Anaesthetic considerations in nonagenarians and centenarians

Introduction

The World Health Organisation defines the elderly as people aged 65 years or above. Population ageing is a worldwide phenomenon and, together with declining fertility, the proportion of elderly citizens is expected to double from 8% to 16% between 2010 and 2050[1]. In parallel, advances in technology and healthcare, have increased global life expectancy by 5.5 years to 72 years between 2000 and 2016, although this still varies considerably with the economic development of countries. The overall implication is that we will encounter more elderly patients in clinical practice and a significant proportion of them will be under the categories ‘older old’ and ‘oldest old’. This is supported by statistics showing the proportion of centenarians has increased from 2.9 per 100,000 adults (aged more than 65) in 1990 to 7.4 in 2015, and the number is anticipated to rise to 23.6 by 2050[2]. Patients at older ages are conventionally classified as those with ‘high anaesthetic/surgical risk’, and this is evidenced by the inclusion of ‘age’ as a scoring factor in most established risk stratification

tools, such as the Surgical Outcome Risk Tool (SORT)[3] and the Physiological and Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM)[4]. A study investigating the outcomes of elderly undergoing colorectal cancer surgery revealed an increasing trend of various postoperative complications such as pneumonia/respiratory failure, adverse cardiovascular events, stroke and thromboembolism[5]. Similarly, data from the National Emergency Laparotomy Audit[6] has demonstrated an escalating crude in-patient mortality rate for those who are older. Concurrently, recommendations from recent national reports and audits[7] reveal a gap in service delivery for older surgical patients. In this article, we will focus on three important aspects of anaesthesia for nonagenarians and centenarians, and then provide recommendations for clinicians who are involved in the perioperative care of these patients.

Recommendation 1: Every institution should have a protocol which specifically targets patients at the extremes of age undergoing surgery

With increasing longevity, chronological age is no longer an accurate indicator of general fitness, nor should it be the sole reason for declining a patient to undergo major surgery. Nevertheless, functional reserve and maximum organ function do decline with age. *Table 1* summarizes the important pathologies in major organ systems that occur during ageing. Apart from the above, both the number of chronic diseases and the proportion of people with morbidities also increase linearly as one ages[8]. It is, therefore, imperative to take these factors into consideration during pre-operative assessment.

Multimorbidity is linked with diminished functional reserve, increased hospital stay, and shorter life expectancy[9,10]. Among surgical patients, it complicates the perioperative journey by increasing the complexity of cases which invariably worsens postoperative outcomes. It is, therefore, vital for institutions to implement organ protection guidelines and enhanced care pathways for elderly patients with multimorbidity. Appropriate education and training should be provided to the staff involved in the care of this special group of patients. In planning an effective bundle of perioperative care targeting elderly patients, a comprehensive package should include a robust assessment of comorbidities

and recognition of previously unattended problems specific to this age group, such as frailty and cognitive dysfunction. This should be followed by risk stratification for each individual, and attending physicians should identify modifiable factors for optimization such as preoperative anemia. If appropriate, patients should be referred to paramedical professionals for supervised exercise training and nutritional supplementation. Cases carrying high postoperative risk should involve shared decision-making between surgeons, anesthetists, patients and their families. A postoperative care pathway, including a disposal plan should be available, and postoperative complications should be anticipated and managed within this. Finally, rehabilitation and discharge planning should be initiated early to ensure a smooth transition from hospital stay to the usual daily activities at home.

Traditionally, anesthetists have only been involved in pre-operative assessment and intraoperative management of patients. After surgery, patients will be discharged to either the intensive care / high dependency unit or the surgical ward. However, new models of care have been developed recently and include anesthetist-led “high risk” clinics with an experienced anesthetist responsible

for initiating most of the perioperative care package as described above. Another model is the comprehensive geriatric assessment that is geriatrician-led and which has also shown a positive impact on postoperative outcomes for elderly undergoing elective surgery[11]. Undoubtedly, each model has its own strengths and weaknesses, and the best model of care has yet to be determined by large scale studies. Furthermore, a systematic review also demonstrated that an enhanced care program designed for elderly patients is safe, feasible and could diminish both complications and length of stay after surgery[12]. In conclusion, irrespective of the type of model of care employed, the element of utmost importance within the pathway is a team of trained professionals with both the knowledge and skill in provision of specialized care for this particular patient group.

