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Consensus and Guideline

Expert consensus on preoperative assessment and management for older patients with degenerative spinal diseases

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Abstract

Population aging has drastically increased the prevalence of degenerative spinal diseases in Chinese patients aged 65 years and older, who frequently carry multiple systemic comorbidities that significantly elevate perioperative surgical risks. Standardized preoperative evaluation and individualized perioperative management are urgently needed to improve spinal surgery safety for

this vulnerable population. This expert consensus was formulated by a multidisciplinary panel of spinal surgeons, geriatricians, cardiologists, anesthesiologists and respiratory specialists, using a modified Delphi process based on domestic and international clinical evidence, aiming to unify preoperative assessment criteria and optimize comprehensive perioperative strategies for older patients with degenerative spinal disorders. The consensus systematically elaborates standardized assessment and management protocols covering ten core clinical issues: coronary heart disease and antiplatelet therapy after percutaneous coronary intervention (PCI), perioperative anticoagulation for atrial fibrillation, hypertension control, glycemic regulation for diabetes, cardiopulmonary function evaluation, cerebrovascular disease screening, nutritional risk intervention, preoperative cognitive function assessment, and frailty. This consensus provides a standardized, operable clinical framework for perioperative risk control in older spinal surgery patients, reduces perioperative major adverse events, and facilitates safer, more individualized perioperative management for aging patients with degenerative spinal diseases.

Keywords: aged, spinal Diseases, perioperative care, risk assessment, consensus

1. Introduction

Population aging has become a major public health challenge in China and across the world. Aging is an important risk factor for degenerative spinal diseases. With the acceleration of population aging, the incidence of such diseases has increased year by year. In this consensus, older patients are defined as those aged $\geqslant$ 65 years, consistent with the World Health Organization's definition of older adults and the threshold commonly used in the spinal surgery literature.

Older patients with spinal diseases are frequently complicated with a variety of systemic underlying diseases. For those scheduled for surgical treatment, in addition to local spinal lesions, comprehensive preoperative assessment of general physical status is essential to predict and reduce surgery-related risks.

To further standardize the preoperative evaluation criteria for older patients with spinal diseases, improve surgical safety and optimize the overall perioperative management, this expert group formulated the consensus in accordance with standardized procedures. Focusing on common

comorbidities and issues concerning preoperative evaluation in older patients undergoing spinal surgery, we collected opinions from multidisciplinary experts including surgeons and physicians at numerous top spinal centers nationwide in China, and finally completed this expert consensus. We graded the quality of evidence and strength of recommendations based on the GRADE system. All recommendations are labeled with the level of evidence (High, Moderate, Low, or Very Low) and the strength of recommendation (Strong or Conditional) according to the GRADE approach.

2. **Methods**

This consensus was developed following a structured, evidence-based process. The expert panel comprised 30 multidisciplinary specialists from the fields of spine surgery, geriatrics, cardiology, anesthesiology, and respiratory medicine, representing multiple tertiary spinal centers in China.

A systematic literature search was conducted in PubMed, Embase, CNKI, and the Cochrane Library up to December 2024, supplemented by manual screening of the reference lists of relevant guidelines and reviews. For each clinical question, the panel formulated a structured question using the PICO (Population, Intervention, Comparison, Outcome) framework.

Two rounds of a modified Delphi voting process were conducted, with an 80% agreement threshold required for consensus. Disagreements were resolved through structured discussion, followed by a third voting round when necessary.

The quality of evidence and the strength of recommendations were graded using the GRADE approach. The scope of this consensus is limited to elective spinal surgery in older patients (aged $\geqslant$ 65 years) with degenerative spinal diseases; emergency and urgent procedures are excluded. The recommendations are primarily based on patients undergoing general anesthesia.

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3. Indications for preoperative coronary computed tomography (CT) angiography or coronary angiography

Patients with a documented history of cardiovascular disease (CVD) [1] (including those receiving

pharmacological therapy, prior percutaneous coronary intervention (PCI), or post-coronary artery bypass grafting), or those with high-risk factors for coronary artery disease [2] (e.g., hypertension, diabetes mellitus, hyperlipidemia, or smoking), who present with exertional chest tightness, chest pain, or dyspnea, or demonstrate ST–T abnormalities on electrocardiography [3], or exhibit regional wall motion abnormalities or a reduced left ventricular ejection fraction (< 50%) on echocardiography [4], may be considered for coronary CT angiography (CCTA) to provide an initial assessment of coronary status and to aid in stratifying the risk of perioperative major adverse cardiovascular events (MACE).

Older patients in whom CCTA demonstrates single- or multi-vessel coronary stenosis greater than 70% [2, 5], should undergo invasive coronary angiography (ICA) for further evaluation of coronary lesions and determination of the need for PCI. The final decision may be made in consultation with a cardiologist.

