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Review Article

Transcatheter Aortic Valve Replacement Patient Selection: A Frailty-Centered Approach

Samer Ellahham[1,2*], Hanan Sheikh Ibrahim[2], Mariam Hassan[3]

ABSTRACT

Aortic stenosis (AS) is, single-handedly, a significant cause of morbidity and mortality among the elderly. An indubitable appreciation has mounted for transcatheter aortic valve replacement (TAVR) in scenarios that mandate rectifying stenotic aortic valves. This procedure is a sensible alternative to surgical replacement in severely symptomatic or high-risk patients. Furthermore, the elderly population is innately liable to cultivating a variety of seemingly innocuous risk factors, termed frailty syndromes. Although proven to be a predictor of poor post-TAVR outcomes, frailty is more often than not omitted from preprocedural screening. It is only fair that repair strategies are extensively discussed between cardiologists and geriatricians, alike. As such, the current review aims to highlight the role of frailty in patient selection for TAVR, prognostication, and tailoring post-operative care to enhance quality of life. Further research in this area will empower cardiologists to better assign management plans for TAVR patients by employing frailty, and so reducing overall cardiovascular risk.

Keywords: Aortic stenosis; Aortic valve replacement; Cardiovascular disease; Elderly; Frailty; geriatric; Guidelines; TAVR

Abbreviations: ACC: American College of Cardiology; AGS: American Geriatrics Society; AHA: American Heart Association; AI: Artificial intelligence; AS: Aortic stenosis; CCS: Canadian Cardiovascular Society; CFS: Clinical Frailty Scale; CGA: Comprehensive Geriatric Assessment; Comprehensive Geriatric Assessment; CVD: Cardiovascular disease; EACTS: European Association for Cardio-Thoracic Surgery; EFS: Edmonton Frail Scale; EHJ: European Heart Journal; ESC: European Society of Cardiology; EuroSCORE: European System for Cardiac Operative Risk Evaluation; FDA: Food and Drug Administration; HR: Hazard ratio; IANA: International Association of Nutrition and Ageing; ICFSR: International Conference of Frailty and Sarcopenia Research; JACC: Journal of the American College of Cardiology; MGA: Multidimensional Geriatric Assessment; MPI: Multidimensional Prognostic Index; SAVR: Surgical aortic valve replacement; SPPB: Short Physical Performance Battery; STS: Society of Thoracic Surgeons; TAVI: Transcatheter aortic valve implantation; TAVR: Transcatheter aortic valve replacement

INTRODUCTION

A diagnosis of frailty is usually made on subjective grounds, or "from the foot end of the bed." In recent years, an increasing number of clinicians have segued from presumptuous spot diagnoses that stem from the patient's exterior, to attempting to adopt unbiased techniques, namely a clear-cut definition combined with a valid frailty assessment tool. Even so, frailty remains a poorly demarcated phenomenon owing largely to the lack of a single universally agreed upon description. For the purpose of unification, Fried's definition of frailty will be employed here: "a biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems, and causing vulnerability to adverse outcomes" [1,2].

[1]*Cleveland Clinic Foundation, Ohio, United States of America;* [2]*Cleveland Clinic Abu Dhabi and Cleveland Clinic Foundation, Abu Dhabi, United Arab Emirates;* [3]*Gulf Medical University, Ajman, United Arab Emirates*

Correspondence to: Samer Ellahham, Cleveland Clinic Abu Dhabi and Cleveland Clinic Foundation, Abu Dhabi, United Arab Emirates, E-mail: ellahas@clevelandclinicabudhabi.ae

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The Comprehensive Geriatric Assessment (CGA) is an unrivalled, multidisciplinary approach for covering the domains of frailty. It endorses systematic management of patients with a potentially underlying diagnosis of frailty [1]. CGA evaluates the core components of frailty that include, but are not limited to, functional capacity, fall risk, cognition, mood, polypharmacy, social support, financial concerns, goals of care and advance care preferences [1]. While CGA has always been the gold standard for addressing the constituents of frailty, it is not the most efficacious tool in any clinical setting because it is time-consuming, labor intensive and deemed sophisticated by physicians with nominal knowledge on the cornerstone of geriatric practice.

