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Periprocedural care for frail older patients with aortic stenosis undergoing transcatheter aortic valve replacement

Joshua Eng [a,1], Jie Jun Wong [a,1], Kay Woon Ho [a,b], Angela S. Koh [a,b,2,*], Ru-San Tan [a,b,2]

[a] Department of Cardiology, National Heart Centre Singapore, 5 Hospital Drive, 169609, Singapore
[b] Duke-NUS Medical School, 8 College Road, 169857, Singapore

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ABSTRACT

Degenerative aortic stenosis (AS) is an aging-associated disease with alarmingly high mortality that has risen in prevalence in tandem with the global population aging. Treatment options for AS are currently limited to surgical or percutaneous valve intervention, which are associated with significant morbidity. It is increasingly recognized that the care of AS patients is frequently constrained by concomitant frailty, an under-recognized syndrome among older individuals. Many AS patients have concurrent aging-associated diseases, including atherosclerotic diseases, organ impairment, physical frailty, and nutritional deficiencies which limit functional improvement after valve intervention. It has become increasingly crucial for clinicians to address these concurrent issues in frail, older individuals with AS to achieve the best possible outcomes. We aim to review the well-studied relationship between frailty and AS, as well as possible strategies for periprocedural optimization and risk management.

1. Introduction

Degenerative aortic stenosis (AS) is a progressive valvular disease prevalent among older adults, affecting approximately 1 in 20 adults aged 65 years and above [1], likely increasing also with global ageing. Patients with AS often remain asymptomatic until the stenosis becomes severe and symptomatic, at which point AS-associated morbidity escalates significantly[2], reaching 4-year mortality approaching 50 % without valve intervention [3]. The standard of care for symptomatic AS is aortic valve replacement (AVR), either via surgery (SAVR) or percutaneous transcatheter approach (TAVR) [4]. While the less-invasive TAVR is preferred for older, frailer patients, up to 45 % of patients do not improve functionally post-TAVR owing to pre-procedural comorbidities and frailty [5]. Hence, clinicians must understand the impact of aging-related frailty on disease course and management.

2. The frailty syndrome

Frailty is an aging-related syndrome characterized by physiological decline and increased vulnerability to illnesses, comprising of physical, cognitive, psychosocial and socio-economic determinants [6]. Physical frailty is the most explored domain, with assessment often being through subjective or objective measurements of patients' physical strength, stamina, fatigue etc. This is because physical decline and weakness often herald poorer functional reserves, which is essentially the body's ability to return to the normal homeostatic balance of normal physiology after facing a stressor such an acute illness [7,8]. In frail patients, with intrinsically poor reserves across multiple organ systems, there lies increased risk of these patients not being able to return to their physiological baseline, requiring prolonged recovery periods. This in turn translates to longer hospital stays and poorer mobility and function post hospitalization [9]. Of note, while frailty tends to have increased prevalence in those who are older, age itself is not a defining feature of frailty [10].

Validated assessment tools have been created for the purpose of identifying frail patients and for assessing the severity of said frailty in these groups (Table 1), including the Rockwood Clinical Frailty Scale (CFS) [11], Fried Frailty tool [12] and FRAIL scale [13]. The CFS grades

* Corresponding author at: National Heart Centre Singapore, 5 Hospital Drive, Singapore 169609, Singapore.
E-mail address: angela.koh.s.m@singhealth.com.sg (A.S. Koh).

[1] Joint first authors.
[2] Joint senior authors.

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Table 1
Examples of commonly used frailty scales in assessing patients undergoing transcatheter aortic valve replacement (TAVR).

