Preoperative Optimization of the Elderly Patient Prior to Vascular Surgery

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2.1 General Changes Associated with Aging

In aging, multiple factors including biologic, genetic, environmental, and lifestyle choices effect longevity [1]. Elderly patients exhibit diminished physiologic reserves and often require exhaustion of these reserves to maintain homeostasis. Sarcopenia relates to nutrition and decreased muscle mass in elderly patients compared to age-matched controls. It has been found to correlate with a markedly increased risk of mortality and morbidity [2, 3]. Muscle breakdown and anorexia occur due to an upregulation of IL-1, IL-6, and TNF-alpha [4, 5]. Sarcopenia is observed in more than half of patients over the age of 80 and leads not only to a loss of muscle mass but a decrease in strength and functionality [6, 7]. There is a shift in body mass from muscle to adipose tissue. This is associated with a loss of lean body mass and total body water. This has important implications when prescribing and dosing medications, resulting in higher average and peak plasma concentrations and decreased clearance [8]. Additionally, low albumin levels increase the free levels of drugs usually bound by albumin [9]. Given the patient population a vascular surgeon treats, the presence of sarcopenia should be given consideration when counseling patients as it equates to an approximate two- to threefold risk of complications and mortality compared to the nonsarcopenic patient.

Elderly patients have structural anatomical changes that significantly affect the physiology of individual organ systems. From a cardiopulmonary perspective, decreased chest wall compliance, maximum inspiratory and expiratory force, vital

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capacity, mucociliary clearance, cough reflex, and autonomic response to hypoxia and hypercapnia [10, 11]. Due to changes in pulmonary compliance and incomplete elimination of anesthetics, one must remember respiratory drive may be decreased and aggressive pulmonary toilet must be incorporated. Upright positions and early mobilization must be employed to prevent atelectasis [10].

Cardiac changes include septal thickening, atrial and valvular dilation, and fibrosis of the conduction system [12]. Overall, elderly experience decreased contractility, compliance, and arrhythmias. The most common cause of death in the perioperative elderly patient is cardiac in origin [13]. Myocardial infarction mortality is increased in those over the age of 75 compared with those below 55, 17.8% versus 2.0% [14]. It is vital to recall that a third of patients over 85 will present with classic chest pain during cardiac events, whereas nonspecific complaints are more common heralding a cardiac event [15]. Preoperatively, ECG should be obtained, as well as cardiac clearance should the patient have known underlying cardiac disease. In most vascular procedures, cardiac medications can be continued and case-by-case decisions made regarding anticoagulation or antiplatelet agents given the patient's underlying disease and in conjunction with cardiology recommendations. A multidisciplinary approach is recommended to prevent readmission, improve medication compliance, and improve the functional status of the patient [16].

These changes predispose vascular patients to reduced reserve during open operative cases where cavities are violated, proximal aortic clamping is required, and increased blood loss is expected.

Elderly patients often experience renal dysfunction with reduced glomerular filtration rate and are predisposed to volume overload [17], acute-on-chronic kidney injury, and electrolyte abnormalities [18, 19]. The renal dysfunction in elderly patients should be carefully noted as postoperative renal dysfunction in the elderly is perhaps the single biggest risk factor for increased morbidity and mortality in our surgical elderly population [20, 21]. Knowing renal senescence, irreversible functional and structural changes associated with the kidneys of an aging patient, we must be cognizant of volume overload and electrolyte abnormalities, which are often exacerbated in the perioperative period [21]. Renal failure is not necessary to create a poor postoperative outcome as positive fluid balance alone is an independent risk factor for mortality in critically ill patients with acute kidney injury [22, 23].

The gastrointestinal system remains relatively unchanged in physiology compared to those mentioned previously [24, 25]. Dysphagia is often noted in the perioperative period, but this is more so related to neurologic dysfunction [26]. Postoperative dysphagia, which can lead to aspiration, is often best addressed by a multidisciplinary team of nursing, speech therapy, and the surgical team if identified preoperatively, as aspiration precautions should be mandated in elderly patients who are high risk. H. pylori infection does demonstrate increased incidence with age, thus predisposing patients to gastritis and ulcers, but treatment is similar to that in younger patients. Some studies have noted a shortening of the villi and thus decreased surface area of the intestine with age, which may compound the

malnutrition observed in older patients [27]. The presence of malnourishment is observed in 70% of hospitalized elderly patients and is associated with increased morbidity and mortality [28, 29]. Involuntary weight loss is often related to multifactorial risk factors in this patient population [30, 31], but most importantly unintentional weight loss has been repeatedly demonstrated in the literature to be predictive of poor outcomes.

2.2 Preoperative Evaluation of the Surgical Patient: Risk Assessment and Counseling

Consistent with appropriate clinical care, every patient should undergo a thorough history and physical examination, as well as directed evaluation focusing on their underlying comorbidities and extent of necessary operation. Emerging evidence suggests that an objective risk assessment to identify the frail patient can guide decision-making in the preoperative setting, and is important considering 60% of operative interventions performed are done for patients over the age of 65 [32].

