Challenges in anaesthesia for elderly

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**Abstract**

The segment of elderly individuals comprises a growing proportion of the global population. Health care systems and health care providers worldwide need to understand the specific challenges related to treatment of this heterogeneous patient population. The process of ageing is complex and under constant influence by numerous factors, for which reason the way human age is extremely individual.

It is important to understand and acknowledge how elderly differ from younger adults, and how management needs to be modified and tailored to the individual patient in order to improve outcomes. The goal of treatment of an elderly patient is not necessarily to increase human longevity regardless of the consequences, but to increase active longevity free from disability and functional dependence. For older people, deterioration in function can be devastating and is often precipitated by a stressful event such as an acute episode of illness or injury. Therefore a mainstay of treatment of the aged is prevention of functional decline.

In this review, we will outline the extreme variability in the aging process, and its implications for tailoring the perioperative care for the elderly. We will provide an overview of the challenges, when dealing with the aged surgical population with emphasis on postoperative cognitive changes.

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http://dx.doi.org/10.1016/j.sdj.2014.11.003
0377-5291/© 2014 Published by Elsevier B.V.
Introduction

In recent years a growing interest has revolved around the impact of surgery and anaesthesia on the elderly. As life expectancy increases with more elderly patients undergoing surgery [1], it is imperative that knowledge on this important topic is disseminated for health care systems and providers to understand why elderly are different and how management needs to be modified to improve outcome.

Especially postoperative cognitive decline is much more common in the elderly and this has been associated with higher morbidity and mortality among elderly, which challenges the benefits of surgery in this population. In this review, we will provide an overview of the problems when dealing with the aged, with emphasis on postoperative cognitive changes.

Ageing and the aged patient population

Ageing is a physiological process, where the structure and functional capacity of organs and tissue progressively degenerates over time. The ageing process is extra-ordinarily complex, and is constantly influenced by numerous factors; such as life style choices, environment, genetics, social network and chronic diseases [2]. The geriatric population has a higher prevalence of numerous medical conditions and co-morbidity; including atherosclerosis, heart failure, diabetes, chronic obstructive lung disease, kidney impairment, and dementia. Often patients receive several drugs for their chronic diseases, which may have negative connotations. Polypharmacy can be associated with increased risk of adverse drug reactions, problematic drug interactions, and medication errors [3].

Humans age differently, for which reason the elderly patient population is health-wise extremely diverse. A large proportion of elderly is functionally independent; they are healthy or have well treated milder chronic diseases. However, a significant proportion of elderly are particularly frail; they have severe chronic diseases, high level of co-morbidity, and may have low functional capacity.

The human body has the capability to compensate for the age related changes to some extent, but elderly, healthy or sick, have a limited physiological reserve that can become evident upon application of stressors [4,5]. The increased frailty renders the elderly patient at risk of transient disabilities. This can potentially push the elderly into a vicious cycle that ultimately may lead to permanent loss of daily functions, loss of self-care capacity, dependence on supportive care or institutionalization [6]. Clinicians should be particularly aware of tailoring care and support to the individual patient’s needs, and for the elderly this may include careful considerations on how to prevent functional decline and disabilities.

Important aspects of perioperative care of the aged

A preoperative consultation is essential to evaluate the perioperative risks and plan preventive perioperative actions. It is important to address all the aspects of the elderly patient, which include changes induced by the process of aging, the cumulative impact of co-existing diseases, presence of polypharmacy, difficulties in communication and comprehension (reduced hearing or vision), compromised cognitive function, and a consideration whether the patient can provide informed consent [7]. It should always be considered, where a certain procedure for the individual patient could be best carried out. Certain patients should only be treated in places where supportive care and increased monitoring are available, for example elderly patients with bleeding disorders, or significant heart disease going through more invasive procedures. Relevant specialists e.g. a geriatrician should be consulted whenever in doubt how to provide best practice of care.

Generally, adjustment of drug selection and dosage is required for the elderly. Elderly patients are generally more sensitive to analgesics and sedatives. As polypharmacy is frequent, one should be aware of potential interactions. The variability in pharmacodynamics and kinetics is high; usually, smaller doses are needed for clinical effect compared to the adult population, and the duration of action is prolonged. Therefore dosing should be carefully titrated by the principle: “start low – go slow” [8]. Using local anaesthetics for elderly is usually safe. Not different from other adults, clinicians should be aware of allergies, decreased liver and kidney function, and pay attention to correct dosing of local anaesthetics to prevent toxic reactions [9].