A. The Clinical Frailty Scale (CFS) [50]

Category	Description	Utility
CFS 1 *Very Fit*	People who are robust, active, and energetic. This group is well motivated and fit, exercising regularly, and are in the fittest group for their age.	Increasing CFS score has been associated with increased mortality after TAVR. For example, in the OCEAN-TAVI registry [27], increasing CFS stage was associated with increasing cumulative 1-year mortality (namely, 7.2 %, 8.6 %. 15.7 %, 16.9 %, 44.1 % for CFS 1–3, CFS4, CFS 5, CFS 6, and CFS ≥ 7 respectively). Every one category increase of CFS independently predicted increased mortality risk (HR 1.28; 95 % CI 1.10–1.49; p < 0.001). In one *meta*-analysis [51] of 4,923 patients undergoing TAVR across six studies, frailty (defined as CFS ≥ 5) was associated with increased 12-month mortality (19.1 % vs 9.8 %; RR 2.53 (1.63 to 3.95); p < 0.001). In addition, rates of kidney injury (8.7 % vs 5.1 %, RR 1.82 (1.46 to 2.27), p < 0.001), major bleeding (13.9 % vs 8.9 %, RR 1.64 (1.28 to 2.10), p < 0.001), and minor bleeding (13.9 % vs 10.5 %, RR 1.36 (1.07 to 1.74), p = 0.01) were also higher in the frail group.
CFS 2 *Fit*	People who have no severe disease symptoms but are less fit than those in the first group. They occasionally exercise or are occasionally very active.	
CFS 3 *Managing well*	People who have well-controlled medical issues but are not regularly active beyond routine walking.	
CFS 4 *Living with very mild frailty*	People who are still independent in daily activities but for whom symptoms often limit activities. They may complain of being tired or "slowed up" during the day.	
CFS 5 *Living with mild frailty*	People who have issues with higher-order instrumental ADLs and often require assistance. Mild frailty typically progressively impairs shopping, walking outside alone, meal preparation, and housekeeping.	
CFS 6 *Living with moderate frailty*	People who require help with all outside activities and housekeeping. They may also have problems with stairs, bathing, and even dressing.	
CFS 7 *Living with severe frailty*	Entirely dependent for cognitive and physical personal care. However, appear medically stable and not at high risk of dying within the next 6 months.	
CFS 8 *Living with very severe frailty*	Entirely dependent for personal care, approaching the end of life. Typically, they are unable to recover even from minor illnesses	
CFS 9 *Terminally ill*	Approaching end of life (defined as people with life expectancy less than 6 months) who are not otherwise living with severe frailty.	

B. Fried's Frailty Phenotype [12]

Variable	Definitions	Utility
Unintentional weight loss	Unintentional loss of weight of 10 lbs (4.5 kg) or 5 % of the previous year's body weight within 1 year	Patients are stratified into three Fried phenotypes based on the number of criteria fulfilled: Robust (score 0), Pre-frail (score 1–2), or Frail (score 3–5). In the prospective FRAILTY-AVR Study [31], which included 646 patients undergoing TAVR, frailty (fulfilling ≥ 3/5) was predictive of mortality at 1 year (OR 2.05; 95 % CI, 1.36, 3.09) after TAVR. Fried's phenotype was also predictive of worsening disability post-procedure.
Exhaustion	Use of the Centre for Epidemiological Studies Depression Scale (CES-D), which shows evidence of self-reported fatigue or weakness in the last 30 days.	
Weakness	Grip strength of the dominant hand was measured using a hand-held dynamometer, which was adjusted for sex and BMI.	
Slow walking speed	Time to walk 15ft (4.57 m) at the usual pace, adjusted for height and sex.	

Table 1 (*continued*)

A. The Clinical Frailty Scale (CFS) [50]

Category	Description	Utility
Low physical activity	Physical activity per week, calculated via the Minnesota Leisure Time Physical Activity Questionnaire, <383 kcal/week for males and < 270 kcal/week for females	Another prospective cohort study found that the frail phenotype was predictive of a longer hospital stay (9 ± 6 days vs. 6 ± 5 days, p = 0.004).

C. The FRAIL Scale [52]

Variable	Definitions	Utility
Fatigue	How much of the time during the past 4 weeks did you feel tired? 1. All of the time. 2. Most of the time. 3. Some of the time. 4. A little of the time. 5. None of the time. *Responses of 1 or 2 were scored 1 point, and all others scored 0 points.*	Patients are stratified into three FRAIL scale categories: Robust (score 0), Pre-frail (score 1–2), or Frail (score 3–5). In a prospective cohort study of 200 patients undergoing aortic valve replacement [53], the FRAIL scale predicted adjusted 1-year quality of life scores (using EuroQol-5D), adjusted for age and prosthesis type. In a *meta*-analysis of 4,479 patients undergoing any surgery across 18 studies [54], the FRAIL scale was associated with increased 30-day (OR 6.62; 95 % CI 2.80–15.61; p < 0.010) and 6-month (OR 2.97; 95 % CI 1.54–5.72; p < 0.010) mortality. Frailty was also associated with increased postoperative complications (OR 3.11; 95 % CI 2.06–4.68; p < 0.010) and postoperative delirium (OR 2.65; 95 % CI 1.85–3.80; p < 0.010).
Resistance	By yourself and not using aids, do you have any difficulty walking up 10 steps without resting? *"Yes" responses were scored 1, "No" responses scored as 0*	
Ambulation	By yourself and not using aids, do you have any difficulty walking a couple of blocks (e.g., several hundred yards)? *"Yes" responses were scored 1, "No" responses scored as 0*	
Illnesses	The number of comorbid illnesses: 1. Hypertension 2. Diabetes 3. Cancer (Other than a minor skin cancer) 4. Chronic lung disease 5. Heart attack 6. Congestive Heart failure 7. Angina 8. Asthma 9. Arthritis 10. Stroke 11. Kidney disease *5–11 of the above illnesses were scored as 1, whereas 0–4 illnesses were scored as 0*	
Loss of weight	*A weight loss of ≥ 5 % from 1 year ago compared to the present scores 1 point; otherwise, score 0 points.*	