Frailty is now a recognized geriatric syndrome that is a strong predictor of postoperative outcomes [33–36]. Frailty, although similar to the previously mentioned sarcopenia, is defined broadly by the presence of one or more of the following: physiological comorbidities, cognitive, physical function, and nutritional and social decline leading to an inability to tolerate physiologic insults. As frailty has become recognized as perhaps the single biggest global risk factor for poor surgical outcomes including mortality, morbidity, length of stay, and readmission rate, it behooves the vascular surgeon to know the basis for assessing frailty in the surgical patient and have the ability to apply frailty identification in surgical practice. Two classic approaches have been utilized to assess the surgical patient for frailty preoperatively. The first is to identify the *frailty phenotype*, which relies heavily on sarcopenic assessment. This is performed using the classic Fried assessment consisting of grip strength, walking speed, exhaustion, and leisure time assessment questionnaires. This approach, although time-consuming taking 20–30 min to complete, has now been clearly documented with markedly increased negative outcomes in surgical patients. The Fried-Hopkins frailty index, when compared to standard risk prediction models, improved the predictive power of associated perioperative risk. Those identified as frail showed increased risk of complications, length of stay, and discharge to facility [35, 36]. The second approach popularized by Rockwood is referred to as the *deficit accumulation index* (DAI). Several DAI tools are available to assess the presurgical patient including the Risk Analysis Index, the FRAIL scale, and mFI. All of the tools rely on simple powerful questions that are nonphysiologic in nature but have high prognostic validity and have been explored in the vascular surgery patient population. Alluding to the strength of this approach, both the Risk Analysis Index (RAI) and Modified Frailty Index (mFI) have been used to assess national outcome databases to demonstrate that poor outcomes in carotid and aneurysm patients, respectively, can be predicted by assessing the frailty status of the preoperative patient. In specific cases such as carotid endarterectomy where

outcomes are of utmost importance, recent data suggests it is very important that frail patients are informed of the risk-benefit ratio of the proposed procedure, especially asymptomatic patients. Data suggests that higher RAI or frailty scores were correlated with higher morbidity and mortality than the "acceptable" risk of undergoing CEA Carotid Endarterectomy defined by preceding trials. The utility of this approach is the ease of administration of the tool, which takes less than five min to administer. This simple tool provides the surgeon the ability to identify the patient at marked increased surgical risk in an objective and systematic fashion and provide specific counseling to the patient. This in particular has been used to identify the frail patient in a busy clinic and provides an indicator for an opportunity to refer the patient to the palliative care team for discussions on goals of care to best honor the patient's preferences [32].

Special mention regarding cognitive dysfunction is necessary given our patients' age and prevalence of this condition postoperatively. Surgeons must be mindful of postoperative cognitive impairment in elderly patients. The literature suggests that postoperative delirium, an acute change in cognition characterized by fluctuating attention and consciousness, has an incidence of 36–75% in older adults [37, 38]. Although this is often recognized in our patients, it has been shown to correlate with prolonged length of stay, delayed recovery, and increased morbidity and mortality [39]. Although multiple factors may contribute to postoperative delirium, Inouye et al. have identified five independent risk factors: baseline dementia, vision impairment, physical restraints, functional impairment, and a high number of comorbidities [40]. One may perform the Mini Mental Status Exam, Abbreviated Mental Test, or Confusion Assessment Method to confirm the diagnosis and follow improvement or decline. In an effort to combat delirium, we should monitor and correct dehydration and infectious etiology and return glasses and hearing aids to patients as early as possible. To treat acutely, haloperidol can be used, but if ineffective, lorazepam should be considered [39]. Lastly, normalization of sleep-wake cycle may also be useful. Postoperative cognitive dysfunction may occur later in the postoperative course. It is often more subtle compared with delirium but may be more longstanding. It is characterized by impairment of memory, concentration, and social integration. The literature states that 25% of patients were noted to have postoperative cognitive dysfunction and it remained in 10% at 3 months [41]. Similar to delirium, cognitive dysfunction is also related to increased morbidity and mortality [42]. The use of general anesthesia, multiple comorbidities, and poor functional status is associated with increased risk of cognitive dysfunction [43]. Diagnosis is difficult due to lack of uniform criteria and is often confused with features of Alzheimer's, and even when diagnosed there is no uniform evidence for successful treatment [39, 44].

Those who are identified as frail should ideally undergo a comprehensive geriatric assessment and have a palliative care consultation in conjunction with the standard physiologic workup. This approach will allow the vascular team to incorporate shared decision-making and discussion of increased morbidity and mortality compared to the nonfrail patient; develop a comprehensive treatment plan; provide

simple pre-, intra-, and postoperative interventions to improve outcomes; and ultimately increase the communication amongst providers regarding treatment of the high risk patient [40]. An excellent roadmap has been generated by the American College of Surgeons in collaboration with the American Geriatrics Society to create guidelines for the workup of the elderly frail patient. The comprehensive geriatric assessment should not be looked at as an all-or-none endeavor but rather that individual sections of the Comprehensive Geriatric Assessment (CGA) can be chosen a la carte based on the needs of the individual patient [45, 47].