Older patients presenting with acute coronary syndrome (ACS) [6], persistent angina despite maximal antianginal therapy [7], newly diagnosed ischemic heart disease based on stress testing, or those with current or prior noninvasive evaluations suggesting possible left main disease [6, 8] or severe coronary lesions [8], may be referred to cardiology for direct ICA to assess coronary anatomy. Decisions regarding the need for PCI should then be made based on angiographic findings.

3.1 Recommendations

1. We recommend against routine preoperative coronary angiography in patients with stable CVD [9] (Level of evidence: Low; Strength of recommendation: Conditional).

2. It is recommended to carefully weigh the cumulative risks of PCI and spinal surgery when considering preoperative PCI [10]. A comprehensive assessment of the patient's overall health, functional capacity, and prognosis is advised [9] (Level of evidence: Moderate; Strength of recommendation: Conditional).

4. Duration of antiplatelet therapy after PCI and timing of spinal surgery

Patients who have undergone balloon angioplasty without stent implantation may proceed with elective spinal surgery after 2–4 weeks of dual antiplatelet therapy (DAPT) [8, 11-13].

In older patients with drug-eluting stent (DES) implantation, the timing of spinal surgery should be carefully considered. For those undergoing DES-PCI for chronic coronary disease (CCD), spinal surgery is recommended to be delayed for at least 3–6 months after PCI to minimize the risk of perioperative MACE [9, 14]. In patients who have undergone complex DES-PCI (e.g., bifurcation stenting, long stent implantation, or multivessel PCI), or when detailed information regarding prior DES-PCI is unavailable, spinal surgery is recommended after 6–12 months [8,15]. For patients undergoing DES-PCI in the setting of ACS, elective spinal surgery is recommended to be deferred for 12 months after PCI [8, 14, 16]. In selected patients in whom the risk of delaying surgery exceeds the risk of MACE, spinal surgery may be considered at $\geqslant$ 3 months after PCI, following a comprehensive assessment of the individual risk–benefit profile [9, 17].

4.1 Recommendations

1. In patients with a history of coronary artery disease and/or prior PCI, perioperative antiplatelet management is of critical importance in the setting of spinal surgery. The timing of antiplatelet therapy interruption must balance the risk of thrombotic complications against surgical risk (Level of evidence: Moderate; Strength of recommendation: Strong).

2. The duration of antiplatelet therapy interruption should be individualized to balance the risk of perioperative MACE against the anticipated surgical benefit (Level of evidence: Moderate; Strength of recommendation: Conditional).

3. Decisions regarding perioperative discontinuation of aspirin and/or P2Y12 receptor inhibitors should be made through a multidisciplinary team approach, involving the interventional cardiologist, spine surgeon, geriatrician, pharmacist, as well as the patient and their family [9] (Level of evidence: Moderate; Strength of recommendation: Strong).

5. Principles of perioperative anticoagulation management in patients with atrial fibrillation (AF)

5.1 Patients with stable AF, no prior thromboembolic events, and receiving oral anticoagulation (OAC)

(1) Patients treated with non–vitamin K antagonist oral anticoagulants (NOACs)

Given that spinal surgery is associated with a high risk of bleeding, perioperative management of NOACs should be adjusted according to renal function. In older patients with AF receiving factor Xa inhibitors (e.g., rivaroxaban, apixaban, edoxaban) [18], the last dose should be taken on day −3 (i.e., 3 days before surgery) when creatinine clearance (CrCl) ⩾ 30 mL/min, and on day −4 when CrCl < 30 mL/min, thereby omitting two and three full dosing days, respectively, before the procedure (Level of evidence: Moderate; Strength of recommendation: Strong).

In older patients receiving direct thrombin inhibitors (e.g., dabigatran), the last dose should be taken on day −2 (i.e., 2 days before surgery) when CrCl ⩾ 50 mL/min, and on day −4 when CrCl < 50 mL/min, thereby omitting one and three full dosing days, respectively, before the procedure (Level of evidence: Moderate; Strength of recommendation: Strong).

For the above patients, bridging anticoagulation is not recommended during the perioperative period. Resumption of anticoagulation therapy is recommended 48–72 hours after surgery, provided that adequate hemostasis has been achieved [8, 9, 18].

The exact timing of the last dose for each DOAC agent, based on the PAUSE protocol [19], is summarized in Table 1.