D. The Essential Frailty Toolset (EFT) **[31]**

Variable	Scoring	Utility
Physical weakness	Assessed via chair rises (standing from a seated position without use of arms) • *5 chair rises in < 15 s – 0 points* • *5 chair rises in ≥ 15 s – 1 point* • *Unable to do five chair rises – 2 points*	In the prospective multinational FRAILTY-AVR Study [31], an increasing EFT score predicted increasing 1-year mortality after TAVR (EFT score 0–1, 6 %; score 2, 15 %; score 3, 28 %; score 4, 30 %; score 5, 65 %). Compared to other frailty scales (including Fried, Fried+, Rockwood, and Short Physical Performance Battery), EFT was the strongest predictor of 1-year mortality (adj. OR 3.72; 95 % CI 2.54–5.45) (C-statistic improvement 0.071; integrated discrimination
Cognitive impairment	Cognitive impairment is defined as a Mini-Mental State Exam (MMSE) score of < 24 • *No cognitive impairment – 0 points* • *Cognitive impairment present – 1 point*	
Haemoglobin	• Males ≥ 13.0 g/dL; Females ≥ 12.0 g/dL – *0 points*	

(*continued on next page*)

Table 1 (*continued*)

A. The Clinical Frailty Scale (CFS) [50]		
Category	**Description**	**Utility**
Serum albumin	• Males < 13.0 g/dL; Females < 12.0 g/dL – *1 point* • Serum Albumin ≥ 3.5 g/dL – *0 points* • Serum Albumin < 3.5 g/dL – *1 point*	improvement 0.067). EFT was also the strongest predictor of worsening disability at 1 year (adjusted OR 2.13; 95 % CI 1.57–2.87).

Table 1. **Examples of commonly used frailty scales in assessing patients undergoing transcatheter aortic valve replacement (TAVR).** This table outlines the variables, definitions, and applications of four widely used frailty scales to evaluate patients undergoing TAVR. The scales discussed are **(A)** the Clinical Frailty Scale (CSF), **(B)** Fried's frailty phenotype, **(C)** the FRAIL scale, and **(D)** the Essential Frailty Toolset (EFT).

patients on a scale of 1 (very fit) to 9 (Terminally ill and bedbound) and takes into account factors such degree of Independence in both basic and instrumental Activities of Daily Living (bADL, iADL), number of chronic conditions, a self-reported assessment of one's health as well as degree of physical exhaustion and ability to participate in strenuous activities such as sports [11]. The Fried Frailty Tool/modified Fried's criteria investigates 5 main domains to assess for the presence of frailty. These include self-reported domains such as Exhaustion and low physical activity, as well as objective measures such as unintentional weight loss of 5 % or more of body mass in the past year, measured slow gait speed as well as weak handgrip strength measured via a dynamometer [12]. Frail patients would have 3 or more of said aspects, pre-frail 1–2 aspects while robust patients have 0. In a similar vein, the FRAIL scale also stratifies patients into frail, pre-frail and robust based on a 5-item questionnaire, measuring similar items of Fatigue, ability to climb up stairs (Resistance), ambulating several hundred yards without aids (Ambulation), number of chronic conditions (Illnesses) and Loss of Weight of 5 % of body mass or more in the past year [13].

With the early identification of frail patients, clinicians can subsequently be more cognizant of the different treatment considerations that they would likely need to make to optimize overall care.