Alluding to the usual sound clinical judgment, mortality rates for elective operations in the elderly are similar to those in younger cohorts; however, this is not applicable in emergent cases. Emergent cases are both more prevalent in elderly patients and carry a much higher morbidity and mortality when compared with younger patients [48–51]. Furthermore, many postoperative elderly patients require discharge to facilities and experience a significant decrease in independence [51, 52]. Taken in total, the data stresses the importance of screening and optimization of elderly patients who must undergo surgical intervention. Additionally, this should encourage us to have appropriate and candid discussions and place emphasis on shared decision-making regarding appropriate risk and end-of-life care.

2.3 Optimization of the Preoperative Patient

Once a surgeon identifies a patient being at higher risk due to physiological comorbidities, and cognitive, social, physical, or nutritional dysfunction, an attempt should be made to address the underlying cause of the dysfunction and ameliorate the perioperative stress. Preoperative patient comorbidities are common, and once identified, the treatment of pulmonary, cardiac, and renal dysfunction should be addressed through appropriate consultations and medical management, the scope of which is beyond this chapter. From a frailty perspective, the ability to reverse or ameliorate the individual aspects of dysfunction is in its infancy, and it is expected over the next decade that intense research and trials will occur to address the ability of interventions to improve the outcomes in this vulnerable population. Current evidence demonstrates that individual interventions can improve the underlying dysfunction if given adequate time. Given that many vascular surgery patients are elderly and many are frail, the obvious question to ask is whether preoperative frailty is a modifiable risk factor. Data in community-dwelling patients suggests that frailty in fact is a syndrome where a patient can fall in and out of frailty over time. Thus, it would appear that frailty can be modified. What remains to be seen is whether the modification can be made for the vascular surgery patient who is often in a situation where delaying elective procedures is not an option, such as symptomatic carotid disease or rest pain. However, there are situations where a person who is frail may benefit from preoperative intervention, including elective abdominal aortic aneurysm repair depending on aneurysm size and asymptomatic carotid

artery. Individually, the frailty domains of social, cognitive, nutritional, and physical function have not been widely studied in frailty specific populations. Perhaps the easiest and most promising route of intervention is that of nutrition. A recent pilot randomized study in colon cancer patients has shown the ability of nutrition counseling plus whey protein to significantly improve physical function in the form of walking. A similar pilot study combining nutritional counseling with anxiety reduction demonstrated postoperative walking to be significantly improved in the intervention arm. Thus, it seems nutritional intervention may be a likely target for patients that is relatively easy to administer, but it is yet unknown whether improvements in surgical outcome will occur. In contrast to nutrition, where human intervention is well accepted and reasonable, postoperative cognitive dysfunction is thought to be associated with a neuroinflammatory state with upregulation of IL1-Beta, IL-6, and TNFalpha. Several substances including lithium and candesartan in the aged rat model have proven to be neuroprotective after laparotomy, and suggest a potential avenue for tackling this vexing problem. Socially, little has been done in the way of intervention, but data from cardiac surgery suggests those patients with high levels of social deprivation are expected to have worse outcomes. Although frailty itself is reflective of systemic dysfunction by multiple systems, it is perhaps the best treatment preoperatively, being a wide and diverse approach as advocated by the Proactive care of older people undergoing surgery (POPS) study by Harari et al. [52]. Using multidisciplinary preoperative CGA service with postoperative follow-through, the authors demonstrated marked improvements in surgical outcomes including delirium, pneumonia, and pain control. These findings were repeated in both Scotland and Nebraska, where coordination of preoperative care among a diverse and collaborative team resulted in markedly improved outcomes for frail elderly patients. Thus, as the literature stands there is no magic pill to reverse frailty or single interventions to markedly improve outcomes. However, growing evidence suggests that multimodal intervention through increased communication and use of geriatric or palliative care consultations holds promise to significantly improve surgical outcomes.

Key Points

- Vascular surgery is a challenging specialty, with the average age of our patients being >65 years. Thus, a knowledge of the physiological changes in the arterial system is of significant importance to the vascular surgeon.
- Given the multiple comorbidities present, it is crucial for the vascular surgeon to be able to identify the frail vascular patient with comorbidities and improve the outcomes of operations by optimizing the comorbid conditions.
- Vascular surgery broadly encompasses interventions related to arterial, venous, and lymphatic pathophysiology. The vascular surgeon establishes a diagnosis and a therapeutic plan and then must determine whether elective, urgent (24–72 h), or emergent intervention is warranted. In the case of urgent or elective interventions, time may allow for a more extensive preoperative evaluation.

- Vascular patients by default due to multiple comorbidities often require extensive workup. When coupled with the average age of the vascular patient, it becomes clear that vascular surgeons are often intervening on the multiple chronic condition elderly patient, and thus the recognition of changes associated with aging is paramount in our specialty.

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