It is essential to avoid inadequate pain relief; particular awareness should be given to the patients lacking communication abilities, as they may not be able to express if they experience pain (for an example a patient with severe dementia, or a patient suffering from a severe stroke). The use of multimodal analgesia is usually beneficial. This includes a combination of different analgesics and adjuvants. Anti-inflammatory drugs should be used cautiously, especially because of the risk of gastric bleeding, and renal impairment [10].

Sedation should be carried out with extreme caution since elderly are more susceptible to drugs acting on the central nervous system. Premedication with anxiolytics with weak sedative effects may be feasible with no further monitoring [11]; however deeper sedation should be carried out under continuous monitoring of vital functions (oxygen saturation, respiratory rate, heart rate, blood pressure, and electrocardiogram). General anaesthesia can be performed with either intravenous or inhaled anaesthetics. Selection of anaesthesia has to be individualized and influenced not only by the condition, but also by the anaesthesiologist’s skill and expertise.

Elderly are at higher risks for complications postoperatively. The immune system is not as effective as in the younger population, why elderly are more prone to hospital
acquired and surgical infections. Other common complications include thromboembolic events, dehydration, insufficient nutrition intake, and insufficient pain treatment [12].

In past years, a growing interest has revolved around a significant part of elderly patients that experience cognitive decline after an operation. It has been proposed, that anaesthetics could induce cognitive alterations.

**Syndromes of postoperative cognitive deterioration in the elderly**

Postoperative cognitive impairment can potentially affect patients of all ages, but is predominantly seen in the elderly.

Postoperative delirium (POD) and postoperative cognitive dysfunction (POCD) are the most common syndromes of neurobehavioral disturbances presenting after surgery; it is an on-going discussion whether these syndromes are part of a continuum or separate entities [1,13,14].

**Postoperative delirium**

Two types of delirium can be present in the postoperative phase; emergence delirium (ED) and postoperative delirium (POD). ED is benign temporal cognitive disorientation, that can occur during the transition from anaesthesia to wakefulness and resolves within minutes or hours [15,16], whilst (POD) is an acute organic brain syndrome that usually develops within the first few postoperative days [13,16].

POD is a common condition; approximately 15% of elderly patients experience POD after elective procedures, with a pronounced higher incidence rate (30–70%) for elderly undergoing emergency or major surgery [17,18]. A key feature of POD is the sudden onset of symptoms that tend to fluctuate during the course of the day. Following a lucid interval after surgery, patients characteristically debut with a disturbance in consciousness (reduced clarity of awareness, reduced ability to focus or sustain attention, reduced awareness of the surrounding environment). This is accompanied by cognitive changes (memory deficit, disorientation, language disturbances) or/and perceptual disturbances such as vivid hallucinations [18,19]. The severity of symptoms varies tremendously, which has been acknowledged by implementation of sub-diagnoses of POD based upon the patient’s psychomotor behaviour. The psychomotor types of delirium can range from hypoactive states e.g. the patient is sluggish or lethargic to hyperactive states, where the patient may be restless, agitated or even aggressive or violent [16]. Hypoactive forms of POD may be under-diagnosed due to a relatively non-disturbing behaviour, or misdiagnosed as symptomatic manifestations of dementia or depression [20]. However, clinicians should be particularly aware of signs of psychomotoric inhibition in elderly patients (to the point of stupor), as patients that develop a hypoactive form of POD seem to have a relatively increased mortality [20].

The pathophysiology of POD is still poorly understood. It may be related to disturbances in the production, release, or inactivation of neurotransmitters [21]. Another suspected culprit of POD is modulation of the inflammatory signalling system. This hypothesis suggests recruitment and activation of inflammatory substances in response to the surgical stress and anaesthesia may trigger neuroinflammation, thus contributing to POD [22–26].

Despite the underlying mechanism is still poorly understood, several predisposing and eliciting factors have been recognized. Predisposing factors include advanced age, preoperative cognitive impairment such as dementia, pre-existing medical disease burden, and genetic factors, for an example patients with a high-risk gene identified in Alzheimer’s disease (apolipoprotein E4 phenotype) have higher incidence and longer duration of POD [27].

Eliciting factors have been identified to include infection/inflammation, metabolite disturbances, substance withdrawal, medications, discomfort, environmental disturbances including sleep disruption, and severe pain with inadequate analgesia [28]. The risk factor for developing POD is additive, therefore recognizing the presence of one or more of the factors should render clinicians particularly aware of cognitive changes in the postoperative phase. Treatment of POD requires a multicomponent strategy aimed at both optimizing preventative measures in addition to eliminating eliciting triggers, if this does not reverse the symptoms, pharmacologic intervention with haloperidol may be required after excluding modifiable causes [29].