Table 1 Important age-related pathologies in major organ systems that are relevant in the perioperative period

Cardiovascular System	■ Undiagnosed diastolic heart failure ■ Cardiac conduction system fibrosis - increased incidence of atrial fibrillation, cardiac conduction abnormalities and impaired sinoatrial function ■ Impaired heart rate response and myocardial contractility ■ Asymptomatic ischemic heart disease is prevalent ■ Calcified aortic stenosis is common ■ Reduction in endothelial nitric oxide synthase activity ■ Increased levels and activity of inflammatory factors

	■ Atherosclerosis and reduced vascular compliance ■ Hypertension is common
Cerebrovascular System	■ Impaired autoregulation ■ Response to blood pressure, hypoxia, hypercarbia and cerebral metabolism is diminished ■ Reduced ability of the blood brain barrier to selectively uptake and transport nutrients and hormones exposes brain to altered metabolism and increased toxin exposure increasing brain cell vulnerability to acute insults such as strokes ■ Increased multi-infarct dementia, Alzheimer's and neurodegenerative disease ■ Impaired balance and proprioception

Gastrointestinal Tract	■ Malnutrition ■ Reduced drug absorption ■ Reduced absorption of food with delayed gastric emptying
Haematological System	■ Preoperative anemia is common and could be secondary to ■ Bone marrow malfunction ■ Iron deficiency ■ Malnutrition ■ Chronic disease / inflammation
Respiratory	■ Undiagnosed Chronic Obstructive Pulmonary Disease is common – one of the major determinants of postoperative pulmonary complications

	■ Reduced FEV1 , FVC and VO_2 max ■ Increased pulmonary dead space ■ Undiagnosed Obstructive Sleep Apnea is common ■ Respiratory muscle strength decreases and can impair effective cough ■ Reduced ventilatory response to hypoxia and hypercapnia ■ Reduced perception of bronchial constriction
Renal	■ Impaired renal function – often overlooked if based on measurement of serum creatinine alone ■ Benign Prostatic Hypertrophy – difficulty In inserting and weaning urinary catheters

Endocrine System	■ Diabetes is common and tight glycemic control can increase the risk of hypoglycemia ■ Increased autonomic dysfunction ■ Undiagnosed hypothyroidism is common

Recommendation 2: Pre-operative consultation should routinely include an assessment of frailty and interventions should be initiated if diagnosed

Frailty refers to a decline in physiological reserve that manifests through various organ systems in the body, and the frail person will become susceptible to an apparently trivial external stressor such as a change in medications, an uncomplicated infection or minor surgery, in a disproportionate manner[13]. Consequently, a substantial decline in health status may ensue which is characterized by, but not limited to, an increase in dependency, decrease in

mobility, increase in the tendency to fall or a deterioration in cognitive status. Frailty is common in the older population and its prevalence increases steadily with age so that it is found in approximately 26% of those 85 years or above[14]. It is important because it is well-proven to be associated with numerous adverse perioperative outcomes such as morbidity, mortality, length of hospital stay and institutionalisation[15]. Therefore, the importance of identifying frailty has been outlined in a number of major national audit reports such as 'An Old Age Problem' and the 'National Confidential Enquiry into Outcome and Death'[16], which clearly states that comorbidity, disability and frailty should be identified as independent risk factors for elderly patients. Moreover, professional societies such as the American College of Surgeons and the American Geriatrics Society published guidelines and a consensus statement respectively[17], which emphasized the importance of including frailty assessment in our pre-operative consultations.

Currently, there are two main models for assessing frailty, namely, the phenotype model and the deficit-accumulating model, which use data obtained from the Cardiovascular Heart Study[18] and the Canadian Study of Health and