Ideally, the aforementioned variables would be reassembled in a newly constructed or modified version of the CGA for pragmatic use. This idea is being heavily contemplated and explored in the hopes of acquiring a standardized diagnostic tool, which brings spectators to a subsequent dilemma: availability of numerous frailty instruments. The abundance of frailty measuring tools is beneficial and prejudicial, simultaneously. A wide array allows for purposeful selection of a tool that is most convenient for caregivers. Yet, the rationale behind their purposeful formulation is not fulfilled. When there is sufficient neglect of the factors which govern frailty, as in a majority, if not all, frailty assessment tools, treatment plans put forth to tackle cardiovascular disease of any etiology are unapt and merely fuel the cost of caring for patients. This is becoming especially relevant to a global community with a flourishing elderly population.

Cardiac-related diseases are heavily prominent amid the geriatric division and are anticipated to surge accordingly. A systematic review and meta-analysis published in the European Heart Journal (EHJ) by European Society of Cardiology (ESC) divulges that aortic stenosis (AS), for example, is "the most common valvular disease in the Western World, affecting 1 in 8 individuals over the age of 75 years [3]." According to the American Geriatrics Society (AGS), frailty has impact across stable cardiovascular disease (CVD), subclinical CVD, coronary syndromes, heart failure, cardiac surgery and transcatheter aortic valve replacement (TAVR) [4]. Unsurprisingly, the subset of patients being deliberated for TAVR are typically of advanced age and harbor multiple comorbidities. Thus, they are already under a great deal of influence by frailty, with prevalence being reportedly as high as 63% [5,6]. When exposed to stressors, such as chronic illness and surgery, frail patients are prone to " procedural complications, prolonged recovery, functional decline and mortality" [7].

Hence, the review strives to highlight the current role of frailty in terms of selecting suitable TAVR candidates. The authors also unravel its aptitude to prognosticate and individualize post-operative care, while accentuating the largescale paucity in our awareness of frailty application. The table below provides a synopsis of overlaps noted among international guidelines with respect to the management of frailty.

Table 1: Correspondence of international guidelines on frailty management [1].

Correspondence of international guidelines on frailty management
Frailty is not necessarily identified in patients with severe comorbid diseases.
Frailty may be reversible and, thus, should be a mandatory component of the evaluation process.
A holistic approach to caring for patients will help cover the foundations of frailty. This may entail referral to a geriatric specialist or requesting a social worker to communicate with the family.
Certain prerequisites must be met before validating a frailty assessment tool, including practicality and a user-friendly interface.
Frail patients require careful monitoring and follow-up.

CURRENT PRACTICE FOR TAVR PATIENT SELECTION

TAVR has become the established management strategy for patients with medium-to-high operative risk. More recently, the U.S. Food and Drug Administration (FDA) has expanded the indication for TAVR to patients that are at low risk for adverse post-operative outcomes or mortality associated with open-heart surgery [9]. This groundbreaking advocacy is likely to propel further consolidation of TAVR as the standardized procedure for symptomatic AS. Nonetheless, TAVR is superior to medical therapy and also associated with lower 12-month mortality rates compared to surgical aortic valve replacement (SAVR) [10].

Table 2: A synopsis of TAVR.

A synopsis of TAVR

1.TAVR is performed in severe AS-"a problem that occurs when the valve in the heart's main artery doesn't open fully, forcing the heart to work harder to pump blood" [8].

2. Unlike open surgery, TAVR involves threading a replacement valve through a catheter in the groin [8].

3. TAVR is used interchangeably with transcatheter aortic valve implantation, or TAVI.

"*The correct selection of patients who could be candidates for transcatheter aortic valve replacement (TAVR) is one of the major challenges in modern geriatric cardiology*" [11].

A systematic review confirms the relationship between frailty and mortality in the TAVR population [12]. A doubled risk [hazard ratio (HR) 2.35] of early (≤30 days) death in frail patients, and a 1.63 HR of later death is identified [12]. A multisociety expert consensus statement published by the Journal of the American College of Cardiology (JACC) supports the notion that "transcatheter valve repair or replacement devices are unique in that an understanding not only of early risk, but also of long-term durability, is essential for determining the appropriate patient subgroups for these therapies" [13]. The repercussions play a fundamental role in this inherently autonomous struggle-steering cardiologists towards or away from proceeding with TAVR.