POD is an acute disorder, but has been associated with a wide range of negative long-term outcomes for the elderly, despite that patients may initially recover completely [28,30]. POD is associated with reduced function and independence, increased short- and long-term mortality, and prolonged cognitive impairment in survivors [28]. It has been suggested, that POD could induce dementia, but the association is not confirmed. There seems to be a significantly higher proportion of patients who experience POD that eventually will be given a diagnosis of dementia [31], but this may reflect that patients with pre-existing cognitive impairment may be more frail thus developing cognitive problems more easily.

**Postoperative cognitive dysfunction**

Opposed to POD, postoperative cognitive dysfunction (POCD) is more subtle. POCD can affect a wide spectrum of neuropsychological domains such as memory, psychomotor speed, information processing, and executive functions. The patient experiences, or their relatives observe, a subtle deterioration of daily cognitive performance that typically last for weeks or months postoperatively [31,32]. The majority of patients experiencing POCD debut with minor decrement of cognitive function such as discrete memory problems, mild personality changes, or the experience that formerly uncomplicated daily tasks suddenly are somewhat difficult to execute; for an example patients report that they cannot concentrate sufficiently to read the newspaper, or have forgotten how to brew coffee. Profound changes with significant loss of memory, intellectual abilities, or executive functions can be seen. Most patients return to their preoperative function after a shorter period of time, but whether POCD can precede a permanent deterioration of a patient’s cognitive trajectory is still debated and not entirely clear [13,30].

Approximately 10% of elderly undergoing surgery will develop POCD [33]. The true incidence is probably
underestimated, since many studies have excluded patients with pre-existing cognitive impairment or dementia at baseline [32,33].

The pathogenic mechanism leading to POCD is not well understood. Loss of cognitive reserve, cumulative effect of chronic disease, altered response to anaesthetics, and toxic effects of anaesthetics have been suggested, but not been proven to be responsible for postoperative cognitive decline in the elderly [34–36]. Similar to POD, the incidence rate of POCD varies with higher incidence in the subpopulation of elderly undergoing major surgery suggesting that a profound systemic inflammatory response may induce alteration of neurotransmitter function, neuroendocrine or immunomodulatory pathways [37–40], which eventually can lead to cognitive dysfunction.

Predisposing factors for POCD have been identified, which are quite similar to POD. These include advanced age, prior cognitive impairment, post- and perioperative complications (infection, second operation), and lower levels of education [1,41,42]. However, the evidence is slightly divergent, as some studies support while others cannot confirm correlations between these factors and POCD [36].

The development of POCD may adversely influence long health term outcome; it is associated with impairments of daily functioning, premature departure from the labour market and dependency on financial and personal support from government or family after hospital discharge, and most disturbingly is POCD associated with increased mortality [1,42,43].

### Diagnosing postoperative cognitive impairment

To detect a postoperative cognitive decline, the clinician must foremost be aware of the patient’s habitual cognitive status to make a reasonable evaluation of changes from their individual baseline status. Various studies of both POCD and POD indicate that new onset of cerebral dysfunction in elderly is readily overlooked due to an incorrect assumption of pre-existing cognitive dysfunction.

The diagnosis of POD is based on detection of symptoms, where POCD encompass more subtle cognitive changes of one or more cognitive domains, which is why detection requires repeatedly neuropsychological testing.

Delirium is well defined in international disease classification systems, which relies on various compositions of diagnostic criteria [44,45]. Nevertheless, rapid bed-side assessment tools are more clinically appropriate for discovering delirium for the individual patient. Numerous suggestions of user-friendly diagnostic tools such as The Confusion Assessment Method (CAM), Nursing Delirium Symptom Checklist (NuDESC) have been developed. The Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) have been validated in non-postoperative settings [46,47]. However, there are shortcomings of these tools; they have failed to stratify severity of delirium [48], and studies have questioned their specificity when used in postoperative settings [46]. Invention of an easy and exact clinically applicable delirium tool validated in postoperative settings is still demanded. Full-scale hyperactive delirium is usually easy to detect; however when suspicion of milder and fluctuating neuropsychological changes arises, repeatedly testing to capture the presence of POD should be initiated.

