vasopressors may be required. If general anaesthesia is selected, the dose of drugs must be reduced, and intubation of the trachea and supported ventilation is usually preferred. An LMA is used, but it may pose a problem in edentulous patients. Intravenous paracetamol is considered as effective as morphine or a continuous femoral catheter in relieving postoperative pain associated with hip fracture surgery,

Dislocation of a prosthetic hip needs urgent manipulation to relieve pain. A brief anaesthetic requiring adequate relaxation of muscles may be required.

7.5.2 Surgery for other fractures

Other orthopaedic surgery includes fracture of humerus, tibia, fibula, ankle, wrist, and others. The use of regional anaesthesia is favoured, which includes brachial plexus block, peripheral nerve block, intravenous regional anaesthesia, and so on. If general anaesthesia is required, a simple anaesthetic technique using a LMA or endotracheal intubation and ventilation may be required, depending on fasting status. At the end of many procedures, a plaster of Paris cast is applied.

7.6 Sedation during regional anaesthesia

Sedation is often used in patients undergoing regional anaesthesia because of the noise arising from the use of instruments during surgery (see Box 7.2). The duration of surgery combined with operative noise, as well as the lateral position for hip surgery, makes patients restless and uncomfortable. Midazolam titrated in 0.25 to 1 mg aliquots is often used but can occasionally cause confusion and, in excess doses, can lead to loss of control of the airway. However, there are reports of increased morbidity after sedation in the elderly, and these patients must be monitored carefully.

Box 7.2 Sedation in the elderly

- There is excessive noise during surgery.
- The patient cannot remain in a lateral position for a long duration during surgery.
- Sedation is common during regional anaesthesia.
- There are reports of increased morbidity after sedation in the elderly.
  - Excess dose of sedative can also lead to loss of control of the airway, and confusion.

7.7 Thromboembolic prophylaxis

Although DVT may complicate any surgery, it is associated particularly with surgery on the pelvis, hip, or knee. DVT prophylaxis is clearly necessary in patients undergoing hip surgery (see Box 7.3). Most DVT episodes occur in the first week after a hip fracture, and the risk is substantial in either the preoperative or intraoperative period. Patients with hip fracture have a high risk of fatal PE, with rates of 4%–14%. PE is often fatal in this age group and is the cause for majority of deaths after hip replacement. There is no universal method of preventing DVT and PE, and multiple measures are adopted. Heparin is known to reduce fatal PE in susceptible patients. Various studies have compared results of DVT prophylaxis in elderly patients with hip fracture; and although no particular treatment is distinctly superior, some type of medication should be used (warfarin, low-molecular-weight heparin, unfractionated heparin, aspirin, and sequential compression devices).

Summaries of the literature suggest that low-molecular-weight heparin (LMWH) may decrease the incidence of DVT more effectively compared with other therapies; however, this is disputed as the most cost-effective choice. LMWH inhibits the coagulation enzyme Xa and binds antithrombin 3. Managing such therapy and the risks of potent anticoagulation regimens in frail, elderly patients is often difficult. In the setting of selected high-risk patients, aspirin or even simple mechanical measures such as pneumatic compression devices may be effective. Compression stockings have an additive thromboprophylactic benefit with negligible risk, and, therefore, they should be used in combination with other treatment.

Evidence supports the use of a therapeutic regimen beginning at the time of hospitalization (preoperative). Aspirin or warfarin may be given the night before or after surgery and continued after surgery per normal dosing regimens. LMWH should not be administered at an interval closer than 12 hours before surgery. The available data on the appropriate duration of postoperative DVT prophylaxis are scarce. At a minimum, patients should continue with at least a daily dose of aspirin and wear compression stockings for 6 weeks after surgery.

Box 7.3 Thromboembolic prophylaxis in the elderly during major orthopaedic surgery

- DVT is associated particularly with surgery on the pelvis, hip, or knee.
- Most DVT episodes occur in the first week after a hip fracture and can lead to PE.
  - Risk is substantial preoperatively or intraoperatively (4%–14%).
- There is no universal method of preventing DVT or PE.
- Multiple measures are adopted.
  - Heparin is known to reduce fatal PE in susceptible patients.

Box 7.4 Prevention of infection

• Orthopaedic surgery is often performed under a laminar flow hood.
• Preoperative use of antibiotics is common.
  • Antibiotics must be administered before a tourniquet is inflated.
  • They must be continued in the postoperative period.
• Many orthopaedic surgeons insist on the use of a facemask.

7.8 Antibiotic prophylaxis

Orthopaedic surgery is often performed under a laminar flow hood, which blows clean filtered air downwards. Perioperative antibiotics are routinely used to decrease the incidence of wound infection in orthopaedic surgery (see Box 7.4). In patients with hip fractures, it is critically important to provide such perioperative prophylactic coverage because the integrity of the prosthetic components must also be considered. If drug allergy is not an issue, first- or second-generation cephalosporins are the antibiotics of choice for the prevention of these infections. Optimal infection prophylaxis is provided by administering the first dose of intravenous antibiotic in the immediate preoperative period and continuing for a total duration of 24 hours.

7.9 Temperature imbalance

Heat is redistributed from core to periphery during anaesthesia, leading to reduced body temperature (see Box 7.5). Hypothermia is often present on transfer from the ward, and active warming should be considered, especially if a prolonged period in the anaesthetic room is envisaged. There is very little subcutaneous fat in the elderly for insulation, and evaporative loss from the body and the operative site may be excessive. Intravenous fluid stored at room temperature if not administered through a blood warmer will further decrease body temperature. Return of core temperature takes longer especially after the vasodilatation because of the central neuro-axial block. Hypothermia is known to be associated with increased blood loss and the risk of infection. The most effective way of maintaining intraoperative normothermia is using a forced-air warming system, administering warmed intravenous fluid, and utilizing impermeable surgical drapes.

7.10 Blood loss

Blood loss may be extensive during revision hip surgery and towards the end of knee surgery following the release of tourniquet. Some blood is lost into the

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Box 7.5 Temperature control during surgery

- Hypothermia is common in the elderly.
  - They have little subcutaneous fat and hence poor insulation.
  - It occurs when the patient is transferred into a cold environment.
  - Prolonged stay in the anaesthetic room at lower temperature is another cause.
  - The body and the operative site have evaporative heat loss from during prolonged surgery.
  - Administration of cold intravenous fluid and blood lowers body temperature.
- Return of core temperature takes longer, particularly resulting from vasodilatation after central neuro-axial block.
- Hypothermia is associated with increased risk of infection.
- Measures should be taken to prevent hypothermia by using a forced-air warming system, by heating intravenous fluid/blood, and by utilizing impermeable surgical drapes.

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deeper tissues. Blood loss can be minimized by maintaining normothermia, good surgical technique, and positioning the patient. Epidural and spinal anaesthesia also help to reduce blood loss. If excessive blood loss is anticipated, predeposit donation of blood by the patient and acute normovolaemic haemodilution may help. Drugs that increase bleeding such as non-steroidal anti-inflammatory drugs (NSAIDs) and aspirin should be stopped well in advance.

7.11 Postoperative pain relief

Postoperative pain after orthopaedic surgery is usually short-lived, but some operations, such as knee surgery, are very painful. Effective pain relief helps in mobilization. A regional technique with opioids provides good and prolonged pain relief. Epidural analgesia with potent local anaesthetic agents may cause prolonged motor block, which will hinder mobilization. Hypotension, respiratory depression, and urinary retention may also occur with epidural block. Continuous infusions through peripheral catheters or infiltration of local anaesthetic may provide useful analgesia. A PCA with an intravenous opioid is a good method of pain relief, but some elderly patients may not use it properly because of arthritis or impaired cognitive function. For both hip and knee surgery, the regular use of paracetamol, other NSAIDs, and weak opioids for moderate or low-intensity pain is recommended for continuing analgesia after the primary analgesic techniques for high-intensity pain have worn off or been discontinued.

7.12 Urinary retention

Urinary bladder catheter may be required in many patients because of the need for immobilization before or after surgery. Prolonged use of an indwelling urinary catheter is associated with an increased risk of urinary retention and infection. Catheters should be removed routinely when patients are able to get out of bed. If urinary retention occurs after removal of the catheter, intermittent catheterization should be used to maintain low bladder volumes and decrease the risk of infection.

7.13 Impaired cognitive function

Delirium is a common problem in elderly hospitalized patients and it occurs to some degree in the vast majority of patients with other dysfunction (see also Chapters 5 and 13). The most important risk factors for delirium are advanced age, dementia, alcohol use, and prehospitalization functional status. Drugs such as opioids, sedative-hypnotics, anticholinergics, and anticonvulsants may predispose to this condition. Fat embolism can be a major cause of delirium and even death in a patient with hip fracture. Other important and frequently encountered causative factors include urinary retention, uncontrolled pain, medications used for pain, and the change in environment from home to hospital.

   If delirium does occur, the patient should be carefully evaluated for an underlying cause. After surgery, the cause is usually multifactorial. The most common contributing yet treatable causes include hypoxia, infection, fluid and electrolyte abnormalities, drug toxicity, and hypotension. Excellent geriatric nursing care with reassurance, reorientation, and provision of adequate pain control is essential. In addition, environmental adjustments should be made to help prevent sleep deprivation.

7.14 Rehabilitation and recovery

Early mobilization and ambulation within 24 hours of surgery is standard practice. Studies have shown that this strategy is safe for most patients and that it is associated with a trend towards earlier discharge. There also may be long-term benefits in functional status. During rehabilitation, a patient's risk of falling should be carefully assessed. Gait training and exercise programmes are effective in reducing the long-term risk of subsequent falls. Most hip fractures in elderly patients occur because of osteoporosis. During the recovery process, treatment for osteoporosis is addressed when appropriate. Medical regimens should be reviewed for use of calcium and vitamin D, bisphosphonates or calcitonin should be considered. Oestrogen therapy should be reserved until after convalescence because of its known thrombogenic potential. A plan for follow-up and re-evaluation should be established before a patient is discharged. If bone densitometry is used to evaluate the response to therapy, an outpatient baseline study should be obtained.

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Anaesthesia for major abdominal surgery in the elderly

KEY POINTS

- Emergency abdominal surgery is the highest risk for mortality in the elderly.
- Assessment of dehydration is imperative.
- Direct (intra-arterial) monitoring of blood pressure is necessary.
- Effective analgesia improves outcome.
- Only experienced anaesthetists should manage emergency abdominal surgical cases.
- Not all abdominal pain is surgically treatable.
- Fluid losses are very common and may be difficult to measure.
- Temperature loss is universal.
- Nitrous oxide causes bowel distension, and it should be avoided.

8.1 Introduction

The elderly population represents a considerable consumer of health care resources. Demographic studies show that the numbers of 'old olds' (75–84 years) and 'oldest' (85+) persons are increasing in our population. This trend is projected to continue with an estimated 3.8% of the population being in the 'old olds' group by 2031. Consequently, an increasing number of elderly patients will present for elective, as well as emergency, surgery. The preparation for elective surgery, which requires an assessment of functional reserve, as well as planning for postoperative care, is necessarily restricted in the emergency setting. Unfortunately, these emergency patients are also the most severely compromised, and they most need careful but rapid resuscitation before surgery. Both the preparation and management of these patients are described for elective surgery, and key areas are highlighted for the emergency cases later in the chapter.

The normal process of ageing results in a number of pathophysiological changes, which influence an individual's responses to anaesthesia and surgery (see Chapter 2). In addition many of these patients may have associated, possibly advanced, comorbidities. These factors need considered before embarking on anaesthesia for major abdominal surgery in elderly patients.

Although basal physiological function may often be well preserved with increasing age, the elderly show a progressive decline in functional reserve, limiting their ability to cope with the stress of anaesthesia and surgery. The pharmacokinetic properties and pharmacodynamic effects of some drugs may be different in the elderly, with changes in volume of distribution, metabolism, and elimination (see Chapter 3).

Consequently, the elderly patient may already be receiving a variety of drug therapies with an increased potential for drug errors and interactions. Compliance is often poor before admission, and several drugs may need to be stopped before surgery, while the continuation of others remains essential. The elderly may have compromised nutritional status. Cognitive impairment and loss of visual and hearing acuity may compromise perioperative management.

A number of factors have been associated with or identified as risk factors for postoperative deterioration in elderly patients, particularly with regard to postoperative delirium and postoperative cognitive dysfunction (see Chapter 14). These include age itself, preoperative dementia and depression, intraoperative blood loss, postoperative anaemia, anticholinergic drug administration, and pain. There are various guidelines published that provide evidence based approaches to preoperative tests. National Institute for Health and Care Excellence guidelines include specific recommendations for patients aged over 80 years.

Whilst 30-day mortality rates for patients of all ages undergoing major surgery may be in the region of 5%, this rate is much higher in the elderly. An accurate assessment of risk for an individual patient is difficult; hence, informed discussion with the patient about the consequences of proceeding to surgery will be incomplete. Although age and American Society of Anesthesiologists classification have been identified as predictors of mortality in several scoring systems, there are limitations to many of these. POSSUM (Physiological and Operative Severity Score for Enumeration of Mortality and Morbidity) is well validated, but it is designed to compare risk on a population basis rather than an individual patient basis. The disease specific model for colorectal surgery (CR-POSSUM) and the model developed by the Association of Coloproctology of Great Britain and Ireland generally outperform generic models in estimating operative mortality. Quality of life and the length of time that it will take for the patient to resume their normal daily activities should be discussed. It is helpful to have a patient's relatives present at the time of preoperative assessment because deafness and cognitive impairment may severely restrict the ability of the patient to understand the consequences.

8.2 Elective abdominal surgery

8.2.1 Surgical preparation

Many surgical procedures involve the colon and rectum, and often these procedures are preceded by vigorous bowel preparation. This usually involves the

Table 8.1 Severity and signs of dehydration			
Severity	Body-weight loss (%)	Estimated volume loss (L)	Clinical signs
Mild	4	3	Thirst (unreliable in the elderly); dry mucous membranes Capillary refill time >2 seconds Skin turgor reduced (unreliable in the elderly)
Moderate	5–8	4–6	All of the above + tachycardia Oliguria (<0.5 ml kg^{-1} h^{-1}) Postural hypotension
Severe	8-10	7+	All of the above + Hypotension Imminent cardiovascular collapse

administration of potent laxatives and enemata to clear as much faecal matter as possible. Unfortunately, they also cause marked water loss. This is frequently severe enough to lead to dehydration (Table 8.1) that necessitates treatment before surgery. The patient should be weighed before bowel preparation and regularly before surgery. All weight loss can be assumed fluid loss and should be replaced, volume by volume, with a physiological saline solution. In recent years, the value of preoperative bowel preparation has been questioned, and most centres do not practise this protocol.

8.2.2 Premedication

Many elderly patients are very anxious and frightened in a strange environment. They may have a short-term memory loss and, despite explanations, many are completely unaware of what is going to happen to them. It used to be good practice to prescribe benzodiazepines to allay this anxiety, but the duration of action of benzodiazepines can be very prolonged in the elderly. This is less pronounced with temazepam than with diazepam, but because of these concerns, premedication is generally avoided.

8.2.3 Monitoring

Standard patient monitoring should be instituted upon entering the anaesthetic room. Unless there are contraindications, invasive monitoring should be instituted before induction. The beat-to-beat real-time information obtained from invasive monitoring of arterial blood pressure may be beneficial in high-risk patients. Atrial fibrillation, common in the elderly, may render automated noninvasive blood pressure monitoring inaccurate, and it is prone to delay because of the beat-to-beat variation in pulse pressure. Arterial access also allows near patient testing of

haemoglobin concentration and acid–base status. Central venous pressure monitoring is mostly accessed via the internal jugular vein, while the use of a long-line sited in the antecubital fossa is an alternative less-invasive approach. Monitoring of neuromuscular function and temperature are equally important.

8.2.4 Choice of intravenous induction agent

There is little evidence that any one anaesthetic technique offers specific advantages over an alternative. The majority of major abdominal surgery will require a general anaesthetic technique because of the requirements for adequate surgical access, major surgery can be prolonged, and there are specific requirements for planned major laparoscopic surgery. Most operations can be performed within 2–3 hours but some such as abdominoperineal resection may take more than 4 hours. Laparoscopic surgery may take longer still. A standard general anaesthetic technique for major abdominal surgery consists of endotracheal intubation facilitated by appropriate muscle relaxants and intermittent positive pressure ventilation. The use of pressure-controlled modes of ventilation may have benefits in terms of reduction in volutrauma and positive end-expiratory pressure (PEEP) (e.g. 5cm H_2O) may be beneficial in reducing basal atelectasis. A regional technique might be feasible in very high-risk patients, but it may be difficult for patients to tolerate regional anaesthesia for such long durations and in awkward positions.

The initial distribution of a drug is often impaired in the elderly. Protein binding is less efficient. Induction agents should be administered more slowly, and with longer pauses between bolus doses than in the younger patient because prolongation of arm–brain circulation time increases the time taken for the patient to lose consciousness. Reduced protein binding coupled with a contracted blood volume lead to a higher free drug concentration. An overdose may easily occur, which will lead to inadvertent marked cardiorespiratory side effects. The haemodynamic consequences of propofol induction are enhanced and delayed in the elderly, and the dose should be carefully titrated to effect. Etomidate may have advantages because of its improved cardiovascular stability, particularly in patients in whom there is considerable cardiac compromise, but there are concerns about adrenal suppression following administration of even a single dose. The incidence of side effects is similar with propofol and thiopentone. The use of short-acting opioids, such as fentanyl or alfentanil, reduces the dose of induction agent required and attenuates the stress response to laryngoscopy.