3. Aortic Stenosis: Paradigm shifts with TAVR

Aortic valve intervention is indicated when the AS has progressed to severe, defined as peak velocity ≥ 4 m/s, mean pressure gradient ≥ 40 mmHg, and aortic valve area ≤ 1.0 cm^2 (≤0.6 cm^2/m^2) [14]. AS symptoms (e.g., angina, syncope, or dyspnoea) and impaired left ventricular ejection fraction < 50 % are Class 1 indications for aortic valve intervention [14].

Once the decision for aortic valve intervention has been made, the choice between SAVR and TAVR is individualized to the patient's age, comorbidities such as coronary artery disease, perioperative risk, and patient preferences [14]. The PARTNER trial program has consistently demonstrated non-inferiority of TAVR vs. SAVR in mortality in high-, medium-, and low-risk groups [15–17]. Consequently, the clinical adoption of TAVR has burgeoned, allowing many older patients or those with more comorbidities access to aortic valve intervention procedures.

4. Impact on frailty on aortic stenosis

The prognoses of patients with symptomatic versus asymptomatic severe AS are significantly different, with a two-year mortality rate of 68 % observed in untreated symptomatic AS [18]. However, symptom attribution to severe AS may be difficult in frail patients with multimorbidity. AS symptoms may be altered or masked and are often indistinguishable from common co-existing cardiac (Fig. 1) (e.g., ischemic heart disease, arrhythmias, amyloid cardiomyopathy, and heart failure) and extracardiac conditions (e.g., chronic lung disease,