Table 1. Preoperative discontinuation timing of direct oral anticoagulants (DOACs) for elective spinal surgery

Drug	Renal function (CrCl)	Timing of last dose
Rivaroxaban/apixaban/edoxaban	⩾ 30 mL/min	Day −3 (omit 2 full dosing days)
Rivaroxaban/apixaban/edoxaban	< 30 mL/min	Day −4 (omit 3 full dosing days)
Dabigatran	⩾ 50 mL/min	Day −2 (omit 1 full dosing day)
Dabigatran	< 50 mL/min	Day −4 (omit 3 full dosing days)

(2) Patients receiving warfarin therapy

In older patients with AF receiving warfarin, discontinuation is recommended 5–7 days prior to spinal surgery, with a target international normalized ratio (INR) of 1.8–2.0 before surgery [20]. For patients at low to moderate thromboembolic risk, bridging anticoagulation is generally not recommended [9]. In contrast, for patients at high thromboembolic risk—such as those with prior mechanical valve replacement, a CHA_2DS_2-VASc score $\geqslant$ 6, or a history of stroke or transient ischemic attack (TIA) within the past 3 months [9], bridging anticoagulation with low-molecular-weight heparin (LMWH) is recommended [21, 22].

The timing of postoperative resumption of warfarin following spinal surgery should be determined through a comprehensive assessment of bleeding and thrombotic risks, ideally via multidisciplinary discussion involving spine surgeons and geriatricians. In patients at low to moderate thromboembolic risk, warfarin may be resumed on the first day of planned anticoagulation reinitiation. In high-risk patients, combined therapy with warfarin and LMWH is recommended starting on day 1 of anticoagulation resumption, with LMWH discontinued once the INR reaches 1.8–2.0, after which warfarin monotherapy should be continued [9].

5.2 Older patients with AF and a history of thromboembolism

In older patients with AF and a prior history of thromboembolism, oral anticoagulants should be discontinued preoperatively according to the aforementioned protocols, and bridging anticoagulation with LMWH is recommended. LMWH should be withheld on the day of surgery [9, 19]. Postoperatively, in the absence of bleeding complications, LMWH anticoagulation should be resumed as early as feasible. Following hospital discharge, patients may return to their previous long-term anticoagulation regimen.

5.3 Patients with newly diagnosed AF

In patients with newly diagnosed AF, both bleeding risk and thromboembolic risk should be systematically assessed. Anticoagulation is recommended in patients who meet thromboembolic risk thresholds—men with a CHA_2DS_2-VA score $\geqslant$ 2 and women with a score $\geqslant$ 3, according to the 2024 ESC guidelines [23]. The HAS-BLED score should be used to identify modifiable bleeding risk factors and to guide closer monitoring and periodic reassessment, rather than as a

criterion for determining anticoagulation eligibility. In such patients, bridging anticoagulation with LMWH may be considered preoperatively, and anticoagulation therapy should be resumed as early as feasible after surgery [9, 24]. Referral to cardiology is recommended to guide the selection of an appropriate anticoagulant regimen based on the patient's clinical profile. Importantly, a HAS-BLED score $\geqslant$ 3 does not constitute a contraindication to anticoagulation [25]. In patients at high bleeding risk, closer monitoring and periodic reassessment are warranted, as bleeding risk is dynamic [26]. Accordingly, anticoagulation strategies should be individualized and adjusted over time based on the patient's evolving clinical condition [19].

5.4 Recommendations

1. In older patients with AF receiving long-term OAC, balancing perioperative risks remains particularly challenging. When formulating a perioperative management plan for elective spinal surgery, patient-related factors (e.g., age, thromboembolic risk, renal function, and bleeding history), procedure-related factors (e.g., operative duration and bleeding risk), and pharmacologic characteristics (e.g., dosage, drug interactions, and onset/offset of action) should all be taken into comprehensive consideration (Level of evidence: Low; Strength of recommendation: Conditional).
2. Whenever feasible, a multidisciplinary evaluation is recommended, including the OAC prescriber, cardiologist, spine surgeon, anesthesiologist, and geriatrician, to optimize perioperative risk assessment (Level of evidence: Moderate; Strength of recommendation: Strong).

6. Perioperative blood pressure management and antihypertensive therapy

In older patients with a confirmed diagnosis of hypertension who have well-controlled blood pressure under long-term medication, the preoperative antihypertensive regimen may be continued without modification, with regular monitoring of blood pressure fluctuations during the perioperative period.

In older patients with poorly controlled hypertension and additional cardiovascular risk factors, if preoperative systolic blood pressure (SBP) $\geqslant$ 180 mmHg or diastolic blood pressure (DBP) $\geqslant$ 110 mmHg, adjustment of the antihypertensive regimen is recommended, and elective surgery should be postponed to reduce perioperative cardiovascular risk [27]. When preoperative SBP is

between 160 and 180 mmHg, timely optimization of antihypertensive therapy is recommended, and surgery may be performed once blood pressure is adequately controlled [28]. If preoperative SBP is ⩽ 160 mmHg, postponement of spinal surgery is not recommended, and only adjustment of antihypertensive medication is required [9].