8.2.5 Choice of inhalational anaesthetic agents

The minimum alveolar concentration of all inhalational anaesthetic agents is reduced by 20%–40% from young-adult values. Desflurane may allow earlier extubation, particularly after prolonged surgery; however, the earlier recovery characteristics, compared with those of other agents, are short-lived. Sevoflurane has been used extensively in the elderly because it is relatively nonirritating for both induction and maintenance of anaesthesia, and it appears to be an attractive option because of relatively fewer cardiovascular side effects. Gas induction

is likely to be slower in the elderly because of ventilation/perfusion mismatch, which can be exacerbated by elderly supine patients having their closing capacity within tidal breathing. An air–oxygen mixture is preferred as a carrier gas, rather than nitrous oxide (to avoid bowel distension and increased incidence of nausea and vomiting).

8.2.6 Choice of analgesic agents

Opioid pharmacokinetics is hardly affected by age, but the central nervous system sensitivity to these drugs is markedly increased in the elderly. The dose of opioids should be reduced in the elderly. However, there are marked inter-individual variations. Remifentanil appears to be a better drug because of its titrability and absence of lingering effect; however, the dose must be titrated carefully. Haemodynamic depression is known to occur with excessive doses. Thoracic epidural anaesthesia used to be combined often with general anaesthesia to provide intraoperative analgesia, but its routine use is now questioned.

8.2.7 Choice of neuromuscular blocking agents

Ageing is associated with a reduction in muscle mass, which may be expected to lower the dose requirement of neuromuscular blocking drugs. However, the potency of neuromuscular blocking drugs is similar in all adult populations owing to the development of extra-junctional cholinergic receptors in the elderly. Depolarizing muscle relaxants are generally avoided in elective patients unless their use is warranted (prevention of acid aspiration). Vecuronium and rocuronium demonstrate a slower onset and longer duration of action than in younger patients when compared with atracurium and cisatracurium. Atracurium is the preferred drug because its duration of action is very similar to that in younger patients. Hoffman degradation and spontaneous ester hydrolysis compensates for the reduction in hepatic clearance. Dose requirements of neuromuscular blocking agent for maintenance are reduced by concurrent use of other anaesthetic agents used during anaesthesia. Reversal of neuromuscular blockade with anti-cholinesterase drugs tends to be similar to that in younger adults, with smaller increase in heart rate from the accompanying anticholinergic. Monitoring of neuromuscular functions is highly desirable.

8.2.8 Airway maintenance

Intubation and controlled ventilation are the preferred choices during major abdominal surgery. Muscle relaxation is required to secure the airway, although care needs to be taken in securing the endotracheal tube, as adhesive tape may damage frail skin in the elderly. Intubation is sometimes difficult in patients with arthritis who have reduced neck mobility, but, generally, these patients are edentulous. The obtunded protective airway reflexes, reduction in gastric emptying, and reduced gastro-oesophageal sphincter tone all make reflux of gastric contents and subsequent aspiration more likely in the elderly. The use of narrower endotracheal tubes reduces the incidence of sore throat in the postoperative

period. Normal levels of oxygenation and normocapnia should be maintained. Ventilation pressures should be kept as low as possible. The addition of slight PEEP may be required to maintain haemoglobin saturation.

8.2.9 Intravenous fluid administration

Patients undergoing major abdominal surgery require careful attention to fluid management. The aim of perioperative fluid management is to maintain hydration, electrolyte homeostasis, haemodynamic stability, organ perfusion, and function. Urinary losses, as well as third-space loss, fluid sequestration into the gut, and loss from high-output stoma sites all need to be considered in terms of fluid and electrolyte therapy. Loss of potassium, chloride, magnesium, and phosphate together with malabsorption may all be issues in the perioperative and postoperative periods. Large-bore intravenous access will be required, unless for minor surgery, but securing intravenous cannulas may be difficult because of skin fragility. Care needs to be taken if fluids are administered under pressure because fragile vessel walls may rupture, leading to extravasations of fluids. Preoperative fluid depletion was a common occurrence owing to prolonged starvation periods and the use of purgative bowel preparation, but with recent adoption of enhanced recovery programmes, purgative bowel preparation is now used less, and patients are actively given oral fluids as part of preoperative carbohydrate loading. Fluid replacement is traditionally guided by central venous pressure monitoring if extensive fluid loss is anticipated. More recently, a goal-directed fluid therapy using an oesophageal Doppler is shown to be associated with less administration of volumes during surgery, leading to quicker recovery of bowel function and shorter postoperative stay. Hypovolaemia remains a major contributor to hypotension during the perioperative and postoperative periods. The elderly are less able to compensate for hypovolaemia because of the effects of ageing on cardiovascular and renal systems.

A urinary catheter should be used throughout the perioperative period, although the presence of a urine output may only indicate an adequate rather than optimum fluid balance. Central venous pressure monitoring may be beneficial in the elderly, but it may not be a reliable guide to fluid status. A worsening base deficit from arterial blood gas analysis may imply that organ perfusion is compromised because of hypovolaemia. Patient positioning may have an effect on the adequacy of fluid replacement. The increase in venous return seen when the patient is placed in the head-down position may falsely elevate central venous and arterial blood pressures, resulting in reduced fluid replacement unless these postural changes are taken into consideration. The use of oesophageal Doppler as a less-invasive way of monitoring cardiac output to direct fluid replacement has received attention, and it appears to offer benefits over conventional invasive monitoring.

Blood loss may vary with the type of surgery. Blood loss is often insidious with little measured blood loss in suction containers. Swabs should be weighed throughout surgery in order to obtain accurate estimates of blood loss. Blood

replacement is better instituted using transfusion triggers based on near patient testing of haemoglobin or haematocrit. Although a haemoglobin concentration of 7–8 g dL^{-1} may be well tolerated in the younger population, this may be less acceptable in the elderly owing to the presence of cardiac disease and reduced cardiac reserve. Blood transfusion should always be considered if there is excessive blood loss.

8.2.10 Temperature maintenance

Maintenance of body temperature is essential during the perioperative period, and it should start when the patient enters the theatre environment. Hypothermia is more common in the elderly, and these patients are less able to conserve body temperature because of the effects of ageing. Although they have reduced muscle bulk that reduces the oxygen demand created by shivering, this may still impose a requirement that exceeds respiratory and cardiac reserve, although the effects may not be as great as once thought. Elderly patients also lack the metabolic and muscular reserve to restore their body temperature back to normal levels. There is a tendency for body temperature to fall during anaesthesia (poikilothermia) caused by vasodilation and a distribution of blood away from the core, lack of thermoregulatory control, and loss of heat to the environment. Hypothermia is associated with an increase in wound infection, delayed removal of sutures, and prolonged hospital stay.

Patients will frequently be hypothermic by the time they enter the theatre from the anaesthetic room, particularly if the anaesthetic time is prolonged from establishing an epidural and inserting invasive monitoring. Further evaporative heat losses occur from the exposed surgical site, and it may be difficult to restore normothermia unless all available measures are used. Passive measures such as reflective drapes and warmed intravenous fluids can only help prevent heat loss. The use of epidural anaesthesia during the perioperative period means that heat loss from the lower extremities is increased because of sympathetically mediated vasodilatation. In order to restore a hypothermic patient to normothermia, forced warm air systems and warming mattresses are more useful, particularly if placed on the lower extremities. However patient positioning, particularly the Lloyd–Davis position, can make it difficult to use all of these methods. Core temperature monitoring is easily achieved with nasopharyngeal temperature probes. The core temperature should be within normal limits before the patient leaves the recovery area.

8.2.11 Positioning

Positioning may pose a challenge owing to the reduced joint mobility from arthritic changes or previous prosthetic joint replacement. Vertebrobasilar insufficiency should be assessed because prolonged neck extension in the prone position may lead to arterial occlusion. Care should be taken to ensure that pressure areas are well padded to avoid nerve injury and pressure sores. The latter may be debilitating and entail a hospital stay longer than that for the original surgery. Appropriate

mattresses should be used to prevent pressure sores should the hospital stay be longer than anticipated.

8.2.12 Postoperative pain control

A midline incision is common during major abdominal surgery, and this is associated with significant pain because the incision crosses several dermatomes. More surgery is now being performed with transverse or muscle splitting incisions to reduce the impact of a midline incision on respiratory function, as well as for the reduction in pain.

Pain is more than unpleasant: it also contributes to potential morbidity and mortality. Pain can affect every organ system, and this includes impaired respiratory function as deep breathing exacerbates the pain; patients therefore avoid this and fail to expand their lung bases. This effect is believed to lead to the retention of respiratory tract secretions and an increase in the incidence of pneumonia and respiratory failure. Haemodynamic changes can occur as the pain results in an enhanced stress response, tachycardia, and hypertension. Patients undergoing abdominal surgery will require significant levels of perioperative and postoperative analgesia.

Options for perioperative analgesia include morphine, remifentanil infusion, or epidural analgesia. Postoperative pain control is most easily achieved with patient-controlled epidural analgesia (PCEA) or patient-controlled analgesia (PCA) using morphine. However, the presence of confusion and cognitive dysfunction may make assessment of pain and treatment with PCEA/PCA techniques problematic.

The evidence supporting that epidural analgesia is associated with improved outcomes is now questioned, but reduced respiratory complications and thrombotic complications have been demonstrated. Epidural analgesia may offer better quality postoperative analgesia than other regimens do; however, there is little evidence from trials carried out exclusively in the elderly. Epidural analgesia may be associated with a significant failure rate unless intensive and active follow-up is implemented. The epidural should ideally be inserted in the awake patient. The catheter should be sited at the appropriate level for surgery, while minimizing the risk of spinal cord damage. For abdominal surgery, the catheter is most appropriately placed at lower thoracic spaces (T8–T11). The use of low-dose local anaesthetic combined with low-dose opioid is common. The use of higher strength solutions of local anaesthetic agents, such as 0.5% bupivacaine, is more likely associated with motor weakness and a greater drop in blood pressure, depending on the degree of sympathetic blockade produced. Patients are usually more awake and mobile, and they suffer less nausea and vomiting compared with those in which intravenous opiate is used. It is essential that the patient be nursed in an area where the staff are familiar with epidurals and their complications and have the time and expertise to look after the patient.

Alternatively, intravenous morphine is administered through a PCA machine using a bolus regimen with a set lockout interval. Analgesia is first achieved with an intermittent titrated loading dose of morphine, and then a PCA machine is

attached. However, the use of a background infusion should be avoided because it is associated with an increased incidence of hypoxia and respiratory depression. Other side effects include nausea, vomiting, dreams, hallucinations, and temporary impairment of cognitive function.

Transversus Abdominis Plane block or a directly placed rectus sheath catheter or wound filtration is increasingly used to provide postoperative analgesia, and it may reduce postoperative analgesic requirements.

Non-steroidal anti-inflammatory drugs are useful adjuncts to both PCEA and PCA. However, the benefits need to be balanced against the risk of renal complications caused by using these drugs in patients with pre-existing age-related renal dysfunction, impaired fluid handling, and the potential for postoperative hypovolaemia. The choice of analgesic technique should weigh all risks and benefits, including patient preference.

8.2.13 Postoperative oxygen administration

Oxygen is administered to prevent postoperative hypoxaemia and myocardial ischaemia. High concentrations of oxygen have been associated with a decreased incidence of wound infection and postoperative nausea and vomiting; therefore, it seems appropriate to use a high level of oxygen in the intraoperative and recovery phases.

8.2.14 Postoperative care

Elderly patients should receive postoperative care in an environment that is appropriate to the degree of comorbidity and type of surgery. They are more likely to require high-dependency or intensive care facilities after surgery. A high patient/nurse ratio allows closer attention to oxygenation, fluid balance, acid–base status, and analgesia, and recognition of postoperative complications may be noted sooner. It is known that patients electively admitted to a critical care environment following high-risk surgery show an improved outcome compared with patients who require subsequent admission from a ward because of deterioration in their condition. Moreover, recent guidelines from the Royal College of Surgeons of England suggest that patients with a predicted mortality of greater than 10% should be electively admitted to a critical care environment.

Chest physiotherapy and incentive spirometry may also be appropriate. Early mobilization should be encouraged. The patient should receive continuous humidified oxygen, particularly while epidural or PCA opiates are being used. Epidural analgesia is usually continued for 3–5 days, supplemented by simple oral analgesics such as paracetamol.

Elderly patients presenting for abdominal surgery present a significant challenge. This group of patients undergoing intra-abdominal surgery is considered to be in one of the highest risk groups for cardiac complications. They should be managed by health care professionals who are aware of the needs of the elderly and appropriately tailor the anaesthetic and surgery accordingly.

8.3 Laparoscopic surgery in the elderly

Minimally invasive laparoscopic surgery is increasingly used for adults, including elderly patients, with perceived benefits of shorter recovery, shorter length of stay, improved morbidity, and early mortality.

8.4 Anaesthesia for emergency abdominal surgery

Emergency abdominal surgery is the most common life-threatening surgical presentation in the elderly. It carries high mortality and morbidity and, hence, should only be managed by experienced anaesthetists and surgeons. All the considerations discussed in the chapter are necessary, but the time to assess, resuscitate, and present to theatre is short, and when urgent will occur concurrently. A critical review of the non-surgical causes of acute abdominal pain, inferior myocardial infarction, pancreatitis, ketoacidosis, or porphyria, for instance, should be performed.

Emergency surgery is often carried out for obstruction, gastrointestinal bleeding, or peritonitis. The diagnosis may not be known, and the duration of surgery may be unduly prolonged. Pain relief should be started before surgery, as should fluid replacement therapy. Abdominal distension from the ileus should be treated with aspiration through a nasogastric tube, and this should be left on free drainage throughout.

A rapid sequence induction is indicated. Although basic principles and practice of anaesthesia are essentially similar to elective procedures, one has to be prepared for all potential complications, including vomiting and regurgitation, hypovolaemia, haemorrhage, cardiovascular disturbances, abnormal reaction to drugs in the presence of electrolytes disturbances, and probably renal impairment (see Chapter 4). Complete cardiovascular and other monitoring may be required.

Provision of postoperative pain relief and postoperative care are especially important because there are usually percutaneous drains *in situ*, and these increase the pain, especially on movement. Pain assessment in the elderly is poor, and it requires a dedicated carer to assess pain regularly and ensure that effective analgesia is both prescribed and administered. These patients usually receive an intravenous opiate through a PCA machine because there may not be time for epidural anaesthesia, and in certain cases, epidural anaesthesia may not be appropriate.

The impact of an acute surgical procedure for an abdominal emergency will challenge the organ function of renal, hepatic, and immunological systems. Postoperative complications should be expected in all organ systems, and these patients are likely to require nursing and medical care in a critical care bed area to receive the necessary attention of experienced clinicians.

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Neurosurgery in the elderly

KEY POINTS

- Neurosurgical procedures are performed commonly in the elderly.
- Palliative procedures are more common in the elderly.
- Degenerative conditions are more likely to present for surgical treatment in the elderly.
- Surgery for haematoma evacuation in stroke patients is becoming routine.
- Spinal cord blood supply is often compromised.
- There are no fast neurosurgical operations.
- Temperature loss can be significant.
- Positioning may be difficult.
- Pressure sores, deep vein thrombosis, and nerve damage are more likely to occur.
- Remifentanil and desflurane are particularly valuable in the elderly neurosurgical patient.

9.1 Introduction

Until the later years of the twentieth century, the belief remained that neurosurgical procedures on the elderly were associated with poor outcomes. The development of surgical techniques and anaesthesia has mitigated this position, and many more procedures are now performed on these patients.

These operations largely fall into two groups:

1. Operations that are now being performed in older groups, although they have been available to younger patients for some time.
2. New operations that have an age-related bias.

The former range from surgery for intracranial tumours to spinal procedures to relieve cord compression, whereas the latter include aggressive surgery for pain relief and palliation following malignant vertebral collapse or evacuation of an intracerebral haematoma in stroke patients. These procedures can be further divided into those that are related to the axial skeleton/craniocervical junction and intracranial procedures.

9.2 **Anaesthetic considerations**

Most neurosurgical procedures are relatively urgent. This may be immediate if there is a grossly raised intracranial pressure or sudden onset of cord compression. Most can be managed within a week of presentation, and some are truly elective. Prior activity levels and cognitive function are essential elements in the preanaesthetic screening because they will often determine outcome and, therefore, the choice of operation and anaesthetic technique.

Most neurosurgical operations take at least an hour, and many last 4–7 hours. It is common for reconstructive surgery to take more than 10 hours. Surgeries of this duration pose problems in young fit patients that may be insurmountable for the elderly. It is rare that complete recovery occurs after neurosurgery, unless the operation involves 'silent' areas of the brain.

Concurrent drug therapy has to be reviewed, and decisions about continuing the medication for the perioperative period have to be made. Most drugs do not have a severe withdrawal effect, but alcohol and nicotine do. Many patients are started on steroids to reduce tumour size, and these can precipitate a diabetic state, especially in the elderly.

There are several aspects of anaesthesia that are important and worth re-emphasising.

For patients, many emergency operations pose risk to either the brain or the spinal cord function from a reduced perfusion pressure. This may be due to increased fluid (oedema), neuronal damage, hypotension, or hypoxia, for example. There are several strategies to try to manage this, but they differ between the brain and spinal cord.

Hyperventilation is the most common technique used to try to lower acutely intracranial pressure and improve cerebral perfusion pressure. The relationship between arterial carbon dioxide concentrations and cerebral vasoconstriction is maintained with age, but the elderly brain tolerates falls in metabolic substrate delivery poorly. The mean blood flow to the brain falls with advancing age, but this probably reflects the cellular neuronal loss that also occurs (Fig. 9.1).

There are few data on the effect of hyperventilation on the management of cord ischaemia secondary to increased spinal canal pressure, although increasing ventilation to reduce arterial carbon dioxide concentrations will increase the mean intrathoracic pressure and potentially indirectly increase the transmitted pressure into the thoracic spinal canal. A reduction in inferior vena cava return, as well as epidural diversion of venous return, is another possible unintended consequence of hyperventilation.