Ultimately, perilous post-TAVR risks can be easily miscalculated when frailty-determining factors are overlooked. The apprehension is becoming ever more applicable to an expanding elderly population-demanding the selection process be highly focused on those whom will benefit in the long run and relegating a rather financial perspective. Moreover, little light has been shed on the fact that "a significant percentage of elderly patients do not see improvements in their overall health status after TAVR" [11]. A position statement by the Canadian Cardiovascular Society (CCS) testifies to this: "not all patients may experience significant clinical improvement after TAVR. Some patients, such as those with severe multisystem (particularly pulmonary) disease, malignancy, or dementia can deteriorate despite a successful procedure" [14]. This only reemphasizes the magnitude of accounting for the parameters of frailty via a reliable score.

Presently, surgical prediction models are utilized to distinguish patients that are apt for TAVR. Cardiologists gravitate towards the European System for Cardiac Operative Risk Evaluation (EuroSCORE) or the Society of Thoracic Surgeons (STS) models, both of which evaluate for likelihood of mortality after cardiac surgery [12]. These standard risk scores, however, are insufficient for the prediction of adverse events in older adults [12]. The chief drawback of both prototypes is their disregard for frailty albeit having been corroborated to anticipate TAVR aftermath. The 2017 ESC and the European Association of Cardiothoracic Surgery (EACTS) guidelines accentuate their capacity to "more accurately discriminate high-and low-risk surgical patients," as opposed to "considering disease severity" or investigating frailty [15].

Examples of important risk factors in the geriatric group that are not represented in standardized preprocedural screening include cognitive impairment, mood disorders and physical frailty [10]. Cognition is merely a single pillar of frailty proven to determine postoperative recovery, functional dependence and quality of life. The American College of Cardiology (ACC) suggests more research is conducted to pinpoint the patients whom are at risk for cognitive decline following TAVR [16].

FRAILTY INSTRUMENTS FOR TAVR

Despite the "heterogeneity in frailty measures", poor post-TAVR outcomes have been reported across a multitude of virtually accessible literature [17]. Therefore, operationalization of the term 'frailty' must be reviewed alongside the equipment devised for its measure. Justified elimination may ensue-drawing attention to the more relevant frailty assessment tools that enable TAVR risk assessment and prediction.

The 2017 ACC 'Expert Consensus Decision Pathway' for TAVR proposes that, in addition to customary patient evaluation, "qualitative rating scales like the Canadian Study of Health and Aging Scale, performance-based assessments like the 'Up and Go' test and chair stands, deficit accumulation summary measures like the Rockwood Frailty Index, or frailty phenotype scales like the Cardiovascular Health Study Frailty Scale or Edmonton Frail Scale (EFS)" be exploited [18]. Likewise, a study published in JACC recommends combining conventional risk scores with frailty assessment-via the multidimensional geriatric assessment (MGA), more specifically-and further emphasizes that experienced geriatricians should be a part of the "heart teams" [19].

Another study based in Japan, and that has been published by the AHA, agreeably correlates the use of Rockwood's Clinical Frailty Scale (CFS) to measure frailty with mortality among elderly patients [20]. The authors conclude that CFS not only reflects the degree of frailty but is a simple tool and useful marker for predicting late mortality [20]. The fact that it can be used by nongeriatric specialist, thereby possessing promising "clinical utility", may sanction cardiologists to ensure that frailty is integral to their routine cardiac assessment.

A UK-based TAVR registry (2013) showcases the association between frailty and TAVR outcomes through three frailty measures: Canadian Study of Health and Ageing, KATZ and poor mobility [17]. This study fortifies the gravity of frailty in risk stratification [17]. The noteworthy suggestion put forth was implementing the use of any feasible frailty tool until a more objective scale is experimented with, validated and enforced. A recent review article reinforces this concept by emboldening caregivers of every specialty to embrace frailty-measuring instruments as the consequence of frailty negligence altogether could produce worse post-operative outcomes [1].

The CGA-TAVR multicenter registry has shown that "of the multiple components of the CGA that were evaluated, the multidimensional prognostic index (MPI) and the Short Physical Performance Battery (SPPB) both had value for predicting the likelihood of death and/or hospitalization in the first 3 months following TAVR [21]." The MPI is derived from the CGA and has been shown to have a high predictive power for "assessing mortality after hospitalization of older patients [21]." The SPPB, on the other hand, is favorable in terms of time-efficiency [21].

Lastly, task force of the International Conference of Frailty and Sarcopenia Research (ICFSR) released the 'International Clinical Practice Guidelines for Identification and Management (2019)' of frailty in older adults [22]. The screening tools that are recommended by the ICFSR include CFS, the International Association of Nutrition and Ageing (IANA)'s FRAIL scale, and the EFS [22].