In older hypertensive patients receiving long-term β-blocker therapy, perioperative continuation of β-blockers is recommended [9]. In older patients receiving antihypertensive regimens containing reserpine, discontinuation or replacement with alternative antihypertensive agents is recommended 1 week prior to surgery [29], to avoid refractory intraoperative hypotension.

In older patients treated with diuretics for hypertension, temporary discontinuation on the day of spinal surgery is recommended [30]. For patients receiving renin–angiotensin–aldosterone system inhibitors (RAASi), perioperative blood pressure monitoring is recommended, and if necessary, withholding RAASi 24 hours preoperatively may be considered to reduce the risk of intraoperative hypotension [9]

In older patients, large perioperative blood pressure fluctuations should be strictly avoided, with particular emphasis on preventing perioperative hypotension. Intraoperatively, it is recommended to maintain a mean arterial pressure (MAP) ⩾ 60 mmHg or systolic blood pressure (SBP) ⩾ 90 mmHg [9, 31]. Perioperative blood pressure variability should be limited to within ± 20% of baseline values, and excessively low target blood pressure should be avoided. This is especially important in older patients with a history of cerebrovascular disease or carotid artery stenosis, in whom adequate perfusion of vital organs (including the heart, brain, and kidneys), should be ensured to reduce the risk of adverse cardiovascular, renal outcomes and mortality.

6.1 Recommendations

In addition to baseline blood pressure, perioperative blood pressure management in older patients should be individualized by integrating overall cardiovascular risk, age, comorbidities, surgical type, anesthetic technique, and the risk of short-term perioperative complications (Level of evidence: Moderate; Strength of recommendation: Strong).

7. Perioperative glycemic management

Preoperatively, older patients undergoing spinal surgery should undergo routine screening of fasting plasma glucose and glycated hemoglobin (HbA1c). Elective surgery is recommended to be postponed in patients with HbA1c > 8.0% [32].

In older patients with diabetes who are in good or intermediate health status, an HbA1c target of < 8.0% is recommended before elective spinal surgery [32].

In the absence of hypoglycemia, acceptable perioperative glycemic targets include a fasting blood glucose < 8.3 mmol/L and bedtime glucose < 10.0 mmol/L [33, 34]. In cases where time-limited (urgent but non-emergent) surgery is required and HbA1c cannot be reduced to < 8.0%, it is recommended that perioperative random blood glucose be maintained within 5.6–10.0 mmol/L [34].

In older patients with diabetes who are in poor general health status and in whom spinal surgery is unavoidable, perioperative glycemic targets may be relaxed, with an acceptable HbA1c target of < 8.5% [35] and a fasting blood glucose range of 5.6–10.0 mmol/L [34]. The timing of surgery should be determined by the surgeon in a comprehensive manner, taking into account the patient's overall clinical condition and perioperative risk profile.

7.1 Antihyperglycemic treatment strategies

In older patients whose glycemic targets are not achieved with lifestyle intervention alone, pharmacologic therapy is recommended, with a preference for safe and simple regimens. First-line recommended agents include metformin (MET), dipeptidyl peptidase-4 inhibitors (DPP-4i), and sodium–glucose cotransporter 2 inhibitors (SGLT2i). If monotherapy is insufficient, combination therapy may be used, and fixed-dose combinations (FDCs) based on metformin are recommended to simplify treatment regimens.

Second-line agents include glucagon-like peptide-1 receptor agonists (GLP-1RA), α-glucosidase inhibitors (AGI), and glinides [36]. In patients with atherosclerotic cardiovascular disease (ASCVD) or high-risk features, SGLT2i or GLP-1RA are recommended as preferred agents [36]. In those with heart failure or chronic kidney disease (CKD), SGLT2i are recommended as first-

line therapy [36]. For older patients with type 2 diabetes mellitus (T2DM) and CKD who are intolerant to SGLT2i, GLP-1RA may be considered as an alternative option [36].

In older patients with a fasting plasma glucose > 11.1 mmol/L or HbA1c > 9.0%, initiation of insulin therapy is recommended, with an emphasis on de-intensified glycemic control strategies [32, 36].

Compared with multiple daily insulin injections and premixed insulin regimens, simplified insulin-based strategies are preferred due to their ease of use and lower risk of hypoglycemia. These include fixed-ratio combinations of basal insulin and GLP-1 receptor agonists [37], co-formulations of dual insulin preparations [36], and basal insulin combined with oral antihyperglycemic agents [37], all of which are more practical and associated with a lower risk of hypoglycemia.