Temperature control in the elderly is more fragile than in younger patients. This is partly due to a fall in metabolic rate and their ability to shiver, but a proportion of elderly patients have disordered central thermostatic control. They are more prone to hypothermia in all environments, including operation theatres and wards. The evidence on wound-infection rates and sepsis related to mild
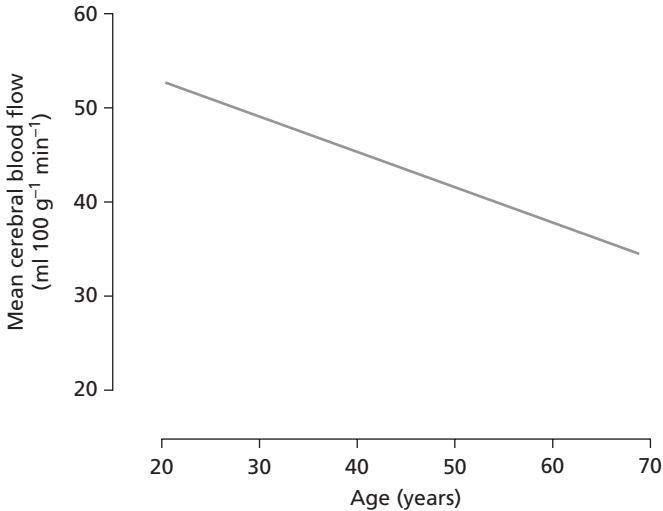
Fig. 9.1 The relationship of human mean cerebral blood flow to age

hypothermia suggest that aggressive prevention is necessary from arrival in the theatre complex to discharge to the postoperative ward.

Availability of anaesthetic agents has changed over recent years, and two of them in particular have made care of the elderly more precise. These are remifentanil and desflurane.

Remifentanil is used because its plasma esterase elimination has similar properties across the range of ages. Its rapid onset and offset that is largely time independent allows profound perioperative pain relief and respiratory drive suppression with a smooth and swift return to normal. This allows active management of recovery from anaesthesia and controlled return of consciousness without coughing on the endotracheal tube, which is invaluable after surgery for intracranial haemorrhage or clot removal.

Desflurane is highly lipid insoluble, more so than sevoflurane, and this is advantageous in the elderly because they have a greater proportion of their body mass as fat than do younger patients of the same body mass index. Recovery profiles are little affected by age and duration of administration. When combined with remifentanil, recovery can be managed, and there is a choice between awake but non-coughing recovery and full return of effective ventilation before arousal.

Intramuscular administration should be avoided in the elderly because they are no longer 'vessel-rich' as are younger patients, and, therefore, plasma drug concentrations are very unpredictable. Equally, they predispose to pressure sore development and contractures because of the delayed absorption of high concentrations of the drug from the muscle bodies. For these reasons, intravenous or oral opiates and non-steroidal anti-inflammatory drugs are preferred.

9.3 Spinal surgery

Increasingly, degenerative diseases affecting the vertebral column such as severe rheumatoid arthrosis, osteoporosis, or osteoarthrosis are being treated by instrumental decompression and fixation irrespective of the age of the patient. This is because their results in terms of retained function nearly match those of younger patients.

The key determinants of successful outcome depend on the careful assessment of pre-existing function and the impact that any myelopathy has on daily activities. It is unusual for these to improve following surgery because the primary aim is to prevent further deterioration. Assessment of pulmonary function is arguably the most important factor in recovery.

However, there are specific problems related to the changes in vascular structure and neuronal function with advancing age. The blood supply to the spinal cord is by one anterior and two pairs of posterior arteries that descend through the foramen magnum and course to the lower end of the cord. But, below the 'watershed' at T4/5, perfusion is more dependent on fine feeding arteries from the descending aorta, and these become more tortuous and rigid with increasing age. Kinking of these vessels during operative positioning or surgical traction can lead to unexpected cord ischaemia during apparently routine operations. The spinal perfusion pressure is analogous to the cerebral perfusion pressure, and it is largely determined by the pressure within the spinal canal and the mean arterial pressure. Hypotensive episodes are predictably harmful if there is a raised pressure within the spinal canal, for instance from a tumour or vertebral collapse.

In general, neurosurgical procedures take a long time, and this time increases if there is a need for instrumentation and fixation following cord decompression. Elderly soft tissues are more friable and less supportive than the soft tissues of younger patients, and elderly patients have more changes that are osteophytic in their spinal column. This can make surgical positioning and access difficult. Pressure sores are a high risk, and all precautions must be used to try to prevent this life-threatening complication.

9.3.1 Specific operations

9.3.1.1 *Cervical and lumbar discectomy*

Decompression procedures usually involve removal of disc material as in younger patients. This may be an urgent procedure if the cord is acutely compressed, or

more usually, an elective one, where segmental neuronal symptoms are present. The differences lie in the ability to position an elderly spine, especially if a frame is necessary for support in the prone position. The elderly are more likely to become hypotensive on lying prone, and the increased intraocular pressure in this position increases the risk of retinal and corneal damage.

In common with all patient transfers in the elderly, rolling and sliding may cause intense pain in the manipulated joints, which can be more severe than the pain at the site of incision.

The anterior approach to the cervical cord may be difficult because of the limited movements of the cervical spine with increasing age. Ligaments are less robust, and osteophytes may obscure the normal bony landmarks. Rigid vessels will bleed more once damaged, and it is more difficult to achieve haemostasis. The risk of slipping off the bone into the cervical cord when drilling off these hard osteophytes is present.

Pain is seldom a problem, but postoperative vigilance is necessary where the operative level is above the larynx because of the risk of postoperative oedema or bleeding. A drain is mandatory.

Odontoid decompression is warranted in patients with severe rheumatoid disease where there is a progressive laxity of the longitudinal ligaments. This leads to brain stem, medulla, or cord compression by the odontoid, and there are symptoms of a high cord lesion. The progressive myelopathy that affects the lower and then upper limbs, leads to great dependency before restricting pulmonary function and ultimately respiratory failure.

The route of surgical access is usually trans-oral, with an incision through the soft palate and the lower nasopharynx. Retraction may lead to glossal oedema, and tissue handling increases the risk of upper-airway oedema after surgery. Securing the airway orally is normal; however, some surgeons prefer a nasal endotracheal tube and a large bore nasogastric tube (which they use to support their retractors). The nasogastric tube has to remain *in situ* for several postoperative days until swallowing is back to normal. Endoscopic techniques are currently being trialled and they avoid most of the complications discussed herein, but long-term outcome data on large numbers of patients are lacking at present.

Although the procedure is prolonged and usually uneventful, manipulation of the odontoid can directly compress the brain stem, with results that range from asystolic vascular collapse to severe tachycardic hypertension. Drilling through the rheumatoid pannus may expose aberrantly positioned vertebral arteries at the second cervical vertebral level.

Spinal instrumental fusion is increasingly used in primary decompression of the disc spaces because of the superior stability that is achieved and the prolonged benefit to the patient. This is also true of patients that are more elderly, but these are long operations. Blood loss may be greater, and a low threshold for replacement transfusion is necessary. Vertebrectomy is an option where there is collapse of a single vertebral body. This is often secondary to metastatic spread of tumour, and the aim of surgery is to prevent further loss of neuromuscular control and

to prevent or alleviate the associated pain. The vertebral body is exposed and removed, often with major blood loss, and a cage is implanted between the adjoining bodies to provide mechanical stability. Bone graft material is used to provide initial stability while healing and fibrosis take place.

Osteoporotic vertebral collapse causes immobility because of severe pain and muscle spasm. This may last several weeks, and it can be dramatically improved by vertebroplasty. This usually involves image-guided placement of a large (epidural) 16 g cannula into the vertebral body and then injecting acrylic cement to fix the body. This procedure is almost immediately effective, but there have been reports of cardiovascular collapse similar to that seen with cemented hip prosthesis insertion.

9.4 Intracranial surgery

Acute/chronic subdural haematoma is a common finding in elderly patients who have had a fall and then become delirious. The decision on whether to evacuate the haematoma in such frail patients is not clear-cut. The growing use of hollow screws placed under local anaesthesia appears valuable in the vulnerable group. The preinjury status of the patient is a vital part of the decision-making process. If they were in a fully dependent environment with disordered cognitive function, little improvement is likely, whereas if they had been independent and very socially active, some optimism would be justified. Re-bleeding is common, and sudden changes in their level of consciousness should alert the team that this may have occurred. Rapid rescanning and possibly further drainage must be considered.

9.4.1 Tumours

Intracranial tumours are commonly metastatic in the elderly, although all other common primary lesions can occur. Presentation may differ in that the progressive loss of brain substance with ageing will limit early signs of a raised intracranial pressure. As the brain is an immunologically isolated site, occasionally a secondary metastasis is found without an identifiable primary. The prognosis in these patients is usually very good.

Unfortunately, the elderly brain tolerates retraction and hypotension poorly. Hyperventilation is rarely needed and is best used for only very short periods when pressure reduction is imperative. As with spinal surgery, positioning can pose problems for the elderly patient, especially if posterior fossa surgery is planned. The sitting position is rarely used in the elderly because of the difficulty in maintaining cardiovascular stability.

There is an increased drive to assess rapidly and treat patients who present with stroke. Many of these, up to 80%, are occlusive events, and, after rapid clinical evaluation and MRI investigations with contrast to identify areas with critical perfusion, thrombolytic therapy is started. For those patients who have a haemorrhage with a volume estimated as greater than 30ml, surgery is likely to

be considered. The reduction in clot size improves the vasospasm commonly present and improves outcome in a similar manner to thrombolysis. This aggressive surgery has become routine in most neurosurgical units.

Endocrine disease increases in prevalence with ageing, and this is reflected in the number of patients who have a pituitary adenoma. These are usually removed transnasally. The use of potent vasoconstrictors may be problematic in the elderly because of the potential rise in blood pressure that can accompany their use.

Neurosurgical management of other medical conditions has resurged with the advent of stereotactic guidance systems that allow very accurate positioning of probes within the brain. This has been used to treat the tremor associated with Parkinson disease and for intractable epilepsy for some time. These procedures usually require a 'wake-up' during the anaesthesia to confirm the correct placement of the probe. The speed and completeness of arousal is reduced in the elderly, and greater skills and judgement are required to achieve this. Alternatives, such as using gamma sources have also been used with success.

The implantation of stem cells to try to regenerate failed neurological systems have met with little success, largely because the original use of mesodermal stem cells in ectodermal cell lines was ill-considered. Recent work using ectodermal cell lines has been more promising.

Trigeminal neuralgia is a severely painful condition that may become unresponsive to medication. Lesioning the trigeminal nerve can stop this painful process, and such is the intensity of the pain that most patients will accept a major posterior fossa exploration to gain the benefit. Positioning to allow surgical access to the trigeminal fossa can be difficult, especially in the elderly.

9.5 Summary

The elderly are more likely to undergo neurosurgery than in the past, and many of these procedures are specifically for conditions closely related to ageing. Their responses to anaesthesia and the 'routine' intraoperative techniques such as hypoventilation do differ considerably, and great care is needed in their use. Positioning and padding once positioned are more important in the elderly than in younger patients because their risk of tissue damage, nerve or skin, is that much greater.

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Urological and gynaecological surgery in the elderly

KEY POINTS

- The most common urological and gynaecological procedures performed in very old patients are usually endoscopic or perineal.
- Urinary tract endoscopy and surgery should be performed in patients with sterile urine.
- Simple measures may prevent most of the transurethral resection of the prostate (TURP) syndrome cases.
- Endoscopic urological surgery in patients on chronic anti-platelet treatment may lead to life-threatening haemorrhage, but interruption of the anti-platelet drug(s) must be kept to a minimum.
- Modern general anaesthetic techniques may challenge the dominant position of spinal anaesthesia.

10.1 Common urological surgery

Apart from major carcinological procedures, which have no specificities in the elderly, the most common urological and gynaecological procedures performed in old or even very old patients are mainly endoscopic or perineal procedures: TURP or of bladder tumours; de-obstruction of the urinary tract, including placement or change of ureteral prosthesis; cure of phimosis; endoscopic uretrotomies; bladder neck incision; subalbugineous orchiectomy (pulpectomy); prostatic biopsies; treatment of urinary incontinence in women (transobturator or transvaginal tapes; various surgical cures of cystocele, rectocele or urogenital prolapse; LeFort colpocleisis; vaginal hysterectomies); and in men (artificial urinary sphincter placement); as well as peritoneal dialysis catheter placement in end-stage renal failure patients.

For most of these procedures, the choice between general and regional (mainly spinal) anaesthesia must be discussed, considering the specific medical condition of the patient and his/her wishes.

Infection of the urinary tract is always a threat, specifically in obstructive diseases and in patients with permanent bladder catheters.

Transurethral resection of the prostate conveys risks of not only specific 'TURP syndrome' but also haemorrhage (a risk also associated to transurethral resection of bladder tumours and to supra- or retropubic adenomectomy). Very often in

the elderly on anticoagulants or anti-platelet treatment, a delicate balance has to be found between the importance of these treatments and the necessity to limit the haemorrhagic consequences of surgery.

Placement of peritoneal dialysis catheters often brings on the challenge of anaesthetizing very old, frail patients with end-stage renal failure.

10.2 TURP surgery

TURP is a very common surgical procedure, representing more than a third of all urological surgery. It is performed by introducing in the bladder a urethroscope and resecting prostatic tissue with an electrically powered metal loop, which coagulates during resecting. The procedure usually lasts around 1 hour, and it is performed in the lithotomy position. The prostate is an organ rich in blood supply, and it usually harbours a significant amount of bacteria that are difficult to eradicate because the penetration of most antibiotics in this tissue is poor. TURP is usually to alleviate the obstruction created by a prostatic adenoma, but in the elderly, the obstruction may also be due to advanced prostatic cancer.

The long-term mortality after TURP has been estimated around 15%–20% in several studies. Nevertheless when compared with a cohort of matched non-operated individuals, the mortality risk was not increased by TURP.[1] Therefore, the outcome depends mainly on comorbidities. Nevertheless, some complications may occur, and steps should be taken to reduce their incidence and severity.

10.2.1 Infection

Bacteraemia are very frequent during urinary tract surgery, and it is mandatory not to operate on non-sterile urine. Nevertheless, when bacteria are present at the preoperative urine analysis, the current tendency is to shorten (down to 12 hours) the duration of preoperative antibiotic treatment in an asymptomatic patient devoid of a preoperative indwelling catheter, provided the choice of the antibiotic is based on an antibiogram. Even if the urine is sterile, it is the rule to administer a single dose of prophylactic antibiotic intravenously on arrival in the operation room, which may be repeated every 2 hours while surgery is ongoing. The nature of the antibiotic depends on the ecology of the hospital, but second-generation cephalosporins (e.g. cefamandole) are the most common choice.

In the presence of a chronic indwelling catheter, the risk of urine colonization is very high, and it is difficult to get rid of the contamination as long as the catheter is present. Before surgery, patients with chronic indwelling catheters should receive an antibiotic treatment adapted to the bacteria found in the urine, not so

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[1] See Cattolica EV1, Sidney S, Sadler MC. The safety of transurethral prostatectomy: a cohort study of mortality in 9,416 men. J Urol. 1997 Jul;158(1):102–4.

much to eradicate the infection but rather to render the blood 'hostile' to those bacteria and, thereby, prevent bacteraemia and further infectious consequences.

10.2.2 TURP syndrome

The TURP syndrome is a clinical and biological entity that results from excessive absorption of irrigation solution, usually glycine 1.5%. Intraoperative irrigation solutions used are purposely moderately hypotonic to improve visualization of the surgical site, and they must not have any electrical conductivity because the technique is based on electrocautery. Consequently, when a significant amount enters the blood stream, fluid overload and hyponatraemia occur. The symptoms are those of hypervolaemia associated with water intoxication. As soon as the diagnosis is suspected, urgent treatment should be initiated: interruption of surgery as early as possible (haemostasis!), replacement of glycine by saline in the irrigation solution, and administration of diuretics to alleviate fluid overload: in serious cases, catecholamines may be required to sustain the heart. Plasma sodium concentration should be repeatedly checked. If it remains over 120 µmol L^{-1}, restricting water input and diuretics are usually enough. In case of severe hyponatraemia, that is when plasma sodium concentration is less than 120 µmol L^{-1}, careful infusion of hypertonic saline may be required, keeping in mind that some authors consider that a too-rapid correction may lead to neurological complications (central demyelination). Glycine by itself has toxic effects, mainly on the heart and retina. Nevertheless, glycine toxicity is uncommon among TURP patients.

Specifically in frail elderly patients, TURP syndrome is dangerous, and it should be prevented. The French Health Authorities (1998) have noted the following guidelines for the prevention of TURP syndrome:

- Surgery should not last more than 60 minutes.
- Limit hydrostatic pressure in the bladder by allowing no more than a 2-ft difference in height between the bladder and the irrigation pouch.
- Use double stream optic resectors to permit a continuous drainage of the bladder content.
- Limit the extent of the resection (the amount of reabsorbed fluid is proportional to the amount of resected tissue; see Box 10.1).

Box 10.1 Prevention of TURP complications in the elderly

- Do not operate on non-sterile urines; use antibiotic prophylaxis.
- Limit the duration of resection to 60 minutes.
- The cut-off volume of the prostate for TURP is approximately 60–80 g. If higher, suprapubic adenomectomy should be performed.
- Limit hydrostatic pressure in the bladder.
- Control blood loss and transfuse if necessary.

10.2.3 Bladder perforation and rupture

Accidental perforation of the bladder during endoscopic urological surgery is rare, but it may happen either because of surgical instrumentation or overdistension of the bladder. Most of the time, the perforation is retroperitoneal. An early sign of this complication is the decreased return of the irrigation fluid from the bladder. Later, if under regional anaesthesia, the patient may experience abdominal distension and distress, hypotension, and nausea. When the perforation is instrumental, the surgeon is usually aware of it. Immediate suprapubic bladder suture is advocated.