DISCUSSION

To reiterate, formulating an all-encompassing definition for frailty, followed by a measuring technique that is easy to use, feasible, not labor intensive, and applicable to various clinical settings would construct the ideal frailty assessment tool. A wide range for selection has become almost counterproductive in clinical practice. Caregivers are, more often than not, perplexed in their choice of frailty risk scoring. More importantly, they are uncertain as to how a prefrail or frail state will guide patient care. An inquest for the following queries has intensified in the recent years: *Which frailty assessment tool should a physician use to best estimate the magnitude of frailty? How will frailty influence case management? If attempts to tackle frailty are made, will these seemingly trivial adjustments provide ephemeral benefit, or will the efforts ameliorate disease burden hereafter?*

The authors appeal for a blueprint pertaining to frailty seen in cardiovascular-related conditions-if not for a more narrowed subset, like TAVR-elected patients. Yet, international guidelines remain divided on a frailty assessment tool that can be aptly integrated into the patient evaluation process. It is imperative that a consensus be reached in order to swiftly navigate through a complete and efficacious survey of patients with severe or symptomatic AS.

CGA is the geriatric gold standard for identification of frailty. However, administration is time-consuming and quite dependent upon the environment and expertise of the clinician. An assessment tool that is derived from or closely resembles the CGA would serve the purpose of frailty identification, prognostication and management. The reviewers propose drawing exclusive attention to the CFS and EFS in light of flourishing evidence for their use in TAVR patient selection.

The CFS is substantially validated as "an adverse outcome predictor in older people" [23]. A disadvantage is that the scoring of frailty may be deemed subjective. Health professionals must determine the description which best fits the patient after having undergone the CGA. Contrarily, the EFS is a brief, user-friendly screening interview with "acceptable internal consistency, good construct validity" and reliability [24]. EFS has been utilized by non-specialists with minimal or no formal training in geriatric care proving its potential as a practical measure of frailty [24]. In spite of this, the EFS requires that an elderly patient performs tasks to sufficiently evaluate cognitive and functional performance domains. This is unlikely to be completed in an acute or recovery setting (Figure 1).

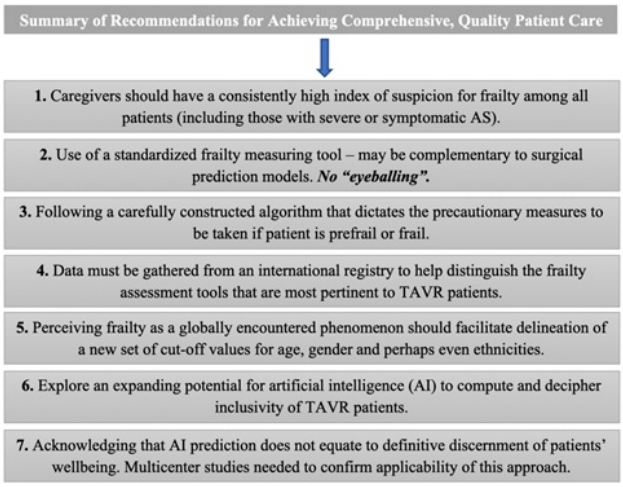

Figure 1: Summary of Recommendations for achieving comprehensive, Quality Patient Care

The reviewers also theorize a potential for accelerating the introduction of artificial intelligence (AI) into such highly specialized medical field. 'Expert' systems allow for the generation of "solid and reliable indications to the parameters" of manufacturing and demonstrates "high accuracy" during transcatheter aortic prosthesis selection [25]. AI may revolutionize frailty recognition while promptly ascertaining the patients that are in dire need of TAVR.

Moreover, while frailty would be typically diagnosed by a geriatrician, this syndrome is not confined to the geriatric population. Caregivers often overlook the possibility of frailty in adults that harbor multiple comorbidities and that have subtly and gradually cultivated certain risk factors that limit their activities of daily living. Hence, the authors suggest that future studies reconsider a new cut-off value for age; gender and ethnicity can also be taken into consideration.