In the majority of older patients with diabetes, preexisting antihyperglycemic regimens can be continued until the day before surgery. On the day of surgery, all oral antihyperglycemic agents and rapid-acting insulin should be withheld, while basal insulin should be reduced to 60–80% of the usual dose [32]. For patients receiving GLP-1 receptor agonists (GLP-1RA), weekly formulations should be discontinued 1 week prior to surgery, and daily formulations 1 day prior to reduce the risk of intraoperative aspiration [32, 38]. For patients receiving SGLT2 inhibitors (SGLT2i), therapy should be discontinued 2–3 days before surgery to reduce the risk of diabetic ketoacidosis (DKA) [32].

In patients with severe illness, undergoing complex surgical procedures, with an operative duration exceeding 4 hours, or with persistently elevated blood glucose levels, intravenous insulin infusion is recommended as the preferred strategy [32]. When glucose infusion is required, it is recommended to add neutralizing insulin at a glucose-to-insulin ratio of 3–4:1 (U) to achieve appropriate glycemic control [34].

7.2 Perioperative glycemic monitoring

During the perioperative period, it is essential to monitor both hyperglycemia and hypoglycemia and to minimize glucose fluctuations. In most older patients with diabetes, perioperative blood

glucose targets are 7.8–10.0 mmol/L [32]. In patients with severe comorbidities or frequent hypoglycemia, the upper limit of the target range may be relaxed to < 12 mmol/L [33, 34].

To minimize the impact of hyperglycemia on surgical outcomes, diabetic patients are recommended to undergo surgery in the morning or as early as possible. For patients scheduled later in the day, continuous glucose monitoring in the ward is advised. Postoperatively, intravenous insulin infusion can be used to control blood glucose until normal oral intake is resumed, after which preexisting antihyperglycemic regimens can be gradually reinstated [39]. Metformin may be resumed 48 hours postoperatively, once dietary intake is restored and renal function has been re-evaluated and found stable [40].

7.3 Recommendations

Glycemic management in older patients should be patient-centered, taking into full account cardiac, hepatic, and renal function, comorbidities and complications, risk of hypoglycemia, frailty status, body weight, and the preferences of patients and their families. Based on these considerations, highly individualized antihyperglycemic regimens should be developed (Level of evidence: High; Strength of recommendation: Strong).

8. Perioperative cardiopulmonary function assessment

In older patients, preoperative evaluation should routinely include cardiac troponin, N-terminal pro–B-type natriuretic peptide (NT-proBNP), and transthoracic echocardiography [9].

In older patients with NT-proBNP > 1000 pg/mL but without clinical symptoms of heart failure and with preserved left ventricular ejection fraction on echocardiography, perioperative management should focus on careful fluid balance, restriction of infusion rate, and appropriate use of diuretics [41-43].

In contrast, in patients with NT-proBNP > 1000 pg/mL accompanied by heart failure symptoms and reduced left ventricular ejection fraction (< 50%), spinal surgery is associated with high perioperative risk. In such cases, the decision to proceed with surgery should be made after comprehensive multidisciplinary evaluation of the patient’s overall condition, and postoperative

admission to the intensive care unit (ICU) should be considered. When necessary, goal-directed hemodynamic management guided by stroke volume variation, cardiac index, and mean arterial pressure may be employed, which may help improve heart failure outcomes [9, 44].

8.1 Preoperative pulmonary function assessment

Older patients scheduled for spinal surgery should routinely undergo preoperative pulmonary function testing. In patients able to cooperate with testing, comprehensive pulmonary function evaluation is recommended [45].

Patients with FEV1 > 2.0 L, FVC > 3.0 L or > 50% of predicted, FEV1/FVC > 70%, and resting PaO2 60–80 mmHg have a relatively low risk of postoperative airway complications. In contrast, patients with FEV1 < 0.8 L, FVC < 1.5 L or < 30% of predicted, FEV1/FVC < 50%, and resting PaO2 < 60 mmHg are at very high risk of postoperative airway complications, and surgery is not recommended [46, 47].

In older patients who are unable to complete pulmonary function testing due to hearing impairment or other limitations, arterial blood gas analysis combined with questionnaire-based assessment is recommended for preoperative evaluation [45, 48]. On room air, patients with $PaO_2 \geqslant 70$ mmHg and oxygen saturation (SpO_2) > 90% are generally considered fit for surgery [46].

If PaO_2 is below the target range, low-flow oxygen therapy (3–5 L/min) may be administered, followed by repeat arterial blood gas analysis after 5 minutes. In the absence of CO_2 retention, patients with PaO_2 between 60 and 70 mmHg may still proceed with surgery, provided that risks are fully explained, and postoperative management includes continuous low-flow oxygen therapy along with reinforced breathing, coughing, and sputum clearance exercises. Respiratory function should also be assessed using the modified Medical Research Council (mMRC) dyspnea scale, and patients with grades 0–1 may proceed with surgery as planned [49].