10.2.4 Bleeding

Transurethral resections of both prostate and bladder tumours often lead to significant haemorrhage. This risk is further increased by anticoagulant or anti-platelet treatments, which are very frequent in the elderly. The exact amount of blood lost is difficult to estimate during surgery because of the constant irrigation, and blood replacement will be based on haemoglobin concentration or haematocrit measurement. In the elderly, a haemoglobin concentration under 10 g 100 ml^{-1} usually requires blood transfusion. At the end of the procedure, a significant hypovolaemia may exist, and the transition from the lithotomy to the supine position must be progressive, one leg at a time, to avoid dangerous hypotension. In the postoperative period, irrigation is carried on with saline, in order to avoid intravesical blood clots, which may lead to re-operation for emptying the bladder and haemostasis. New surgical techniques (photoselective vaporization of the prostate; green laser) may reduce this problem in the near future.

10.2.5 The elderly patient taking anti-platelet or anticoagulant drugs and presented for endoscopic urological surgery

Anti-platelet therapy has become a major treatment for both coronary artery disease and stroke. Consequently, several million persons are thus treated in Western Europe, the vast majority being elderly patients. Further, smoking is an important contributive factor of both atherosclerosis and bladder tumours. Thus, having to anaesthetize an elderly patient on anti-platelet drugs for an endoscopic urological procedure is a frequent situation.

Interrupting anticoagulation therapy is associated with a real risk of severe coronary event, occurring with a mean delay of 11 days to recovery of platelet function. In the month following coronary stent implantation, temporary interruption of one or both anti-platelet drugs translates to a risk of death through stent thrombosis of approximately 25%. To reduce this risk, it is necessary to wait at least 6 weeks after bare metal stent implantation to propose a temporary interruption, at least partial, of the treatment. The risk of stent thrombosis is even higher when drug-eluting stents have been used.

However, endoscopic urologic procedures are associated with significant bleeding, which may threaten life. In the postoperative period, this bleeding may

require surgical clot removal and haemostasis. Bleeding and its consequences are significantly increased in patients under anti-platelet treatment.

There are no completely satisfactory solutions for this problem, even if new surgical approaches are promising. In all cases, adenosine diphosphate (ADP) receptor inhibitors (clopidogrel and ticlopidine) should be interrupted, and replaced if mandatory, by low-dose aspirin. Aspirin itself should be interrupted 4 or 5 days before surgery to associate some recovery of platelet function and some minimal protective anti-platelet residual effect. The interest of substitution (low-molecular-weight heparin [LMWH], short half-life non-steroidal anti-inflammatory drugs such as flurbiprofen) therapy is controversial because its efficiency is not proven and it may delay resuming the former treatment. The decision should always involve the patient, the cardiologist (or neurologist), the anaesthetist, and the surgeon and be recorded in the patient's file.

When the preoperative evaluation leads to the discovery of a coronary stenosis requiring stent implantation, the discussion may arise to perform the endoscopic urological procedure under β-blockers and statins, delaying the stent implantation until after surgery.

As far as oral anticoagulants are concerned, they should always be interrupted before urological endoscopic surgery. A substitution by a more manageable drug depends on the indication for anticoagulation. Patients with metallic mitral valves (and, at a lesser degree, metallic aortic valves) and patients suffering from atrial fibrillation usually receive a substitution treatment by heparin in the perioperative period.

10.3 TURBT (transurethral resection of bladder tumours)

The procedure can range from diathermy of a small lesion in the bladder to resection of large tumours. The larger resections have similar problems to TURP with regards blood loss, although the absorption of irrigation fluid is seldom a problem because the large venous sinuses of the prostate are not opened.

10.4 Laparoscopic surgery

Laparoscopic surgery is now increasingly utilized in urology. It is used for nephrectomy, pyeloplasty, prostatectomy with or without pelvic lymph node dissection, and retroperitoneal lymph node dissection. Anaesthesia is similar to that for other laparoscopic procedures.

10.5 Radical cystectomy

This is a major operation often undertaken in patients with multiple comorbidities, and it carries a significant mortality risk. There may be a significant and rapid

blood loss requiring transfusion. Invasive arterial monitoring is beneficial, and most patients have central venous pressure monitoring if they have limited cardiorespiratory reserve. General anaesthesia is often supplemented with epidural anaesthesia for open cystectomy and the epidural should be continued into the postoperative period.

10.6 Endoscopic or perineal urological surgery in the elderly: which anaesthesia?

In most anaesthesia textbooks, the use of spinal anaesthesia has been recommended in endoscopic or perineal urological surgery in the elderly: the procedure is technically simple. The lithotomy or gynaecologic position limits the haemodynamic consequences of the sympathetic blockade, and the patient remaining conscious allows rapid diagnosis of complications such as ruptured bladder or TURP syndrome. In the treatment of urinary incontinence by suburethral tapes, some surgeons prefer the patient to remain conscious and able to cough when asked to optimize the tension of the tape. Other surgeons stress that this adjustment on cough is useless because patients are not expected to void in the lithotomy position. New anaesthetic agents and techniques have somehow tilted the balance back towards general anaesthesia, specifically in cases in which difficulties may arise with spinal anaesthesia. In patients on anticoagulants or anti-platelet therapy, even if spinal anaesthesia is not directly contraindicated in all cases, the risk of complications must be discussed, and the reason spinal anaesthesia is chosen should be recorded in the patient's file. The risk of medullar haematoma is increased by the technical difficulties, and the technique should be abandoned if not successful at the first attempt. In patients with hypertension and/or cardiac failure, it is often easier to maintain haemodynamic stability with general anaesthesia. In rheumatic patients, the gynaecologic position sustained for more than 30 minutes may generate backache or pain in the lower limbs, which may be attributed to spinal anaesthesia, thus inducing complaints and litigation.

As with any anaesthesia, the aim is to maintain the patients physiology as close to their normal as possible whilst providing optimal conditions for the surgery to progress. If general anaesthesia is chosen, a simple and efficient solution is to use a laryngeal-mask airway (LMA) with pressure support ventilation. Fit elderly patients can breathe spontaneously through an LMA. Patients with pre-existing respiratory or cardiovascular disease should be formally ventilated. Positioning has to be balanced within the limitations imposed by the considering morbidities and conditions of the patient (fixed or reduced mobility). Hypnosis can be maintained either with propofol target controlled infusion (TCI) (Schnider's model) or volatiles (preferably desflurane or sevoflurane), and analgesia is achieved with a rapid-action opioid (alfentanil or remifentanil) in order to adjust the opioid to the respiratory rate (around 10–12 min^{-1}).

Prostatic biopsies are usually performed under local anaesthesia, but if necessary, some degree of conscious sedation may be used. Changes of ureteral prosthesis in women can also be performed under local anaesthesia, but a low target remifentanil TCI can significantly improve the acceptance of the technique.

10.7 Major gynaecology surgical procedures in the elderly

With the projected increase in women aged 65 and older in the next few decades, the number of women seeking routine and acute gynaecological surgical interventions is expected to increase dramatically. Many of the major gynaecological surgical procedures performed are for cancer, pelvic organ prolapse, or urinary incontinence. These procedures are performed abdominally, vaginally, or laparoscopically.

A reduction in induction doses of intravenous anaesthetic agents is the key. Any standard technique of anaesthesia is safe if performed carefully, but regional anaesthesia has some advantages over general anaesthesia because there is a decreased incidence of postoperative thromboembolic events, stress response to surgery, blood loss, and incidence of postoperative cognitive delirium. However, there are no data to support the superiority of one over another. Hypothermia is pronounced and prolonged because of low basal metabolic rate, hypothyroidism, high ratio of surface area to body mass, impairment of autonomic mechanisms for thermoregulation, less effective cold-induced vasoconstriction, and delayed shivering. The patient should be maintained in a warm operating room and active warming measures should be instituted. Adequate pain control is important, but caution is observed for opioid effect owing to increased sensitivity.

Incidence of gynaecology surgery is likely to be increased significantly over the next few decades. Optimizing health and improving outcome and the quality of life of the elderly will involve understanding the multiple facets in caring for older females during preoperative, intraoperative, and postoperative care.

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Postoperative care and analgesia

11.1 Postoperative care in the elderly

Intermediate recovery is a dangerous period when resuming of autonomy for vital functions of the patient allows close monitoring to shift towards less individualized care, but the patient cannot yet be safely left alone. Ideally, the mental status and awareness of the environment regain their preoperative values; cardiovascular and respiratory functions are stabilized; and pain and postoperative nausea and vomiting are controlled. Unfortunately, this may take a long time, especially in the elderly, and often, intercurrent obstacles must be overcome.

11.2 Delayed recovery

Astonishingly enough, delayed recovery has not been extensively investigated, perhaps for lack of a clear definition. In intubated patients, delayed recovery may be considered if removal of the tracheal tube is impossible owing to altered consciousness (Glasgow score <9).

There are several causes of delayed recovery or prolonged unconsciousness after anaesthesia, which may include patient factors, anaesthetic factors, duration of surgery, painful stimulation, pharmacological factors, or metabolic factors, among others. Non-pharmacological causes may have serious sequelae; thus, recognizing these organic conditions is important. Factors are summarized in Tables 11.1, 11.2, and 11.3.

Table 11.1 Causes of prolonged unconsciousness after anaesthesia

Pharmacological effects

Drug factors	Patient factors	Surgical factors
Dose	Age (especially extremes)	Requirement for muscle relaxation
Absorption	Genetic variations	Duration of surgery
Distribution	Disease processes: renal and hepatic failure	Utilization of regional techniques
Metabolism		Degree of pain/ stimulation
Excretion Context-sensitive half-life Pharmacodynamic Interactions (summation, potentiation, and synergism) Pharmacokinetic interactions (distribution, metabolism, and excretion) Respiratory failure Central drive Muscular/ventilatory disorders Pulmonary pathology Neurological causes Intracerebral event Seizures Central hypoxia Central ischaemia Local anaesthetic toxicity Metallic causes Hypoglycaemia Hyperglycaemia Hyponatraemia Central anticholinergic syndrome Hypothyroidism Hepatic or renal failure (uraemia) Sepsis		

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Table 11.2 Interactions with neuromuscular antagonists	
Interactions with non-depolarizing muscle relaxants	
Drug interactions	Volatile anaesthetic agents Aminoglycosides Lithium Diuretics Calcium channel antagonists
Metabolic causes	Hypothermia Acidosis Hypokalaemia Hypermagnesaemia
Genetic	Myasthenia gravis Eaton Lambert/myasthenic syndrome
Interactions with depolarizing muscle relaxants	
Genetic	Suxamethonium apnoea Myotonic dystrophy
Acquired acetylcholinesterase deficiency	Pregnancy Liver disease Renal failure Cardiac failure Thyrotoxicosis Drugs (ecothiopate, ketamine, oral contraceptive pill [OCP], lidocaine, neostigmine, and ester local anaesthetics)
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Another major cause is residual effects of neuromuscular blocker in the conscious patient, which can mimic unconsciousness. In addition, neuromuscular blockers may result in prolonged unconsciousness after surgery if a residual block causes hypoventilation. A large number of pharmacological interactions can occur with neuromuscular blocking agents prolonging neuromuscular block (Table 11.2).

Elderly patients are particularly exposed to both. Neurological complications leading to delayed recovery are mainly stroke (ischaemic or haemorrhagic) and epilepsy. Strokes are very rare in the postoperative period outside of cardiac, intracranial and vascular procedures.

Consciousness may be impaired by metabolic disturbances (e.g. hypomagnesaemia and hypocalcaemia; see Table 11.3).

Table 11.3 Endocrine disturbances	
Endocrine disturbance	Causes
Hypoglycaemia	Diabetes Starvation Alcohol Sepsis Liver failure Paediatrics Sulfonylureas Endocrine tumours Hypoadrenalism
Hyperglycaemia	Ketoacidosis Hyperosmolar non-ketoacidosis (HONK) Lactic acidosis Gestational diabetes Insulin resistance (acromegaly and Cushing) Pancreatitis Inherited syndromes
Hyponatraemia and water excess	Na deficient IV fluids TURP syndrome Excessive drinking SIADH Drugs Nephrotic syndrome
Hyponatraemia and dehydration	Diuretics Hypoadrenalism Cerebral salt wasting Nephritis Diarrhoea and vomiting Pancreatitis Renal tubular acidosis

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Most of the time, delayed recovery is due to excessive sedation by residual action of sedative drugs used either during surgery or as a premedication. Thus, midazolam, even at low doses, or clonidine used as premedication may delay recovery in elderly patients. This increased risk of residual sedation reinforces the recommendation to favour short-acting titratable anaesthetic agents in this population, and this may help in diagnosis and management of the patient. See Box 11.1 and Fig. 11.1.

Rapid assessment of
A B C

→ 100% Oxygen, airway adjunets,
manual ventilation
Is the airway protected?

↓

Assess GCS
Stimulate the patient

↓

Review anaesthetic chart

Drugs, timing, interactions
Take account of patient characteristics

→ Consider:
Naloxone
Flumazenil
Neostigmine
Doxapram

↓

Capillary blood glucose

→ Correct glucose if low or high

↓

Measure temperature

→ Warm if temp < 35.5°C

↓

Arterial blood gas analysis

→ Correct hypoxia, hypercapnia or
acidosis

↓

Full clinical examination, with
particular attention to respiratory
system and nervous system (including
focal or lateralising neurological
signs)

→ Consider further diagnostic tests:
CXR,
CT head

↓

Blood Tests
U+E, FBC or haemocue, glucose, TFT

↓

If patient remains unconscious decide:
Where this patient should be managed?
Further course of action?
Consider a dissociative test where other
diagnoses absent

Fig. 11.1 A stepwise approach to the patient with prolonged unconsciousness

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> **Box 11.1** Guidelines for aetiological diagnosis of delayed recovery
>
> - Hypoxaemia? Check monitoring.
> - Severe hypo- or hypercapnia? Profound anaemia? Check.
> - Residual action of hypnotic drugs? Of opioids? Residual muscle relaxation? Check anaesthesia sheet.
> - Hypothermia?
> - Chronic treatment by clonidine or lithium?
> - Nature and dose of premedication?
> - Neurological state: Glasgow score, focal neurologic signs? Pupil size and reactivity?
> - Is the patient at risk for epilepsy?
> - Metabolic disturbances (e.g. hypoglycaemia and severe acidosis)?
> - Central anticholinergic syndrome?

In a case of delayed recovery, the first step is to protect the patient mainly from the respiratory consequences of this coma (aspiration of gastric content and obstructive apnoea). The airway must be protected, and if necessary, ventilation controlled to normal oxygen and $P_{ET}CO_2$ levels.

11.3 Emergence delirium

Emergence delirium in the postanaesthetic care unit (PACU) remains poorly understood. It can become dangerous (self-inflicted injuries, haemorrhage, self-extubation, and removal of catheters), requiring physical and chemical restraint. Age is a significant contributive factor, as are linguistic problems, chronic alcoholism, previously altered mental status, depression, or Parkinson disease. If the lingering effect of anaesthetic agents rather leads to sedation, a poor recovery of consciousness associated with significant pain may trigger agitation. Patients on chronic benzodiazepine treatment are also more likely to develop emergence delirium, even in the absence of proper withdrawal syndrome. Traditionally, anticholinergic agents have been accused to trigger agitation in the elderly. It remains a minor causative factor in the PACU.

11.4 Causative factors for PACU agitation

The first step to alleviate agitation in the elderly is to eliminate obvious causes.

11.4.1 Postoperative urinary retention (POUR)

Retention of urine is a common postoperative problem, and it may lead to agitation and confusion until relief is brought by bladder catheterization. Age is an independent risk factor for POUR (the risk is doubled after age 60 years), as is the amount of intraoperative fluids and bladder volume on entry in the PACU.

Considering the alterations of urodynamics physiology with ageing, a single episode of POUR, if not rapidly treated, may increase the risk of further retentions. Patients arriving in the PACU with an intravesical volume of more than 270 ml represent half of the patients having received with more than 750 ml of intraoperative fluids. Of them, 30% will have a POUR in the PACU. Other significant factors are sex (male, and the responsibility of undiagnosed prostatic adenoma is likely), large intraoperative opioid doses, and central blockade including epidural analgesia.

11.4.2 Pain

Excruciating pain will generate agitation, and it must be treated as an emergency.

11.4.3 Obstruction of a tracheal tube

The other aetiologies must be checked out in the order of emergency.

Hypoxia is less frequent nowadays when supplemental oxygen is widely used and tissue oxygenation monitored through pulse oximetry.

Hypotension may reduce brain perfusion pressure, specifically in patients with a history of stroke.

The metabolic disorders that may trigger agitation are mainly hypoglycaemia (diabetic patients and those with liver failure), hyponatraemia (Transurethral Resection of Prostate [TURP] syndrome), and hypercalcaemia.

More than 20% of patients suffering from *sepsis* show agitation and confusion. Similarly, unexplained agitation after intra-abdominal surgery hints at surgical complications.

Residual paralysis may occur after a single intubating dose of non-depolarising muscle relaxant, and, in the absence of reversal, as much as 45% of patients admitted in the PACU had a Train of Four ratio inferior to 90%.[1] Considering that the clinical duration of action of most neuromuscular blocking agents (NMBA) is prolonged in the elderly, reversal should be the rule in this population, as well as instrumental monitoring of muscle relaxation in all situations in which a muscle relaxant has been used.

Panic when awakening in a foreign environment may trigger or exacerbate agitation. It is worsened by the absence of spectacles and hearing aids, poor preoperative communication with the medical team, and pain.

11.5 Treatment

Once the aetiologies described herein have been considered and treated, symptomatic treatment of persisting agitation is often necessary.

If possible, the patient should be placed in a quiet environment, and the number of staff in direct relation with him/her should be reduced.

In a non-communicant elderly patient, reassuring words may not be sufficient.