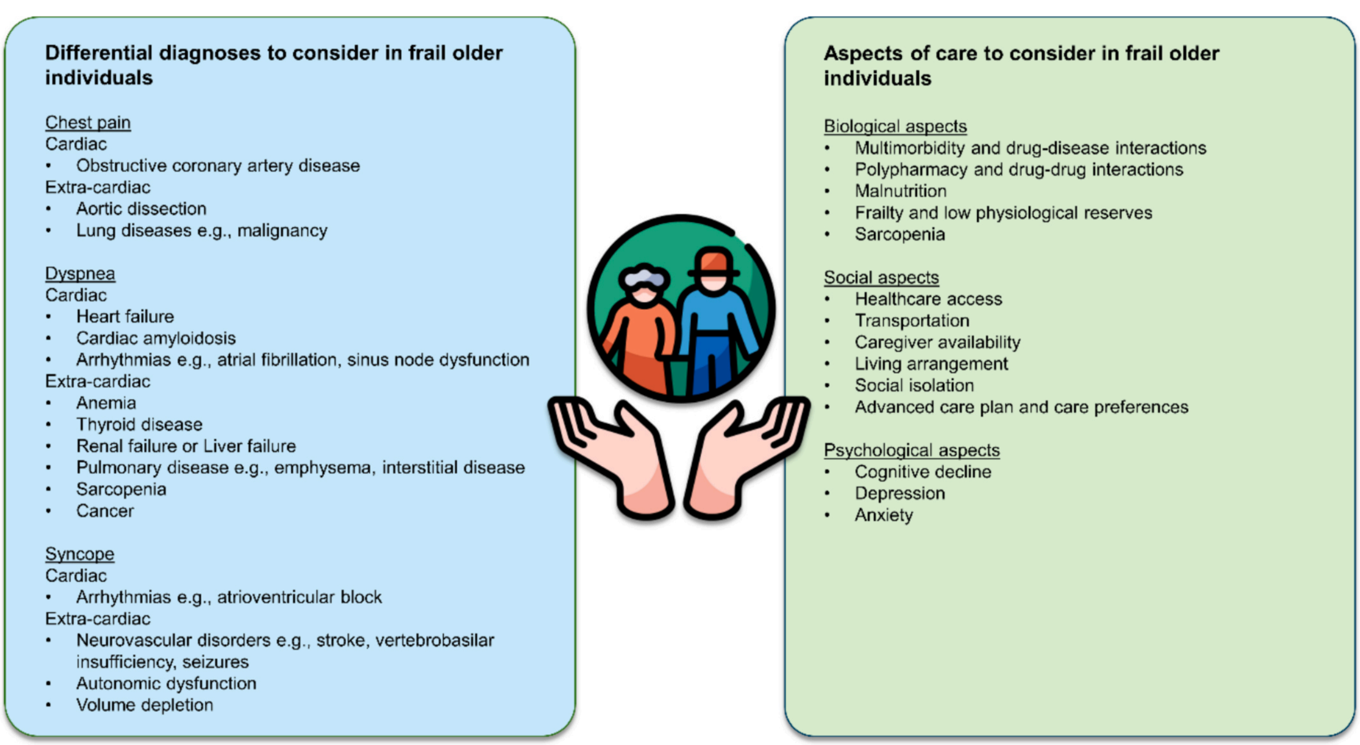

Fig. 1. Approach to frail older individuals presenting with symptomatic severe aortic stenosis. In frail older individuals presenting with symptoms and found to have aortic stenosis (AS), consideration should be given to concurrent pathologies, which are often present with increasing age. These may be broadly divided into cardiac and extracardiac diseases and include atherosclerotic coronary artery disease, amyloidosis, arrhythmias, and lung diseases. Additional care aspects, including biological, social, and psychological issues, must also be considered in frail older individuals. These aspects of care should be addressed as part of the therapeutic care plan. Icons were made by *Chanut-is-Industries* at www.flaticon.com.

anaemia, malignancy) [19,20]. Therefore, symptoms may not resolve completely after TAVR without optimizing comorbid conditions and frailty management.

Cardiac amyloidosis (CA), which is highly associated with AS in the geriatric population (an estimated 4–16 % of cases > 65 years old), is an essential yet under-recognized differential to exclude. Patients with concurrent CA and AS have higher mortality and poorer functional status than individuals with AS alone and may have persistent symptoms or heart failure after valve replacement [21]. Yet, diagnosing CA in the presence of AS is challenging and underrecognized due to overlapping clinical features [22]. A high index of suspicion is required based on clinical red flags (e.g., dysautonomia, carpel tunnel syndrome, lumbar spinal stenosis, loss of hypertension), electrocardiography findings (e.g., low voltage-mass ratio, atrioventricular conduction abnormalities), and imaging features (granular sparkling myocardium appearance, disproportional ventricular hypertrophy, low-flow/low-gradient pattern, etc.) [21,22]. Haematological and radionucleotide evaluation should be undertaken, and patients may require additional therapy for the underlying amyloidosis [22].

In frail patients with multimorbidity undergoing TAVR, the role of frailty assessment is increasingly being recognized [23]. Among patients at prohibitive surgical risk who underwent TAVR, there were marked reductions in symptom burden and mortality compared to medical therapy, although the one-year mortality was still 30.7 % [24]. Of note, patients in the inoperable cohort B of the PARTNER I trial who are at very high surgical risk (Society of Thoracic Surgeons (STS) risk score ≥ 15 %) derived no significant mortality benefit from TAVR compared to medical therapy [25]. In a study of 3437 TAVR patients by Strange et al. (2023)[26], post-TAVR one-year readmission rates (73.9 % vs. 49.5 %, $p < 0.001$) and hospitalization days (>28 days, 13.2 % vs 4.2 %, $p < 0.001$) were significantly raised in patients at higher frailty risks. In the OCEAN-TAVI registry, Shimura et al. (2017) [27] reported a trend toward heightened mortality at the 30-day and 1-year time points with increasing frailty scores and CFS, which was much steeper above CFS 7 and higher [27]. Together, these studies highlight the importance of frailty assessments and specific physical deficits that can be optimized before TAVR.

5. Frailty awareness in AS

Given the tremendous impact of frailty on cardiovascular diseases, there is an unmet need to address the lack of awareness among clinicians of frailty associations, screening, and interventions [28]. Our group studied frailty knowledge, awareness, and practices among cardiologists in multiple centres. 30 to 40 % of respondents indicated they were unaware of any relation between frailty and cardiovascular mortality; 45 to 55 % of respondents were unfamiliar with frailty screening tools, and specific frailty screening was also vastly underutilized; and nearly 70 % of respondents rarely or never performed frailty screening before cardiac intervention procedures [28]. Of note, interventional cardiologists reported particularly low utilization of preprocedural frailty screening, rehabilitation measures, and multidisciplinary team care, which belie evidence that such measures improve patient outcomes [28,29]. Although we did not report findings for AS specifically, our study findings suggest there is still much work to be done to raise awareness among the cardiology community of frailty screening in degenerative AS, where the patients are primarily older with multimorbidity and TAVR, often the only available therapeutic option.