Postoperatively, continuous monitoring of electrocardiography, blood pressure, and oxygen saturation is recommended, and oxygen therapy should be guided by arterial blood gas results. In the absence of hypercapnia, an ideal target oxygen saturation of approximately 94% is suggested [50]. Patients should be encouraged to maintain a semi-recumbent or seated position to reduce the

risk of regurgitation and aspiration. Active management of vomiting, delirium, and other conditions predisposing to aspiration is essential. Early postoperative mobilization, including turning in bed and ambulation, is recommended, along with continued deep breathing and coughing exercises. Adequate analgesia is important to facilitate effective coughing and early mobilization. Increased hydration and nebulized therapy may assist sputum clearance [48].

8.2 Preoperative assessment of older patients with respiratory diseases

Patients with chronic obstructive pulmonary disease (COPD) should have their condition well controlled and clinically stable prior to surgery. Pulmonary function testing should be performed, and patients with an FEV1/FVC ratio $\geqslant$ 50% (mild to moderate disease) are generally considered able to tolerate surgery. In patients with FEV1/FVC between 30% and < 50% (severe disease), a bronchodilator reversibility test is recommended. If post-bronchodilator improvement exceeds 15% or 200 mL in absolute FEV1, surgery may still be tolerated. Perioperative management should include anti-inflammatory therapy, bronchodilation, and mucolytic treatment [51, 52].

Patients with asthma should be in a clinically stable remission phase, and surgery may be performed only when symptoms and signs have completely resolved for at least 3 months [53].

8.3 Recommendations

Respiratory function declines with age, and in older patients, baseline pulmonary changes often do not produce symptoms at rest. However, the impact of impaired lung function becomes more pronounced during anesthesia or postoperative pain. Moreover, older patients frequently have swallowing dysfunction, increasing the risk of aspiration and pneumonia. Therefore, preoperative assessment of respiratory function and optimization of coexisting respiratory diseases are essential to reduce the incidence of postoperative pulmonary complications (PPCs). When needed, joint evaluation and decision-making by anesthesiologists and pulmonologists are recommended (Level of evidence: Low; Strength of recommendation: Conditional).

9. Perioperative assessment of cerebrovascular disease

Prior to spinal surgery, older patients should undergo a detailed cerebrovascular history and routine

carotid ultrasonography [45, 54].

For patients without a history of cerebrovascular disease but with preoperative carotid ultrasound showing stenosis or suspected lesions, further evaluation with head and neck computed tomography angiography (CTA) or digital subtraction angiography (DSA) is recommended to assess cerebral vascular anatomy, blood flow, and potential underlying lesions. When necessary, consultation with vascular surgery or neurology specialists is advised to assist in perioperative risk assessment [55].

In patients with a history of cerebrovascular disease, preoperative assessment should include cranial magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA). If severe cerebral vascular stenosis or other significant lesions are identified, surgery should be postponed until adequate treatment is achieved and the patient's condition stabilizes [56].

For older patients recovering from an acute stroke, elective spinal surgery should be delayed for at least 3 months [9].

Postoperatively, acute cerebrovascular events are common and potentially severe complications in older patients. It is essential to promptly recognize and manage these events. Spinal surgery patients should be closely monitored for changes in consciousness, speech disturbances, or limb weakness. If any suspicious symptoms are detected, immediate cranial CT or MRI should be performed, and neurology consultation obtained. When necessary, patients should be transferred to neurology or intensive care units for further management [57, 58].

9.1 Recommendations

1. Perioperative cerebrovascular disease is common and severe in older patients. Preoperative assessment should be conducted by a multidisciplinary team, including neurology, vascular interventional surgery, anesthesiology, orthopedics, and geriatric medicine. When necessary, patients and their families should also be involved in shared decision-making to ensure the feasibility and safety of the treatment plan (Level of evidence: Moderate; Strength of recommendation: Strong).

2. Management of acute postoperative cerebrovascular events should rely on close collaboration

among a multidisciplinary team involving neurology, neurosurgery, anesthesiology, and critical care medicine. Prompt neurological assessment and neuroimaging should be performed, and treatment strategies should be adjusted in a timely manner to minimize neurological damage and improve patient outcomes (Level of evidence: Moderate; Strength of recommendation: Strong).

10. Perioperative nutritional assessment and intervention

Malnutrition in older patients can lead to organ dysfunction, impaired immunity, cognitive decline, and frailty [59]. In the context of spinal surgery, malnutrition is associated with delayed wound healing, increased risk of infection, higher readmission rates, and increased mortality [60]. Therefore, nutritional assessment is a critical component of the perioperative management of older patients [61].