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[1] See Debaene, et al. (2003).

Benzodiazepines are difficult to handle in the postoperative period, specifically in the elderly, and if the patient has received opioids for pain, they may precipitate a dangerous respiratory depression. Therefore, opioids should be ruled out unless a withdrawal syndrome is suspected. Neuroleptics and specifically haloperidol are the choice treatment, even if their IV administration is not admitted in every country. The initial dosage is 2–5 mg, injected slowly, and repeated every 15 minutes until the desired effect is achieved.

11.6 Postoperative analgesia in the elderly

The elderly patient does not require a complete change in the management of postoperative pain treatment but rather an adaptation of the usual practice to meet the specific requirements in this population.

11.6.1 Perception and expression of pain in the elderly

Postoperative pain may last more than 3 days and affect quality of life for more than 7 days. Pain perception does not decrease with age.

Pain and its intensity may be difficult to recognize and quantify in the elderly because of an atypical expression. Patients may not report postoperative pain for fear of addiction or cognitive impairment. Elderly patients usually ask for less analgesic drugs than their younger counterparts do, but this does not necessarily mean they have a less-intense perception of pain. Pharmacology of analgesic drugs in this population will lead to a reduction in doses and their frequency. Cultural and sociological background may induce a more-restrained expression of discomfort, and even in the absence of real confusion, visual and/or hearing impairment may cut the elderly off from the environment and reduce communication.

11.6.2 Measuring pain in the elderly

The use of very common assessment tools (Visual Analogue Scale, e.g.) may be rendered difficult in visually impaired or confused patients. Easy and simple pain assessment scales are preferable. Dementia or aphasia may make it difficult to assess the pain. To improve communication, spectacles and hearing aids should be given back to the elderly patient as soon as possible during the recovery phase. In children, comportment scales are used to bypass the communication problem. These scales have not so far been formalized in the elderly. Their applicability is reduced by the fact that the evaluation of pain by nurses and doctors may be very different from what the patient perceives, and more so in the elderly. Nevertheless, physiological parameters (blood pressure, heart rate, and respiratory rate) and facial expression may help (Box 11.2).

11.6.3 Pharmacology of analgesic drugs in the elderly

Practitioners are often reticent to prescribe potent analgesics in the elderly under the false assumption that the treatment might be more dangerous than pain

> **Box 11.2** Pain evaluation by the nursing team in non-communicant patients
>
> **Level 1:** Calm, relaxed facial features, may be sleeping, normal respiratory rate, normal heart rate, and no hypertension
> **Level 2:** Anxious, tense, tachypnoeic, and tachycardiac
> **Level 3:** Agitated or prostrated, moaning either spontaneously or when touched, tachycardiac, hypertensive, and sweating

itself. A key feature of ageing is the enhancement of inter-individual variability. Therefore, a titration to effect will always be better than a fixed dosage, and when the mental status of the patient allows it, PCA is quite appropriate. Multimodal analgesia combining different drugs with the aim of reducing doses and minimizing side effects of analgesics is preferred.

11.6.3.1 *Opioids*

The concentration–effect relationship of all opioids is modified in the elderly, and, consequently, the efficient opioid concentrations are reduced approximately by half in this population. Therefore, even in the absence of pharmacokinetic changes, the bolus doses of morphine should be divided by two in the elderly. Renal failure is associated with accumulation of the glucuronide active metabolites. Urinary retention after morphine administration is more frequent in the elderly, specifically in male patients, and it should be called to mind when agitation increases despite adequate pain relief.

11.6.3.2 *Non-steroidal anti-inflammatory drugs*

Non-steroidal anti-inflammatory drugs (NSAIDs) are very efficient painkillers, including in the elderly. In the elderly, an increased risk of severe gastric complications, in comparison to younger patients, has been reported. Unfortunately, their use is associated with a number of unwanted side effects, among which the most troublesome in aged patients is the reduction in glomerular filtration rate, which may precipitate acute renal failure. Hypovolaemia and dehydration, which are common in the elderly, may aggravate the risk of acute renal insufficiency following NSAID, especially in association with angiotensin-converting enzyme inhibitors and in a dose-dependent way. Therefore, the dose should be reduced, and their use should be limited in time in this population. Cox2-inhibitors, the clinical use of which has been restrained by its cardiovascular impact, have the same renal action as other NSAIDs.

11.6.3.3 *Acetaminophen (paracetamol) and nefopam*

Acetaminophen can be readily used in elderly patients, alone or as part of a multimodal analgesic protocol. The dosage is the same as in younger patients, 1 g every 6 hours. Its onset is slow, and the first dose should be given during surgery to be effective at recovery.

Nefopam may also be included in a multimodal analgesic protocol. Its use has no specificity in the elderly.

11.6.3.4 *Tramadol*

Tramadol may also be very useful in the elderly, as it is well tolerated. It is indicated in the case of moderate-to-severe pain. Its elimination is reduced in elderly patients because of impaired renal function. In addition, its active metabolite may accumulate and may cause confusion. Therefore, the interval of time between two doses should be doubled.

11.6.4 Regional analgesia

Regional analgesia may be very effective in elderly patients. It provides an excellent pain relief without interfering with consciousness. Peripheral blockade, when applicable, is particularly well suited to this population. Local anaesthetic techniques play a pivotal role as a part of the anaesthesia plan. If local anaesthesia technique is used it will have a limited duration of analgesia unless a continuous catheter administration technique is utilized. The risk of catheter misplacement, misunderstanding about instructions and loss of sensitivity, patient compliance, and level of comprehension (of the patient himself and of health workers) should be carefully evaluated before deciding to use such techniques. Sometimes the technique can induce a very long postoperative analgesia and sometimes even create concerns for a persistent neurological deficit, so much so that pre-existing neuropathies have not always been documented before surgery (trauma patients). Central blockade is more questionable. It may impair early perambulation and be associated with hypotension and urinary retention.

11.6.5 Consequences of pain and its treatment on postoperative course

Pain per se may have deleterious effects. It is a factor of confusion, and of cardiac and respiratory complications. Conversely, an efficient analgesia is beneficial in frail patients, as well as in others. In orthopaedic surgery, it allows a more effective physiotherapy and an earlier mobilization.

The treatment of pain should be integrated into a wider rehabilitation programme to help elderly patients resume their activities as soon as possible.

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Intensive care and the elderly

KEY POINTS

- The elderly are more likely to need intensive care compared with younger patients.
- Survival is a poor indicator of outcome.
- Pre-existing organ reserve determines outcome.
- End-of-life decisions have to be made before admission.
- Prolongation of dying is an ever-present risk.
- Nearly 50% of all UK intensive care patients are over age 65.
- Advanced directives often include some restriction in intensive care management.
- Medical admissions are higher risk than surgical admissions are.

12.1 Background

Intensive care across the world is limited by the cost of provision of the facilities and the medical and nursing staff needed to provide individualized care—it currently costs 1% of the gross domestic product (GDP) of the USA. The utilization of intensive care by the elderly is increasing in line with the changes in demography. More than 27% of all UK admissions are for patients over 75 years of age. However, the data on age being an *independent* predictor of outcome are limited. There is no doubt that the older one gets, the more comorbid diseases are present, and these, with the age-related decline in functional reserve across almost all organ systems, influence expected outcome. For example, in patients over the age of 85, less than 10% can reach an anaerobic threshold of >11 ml s kg^{-1} min^{-1}. This is the value at which patients enter the 'high-risk' stratification for major abdominal surgery, with a predicted mortality of $>18\%$, but it does not differentiate the cause(s) of the fall in reserve, for instance, between ageing, ischaemic heart disease, diabetes, or autonomic failure.

Discrimination is an integral part of clinical practice, and it forms the basis of allocating resources to those who are likely to gain the most benefit from them. This is clearly a difficult area because the basis of this discrimination can be highly variable. One of the many possible criteria used in the past to make these choices was age. This is being increasingly challenged. A rational approach would be one that tries to identify and quantify the outcome of applying a finite resource to a given problem. How long should we provide ventilatory support for this patient

with severe pneumonia? Will they survive and more importantly get back to their pre-infection mental and functional status?

The growth in the proportion of the elderly population and their greater usage of health care resources mean that in many countries, more will be spent on them than on younger patients (see Chapter 1). Managing the appropriate provision of best care for the elderly at the same time as striving to prevent comorbidities from developing in the young is a challenge.

12.2 Assessment for admission

The fundamental role of intensive care is to restore the patient to 'health' (see also Chapter 4—preassessment). 'Health' implies not just a lack of illness but also well-being at a social and mental level, as well as a physical status. If this is unlikely, much greater thought must be given to which expectations are likely to be met and which cannot. This will need to be reviewed with the patient before admission where possible. It is important to try to define whether the admission is likely to lead to improvement or simply prolong the process of dying. None of this is specific for elderly patients, but rather is both much more difficult and yet much more important in the elderly.

Information on the number of elderly admissions to intensive care units shows differences across countries dependent, to a degree, on the number of Intensive Care Medicine (ICM) beds available. The UK has one of the lowest, at about an eighth of Germany's and a seventh of those in the USA per 100,000 population. Within these bed numbers, the proportion of the elderly admitted is growing, with information from New Zealand suggesting a 5% increase per year in the over 80 years of age group.

Assessing the patient's functional capacity is arguably the most important task, and one that helps define the likely outcome from ICU admission. Specific organ systems then provide more targeted information. See Chapter 4 for more detail.

Behavioural adaptation to the progressive decline in physiological reserve is normal for the elderly, and they begin to restrict what they do to the limits of their functional capability. This is often implicit, and the patients do not recognize that they have changed their pattern of life. For example, they go shopping only with their children (exercise or cognitive function limitation); take relatives or close friends to all social events, including attending outpatient departments (cognitive function decline); or fluid restrict because of incontinence or mobility problems. Simple enquiry from relatives may be more productive than seeking the answers directly from the patient.

12.3 Outcome

Outcome from admission to an intensive care unit is going to be determined by these influences as much as by the immediate cause, such as cardiac failure

Table 12.1 Survival data on patients leaving the Intensive Therapy Unit and at 3 months after: effect of age

Age	Discharge from ITU (%)	3-month survival (%)
75–79	68	54
80–84	75	56
>85	69	51

or pneumonia. There are simple outcome measures that are of limited value. These include mortality. Survival is a binary code, and it is worth remembering that having a good death may be the best option for the patients and their family.

The number of patients over 70 years who survive for more than 3 months after an ICU admission is only 50% (Table 12.1). This doubling in mortality from acute illness to discharge reflects both the frailty of the patients and their limited reserve to recover from the major demands that illness places on their metabolism.

Survival has also to be weighed against the normal pattern of life expectancy and the survival effect. Life expectancy is almost static at about a 50%—5-years survival from the age of 65 onwards. A 90-year-old still has a life expectancy of 5 years! This is because the frail and infirmed have already died, and only the tough (and lucky) have survived.

Better measures of outcome relate to the function of the patient in terms of their preadmission status. This may be assessed across a large number of domains, but it usually includes those relating to cognitive or neurophysiological status, activities of daily living, or handicap. In general, patients who survive for more than 3 months also have a reasonable functional outcome, although this may simply be another way of defining the same thing; patients who can recover well also survive. There are 'geriatric' scoring systems that show that over 90% of survivors get back to their social environment, but only about two-thirds regain their activities of daily living. This may be due to the short-time frame of the surveys because many elderly take more than 6 months to recover from intermediate-level surgery. Getting over major surgery or overwhelming infection is likely to take longer still.

Serious pre-existing illnesses such as congestive cardiac failure, dementia, malnutrition, or diabetes all limit functional recovery.

Quality of life is very personal and individual, but it is often assessed as an outcome measure. When elderly patients were reviewed after ICU admission, many thought they had a good quality of life despite reduced function. The alternatives may have been seen to be worse, but these findings do indicate that subjective assessments by the care team of what the quality of life may be should not be used to decide on treatment plans.

12.4 Technology

Advances in organ support systems over the last few decades have meant that more patients, the elderly included, will survive for longer than they would have done without this support. This process may extend dying, rather than allowing recovery, and it can be inappropriate in some patients. It is for these reasons, among others, that clinical review of all patients is recommended before admission to intensive care units. The key decisions to be made are related to the likely benefit to the patients of such an admission, and their own wishes (even if admission were to be of value). This may be difficult if there is missing information on the presenting clinical condition or other underlying disease states, such as malignancy, that may influence likely prognosis.

Where identified, these may indicate limiting intensive care either by time or by intervention. Some patients expressly reject ventilation as being a step too far, and others wish for a 'Do Not Attempt to Resuscitate' (DNAR) to be enacted with immediate effect. It is more unusual in the elderly for the family to wish to 'have everything done'.

Patients who present severely ill from a medical cause have a different prognosis to those admitted with either a surgical or a traumatic cause. The latter is likely to have a condition that is improved by the surgery, valve replacement surgery, for example, or a fractured pelvis after fixation. Patients with acute exacerbations of chronic illnesses such as severe pulmonary oedema on a background of ischaemic heart disease will have a limited chance of recovery of function. As more of acute care is interventional rather than surgical, so has the proportion of medical admissions to the ICU increased, and it may be as high as 80% in unselected admissions units.

One area of intensive care that has a positive benefit to elderly surgical patients is in the preoperative aggressive management to optimize their oxygen delivery before surgery. This 'goal-directed' care improves clinical outcome and survival at all ages. At present, it is routinely used in only a few units in the UK but is likely to become more widespread as pressure on ICU and surgical beds continues to mount.

12.5 Futility and palliative care

As the patient's response to treatment in progress or being planned is reviewed, it is important to assess whether there has been or is likely to be any benefit from the treatment. On one level, this is about causing minimum harm to the patient and, on another, about not prolonging the act of dying. This is clearly good medical practice and it should be common across all areas of clinical practice. However, this is a frequent event within intensive care units, and most units have clear protocols for the withdrawal of treatment based on the latest General Medical Council UK (GMC) guidance. Actively moving to focus on providing palliative care for these patients is one avenue, whereas the dignified withdrawal of active measures may be another.

Palliative care starts well before admission to intensive care units, in the sense that it can be defined as treatment that does not directly alter the disease process(es), leading to the clinical presentation: for example, this may be simply providing effective analgesia. Multidisciplinary palliative care that is more formal will become the main priority when treatment options are identified as futile. Accepting that further clinical care is futile is very difficult for many practitioners, and often for the close family of the patient as well.

Convincing the current elderly cohort of patients that medicine does not provide immortality is usually straightforward, but the over-optimistic portrayal of recovery from near death on TV programmes is confusing for their relatives and younger family members. Creating enough time to educate them into understanding reality may be hard. On occasion, this makes it difficult to move from treatment to palliation. The timing of implementation of these decisions will depend on the acceptance by the patient and their family that there is no further benefit to be gained and that further systems support will only prolong the process of dying. This may take no time at all or several days. During the latter process, the care team will also need emotional support to continue what they may believe is unnecessary interventional management.

The palliative care team, intensive care practitioners, and the patient, with their carers, will explore options to ensure that all human rights of the patient are in place. This will include analgesia for symptomatic control of pain, religious support, financial and social advice, and daily reviews to monitor progress. Planning for their imminent death and the future care for their family are areas that need to be talked through and any support that may help should be identified.

One of the most extreme and pressing situations for the assessment of futility is when a cardiac arrest occurs in the hospital. This frequently involves elderly patients who have significant pre-existing medical problems. The success of resuscitation leading to discharge from the hospital is very low. Approximately 15% of all patients will survive, but this falls with increasing age. No survivors are likely after the age of 70, although they may be resuscitated enough to be admitted to the ICU. Of those who are admitted, 50% have significant neurological damage, and the others develop depression or other stress-related disorders.

In the face of these dreadful outcomes, many elderly patients choose to enact DNAR in the event of a cardiac arrest. These wishes may be formally communicated by the patient or more informally through their relatives. If the ward staff are not aware of these DNAR records, resuscitation will be attempted.

12.6 Complications

Many complications owing to the complex nature of the multiorgan support may be necessary for the elderly patient, but these are usually short lived and related to either practical interventions or drug therapy. Some, however, are responsible for prolonged disability and loss of independence. These include postoperative cognitive dysfunction and sleep disorders (see Chapter 14). They may

be physical, psychological, and social problems. Unlike in younger patients, once these complications arise in the elderly, they may prove insurmountable.

Weight loss and muscle loss are common after prolonged immobilization. Partly because of the catabolism and poor nutrition, the patient's ability to mobilize is limited, and, especially in the elderly, which increases the convalescence time. Further muscular dysfunction affects the diaphragm and intercostal muscles. This results in breathlessness on exertion, as well as a predisposition to respiratory complications owing to inefficient coughing and sputum clearance. Sensory and motor neuropathies may occur, as can alterations in the special senses of sight, smell, and hearing. If the airway has been instrumented—tracheostomy/ endotracheal tube—for a length of time, then tracheal stenosis, vocal cord damage, or stridor may occur.

Patients often have difficulty in relating back into their social grouping, whether family or care home. This may be due to their experiences during admission or subtle cognitive changes because of the illness and therapies needed for recovery.

12.7 Advanced directives/capacity

Increasing numbers of elderly patients have chosen what level of medical care they wish to receive if they become incapacitated. In the UK, this was enacted by law to recognize the 'power of attorney' legally granted to carers (often relatives) to enable decisions of medical treatment, as well as financial and other matters, to be made in the best interests of the patient. It is important that the power of attorney relating to health explicitly states what action should be taken with regard to withdrawal or withholding of treatment because this must be explicitly recorded whilst the patient is competent to make that decision. It cannot be added once incapacity has occurred. Historically, many of these powers were abused, although this was usually in the financial arena for self-gain (see Chapter 15).