6. Screening for frailty in AS

As per previously mentioned, there have been several screening tools implemented to help identify patients at risk of frailty. Within the context of patients with severe AS for whom procedural management is a potential option, screening tools can be employed to stratify patients into 3 groups: (1) robust or prefrail patients, at much lower risk of periprocedural mortality/morbidity; (2) frail patients, for whom interventions can be performed to reverse frailty or reduce mortality/morbidity [30]; and (3) severely frail patients, for whom the risks of intervention may outweigh any benefits derived.

In the FRAILTY-AVR study, six frailty scales were compared against mortality outcomes and STS scores in AS patients undergoing TAVR or SAVR [31]. The "Essential Frailty Toolkit" (EFT) [31] – encompassing lower limb strength (five chair raises), cognitive impairment (mini-mental state examination score < 24), hemoglobin and serum albumin levels – was predictive of 1-year mortality (adj. OR = 3.72; 95 % CI = 2.54 to 5.45) and worsening disability (adjusted OR: 2.13; 95 % CI: 1.57 to 2.87). The salutary performance, ease of implementation, multidomain approach, and use of objective biomarkers highlight EFT as an accurate and readily usable frailty tool in predicting outcomes for patients undergoing AS intervention. However, the ideal tool for stratifying AS patients into groups for frailty-based clinical decision-making remains elusive, highlighting potential areas which could be further studied.

7. Management of frailty for patients undergoing TAVR

Strategies targeting frailty may be calibrated to focus on specific aspects of frailty associated with poorer outcomes (Fig. 2). Precise interventions targeting physical conditioning, endurance, or nutrition may be aligned with deficits detected using EFT [31]. Among older adults planned for TAVR, 27 % were at risk of malnutrition (as measured by the mini nutritional assessment – short form), and 69 % did not meet the recommended physical activity levels (<7100 steps/day averaged over a week) [32,33]. Deficient nutrition and physical inactivity often persist post-TAVR [32], emphasizing the need for continued pre- and post-TAVR diet and exercise management.

The benefits of Cardiac Rehabilitation (CR), which involves a multidisciplinary team approach to exercise training, psychosocial support, cardiovascular risk optimization, and outcome assessment, has been shown to benefit patients with acute coronary syndromes (ACS) [34] and heart failure (HF)[35]. CR in AS typically involves post-SAVR patients [36]; however, CR benefits have also been reported for post-TAVR patients, and its use can also be expanded further in these patients [37,38].

In the 4P-TAVR study [39], 101 patients with high EuroSCORE surgical risk planned for elective TAVR were randomized into control ($n = 50$) and intervention ($n = 58$) groups, with the latter undergoing double the duration of standard post-TAVR physiotherapy plus additional pre-TAVR inspiratory muscle training and daily walking exercises compared to controls receiving usual care. Patients in the intervention group had reduced hospitalization rates (10.1 vs. 13.5 days, $p = 0.020$) and post-procedural pneumonia rates (5.1 % vs. 20.0 %, $p = 0.016$) compared to control [39].

Preoperative breathing and aerobic exercises reduce rates of postoperative pneumonia and length of hospital stay in patients undergoing cardiac surgery [40], however are few studies on their effects on TAVR patients. Several ongoing trials studying the effects of pre-TAVR exercise training (e.g., PERFORM-TAVR (NCT03522454) [41], TAVR-FRAILTY (NCT02597985), TAVR-Prehab (NCT031078970)) and nutritional optimization (PERFORM-TAVR (NCT03522454)) should report their results in the coming years and will be useful in providing evidence for frailty interventions.

Clinicians should also be aware that frail patients are at higher risk of *peri*-procedural complications such as Acute Kidney Injury (AKI) and delirium. Pre-hydration regimes can be used to reduce AKI risk patients with chronic kidney disease [42]. Minimizing intra-procedural contrast usage will also reduce the risk of kidney injury, and this can be achieved by employing ultrasound and echocardiography to guide puncture and valve positioning. Delirium risk can be mitigated by avoiding unnecessary lines, sedatives [43], catheters and opting for sedation rather than general anaesthesia [44]. Vascular access complications can also be