Prior to spinal surgery, older patients are routinely recommended to undergo laboratory evaluations, including liver and kidney function tests, total protein, albumin, and nutritional risk assessment [62]. The primary goal is to identify and address malnutrition early, thereby improving surgical tolerance and reducing perioperative adverse events [63].

older patients at high nutritional risk—defined as weight loss of 10–15% within the past 6 months, body mass index < 18.5 kg/m² with poor general condition, NRS2002 ⩾ 5, or serum albumin <30 g/L without hepatic or renal dysfunction, or those who are malnourished [59, 64], are recommended to receive 1–2 weeks of preoperative nutritional support [65].

For older patients with normal gastrointestinal function, oral intake may be resumed 6 hours postoperatively. If oral intake is insufficient, oral supplementation with enteral nutrition formulas is recommended. For patients whose oral or enteral intake is less than 60% of the target for more than 7 days, parenteral nutrition should be added [59, 65].

For patients at nutritional risk, it is recommended to repeat nutritional risk screening, comprehensive nutritional assessment, and serum albumin measurement every week, with timely adjustment of the nutritional support plan [59].

10.1 Recommendations

1. It is recommended to use the Nutritional Risk Screening 2002 (NRS2002) and/or the Mini

Nutritional Assessment–Short Form (MNA-SF) as standard tools for nutritional risk screening in older patients (Level of evidence: Moderate; Strength of recommendation: Strong).

2. In older patients identified as being at nutritional risk, comprehensive nutritional assessment and diagnosis of malnutrition are recommended. The Global Leadership Initiative on Malnutrition (GLIM) criteria should be used for the diagnosis of malnutrition and for grading its severity (Level of evidence: Moderate; Strength of recommendation: Conditional).

3. In older patients with high nutritional risk or confirmed malnutrition, active preoperative nutritional support is recommended (Level of evidence: Moderate; Strength of recommendation: Strong).

11. Perioperative cognitive function assessment and intervention

Cognitive decline in older patients is associated with an increased risk of postoperative complications, mortality, and other adverse events following spinal surgery [66]. Preoperative cognitive assessment should be performed as early as possible, as it can predict the risk of perioperative cognitive dysfunction [67] and also serve as a baseline for postoperative cognitive evaluation [48].

The Mini-Cog test is recommended as a rapid screening tool for preoperative cognitive function in older patients. It is simple, efficient, and time-saving (3–5 minutes), consisting of immediate recall, delayed recall, and the clock-drawing test, and is effective in detecting early cognitive impairment [68]. Other commonly used assessment tools include the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) [69]. The MMSE evaluates orientation, memory, attention and calculation, recall, and language, whereas the MoCA assesses visuospatial/executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation. Both are influenced by age and educational level [70]. MMSE may yield false positives in patients with low education and false negatives in highly educated individuals, whereas MoCA is less affected and is more sensitive for detecting mild cognitive impairment. During cognitive assessment, differentiation from delirium and depression in the older should be carefully considered [71].

In older patients identified with cognitive impairment preoperatively, it is recommended that family members familiar with the patient's condition be involved during history taking to improve accuracy and cooperation [45]. Patients with moderate to severe cognitive impairment should receive specialist consultation from neurology or psychiatry departments for further evaluation and management [72, 73]. Preoperative education regarding delirium prevention should be strengthened, along with cognitive training interventions, and medications that increase the risk of postoperative delirium (POD), such as benzodiazepines and anticholinergic agents, should be avoided whenever possible [74].

Intraoperatively, attention should be paid to anesthetic techniques [75] and drug selection [76]. Perioperatively, optimization of comorbidities, nutritional support, and sleep quality improvement are recommended [77]. Additionally, minimizing environmental and personnel changes, and reducing unnecessary catheters and monitoring devices when feasible, may help reduce the incidence of postoperative delirium (POD) and postoperative cognitive dysfunction (POCD) [78].

11.1 Recommendations

1. For preoperative cognitive assessment in older patients undergoing spinal surgery, it is recommended that a geriatrician first perform rapid screening using the Mini-Cog test. Patients with positive screening results should undergo further evaluation using the Montreal Cognitive Assessment (MoCA), preferably in individuals with higher educational levels, or the Mini-Mental State Examination (MMSE) (Level of evidence: Moderate; Strength of recommendation: Conditional).

2. Patients with moderate to severe cognitive impairment should be referred for specialist consultation, with further evaluation and intervention initiated when necessary (Level of evidence: Moderate; Strength of recommendation: Conditional).

12. Frailty assessment and screening

Frailty is a geriatric syndrome strongly associated with perioperative mortality, functional decline, and adverse postoperative outcomes in older patients undergoing spinal surgery [79,80]. Because frailty integrates the cumulative burden of multimorbidity, disability, and decreased physiologic

reserve, its preoperative identification is essential for risk stratification and individualized decision-making.