It is important is to adopt the position that all elderly patients will have an advanced directive until proven otherwise. Finding the details may be difficult, as they may have spoken only to close relatives rather than committing their wishes to paper. Acting in the best interests of the patient until these can be identified is reasonable, but once known, they must be followed to avoid the risk of litigation. The most common stipulation is in the case of needing resuscitation, but the prohibition of nasogastric tubes, catheterization, or even palliative operations may be included as well.

12.8 Summary

The elderly are the most extensive users of intensive care facilities, and many gain tremendous benefit from their admission. This is more likely if their reason for admission is surgical or traumatic rather than an underlying medical cause.

Common sense has to balance the ability to do something with the question of appropriateness.

FURTHER READING

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Anaesthesia for non-theatre environments

KEY POINTS

- Remote locations can greatly reduce the safety margins of anaesthesia, especially in elderly patients.
- Cognitive function should be assessed, especially for previous episodes of delirium or elements of dementia.
- Formal, documented checking of anaesthetically related equipment before any procedure is essential because there will be inevitable delay and risk if, for instance, advanced airway management becomes necessary.
- Only experienced anaesthetists and dedicated anaesthetic support staff should provide care in remote locations.
- Access to critical care facilities, if likely to be required, should be confirmed before starting anaesthesia for the procedure.
- Temperature management may be challenging, and core temperature should be part of standard monitoring.
- Multidisciplinary team discussion and planning before the procedure should include anaesthetic and geriatric clinicians.

13.1 Introduction

An increasing proportion of anaesthetic practice is spent in locations that were not primarily designed for the safe administration of anaesthesia. At the extreme, this may be in a pre-hospital trauma situation. The within-hospital sites range from emergency or outpatient departments where minor surgical procedures may be performed to major endovascular or cardiac suites where complex procedures are performed on ill elderly patients. Anaesthetic support is also necessary where moderate or deep sedation is administered, as well as where general of regional anaesthesia is required. With an increasing use of potent intravenous analgesics and anaesthetic induction agents, for instance, remifentanil and propofol, in elderly patients by non-anaesthetic practitioners, inadvertent overdose leading to respiratory arrest is a more common event, often needing urgent anaesthetic assistance.

Pre-hospital care and anaesthesia is beyond the scope of this volume but it has been well described in others (see further reading).

Common features include locations:

- Where anaesthesia is an additional requirement superimposed on a custom-built environment where the specialist practice has evolved and/or become more invasive and now requires anaesthetic support
- Where there are no trained staff members in that location dedicated to support anaesthetists
- Where equipment for the safe delivery of anaesthesia or sedation and the monitoring of the patient are not incorporated into the design layout: this includes suction, scavenging, and resuscitation equipment
- Where the environment may not be controlled, for instance, there may be no provision for altering the ambient temperature to maintain thermal homeostasis in the elderly or worse it can be directly hazardous with powerful air conditioning to maintain the (low) working temperature of the computing and electrical equipment
- Where large fixed machines, such as C-arms, MRI, or CT scanners, limit access to the patient and may be difficult to make safe in an emergency

It is expected that formal operating theatres, such as those for dental or ophthalmic surgery, are designed, staffed, and equipped to the same standards as in main theatre suites.

The important aspects to be considered are:

- The environment
- The patient
- The procedure
- Recovery
- Discharge

Although the focus of this review is the elderly patient, the same aspects apply for all patients.

13.2 **The environment**

13.2.1 Generic issues

The sites where anaesthesia may be required in these specialized units are usually embedded within the hub for that particular speciality, and this may even be outside the acute hospital setting in isolated standalone units. A useful guide to 'what is isolated' may be inferred from the Royal College of Anaesthetists definition of Local or Level 2 supervision, namely that—the supervisor is on the same

geographical site, is immediately available for advice, and is able to be with the trainee within 10 minutes of being called. Anywhere beyond this is isolated.

Before the provision of anaesthesia at such remote sites can be agreed, a formal assessment of the available facilities at that site should be made. A clear line of funding for the entire provision must be present and signed off by the Trust or Hospital Finance Officers. Written identification should include features that must be provided if absent, exploration of procedures planned, and the expertise of the staff involved. Where will patients be received and what access will the anaesthetists have before the day of admission? What anaesthetic-related equipment is provided, who maintains and services it, and is it in common use throughout the Trust? Where will patients recover from anaesthesia or sedation, and what is the route of access to intensive care? Will training play a significant part in service delivery?

Specific areas to explore on site are the physical aspects. What size is the active area, and is there enough space for an anaesthetic machine, monitoring equipment, and the anaesthetist and assistant? Who has responsibility for the safe storage and registering of controlled drugs and release of them to the anaesthetic team before the procedure? Where will the anaesthetic drugs and the ancillary airway and vascular access equipment be placed during the procedure? Are there enough non-interruptible power sockets? Are piped oxygen, scavenging, and suction provided? Is there adequate lighting to safely monitor the patient or acceptable electronic monitoring if not? Do the trolleys tip, and can they withstand cardiopulmonary resuscitation? Is there enough room to get a trolley, patient, monitoring, and medical staff into lifts or down corridors if necessary?

13.2.2 Specific issues

13.2.2.1 *Monitoring*

The monitoring of the patient must conform to the same standards as all anaesthetic areas, and it includes basic haemodynamic and respiratory monitoring, usually augmented with the capability for invasive arterial pressure monitoring and temperature measurement. Capnography is also essential in all anaesthetized and moderately sedated elderly patients. Where the patient is likely to be some distance from the anaesthetist, some form of brain function monitoring, bispectral index, for instance, will assist in maintaining an appropriate level of either sedation of anaesthesia in the elderly patient.

13.2.2.2 *Environmental safety*

Many interventional suites require long leads or hoses from the anaesthetic machine to the patient, and these can be trip hazards for the staff and disconnection risks for the patient. If the suite has aggressive air conditioning heated, forced-air systems will be needed to maintain normothermia in these elderly patients, and diligent pressure-area care must be provided throughout the

procedure. Where there is exposure to radiation, the patient and staff should have appropriate shielding.

13.2.2.3 *Staffing*

There must be trained and dedicated assistance for the anaesthetist at all times, totally committed to this task alone. Ideally, they should be rotated from the main theatre complex to ensure that they have current competencies to provide support in case of untoward events. A regular, rehearsed and recorded drill for the entire team in the management of cardiopulmonary arrest, anaphylaxis, and other emergencies is essential, with clear identification of who becomes team leader and in what circumstances.

Patients may come to these units from intensive care facilities or may require access post procedure. A formal pathway that ensures such a resource is available before beginning any procedure should be in place.

Whilst training is an essential part of clinical care, it is important to remember that international data show that these procedures and environments are more dangerous for the patient and result in a large proportion, often over 50%, of all negligence/closed claims and, therefore, that supervision and support for both anaesthetic and procedural staff should be available at all times.

13.3 **Elderly patients in remote sites**

The very nature of isolated sites implies a reduction in immediately available support should complications arise. Emergencies occurring on induction, during the procedure, or in the recovery phase are likely to demand initial and continuing rescue by the anaesthetist and his or her assistant alone. Help, even a cardiac arrest team, may be many minutes away, unlike the immediate support present from within adjacent operation theatres in the main complex. This level of risk gets greater with advancing age, where there are usually more comorbidities and multiple chronic drug usage. Preoperative assessment by an anaesthetist several days before the procedure will ensure a proper handling of the main chronic medications and a safer planning of anaesthesia.

As the range of procedures expands, and as they are more likely to be of benefit to elderly patients, greater will be the challenge of providing safe anaesthesia and sedation. Some specialities will have limited experience of working with anaesthetists and understanding their role as perioperative physicians. There may be a lack of insight into the complex interactions between the patient and the cocktail of anaesthetic drugs used in current anaesthetic practice. Although the days of requiring a 'light anaesthetic' have long gone, there is still little detailed understanding outside of anaesthesia on the pharmacokinetic and pharmacodynamic interactions between the older patient, their reduced physiological reserve and homeostatic control, and potent anaesthetic and analgesic drugs.

Cognitive impairment becomes more common with advancing age, as do gradual loss of the special senses of sight and hearing and failing autonomic function.

Careful anaesthetic assessment is a vital component of safety for elderly patients, and time and space has to be made available for this to occur before the procedure. Clearly, there are times when this is not possible, such as emergency stenting of aortic aneurysms, but this imperative should be recorded in the case records.

13.4 Procedures performed in remote sites

The range of procedures that require sedation or anaesthesia in remote sites is growing all the time. A selection from across the range will identify some the challenges that they hold and key factors to be borne in mind.

13.4.1 Sedation or anaesthesia

The elderly patient undergoing a procedure may require support across the spectrum from full awareness to full general anaesthesia (see Chapter 3 and Table 13.1). Whilst the principle of a controlled transition between these conscious states and the maintenance of a chosen state over time appears straightforward, this is hardly ever the case in elderly patients. Their circulation time, drug disposition, apparent volumes of distribution, and variable elimination rates all make titration very difficult.

The choice of drugs is largely determined by the previous experience of the practitioner, and there is no place for learning their use in remote locations. All current anaesthetic agents have been used to provide moderate sedation to general anaesthesia. As with the majority of drugs administered to the elderly, the effective dose is markedly lower than that of younger patients. The use of short-acting agents is attractive if they provide haemodynamic stability. Many procedures, especially interventional intravascular ones, need cardiovascular stability. Tight haemodynamic control is necessary, and inadvertent drug overdose may compromise the entire procedure.

Either volatile or intravenous anaesthetic agents may be used for induction and maintenance, and desflurane or sevoflurane as volatile agents or propofol intravenously are commonly used. As mentioned previously, all are difficult to titrate, and a state of sedation may rapidly become general anaesthesia and vice versa. Brain function monitoring may be useful, but it depends on the use of elderly trained algorithms in the control systems. Target-controlled infusions may help.

Recovery is usually brisk, even in the elderly, but there is an increased risk of emergence delirium, and this is more likely if centrally acting anticholinergics have been administered.

13.4.2 Emergency/pre-hospital care

This emergency provision of urgent airway management and haemodynamic stabilization, with brain perfusion protection where necessary, has moved out of emergency units into the pre-hospital environment. The elderly form a large group of patients who present in this way. Protection of the airway is a cornerstone of

Table 13.1 Continuum of Sedation ASA 2009

	Minimal sedation anxiolysis	Moderate sedation/analgesia ('conscious sedation')	Deep sedation/analgesia	General anaesthesia
Responsiveness	Normal response to verbal stimulation	Purposeful** response to verbal or tactile stimulation	Purposeful** response following repeated or painful stimulation	Unarousable even with painful stimulus
Airway	Unaffected	No intervention required	Intervention may be required	Intervention often required
Spontaneous ventilation	Unaffected	Adequate	May be inadequate	Frequently inadequate
Cardiovascular	Unaffected	Usually maintained	Usually maintained	May be impaired

Excerpted from *Continuum of Depth of Sedation: Definition of General Anesthesia and Levels of Sedation/Analgesia,* 1999 (amended in 2014). Reprinted with permission of the American Society of Anesthesiologists. A copy of the full text can be obtained from ASA, 1061 American Lane Schaumburg, IL, 60173-4973 or online at www.asahq.org.

this area of care, and it always requires anaesthesia. Rapid sequence intubation without effective anaesthesia and rapid paralysis to aid tracheal intubation is only possible in the brain stem-dead patient. As the decision to perform on site anaesthesia requires both the skills to perform it and the judgement as to whether it is in the patient's best interests—time, distance, and terrain to definitive care—may only be made by experienced medical practitioners. In the UK, many elderly patients are edentulous, making effective bag and mask ventilation difficult, and as they are prone to rapid desaturation, early advanced airway support is likely to be needed. This is an area where inexperienced practitioners should not be directly responsible for this care because the rate of failed tracheal intubation ranges between 10%–30%, compared with less than 3% in experienced hands.

In some remote rural areas, such emergency teams may be used to transfer fracture patients to the hospital, where the travel time, often of many hours, is likely to prejudice the patient's recovery. Analgesia, monitoring, and temperature control are especially important for these patients.

The hand over to the base unit is fundamental to patient safety, and it should be as formal an event as the World Health Organization check before surgery.

13.4.3 Endoscopy

Endoscopy has been a part of medical investigations for well over 100 years, and the move to 'open access' to these services means that systems that allow rapid investigation and return home are seen as the most efficient. The majority of these examinations are uncomfortable, and some are extremely painful. Sedation is frequently provided by the endoscopist as sole operator/seditionist with clear concerns unless full monitoring is used. There has been an increase in the use of combinations of agents gradually replacing the single agent, often midazolam, with more short-acting and potent drugs. Specifically in the elderly, the use of such combinations should be limited to anaesthetists.

In addition, there has been an increase in the complexity of procedures being performed. Many centres will provide an endoscopic resection of colonic tumours, retrograde cannulation of pancreatic ducts for stenting or stones, and stenting of obstructing bronchogenic carcinoma. The complications that may arise from these procedures are more than a slow recovery from the sedation and may require emergency surgery. Access to such rescue should be agreed before such procedures are started.

13.4.4 Imaging

Simple radiology, often enhanced with contrast media, is usually tolerated well, but it may require sedation or even general anaesthesia in confused or uncooperative patients. The clinical benefit of the investigation has to be weighed against the risks of anaesthesia. With all radiological procedures, the accumulative risk from ionizing radiation must be monitored, and all regular staff should check their dosimeters regularly.

13.4.5 CT scanning

The current generation of CT scanners provide fast, 3-dimensional images in a few minutes, providing there is no movement by the patient. Enhanced imaging may require administration of contrast dyes. The main anaesthetic problem is in maintaining patient monitoring and protecting the patient and attached equipment during the movement in and out of the scanner. Where moderate sedation or general anaesthesia is required, the airway should be assessed and secured if any doubt exists. Tubing and monitoring cables are at risk from the scanner and should be secured and visible at all times.

Emergency CT scanning is now routine for patients with a suspected stroke, to evaluate if there is a bleed and to estimate what volume of intracranial blood there is. Over 40 ml usually is an indication to neurosurgical decompression. The majority of patients are stable and cooperative, but a proportion is confused and restless, requiring anaesthesia as in other head injured patients. The same precautions on maintaining cerebral perfusion as in other head injuries apply, but maintaining blood pressure may be more difficult in the elderly.

13.4.6 MRI scanning

The magnets used in MRI scanners vary in strength from about 0.5 to above 7 Tesla, and these fields make any ferromagnetic material dangerous when in close proximity to the scanner. Specialized monitoring and anaesthetic equipment are provided, but familiarity with the equipment has to be demonstrated before clinical use. The majority of more powerful scanners can be very noisy and claustrophobic, and the imaging can take 20–60 minutes. Many elderly patients have difficulty tolerating the longer MRI scans, and sedation is often required. Where vascular imaging is important, so too is cardiovascular stability to allow pre- and postcontrast comparison of complex vascular anomalies.

13.4.7 Cardiothoracic catheterization suites

The move from cardiac surgery–provided coronary grafting to endovascular stenting for critically narrowed coronary arteries is almost complete as a first line treatment. The majority of these cases are dealt with as emergencies by the cardiology teams with little input from anaesthesia unless coronary artery rupture or lost stents require immediate thoracotomy and rescue. However, the scope of interventional cardiology practice has continued to expand. One growth area is transcatheter aortic valve implantation (TAVI).

The TAVI procedure, to treat severe high-risk aortic stenosis, is advocated in patients with other severe comorbidities that are contraindications to open surgery (e.g. cirrhosis and/ or previous surgery), but who are predicted to have at least a 1-year life expectancy. However, because of the quality of the results currently published, this minimally invasive procedure appears like a real challenger to open cardiac surgery in elderly patients, even in those with few comorbidities. It is not recommended where there has been previous valve surgery, coronary

bypass surgery, or endocarditis. Access to the aortic valve is either retrograde through the femoral artery (most of the time) or, rarely, through a small thoracotomy and a transapical route. When the femoral route is chosen, it can be performed under general anaesthesia, but nowadays is more often performed under sedation, for example, with a regional ilioinguinal or transversus abdominis plane (TAP) block associated with low-concentration remifentanil target-controlled infusion (TCI). The placement of the valve implant is usually performed under ventricular standstill, achieved through over pacing of the right ventricle to induce ventricular tachycardia. The placement itself may dislodge parts of calcified plaques, leading to stroke or myocardial infarction, dissecting of the aorta, or rupture of the aortic root itself. Multidisciplinary planning is essential, and both transoesophageal echocardiography (TOE) assessment and support using extracorporeal membrane oxygenation (ECMO) can be used under general anaesthesia. Another complication is the appearance of a complete atrioventricular block requiring the emergency placement of a pacemaker.

If general anaesthesia is used, recovery ideally should be rapid with extubation and monitoring in a level 2 critical care unit.

Electrophysiological treatment of rhythm disorders affects increasing numbers of elderly patients, with the current inclusion of resistant, poorly tolerated atrial fibrillations. These procedures are performed under local anaesthesia, but their durations (several hours) often make sedation a useful adjunct to ensure a calm and cooperative patient. Low-concentration remifentanil TCI guaranties an easily rousable patient.

13.4.8 Vascular imaging suites

Many centres are able to provide elective endovascular aortic aneurysm repair (EVAR) procedures for abdominal aortic aneurysms (AAA), and some aim to provide an emergency service if appropriate for the patient. The renal arteries, as with open procedures, are a watershed for AAA repairs, and if the aneurysm is infrarenal, regional anaesthetic techniques with sedation are possible. Higher aneurysms need general anaesthesia as a rule. The haemodynamic stresses are the same as in open procedures because the balloon distension occludes the outflow just as effectively as cross clamping would. As with all of these procedures in radiological suites, the tables are narrow and poorly designed for pressure-area protection, and extra padding and careful positioning are essential.

13.4.9 Neuroimaging suites

The elderly are becoming a larger proportion of the interventional neuroradiology workload.