Frailty incapacitates multiple organ systems. Whether cardiac disease, for example, provokes the steadfast onset of frailty or vice versa, the primary objective is to recognize frailty, alleviate disease and enhance overall quality of life. This is particularly precarious as TAVR is often resorted to for frail patients that cannot handle the physiologic stress induced by conventional surgical approach. The FDA presents an alternative perspective for the role of frailty in rectifying AS: rather than endeavoring to establish the severity of AS, management route should be guided by patients' capacity to withstand the physical and psychological stressors imposed on the human body as a result of undergoing TAVR.

In 2017, the ACC issued a diagram that depicts frailty as a component of the 'Pre-TAVR Patient Selection and Evaluation'. Reference to frailty by the ACC warrants a methodical search

that fulfills an all-inclusive medical practice and perhaps even a legal requirement (Figure 2).

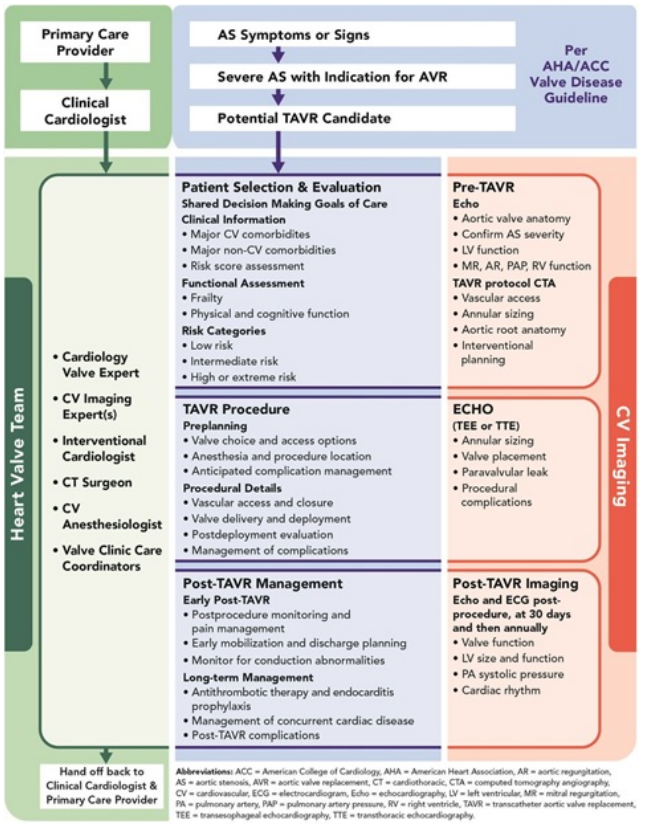

Figure 2: TAVR Decision Pathway Outline-from '2017 ACC Consensus Decision Pathway for Transcatheter Aortic Valve Replacement in the Management of Adults With Aortic Stenosis' [17]

Ultimately, frailty is far from an "all-or-none" diagnosis and understanding the complexity of its presentations will assist in making more informed decisions that cater to patients' individualized needs. Tailoring post-operative care should guarantee and augment an auspicious recovery. Similarly, the ACC encourages careful consideration for the "preferences of patients and/or their caregivers in a shared decision-making framework [11]." Elderly patients, in particular, should be treated with "special considerations, including life expectancy and expected quality of life, with regards to comorbidities and general condition (frailty) [15]."

CONCLUSION

Frailty is inconsistently incorporated into the selection process of suitable TAVR candidates. This demands reform as frailty has repeatedly proven to significantly influence patient selection, prognostication and post-operative outcomes. Traditional surgical scores omit frailty and, thus, are not befitting for delineating risk. The scientific community must come to an agreement on an assessment tool that accurately reflects the definition of frailty wholly.

Many recommendations have been put forth. Although CGA is the cornerstone of geriatric practice owing to its multifaceted, patient-centered approach, it is also time-consuming and easily disregarded by caregivers. The authors recommend that the CFS and EFS are further trialed in AS patients in light of their easy use. If a patient qualifies as frail, the elements of frailty that have been compromised must be systematically addressed to minimize the risk of adverse cardiac events. An orderly algorithm should be pursued relentlessly by caregivers in order to deliver reliable and cost-effective quality care.

Because the interest of bestowing versatile care primarily lies under the jurisdiction of geriatricians, the reviewers stress upon paramount importance of a collaboration between geriatricians and cardiologists alike to optimize patient management strategies and care plans. AI is also slowly gaining recognition in this field as a way of directly accessing, collating and analyzing copious data. This automates the screening process which abolishes need for extensive surgical scrutiny. Overall, these proposals aim to integrate frailty into everyday clinical practice.

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