We recommend routine frailty screening for all older patients scheduled for elective spinal surgery, using a validated tool such as the Clinical Frailty Scale (CFS) or the Fried Frailty Phenotype [81]. The CFS is a pragmatic, clinician-administered tool that grades frailty from very fit to terminally ill, whereas the Fried Frailty Phenotype captures five physical domains: unintentional weight loss, exhaustion, low physical activity, slow gait speed, and low grip strength [82,83]. Both tools have been shown to predict postoperative complications, prolonged length of stay, institutional discharge, and mortality in geriatric surgical populations. Screening should occur as early as possible in the preoperative pathway to allow sufficient time for risk modification.

Patients identified as frail or prefrail should undergo comprehensive geriatric assessment and multidisciplinary discussion, with particular attention to perioperative optimization, rehabilitation planning, and shared decision-making. Frailty status should also inform the selection of surgical approach, anesthetic technique, and postoperative care intensity to balance expected benefits against potential harms.

12.1 Recommendations

1. Routine frailty screening using the Clinical Frailty Scale or the Fried Frailty Phenotype is recommended in older patients scheduled for elective spinal surgery (Level of evidence: Moderate; Strength of recommendation: Strong).

2. In patients identified as frail, comprehensive geriatric assessment and multidisciplinary perioperative planning are recommended to reduce the risk of adverse outcomes (Level of evidence: Low; Strength of recommendation: Conditional).

3. Preoperative frailty screening should be performed as early as possible in the surgical pathway, and shared decision-making should incorporate frailty status to align surgical management with patient-centered goals (Level of evidence: Low; Strength of recommendation: Conditional)

13. **Discussion**

This consensus provides a comprehensive, evidence-based framework for the preoperative assessment and perioperative management of older patients undergoing elective spinal surgery for degenerative spinal diseases, integrating cardiovascular, respiratory, cerebrovascular, metabolic, nutritional, cognitive, and frailty .

We explicitly acknowledge that the recommendations concerning cerebrovascular disease, respiratory function, and cognitive function are largely based on expert opinion (Low or Very Low certainty evidence), owing to the lack of large-sample prospective cohort studies specific to elderly spinal surgery. These recommendations should therefore be considered reasonable clinical guidance pending further validation.

Future research directions include: (1) multicenter prospective cohort studies and randomized controlled trials to validate the effectiveness of these interventions in older spinal surgery patients; (2) prospective studies on minimally invasive spinal surgery under local anesthesia; and (3) interventional trials on frailty, sarcopenia, nutritional optimization, and prehabilitation to improve perioperative outcomes in this vulnerable population.

14. **Limitations**

Several limitations should be acknowledged. First, much of the evidence underpinning this consensus is extrapolated from general noncardiac surgery literature, and high-quality data specific to older patients undergoing spinal surgery remain scarce. Second, the consensus is based predominantly on Chinese clinical practice and expert opinion, which may limit its applicability to healthcare settings outside China. Third, several recommendations—particularly those for cerebrovascular, respiratory, and cognitive assessments—are supported only by low-certainty evidence. Fourth, although the panel composition and the structured voting process were transparent, the final recommendations inevitably carry a degree of subjectivity.

15. **Conclusions**

In conclusion, this consensus emphasizes the importance of comprehensive, individualized preoperative assessment and perioperative management for older patients undergoing elective spinal surgery for degenerative spinal diseases. Key recommendations include the judicious use of

preoperative coronary imaging, standardized perioperative antithrombotic management with precise DOAC discontinuation timing, strict blood pressure and glycemic control, cardiopulmonary and cerebrovascular risk assessment, nutritional and cognitive optimization, and frailty. Implementation of these recommendations is expected to reduce perioperative major adverse events and improve surgical safety and outcomes in this vulnerable population.

Update and Declarations

Update: This consensus is planned to be updated every 3 years, or earlier when significant new evidence becomes available.

Ethics

As an expert consensus statement that does not involve human subjects research, ethical approval was not required.

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Data availability statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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AI contribution statement

During the preparation of this work, the author Yantin Hao used Workbuddy in order to typesetting and formatting of the manuscript and references during the preparation of this article. No AI tools were applied to edit or revise the content of the manuscript.. After using this tool, the authors reviewed and edited the content as needed and takes full responsibility for the content of the published article.

Conflicts of interest

Author Weishi Li serve as Editor-in-Chief, Feifei Zhou serve as Executive Editor-in-Chief of this journal. They were not involved in the editorial review or decision-making process for this manuscript. All editorial decisions were made independently by other members of the Editorial Board who have no conflicts of interest.
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Author contributions

All panel members contributed to the conception, literature review, drafting, and final approval of this consensus.

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