The embolization of vascular lesions, aneurysms or arteriovenous malformations, requires a stable normotensive cardiovascular system to allow safe placement of the embolic material at the mouth of the vessel(s) involved. Sudden increases in arterial blood flow may move the embolic material into normal

vessels and severely compromise the patient. Equally abnormally low flows may make placement look satisfactory but function poorly when perfusion returns to normal. Recovery should be controlled to prevent coughing or straining for the same reasons.

Hyperventilation and hypotension are useful in patients with compromised intracranial perfusion or fragile intracranial aneurysms but are a greater risk in the elderly patient, where autoregulation is frequently poor and watershed vascular areas may be compromised. Unless there are clear indications, both should be avoided.

13.4.10 Psychiatric units

Electroconvulsive therapy (ECT) remains an effective and often lifesaving treatment for severe, suicidal depression, especially in the elderly. The use of ECT is less common than previously, but it is still part of routine psychiatric therapy. Although the ECT suites are accredited (in the UK and many other countries), they are often within psychiatric hospitals rather than on acute hospital sites. The anaesthesia team responsible for providing care for these patients should be at consultant or other permanent staff-members level. Whilst these are excellent training procedures, supervision should be at level 1—immediately available. The risks of ECT to patients with ischaemic heart disease from an uncontrolled seizure are considerable, with hypertension and tachycardia, and careful risk/benefit discussion within the team may be necessary before administration.

Often, only the anaesthetist and their assistant will have advanced life-support skills, although the ECT team should all be trained to the intermediate standard. The equipment and protocols for transfer to a critical care facility, should the need arise, should be checked and practised regularly.

Volatile agents and nitrous oxide are rarely, if ever, used because an induction dose of an intravenous anaesthetic with a short-acting muscle relaxant provides safe anaesthesia for the procedure. The risk of stroke and myocardial infarction is greater in the elderly, and their time in recovery may be long.

13.5 Recovery

The vast majority of elderly patients have poor airway control during sleep, leading to partial airway collapse (snoring), and many have frank obstructive sleep apnoea. This is compounded by delayed recovery from sedative drugs, especially benzodiazepines and opiates. Until they have been eliminated or reversed, these patients should be directly supervised by experienced staff and fully monitored, including pulse oximetry and temperature. Desaturation occurs late in obstruction of the airway and the most common sign is paradoxical breathing, the identification of which requires vigilance at all times. Unidentified airway obstruction is most likely after endoscopy, when anaesthetic personnel are rarely present.

13.6 Discharge

Criteria for discharge from remote sites have to be more stringent than within an acute operating theatre setting because of the distance from the procedural suite to critical care or acute wards. For the more complex cases, this is built into the care protocol, and patients may be returning to an acute ward or critical care as a planned event, but the elderly are prone to unexpected complications from intermediate and minor procedures as well. Although day care is a preferred model for many operations, this needs pragmatic and individualized reviews for the elderly because their home care and support may be inadequate. This may be because their carers are equally old and frail or that they lack the ability to recognize and act on complications that arise at home, such as re-bleeding or chest infection.

13.7 Conclusion

Many more procedures will be performed outside of operating theatres over the next 20–30 years, and predictions of this being the case for over 50% of all operations are commonplace. Understanding the risks inherent in the location and the procedure, with some extrapolation from what we know now, should help us to deliver safe care as these innovative interventions grow in number and complexity.

FURTHER READING

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Cognitive dysfunction and sleep disorders

KEY POINTS

- Of all patients over the age of 65 undergoing major surgery, 25% will have a degree of postoperative cognitive impairment.
- Permanent changes will occur in 11%.
- Up to 73% of elderly surgical patients will have an episode of delirium.
- Assessment of mental function is a core skill for all doctors.
- Knowledge of the causes and treatment of delirium are necessary.
- Evidence for the superiority of any one anaesthetic technique is lacking.
- Elderly patients who complain of cognitive decline after surgery should be taken seriously.
- Cognitive impairment is associated with poor perioperative pain control.

14.1 Size of the problem

The most devastating complications following surgery are due to changes in cognition. The incidence of postoperative cognitive dysfunction (POCD), although possible at any age, is greatest in the elderly. The elderly may suffer an acute episode such as delirium or a more chronic and slightly later onset of cognitive dysfunction. Both conditions are probably indications of loss of reserve of basic neuronal pathways such as the cholinergic or adrenergic systems (Table 14.1).

The identification of the more delayed form of POCD may be made once the patient returns home. It may be missed by all but the close relatives of the patient. The incidence does not appear to have changed over the last half century, at about 25% of all major surgical patients over the age of 65. This is despite all the changes in understanding, monitoring, and newer anaesthetic agents with more benign pharmacodynamics.

14.2 Delirium

This is a medical emergency. It can occur within hours of surgery, often lasting up to 7 days. There are broadly two subtypes of delirium: agitated and quiet, although a mixed pattern can occur. The former is much more likely to be diagnosed than is the withdrawn quiet patient who appears simply compliant with

Table 14.1 Characteristics of delirium versus dementia		
Characteristic	Delirium	Dementia
Consciousness	Clouded Decreased alertness or hyperalert	Usually alert
Orientation	Disorganized	Disoriented
Course	Fluctuating	Steady slow decline
Onset	Acute or subacute	Chronic
Attention	Impaired	Usually normal
Psychomotor	Agitated or lethargic	Usually normal
Hallucinations	Perceptual disturbances May have hallucinations	Usually not present
Sleep–awake cycle	Abnormal	Usually normal
Speech	Slow, incoherent	Usually normal but anomic difficulty finding words
Reproduced from *Delirium,* Flaherty J.H. Copyright (2006), with permission from John Wiley & Sons.		

instructions. The incidence of delirium in all hospital inpatients over the age of 65 averages about 35%, and it increases with advancing age, but depending on the type of surgery, it may rise to more than 70%.

The current classification of delirium is within the ICD -10 Word Health Organization classification, published in1993. It is classified as:

- F05 Delirium, not induced by alcohol and other psychoactive substances
- F05.0 Delirium, not superimposed on dementia, so described
- F05.1 Delirium, superimposed on dementia
- F05.8 Other delirium
- F05.9 Delirium, unspecified

(Reproduced from *ICD-10*. Section FO5.8. http://apps.who.int/classifications/icd10/browse/2016/en#/F05)

There is a classification system derived by the American Psychiatric Association, the Diagnostic and Statistical Manual of Mental Disorders now in its 5th version, but it has been criticized, especially for some criteria that may medicalize normal elderly people.

Risk factors for developing delirium include advancing age, frailty, cognitive impairment, or a previous episode of delirium (Box 14.1). The last two can be confirmed by questioning the family when they may identify other episodes related to infections or minor trauma.

> **Box 14.1** Precipitating factors for delirium
>
> - Hypoxia
> - Anticholinergic medication
> - Infective processes
> - Biochemical abnormalities
>   - Glucose/sodium/calcium
> - Centrally acting drugs
>   - Opiates
>   - Sedatives

The presenting symptoms are of acute and fluctuating changes in cognition and attention. The cognitive changes include disordered thinking, memory, and perception, as well as changes in attention seen as reduced alertness, perception, and directiveness. There is usually an alteration in the patients' sleep/wake balance and they become sleepy through the day and agitated during the nights. The agitation and disorientation suffered by these patients may lead to significant clinical problems, for example, drains and intravenous lines can be pulled out or patients may try to escape their frightening environment despite orthopaedic surgery requiring non-weight bearing. These patients are more likely to fall and further injure themselves.

The underlying cause is believed to involve the cholinergic pathways within the brain, although lymphokines have also been implicated, and these rise with infection, malignancy, or following trauma. Precipitating factors have been identified, and suggested plans for identifying and managing delirium have been suggested (Boxes 14.2 and 14.3).

If patients have been identified as at increased risk for developing delirium, such as having a previous episode or mild dementia, it may be worth involving

> **Box 14.2** Rockwood's five-point plan for the management of delirium
>
> - Identify risk factors
>   - Elderly, frail, very ill, and prior history of dementia
> - Treat reversible factors
>   - Medication, infections, and heart failure
> - Keep control of the behaviours
>   - Family vigils
> - Anticipate problems
>   - Full bladder/constipation and fall risks
> - Prepare for rehabilitation
>
> Data from *Delirium in Old Age*, Lindesay J. et al, 2002, Oxford University Press

> **Box 14.3** Drug therapy for delirium
>
> - Haloperidol
>   - Oral (slow onset)/IM (fast onset)
>   - Not for withdrawal patients
> - Others: seek advice before using them
>   - Atypical neuroleptics
>   - Risperidone/olanzapine/quetiapine
>   - Benzodiazepines
>   - Lorazepam
>   - Antidepressants
>   - Trazodone

the family to provide a 24-hour 'vigil' to maintain a personal orientation for the patient. Strict light/dark cycle (unlike in most continuously well-lit wards) is maintained, and cues to time and place, such as large obvious clocks and calendars, are provided.

Treatment of delirium lies in trying to identify the likely precipitating cause and drug therapy (Box 14.3). Physical restraint is more likely to increase the level of harm and should never be disproportionate for safety. For example, it may be reasonable temporarily to restrain an arm to insert an IV cannula for drug administration but not to tether the arms to the cot sides.

The mainstay of drug therapy is haloperidol, IM or orally. As with all drugs in the elderly, the initial dose should be calculated in relation to the patient's weight/age/sex and the severity of the delirium. Once a therapeutic response is achieved, the loading process should be stopped. Use of 'prn' doses should be reviewed because there may be a need to prescribe a regular, timed dose. The withdrawal of haloperidol should be gradual in case the underlying delirium is not resolved.

If haloperidol does not work, then expert advice from the psychogeriatric service is necessary.

The outcome following an episode of delirium has serious implications for the patient. They have a much higher rate in the presentation of dementia compared with the normally ageing population (18% versus 5%), probably because it may be indicating a critically low functional reserve of cognitive function.

14.3 Postoperative cognitive dysfunction

POCD has been poorly defined yet recognized for more than 100 years as being a particular problem in anaesthetised elderly patients (Box 14.4). The concerns raised in the UK in the 1950s were of such magnitude that they effectively denied elderly patients any major surgery for decades. The evidence to date confirms that approximately 25% of all elderly having major surgery will have an identifiable

> **Box 14.4** Features of POCD
>
> - Cognitive changes that affect
>   - Memory
>   - Planning
>   - Organization
>   - Attention
>   - Speed of information processing
>   - Personality
>   - Disinhibition

fall in cognition. About half of these patients will have a permanent dysfunction. The risk increases with age, and indeed, it is the main predictive factor.

The most common sign noticed by relatives is social disinhibition. Patients behave in mild but often embarrassingly different ways than their usual form of behaviour. This may be as subtle as becoming irritated if kept waiting or making personal remarks about strangers within their hearing. This may last for a week to several months. More pronounced changes such as loss of executive reasoning would leave them more dependent for support with simple tasks of daily living such as shopping.

Part of the problem with POCD and its incidence is related to the methods of testing for it. For a method of testing to be useful, it has to be given before and on several occasions after surgery. It should be reliable and consistent over all of these testing episodes, with no learning effect from repeated testing. A large enough non-operative matched cohort should also be tested to identify the changes in a normal population over the same time epoch. This has led to many forms of testing and, often, heated discussions as to which is most appropriate (Fig. 14.1).

The causes of POCD have been investigated over the years but no single cause is likely to explain the range and extent of the problem. The underlying biological basis is believed to be a cholinergic failure within the central nervous system as the constellation of symptoms is very similar to Alzheimer form of dementia. Hypoxia, hypotension, and general anaesthesia are just a few of the causes that have been proposed, but very large studies have failed to demonstrate that any of them is primarily to blame. Even the debate as to whether regional anaesthesia confers a greater safety margin compared with general anaesthesia is still unproven (Box 14.5)

One possible developing explanation may be the interaction that occurs after microglial and astrocyte activation that follows neuronal injury and the predisposition that astrocyte activation has for damage by a subsequent oxidative stress. This activated state can last for several months if not years. Many volatile and intravenous anaesthetic agents have actions on neuronal receptors, ranging from N-methyl-D-aspartate to cholinergic and adrenergic receptors. Some of these
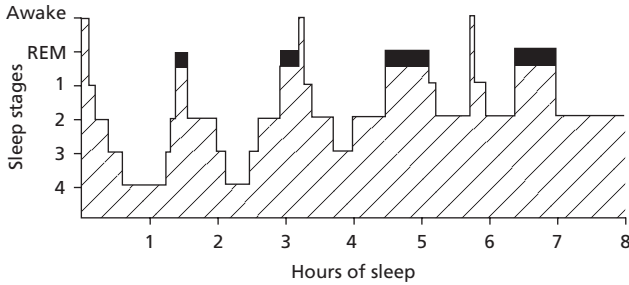
Fig. 14.1 Typical design of a study examination POCD with a profile of normal recovery (diamonds) and incomplete recovery (squares) across multiple postoperative time points. Comparison A: change from baseline to postoperative time point (incomplete-recovery patient). Comparison B: change from baseline to postoperative time point 2 (normal-recovery patient).

Reprinted from Lewis M et al., *Neuroscience & Biobehavioral Reviews*, 28, 'Statistical and conceptual issues in defining post-operative cognitive dysfunction', pp. 433–440. Copyright (2004) with permission from Elsevier.

actions are protective, and others, depending on the concentration and the presence of mild hypoxia, are damaging. Recent work on inflammatory mediators demonstrates a clear link between the magnitude of the inflammatory response to injury (surgery) and cognitive dysfunction.

Assessment of elderly patients' mental state is essential, not just to validate their consent to procedures, but also to check for any decrement following surgery. The simplest test is the abbreviated mental test (Box 14.6), although the mini mental-state evaluation is more useful but takes up to 15 minutes to administer (See Chapter 4).

This testing should be part of the core competencies of all doctors.

Treatment of POCD is difficult because the primary cause is uncertain. Avoiding precipitating drugs, such as the anticholinergic agents, is imperative, and

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Box 14.5 Possible causes of POCD

- Hypoxia
- Hypotension
- General anaesthesia
- Stress responses
  - Central catecholamine changes
  - Steroid effects
- Central cholinergic (nicotinic) changes
- Age

Box 14.6 Abbreviated mental test
Age
Time (to the nearest hour)
Address: to recall at the end of the test—42 West Street (ask the patient to repeat the address to ensure it has been heard correctly)
Year
Name of the hospital
Recognition of two persons (e.g. doctor and nurse)
Date of birth
Year of start of the First World War
Name of the monarch
Count downwards from 20 to 1
Scores should be 9 or above
Reproduced from *Age and Ageing*, 1, Hodkinson H.M, 'Evolution of a mental test score for assessment of mental impairment in the elderly', pp 233–238. Copyright (1972() with permission from Oxford University Press

close control of temperature, pain control and fluid balance is important. These are all known to increase the incidence of POCD. Cholinergic agonists have not been shown to have any benefit.

14.4 Sleep disorders

Disordered sleep is one of the almost inevitable consequences of getting older. Several conditions are prevalent in this age group. Even patients in their late nineties will have much the same duration of sleep in a 24-hour-period as their younger colleagues would, although the content and timing will have changed. The amount of deep slow wave sleep (SWS) (Stage 3–4) falls, but this may be due to the recording amplitude changes resulting from cell loss rather than actual changes in the pattern of sleep. The amount of rapid eye movement (REM) sleep, at about 20%, is also preserved. However, changes in the amplitude of the circadian and ultradian rhythms occur with ageing.

The two main forms of sleep—slow wave and REM—have markedly different underlying physiological processes. SWS is an essentially stable state, with brainstem control of all basic physiological processes such as breathing driven by arterial carbon dioxide concentrations. There are four 'stages' of increasing depth, and during the latter two (SWS stage 3 + 4), many of the restorative cellular processes are believed to occur. Certainly, during these stages, the anabolic hormones are largely released. REM sleep is an active state similar to being awake. Physiological processes react to mentation with the exception that most humans hyperpolarize their spinal motor tracts to cause paralysis during REM. This can fail and lead to sleep behavioural activity or not respond to wakening

and thus lead to sleep paralysis. Whatever the dream mentation includes, physiology matches, dreams of running cause tachypnoea, tachycardia, and hypertension; whereas swimming underwater leads to central apnoea. During both sleep patterns, there is a progressive loss of motor power, and this affects the upper airway as well (Fig. 14.2).

14.5 Circadian changes

The normal sleep pattern of humans is regulated within the hippocampus and reinforced by light and dark cycling. For most people, this is based on a 24-hour cycle. Within this pattern, there is further cyclical influence—the ultradian rhythm—which has a time base of about 60–90 minutes. This modulates the likelihood of being sleepy or awake within the slower sleep/wake cycling. As ageing occurs, these ultradian influences lead to larger oscillations within the circadian cycle, and it becomes more common to feel sleepy during the day and wake through the night. By the age of 70, most people need an afternoon nap and will wake at least once through the night.

The transition to very light sleep through the night means that somatic influences may allow the patient to break through into wakefulness. This is commonly seen where there is joint pain from arthritis, for example. It may also make going to sleep more difficult. The 'socially normal' timing of the sleep/wake cycle has been determined by the middle aged as going to sleep around midnight and waking at about 7:30 a.m. This is not true in either younger or older people. Teenagers do not start to feel sleepy until 2 a.m. in the morning and do not wake spontaneously until nearly noon. The elderly have moved forwards, and they start to sleep at 10:00 and are wake at about 5–6 in the morning. This has an influence on when wards should dim the lights when older patients are admitted.

14.6 Anaesthetic/surgical influences on sleep

Sleep disturbance is universal on admission to the hospital, with the first night being at a much lighter plane of sleep than normal. There is complete suppression of both SWS and REM sleep. This also occurs on the first postoperative night, possibly exacerbated by opiates. There is marked rebound of SWS on the second and third nights, with REM rebound occurring on later nights. The dramatic physiological surges related to REM sleep are believed to account for some of the late but severe complications, such as myocardial ischaemia or stroke.