POCD has been vigorously studied since it first was described in scientific literature half a century ago; however the understanding of POCD is still evolving, thus no international classification system has formulated diagnostic criteria for POCD. A general consensus in scientific literature has formed, that POCD reflects affection of numerous neuropsychological domains, implying that detection relies on pre- and postoperative repeated testing of cognitive function by a battery of comprehensive neuropsychological tests [49]. Still core issues remain to be clarified; what determine a clinical relevant decline in cognitive function, what are the optimal tests for measuring POCD, what are the timeframe in which a cognitive decline could merely be attributed to the perioperative trajectory instead of normal changes related to the ageing process of the human brain, what is the optimal timing for testing cognitive function before and after surgery? Adjustment for anxiety through inclusion of mood and anxiety scores may also be incorporated, because performance may be negatively affected by surgery-associated anxiety [50,51].

The difficulties of understanding and establishing diagnostic criteria for POCD may be ascribed to large diversity and methodological limitations among previous studies; lack of appropriate control groups, lack of baseline data on cognitive function, variation in definition on the magnitude of cognitive change attributed to cognitive dysfunction, missing validation of observations, inconsistent timing of testing, variation in test selection, or use of insensitive test batteries e.g. tests that do not address the patient’s affected cognitive domains, or tests that are insufficient to detect changes in cognitive function over time [49–51].

### Anaesthetic management

At this point, no evidence supports the choice of one anaesthetic over another. The same applies for anaesthetic technique. In the early days of studying patients’ postoperative cognitive trajectories, an association between the anaesthetic technique and POCD was proposed, contemplating that general anaesthesia led to higher incidences of POCD and POD. However, a growing amount of evidence shows that the choice of general versus regional anaesthesia does not appear to influence on the occurrence or magnitude of POD or POCD [42,52,53].

As the pathogenesis of postoperative changes has been associated with inflammatory mediators, intra-operatively use of intravenous lidocaine was believed to provide neuroprotection by modulation of the inflammatory response, however no current evidence supports this theory [54].

Sedation may be employed in elderly in conjunction with regional anaesthesia, but careful age-related dose reduction is needed, and the feasibility of sedation is not quite elucidated [53,55]. In one trial, patient-controlled sedation was administered in elective ophthalmologic day-surgery with a
high level of patient satisfaction and no adverse effects on cognitive function [56], but the technique has not yet been validated in other studies. Perioperative sedation by dexmedetomidine infusion may be superior to other sedatives in reducing the incidence of POD [57,58], the effect on POCD is yet not elucidated.

Intraoperative close monitoring is believed to be essential to sustain physiologic homoeostasis (e.g. continuous measuring by arterial gasses including status of electrolytes, temperature, urinary output, saturation, cardiac output, depth of sedation, brain oxygenation). However, the impact of extended monitoring and goal directed therapy on postoperative cognitive changes is not entirely clear. Carefully titrating anaesthesia perioperative brain monitoring has been a research area of great interest [59]; cerebral oxygen oximetery can be measured by intra-operative near-infrared spectroscopy (NIRS), and depth of anaesthesia can be guided by continuous recordings of electroencephalograms processed by a bispectral index (BIS) monitor or auditory evoked potentials [32,55,59–64].

The evidence on effectiveness of minimizing cerebral oxygen desaturation and depth of sleep has been divergent [32,55,59–66], but there is mounting evidence from several randomised, controlled trials that anaesthetic administration guided by BIS-protocols can decrease POD [62]. However, future research with larger trials is needed to draw conclusions.

Currently there is no good evidence for the efficacy of any specific intervention to decrease POCD and POD. Distinct patient-related risk factors may be of greater aetiological importance than perioperative surgical or anaesthetic management [49,51,67]. From the patient’s hospital admission to discharge, emphases to maintain homoeostasis and restore daily physical function may be most important.

Conclusion

Postoperative cognitive complications are often transitory, but can be associated with devastating outcomes in elderly patients. Understanding the causality concerning both POD and POCD is pending, but seems to be multifactorial.

To further substantiate the optimal management of these patients, future trials should be carefully designed, and employ administration of valid pre- and postoperative tests, that are easily applicable in clinical practice.

To this point, careful patient-centred management is essential to provide elderly patients their best chance of returning to their previous level of function.

Competing interest

No external funding and no competing interests declared.

Dr. Camilla Strenø is supported from Regions Sjælland and Copenhagen University. Professor Lars S. Rasmussen, MD. DMSci is supported by Tryg Foundation.

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