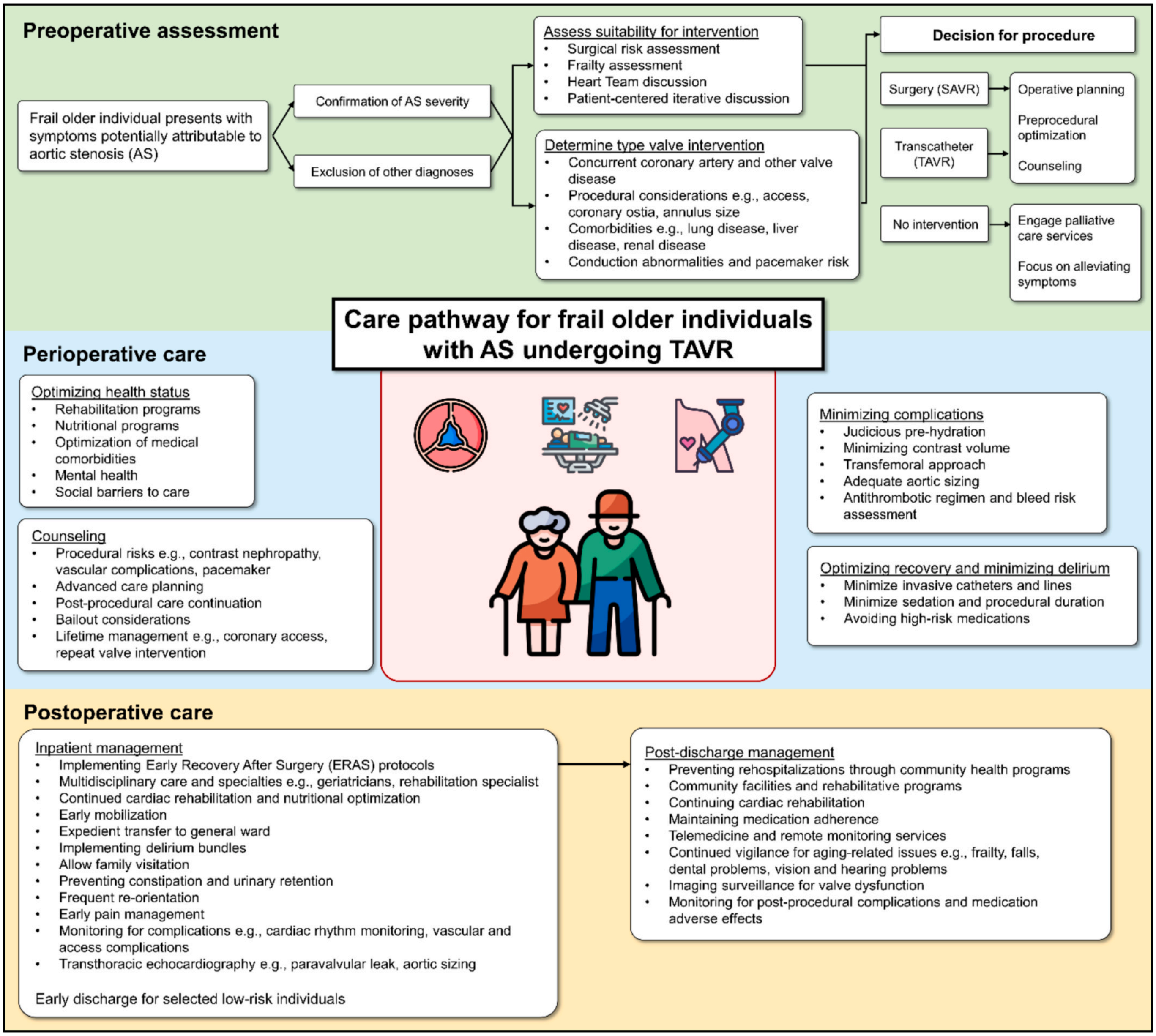

Fig. 2. Suggested care pathway for frail older individuals with aortic stenosis undergoing transcatheter aortic valve replacement. When frail older individuals present with symptoms of aortic stenosis, the severity of valve stenosis should be confirmed, and alternate diagnoses should be considered and excluded. In the preoperative phase, assessments should be made to determine the suitability of the intervention and the type of valve intervention. The decision should be made in discussion with the Heart team and the patient using a patient-centered iterative discussion. After a decision has been made for transcatheter valve replacement (TAVR), older frail individuals should be counseled and adequately optimized to improve their physiological reserves as much as possible. Perioperatively, additional effort should be made to minimize complications and improve postoperative recovery. Early recovery and delirium prevention protocols help facilitate recovery and early discharge in the postoperative phase. Post-discharge, there should be continued care in the community, cardiac rehabilitation, and close follow-up with the cardiologist for valve surveillance. AS = aortic stenosis; ERAS = Early Recovery After Surgery protocol; SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement. Icons were made by *Becris*, *Freepik*, *wanicon*, and *Chanut-is-Industries* at www.flaticon.com.

minimized by utilizing the transfemoral approach, barring any anatomical contraindications [45].