Ageing[19], respectively. In the phenotype model, five distinct predefined characteristics are included, namely unintentional weight loss, self-reported exhaustion, low energy expenditure, slow gait speed and weak grip strength. Those with 3 or more factors are categorized as frail, while individuals with 1 or 2 factors are categorized as pre-frail. Frailty is associated with more frequent falls, immobility, hospital admissions and mortality. One of the major criticisms of this model is that it does not incorporate cognitive dysfunction in the assessment[20] and yet it is well known that cognitive impairment is linked with functional decline. The deficit-accumulating model of frailty counts the number of deficits that a person has suffered over a wide range of clinical domains, such as symptoms, signs, abnormal laboratory parameters, disease states and disabilities[21]. Thus, frailty is seen as a cumulative effect of individual deficits. The frailty index generated has also been shown to be strongly associated with institutionalisation and death[22]. Unfortunately, there have been a few barriers to the implementation of both models in clinical practice, because it either requires special equipment during the assessment (such as a dynamometer for measuring grip strength), or it is too labour-intensive to complete the entire

assessment process, and these factors all limit their usefulness in day-to-day clinical practice. There is also a lack of consensus on which tools can be used in the measurement of frailty because a universally accepted definition does not exist and the context of its measurement may be inconsistent.

Despite the above, there are still numerous tools that have been developed for frailty assessment in the preoperative setting. The Edmonton Frail Scale is a 17-point scale which has been validated for use by non-geriatricians[23] only takes 5 minutes to complete. Another example is the Clinical Frailty Scale[19] which stratifies individuals according to their level of vulnerability based on a 9-point system. It is simple and can be performed easily by trained staff in an out-patient setting. The best tool to be used is yet to be determined but, with regards to the implementation of tools or scoring systems, the objective of identifying and stratifying who are ‘at risk’ should then subsequently be followed by measures which aim at lowering the risk by amending any modifiable risk factors.

There is quite a lot of evidence on how we can modify frailty. For instance, a recent Cochrane review has shown that both strength and function are

improved after a period of resistance training[24]. It was also found that both mobility and the activities of daily living in frail people who required long-term care were improved after group and individual exercise training programmes[25]. Similarly, nutritional supplement such as vitamin D[26] and protein have been proposed, in susceptible individuals, to combat the overlapping geriatric syndrome of sarcopenia, although the role of nutritional enhancement in minimising the adverse outcomes post-surgery for frail patients still requires investigation with further large scale studies[27]. Pharmacological agents, notably, angiotensin-converting enzyme inhibitors (ACEI) have been shown to slow down the decrease of muscle strength in the elderly[28]. Its potential role in reducing the progression of sarcopenia has attracted interest for future research.

In conclusion, preoperative recognition of frailty is essential, and the diagnosis should be followed by measures such as nutritional screening and prescription of exercise training programs with the aim of improving functional status before surgery. These can be incorporated into a comprehensive, multidisciplinary geriatric assessment program as this is the current gold standard for diagnosing

frailty. Anaesthetists should take an active role in pre-operative consultation to diagnose the condition and coordinate with various specialists regarding initiation of treatment and follow-up of patients perioperatively. Additionally, for patients who are categorized to be ‘most frail’, it is important for us to discuss the potential surgical outcomes, in terms of morbidity, mortality and quality of life, with patients and their families so that shared decision-making can be performed on whether major surgery should be undertaken.

Recommendation 3: Every institution should include perioperative neurocognitive dysfunction as part of informed consent in elderly patients requiring anaesthetic care. Appropriate follow-up should be arranged if necessary.

Perioperative neurocognitive disorder (POCD) encompasses a wide spectrum of cognitive disorders that have been identified during the perioperative period, including mild cognitive dysfunction diagnosed before the surgery, such as mild cognitive impairment, dementia, delirium, delayed neurocognitive recovery and

postoperative neurocognitive disorder[29]. These entities exhibit significant overlap in terms of risk factors, clinical presentation, onset and duration of symptoms. Importantly, one diagnosis does not exclude the other. Mild cognitive impairment and dementia are commonly underdiagnosed before surgery. Any form of acute events that occur in the hospital up to 1 week post-procedure or until discharge (whichever happens first) is defined as postoperative delirium. In contrast, an objectively quantifiable cognitive decline that happened from 1 month up to 12 months after anaesthesia and surgery is known as delayed neurocognitive recovery and postoperative neurocognitive disorder, respectively. Neurocognitive disorder is prevalent among the elderly, with 14% to 48% aged over 70 years suffering from mild cognitive impairment and another 10% suffering from frank dementia[30]. Postoperative cognitive disorder is also common and happens in more than 10% of patients older than 60 years old undergoing non-cardiac surgery[31]. Therefore, a substantial proportion of patients who are ‘older old’ and the ‘oldest old’ will suffer from certain degrees of POCD along their perioperative journey. The significance of this issue has been highlighted in 2018 in the Fifth International Neurotoxicity

Working Group[32], with recommendations made for different perioperative phases.