14.7 Episodic airway obstruction during sleep

One common problem in the elderly is that of repetitive airway obstruction during sleep. As ageing occurs, the upper airway becomes increasingly lax, and the negative pressures necessary to initiate airflow during resting ventilation become enough to narrow the airway. If there is a marked constriction, snoring starts,

f-axis from 70% to 100% (SpO2) and 50/min to 110/min (pulse)　　　　　　　　　　　　　　　　　　　SaO2 ——— Pulse ———
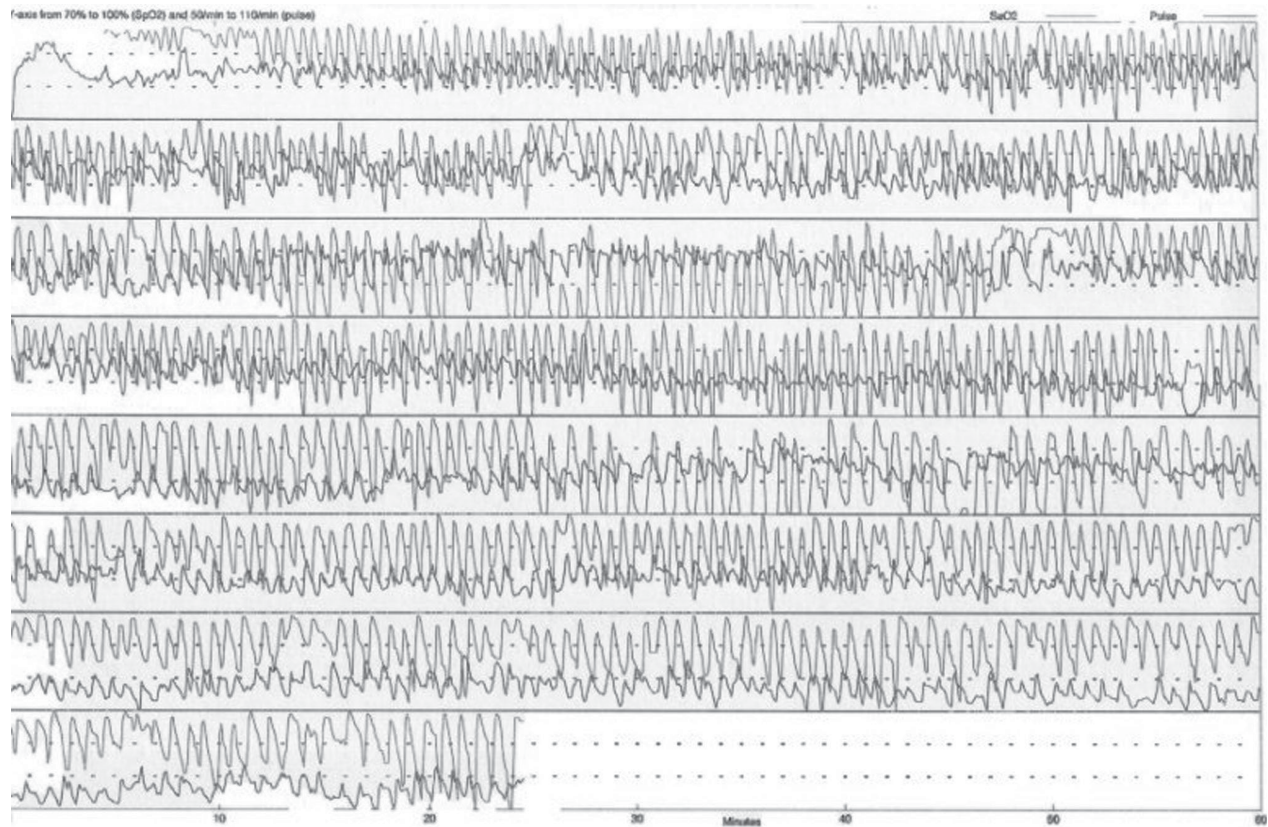
Fig. 14.2 A simplified 'hypnogram' of sleep-stage changes over the night in young adults.
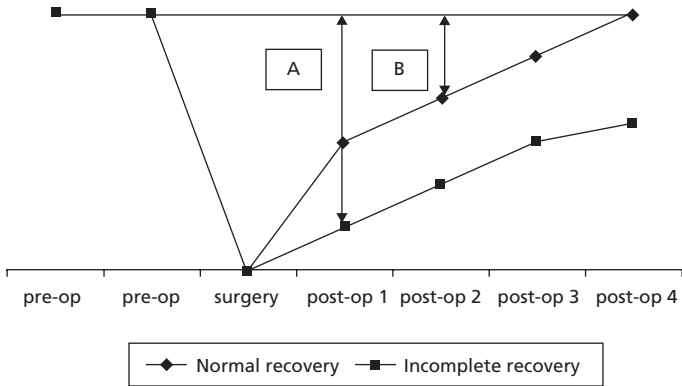
Fig. 14.3 Obstructive sleep apnoea

These traces are from a complete night's sleep recording from a pulse oximeter. The scale is 70%–100% saturation (upper trace) and heart rate 50–110 beats minute^{-1}. Desaturations to <70% are frequent, and obstruction is occurring several times a minute, all night.

and this affects almost 70% of all patients over 65 years. Further narrowing leads to louder snoring, until, ultimately, the airway can be sucked shut. This leads to silence, but also increases efforts to breathe. The longer this continues, the lower the arterial oxygen tension will fall. Recovery is automatic and is due to brainstem arousal reactivating the pharyngeal constrictor muscles among others. This pattern is seen in obstructive sleep apnoea, and in younger patients, it leads to hypersomnolence and an increased risk of right heart failure, stroke, and cognitive dysfunction (see Fig. 14.3).

This process does appear to be more benign in the elderly, and there is a progressive increase in the number of episodes of obstruction with advancing age. However, they are rarely as sleepy as younger sufferers are. It would still seem prudent to protect their airways as though they did have obstructive sleep apnoea. The falls in oxygen tension are very marked in these patients because of their reduced functional volumes, and this does have an influence on wound healing.

Box 14.7 Examples of age-related sleep disorders

- Insomnia
- Obstructive sleep apnoea
- Periodic limb movement disorder
- Restless legs syndrome
- Sleep phase advancement
- Hypersomnia: primary

There are two other common conditions that become more prevalent with ageing: periodic limb movement (PLM) disorder and restless legs syndrome (Box 14.7).

PLM may be present for many years, but if it is first seen in later life, it is frequently one of the very early signs of Parkinson disease, and referral to a neurologist for investigation is warranted. Drug therapy is usually very effective, but it is usually then a lifetime treatment.

Restless legs syndrome may start at any age but it is more common in the elderly. Elderly patients describe a sensation of itching or burning under the skin on their legs that is improved by moving. It can be associated with a low serum iron and should be checked by assaying for serum ferritin levels before initiating treatment, which may be with either ropinirole or pramipexole.

13.8 Summary

Disorders affecting cognition and sleep are common in the elderly. Some may have devastating consequences for patients and their families, yet we still know little about their causes and, therefore, opportunities to treat them.

Sleep disorders are also common, and they may have different outcomes in the elderly than in younger patients.

FURTHER READING

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Ethics and the law involving the elderly

KEY POINTS
• Ethics provide a system to judge whether care is for individual or society's benefit.
• Ultimately, ethical frameworks are the responsibility of society.
• Duty of care follows from accepted ethical practice.
• Consent is a process not a piece of paper.
• Capacity may vary in time and degree.
• Ethics demand that only an experienced doctor can take informed consent.
• No one else (except for children under age 16 years) but the patient (or health attorney, if the patient lacks capacity) can give consent.
• Information should be clearly provided and repeated often.
• The elderly are often deaf, blind, or both, and may be illiterate.

15.1 Ethics

The provision of health care throughout history has evolved by balancing the abilities of medical personnel (and their drugs/equipment, e.g.) with a society's willingness to tolerate their (the doctors) control over such fundamental issues as life or death. When the costs of providing such care are vast, and the resources of the state limited, some degree of rationing has to take place. For this to be fair and just, decisions have to be made about who gets what. The elderly have a place in the society that also changes over time and place. In many parts of the world, they are venerated and respected, whereas in others they are often seen as a burden.

Providing an equitable distribution of resources has to be made somehow. It is in this arena that the use of ethics has such a pivotal role. Ethics are philosophical studies of the moral value of actions that are based on clear rules and principles. This philosophical debate has been adapted for use in clinical areas as 'codes of practice'. There are many sets of rules or theories in use, but the two most common ones are 'consequentialist or utilitarianism' and 'deontological'. These describe different process, and, intrinsically, they are impractical ways of making daily decisions, although both are usually incorporated into our decision making.

In the consequentialist approach, decisions are made simply on the balance of the risk of doing good rather than harm for each action. This ultimately leads to the possibility of doing the best for society rather than an individual. The deontological process involves assessing the action itself against the individual rights, duties, and need for justice. The consequences of the action are not considered.

Practically, ethics have been described as an 'analytical activity in which the concepts, assumption, beliefs, attitudes, emotions, reasons, and arguments underlying medico-moral decision-making are examined critically'.[1] The process is usually described as being based on four principles:

1. Autonomy
2. Non-maleficence
3. Beneficence
4. Justice

Autonomy represents the individual's right to self-determination in all aspects of his or her life even if we do not agree with or share the same beliefs. This is the cornerstone of consent—the giving and withholding according to the individuals choice. The principle that our actions should not be gratuitously harmful is enshrined in the second, and it implies that there has to be a balance between 'necessary harm' (e.g. surgery) for greater benefits. Beneficence is the act of doing good or behaving correctly in all dealings with patients and their families or colleagues. Justice has many shades of interpretation unlike the other three, because it may relate to rationing: an egalitarian approach to scarce resources or a sense of fairness in ensuring that care is given according to need alone.

15.2 Certainty

One of the most common confounding issues in ethical debates is the concept of certainty. Decisions and subsequent actions are usually easy when all the facts are known and there is a logical process to follow. Setting an anaesthetic ventilator is an example; the laws of physics will dictate the mechanical actions and performance of the gases involved. Precise measurements can be made to confirm that the desired effect has been achieved. Unfortunately, clinical practice is nowhere near so clear-cut. We may have risk indices that predict a 90% mortality with an operation, but of the other 10%, which patient survives is impossible to predict. It is against such a lack of clarity that we use ethical processes in our daily practice.

We are all too frequently beset by the law of unintended consequences. We can debate with the patient the likely risks and benefits of a course of action but we cannot provide any guarantees. The deeper we go into trying to describe the

[1] See Gillon (1986).

factors that may have an influence on the outcome, the more likely we are to confuse the patient. Making the judgement on how much to discuss, how much to explain, and when to leave out the finer details varies with each patient.

15.3 Consent

In this context, *consent* means seeking a patient's agreement for the provision of care. The process starts as soon as the patient is seen, and it continues until discharge from care. There are moments where a more formal process is invoked; signing a document agreeing to an operation, for example, but the whole delivery of care to that patient involves consent. It is important to remember that there is no right on the behalf of a patient to demand medical treatment, even if such a treatment is available and the patient would die without it.

Consent, to be valid, has to meet certain criteria. For example, the patient must be competent to make the decision; it has to be given without duress and it must be fully informed. It also serves at least three purposes: it provides a legal framework to defend against criminal charges such as assault, it recognizes the autonomy of the patient in determining his or her future, and it should have a clear clinical purpose to make it necessary.

There are legal limitations on who can give consent, and, while these differ across the world, the European Convention on Human Rights enshrines those individual rights that are relevant to this aspect of medical law. These include the protection of the right to life, freedom of thought, and the prohibition of torture, inhuman or degrading treatment or punishment, among others. In the UK, consent can be given by the following:

- Adults over the age of 18 (or a duly registered person, with a Lasting Power of Attorney for health for that adult, in the event of a lack of capacity in that adult)
- Children over the age of 16
- 'Gillick' competent children under the age of 16

This differs from the ability to give consent in cases in which children who could give consent refuse to do so, in which case this can be overruled by either a person with parental responsibility or the court if it is in their best interests.

15.4 Voluntariness

Decisions that the patient makes with regard to consent must be made without duress or being under coercion. In the elderly, this may be difficult to ascertain because many frail elderly patients do not want to 'burden' their families and will try to choose options with their families' interests at heart rather than their own wishes. Many frail patients are vulnerable to pressure from other carers or even friends to accept or refuse treatment.

15.5 **Information**

There is a duty of care to provide as much information to the patient as to allow them to make an informed choice about their treatment options. This is not the same as the patient's right to know. Until recently, a defence on how much information should be given was that that a 'responsible body of medical opinion' would have provided. However, it is now clear there are several descriptions of risks that should be disclosed. These risks are:

- Obviously necessary
- So obviously necessary that no reasonably prudent medical man would fail to disclose it: for instance, dying during a ruptured aortic aneurysm repair
- Special risks
  - Are specific to that patient, or to form or severity; such as paralysis following odontoid surgery in the neck
- Significant risks
  - These are risks that would affect the judgement of a reasonable patient: this research protocol may lead to injury but it is worth it for all the other patients

The information being provided to the patient must be in a form and at a time that they can understand. It is worth keeping in mind that there is a high level of illiteracy in the UK population, and this remains true in the elderly; estimates are of 5%–10%. Frightened patients do not remember well, and most of the information given after bad news is likely to be poorly recalled if at all. Repeating information and presenting it in different ways improve assimilation and understanding.

The elderly have significant communication problems as well. Almost 35% are very deaf, and the same percentage is almost blind. The combination of the two, blindness and deafness, makes giving information (and signing the consent form) difficult. Pictures and diagrams are usually better than written material is, although patient information leaflets (see the Royal College of Anaesthetists website) are very helpful sources that can be referred to repeatedly.

Suggested areas that should be given to all patients include the following:

- The reason for the consent
- An explanation of the problem
- The options there are for treatment, including doing nothing
- What the surgery (if that is an option) entails
- The risks and complications
- Postoperative expectations: length of convalescence, for instance

These should be evidence based and regularly reviewed. They should have a 'review-by-date' and ideally be available in a range of locally used languages.

15.6 Who should seek consent?

It is the duty of care of the doctor providing treatment or ordering investigations to discuss the reasons with the patient and explain the risks involved. To do this the doctor must have a comprehensive understanding of both the procedure and his or her own competence in it. Delegation should be rare, but if necessary, it should be to another person who has been trained and assessed as competent to seek consent with appropriate knowledge of the procedure or investigation and the associated risks.

15.7 Competence/capacity

Capacity in this instance is the ability or power to do, experience, or understand something. Patients have to be able to understand what is being said to them, believe that it is true, and retain the information for long enough to consider it as part of making their decision. There are different levels of capacity relating to the decisions being made.

Capacity does not equate to making a reasonable decision. Irrational decisions, if the consequences of that decision are understood, have to be accepted. The only person who can give consent apart from the patient is someone who has been nominated with lasting power of attorney (LPA) under the Mental Capacity Act.

Ten years ago, in the UK, the Mental Capacity Act 2005 enshrined case law into a statute to provide protection for those who lack capacity. This included those with learning difficulties, as well as the cognitively impaired elderly patient. The fundamental principle is that autonomy and capacity has to be assumed present until proved otherwise. Equally, all reasonable steps have to be taken to assist the patient to understand. There are two stages to determining capacity under this act. The first asks whether there is a disturbance or impairment in cognition that could make them unable to make a decision. This dysfunction could be temporary, delirium, or drug related, or it could be permanent, following a head injury or in severe dementia. The second relates to the decision process itself, with all the issues of understanding and retaining information, as well as being able to decide and communicate that decision (Box 15.1).

Other factors to consider will include such aspects as previously expressed wishes, the views of close relatives, the patient's beliefs, and so on. The relevant factors must not be restricted to medical issues.

The act creates a new form of advocate for the patient in that they can nominate an individual to have LPA. Only competent adults can nominate someone as an LPA, but it gives that person rights not only over property and financial areas (which were in the previous provision) but also over decisions on health care and medical treatment. Withdrawal or withholding of treatment decisions can be implemented only if the patient, while competent, expressly documented them.

Box 15.1 Key principles of the Mental Capacity Act 2005

- Persons must be assumed to have capacity unless it is established that they lack capacity.
- Persons cannot be treated as unable to make a decision unless all practicable steps to help them do so have been taken without success.
- Persons cannot be treated as unable to make a decision merely because they make an unwise decision.
- You must act or make decisions on behalf of a person who lacks capacity in his or her best interests.
- Before you act or make a decision, you must consider whether the purpose for which it is needed can be as effectively achieved in a way that is less restrictive of the person's rights and freedom of action.

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The creation of a new court of protection (The Office of the Public Guardian), the ability of the court to appoint deputies to act for patients lacking capacity, and independent advocates for those who do not have others to speak for them are all provisions that protect patients, as well as the medical attendants.

15.8 Euthanasia

The right to life has been linked to the right to choose when to die since the early part of the twentieth century. So far, only a few countries have legalized this, and there has been little progress in the UK. The risks inherent in providing care for vulnerable and frail elderly patients if this process became legal are great. They are especially at risk from close relatives or carers who seek financial return from their relative's death.

Unfortunately, the right to the provision of a dignified, pain-free death in a suitable pleasant environment has increasingly been tied to the right to choose when to die. The two are not the same; one is a demand for highly skilled palliative care teams for all who need them, and the other is for a means to be legally killed when life becomes unbearable. Society, ultimately, will have to make their judgement on this issue, although medicine will require that refusing to provide this will not be seen as a failure to provide a duty of care.

15.9 Summary

The ethical issues around consent and capacity are central to the care of the elderly patient, and a clear understanding of the principles is necessary. There are recent changes in UK legislation that we need to be aware of as part of our daily practice and our own personal planning for the future.

FURTHER READING

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Note: figures, tables, and boxes are indicated by the suffixes '*f*', '*t*', and '*b*', for example 81*f* would indicate a figure on page 81.