Additionally, protocols such as the Enhanced Recovery After Surgery (ERAS) [46] can be employed for frail patients undergoing TAVR. These multimodal and multidisciplinary perioperative protocols aim for early recovery post-surgery, minimizing the length of stay and anticipating and mitigating postoperative complications. While exact specifics differ based on the type of surgery patients are planned for, key principles of ERAS include patient education, preoperative nutritional and physical conditioning optimization, minimization of perioperative fasting (and implementation of a carbohydrate drink 2 h preoperatively), optimizing pre-and postoperative glycaemic control, minimizing the duration of anesthesia, sedation, and opioid analgesia use, and early mobilization [46,47].

In one study by Szerlip et al. (2020) [48], the implementation of the ERAS protocol post-TAVR demonstrated shorter length of stay by 1.87 days (adj. $p = 0.001$), trend towards increased discharge home (OR = 1.76, adj. $p = 0.078$) without increased risk of readmissions (OR = 0.74, adj. $p = 0.400$) [49]. The ERAS protocol used in this study focused on moderate sedation over general anesthesia and avoiding intubation, pulmonary artery or urinary catheters while removing arterial lines as early as possible, minimizing postoperative narcotics, early mobilization and ambulation, and early resumption of antihypertensives (except atrioventricular nodal blockers) [48]. This ERAS protocol had a checklist of precise tasks and criteria to be met at each time point (including 0–4 h post-TAVR, 4–12 h post-TAVR, post-op day 1) and clear discharge criteria. Holistic measures were detailed as part of routine post-TAVR care instructions, including physical therapy consult, nutritional optimization with early return to baseline diet, family/caregiver education, and social worker involvement if necessary. If the discharge criteria were met, this protocolized approach enabled patients to be discharged as early as postoperative day 1 (POD1). Additionally, smaller-sized 14-French femoral arterial sheaths were used more frequently after the implementation of ERAS compared to before ERAS (51.9 % vs. 14.9 %); larger-sized 22– and 24-French catheters decreased drastically, from 19.0 % and 25.6 % pre-ERAS respectively to 0 % post-ERAS.

8. Conclusion

Frailty is a vital aspect of managing older individuals with aortic stenosis that needs to be recognized and addressed. Additional elements of care to be considered include identifying and optimizing coexistent cardiac and extracardiac comorbidities, frailty stratification, counseling on procedural risks and shared decision-making using patient decision aids, pre-procedural rehabilitation, and nutrition intervention continuing into the post-procedural period. To adequately address the multifaceted care aspects of older individuals with frailty, multidisciplinary team management, and a protocolized and system-based approach may help ensure frail patients undergoing aortic valve replacement receive complete and holistic care.

Author Contributions

JE, JJW, RST, and ASK contributed to the study conception and design, and they edited the manuscript. JE wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Ethics Declaration

As this is a review study and there were no human participants, ethical approval was not required.

Impact statement

Adopting systematic approaches to exclude confounding diagnoses, assess frailty objectively, and implement individualized strategies that target specific frailty deficits pre-intervention continuing into the post-intervention period would greatly help clinicians manage older frail AS patients undergoing valve replacement and improve outcomes. We certify that this work is novel.

Key points

- Degenerative aortic stenosis (AS) is associated with an alarmingly high mortality that is rising in prevalence with global population aging. Treatment options are limited to percutaneous or surgical valve replacement that carries significant morbidity and is frequently constrained by concomitant frailty.
- It is increasingly important for clinicians to recognize and systematically address concurrent issues commonly encountered in frail older individuals to achieve the best possible outcomes.
- We review current practices in AS management and provide clinical examples of screening, risk stratification, and mitigative strategies against frailty in patients undergoing transcatheter aortic valve replacement (TAVR).

CRediT authorship contribution statement

Joshua Eng: Writing – review & editing, Writing – original draft, Investigation. **Jie Jun Wong:** Writing – review & editing, Writing – original draft, Formal analysis. **Kay Woon Ho:** Writing – review & editing, Supervision. **Angela S. Koh:** Writing – review & editing, Supervision, Investigation, Formal analysis, Conceptualization. **Ru-San Tan:** Supervision, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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