Preoperatively, it is strongly suggested that, all patients aged over 65 should be clearly informed about the risks of POCD after surgery so that both they and their families will have a better understanding of this condition during the postoperative course. Apart from risk conveyance, educating patients and their families can enable them to advance plan and make important decisions should cognitive status really deteriorate after surgery. It also enables all healthcare professionals involved in the care of patients to acknowledge the risk and then implement measures to mitigate the conditions. So, patients falling into the above mentioned age group or those with risk factors should have their baseline cognitive function evaluated with an objective screening tool before the operative procedure. There are many cognitive screening tools available and each has different sensitivity and specificity for identifying cognitive impairment with no specific consensus to dictate which one should be used for this setting. In general, anesthetists can perform a simple and quick assessment with the Mini-Mental State Examination or Minicog which all take less than 10 minutes

to complete. Patients who are stratified as high risk should undergo ‘brain health protective programs’, such as orientation strategies, education on sleep and nutrition hygiene, family engagement and initiation of specific intraoperative management, all of which have been proven to reduce POCD[33].

Intraoperatively, there is no evidence that any particular mode of anaesthesia[34] and agents are associated with an altered risk of developing POCD, while complementing or replacing general anaesthesia with a regional technique is not always feasible and is also not supported by the current literature. However, it is still recommended to employ extra monitoring to avoid overdosing anesthetics in elderly patients, which is relevant for brain protection and prevention of overt hemodynamic fluctuation secondary to the negative inotropic effects of excessive anesthetic drugs. This is supported by the findings from the cognitive dysfunction after anaesthesia (CODA) trial[35] and also a Cochrane review which concluded that intraoperative processed EEG monitoring[36] can enable more meticulous titration of depth of anesthesia and potentially reduce the incidence of POCD. When an inhalational technique is used, it is important to be aware of the age-dependent changes in minimal

alveolar concentration (MAC) of inhalational anesthetics and, therefore, monitor the age-adjusted MAC through end-tidal gas concentration[37]. Propofol intravenous anaesthesia, likewise, should be carefully titrated with a target controlled infusion as there will be increased pharmacodynamic sensitivity. In addition to the above, anesthetists should avoid or minimize the use of drugs that are known to contribute to postoperative dysfunction. Examples include anticholinergics, skeletal muscle relaxants, benzodiazepines, meperidine and metoclopramide.

Delirium increases the risk of death, complications (e.g. falls, pneumonia) and length of hospital stay. Neurohumoral inflammation, surgical stress response, thromboembolism, direct anaesthetic agent toxicity, hypoperfusion and hypoxaemia may all be implicated. Propofol has anti-inflammatory effects, free radical scavenging and preserves cerebral autoregulation[38]. A protective effect of propofol has been demonstrated in diverse models of neuronal injury and it is likely to exert less neurotoxicity than inhalational anaesthetic drugs[39]. A recent Cochrane review found low-certainty evidence that maintenance with

propofol-based TIVA may reduce POCD and identified a number of on-going studies in this field[36].

In the immediate postoperative period, postoperative delirium should be actively sought and treated as it is associated with subsequent development of POCD. For high risk cases, anesthetists should liaise with the parent team to arrange formal assessment of cognitive function and follow-up of patients at outpatient clinics. It is important for institutions that are involved in the perioperative care of elderly patients to establish a protocol with measures to prevent or reduce and follow-up this condition.

Conclusion

Managing ‘the older old’ and ‘the oldest old’ during their perioperative journey is challenging and complex. The scope is not only limited to reducing postoperative morbidity and mortality, but should extend to consideration of the overall well-being and quality of life of older patients before and after surgery. Clinicians should, therefore, not only focus on perioperative anaesthetic management per se, but also actively engage the patients and their families in the whole process by exploring their expectations towards surgery as well as

providing a realistic explanation of what is going to happen throughout the perioperative period. Institutions with a high intake of very old patients should establish protocols targeting specific postoperative problems or complications and should provide sufficient education and training to their staff so that they can be sensitive and competent in managing this vulnerable group.

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