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# Phase 3 Cardiac Rehabilitation and Fall Recovery are Under-Utilized Opportunities to Improve Clinical and Functional Outcomes in Transcatheter Aortic Valve Replacement Patients

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## Abstract

Transcatheter aortic valve replacement (TAVR) patients tend to be older, frail, and have one or more comorbidities. Cardiac rehabilitation is essential to returning these patients to their pre-intervention level of activity and functioning. However, once outpatient (Phase 2) rehabilitation has been completed, most patients remain at elevated risk for serious adverse events, notably falling, that impact their prognosis for meaningful recovery and resumption of an active lifestyle. Home-based cardiac rehabilitation (Phase 3) is elective and often is either not prescribed or haphazardly programmed, and consequently it has received relatively little research and formal practice attention or utilization. This manuscript examines how and why the incorporation of a structured, Phase 3 program for training patients to independently recover from an accidental fall into standard cardiac rehabilitation practice would enhance cardiologists' ability to improve their post-TAVR patients' long-term clinical and functional outcomes as well as quality of life. A model is proposed for a physician-prescribed and -supervised Phase 3 fall recovery program that maximizes patient access and participation while ensuring quality and consistency. This functional fall recovery model program comprises three components: (1) prognostic screening and assessment tools; (2) a specific fall recovery maneuver and supporting exercises; and (3) performance and outcome metrics, not only for clinical application but also to comparatively utilize in research studies of fall recovery methods. Each of these components can be delivered either in person, virtually/remotely or a hybrid by cardiac rehabilitation nurses or other qualified staff.

## Introduction

Transcatheter aortic valve replacement (TAVR) has revolutionized the treatment of valvular heart disease, allowing individuals who otherwise are not candidates for surgical aortic valve replacement (SAVR) to increase their survival and extend their quality of life (QoL) [1-3]. The TAVR procedure is currently performed to treat severe aortic valve stenosis in patients over age 65, and is an American College of Cardiology/American Heart Association class 1A management guideline recommendation for heart failure patients [4]. Candidates for TAVR over SAVR include those patients with previous cardiac surgery, advanced age, multiple co-morbidities, and frailty [5,6]. In association with being older and having co-morbidities, TAVR patients tend to have advanced physical deconditioning at the time of the procedure resulting from sedentary lifestyle, reduced exercise capacity, decreased physical and cognitive function, depression, and sarcopenia [2,7-10].

Cardiac rehabilitation (CR) is a standard practice after TAVR and SAVR. CR is also strongly recommended after other common cardiac procedures such as any open-heart surgery, e.g. coronary artery bypass graft (CABG) for coronary artery disease (CAD) or valvular repair/replacements, and for coronary stent placement post-acute coronary syndrome [10]. Survival and QoL after any cardiac intervention procedure are highly correlated with completion of a CR program [11].

### Phase 3 Cardiac Rehabilitation and Fall Recovery: Overlapping Risk Pathways and Opportunity for Integration

#### Three phases of cardiac rehabilitation

CR has three sequential phases: inpatient during post-operative recovery (Phase 1); a highly structured ("intensive") outpatient program (Phase 2); and optionally, an ongoing, self-guided set of supervised, home-based exercises and practices (Phase 3) [7]. Phase 2 CR is a well-established, insurance-reimbursed process for all heart interventions (including TAVR) that commonly comprises up to a 12-week program of exercise, diet, lifestyle, and mind-body connection, with instruction and practice mostly focused on tertiary prevention of CAD [12]. Exercises prescribed post-operatively are intended to help patients to return to their pre-intervention level of activity and thereafter stay active and mobile for the remainder of their lives [9]. Whereas the technical TAVR procedure itself has continuously improved over time [1,12,13], only a relatively small proportion of patients actually get referred to CR, and most such candidates either choose not to attend or otherwise do not complete a CR program [5-7,14].

Beyond prescribing the Phase 2 CR program, the cardiologist who performs the TAVR procedure has little control over patients' long-term clinical outcomes and improving their QoL past basic activities of daily living (ADL). Graduation from a Phase 2 CR program typically entails completing a 6 minute walk test and basic strengthening and flexibility exercises [15]. Home exercises for patients are available online (e.g., American Heart Association Strength and Balance Exercises [16]) or patients may be provided with a list of recommended exercises. Performing independent home exercises consistently and correctly in this population requires substantial motivation, instruction and support to demonstrate objective success [7,17].

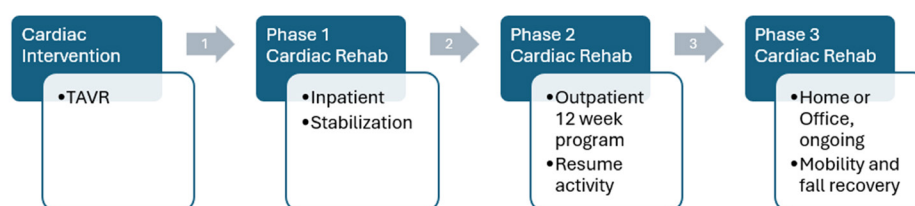
In contrast to Phase 2 CR, Phase 3 CR provides uncertain value and accessibility for physicians and patients in terms of long-term functional gain [7,12]. Particularly for post-TAVR patients, Phase 3

CR is elective and commonly it is not prescribed or is not formally structured in its approach or insurance payment requirements. Phase 3 CR offers valuable opportunities to address functional resilience, gait recovery, and fall vulnerability outside the scope of traditional Phase 2 CR. Thus, Phase 3 CR has many opportunities for innovation, improvement and optimization both in its content as well as its methods of delivery to increase the likelihood of its utilization and positive outcomes-not only for post-TAVR patients but also for other post- cardiac intervention patients [1,7,14,18].

#### Fall recovery

One such target opportunity for Phase 3 CR is reducing the sequelae of accidental falling at ground level. Falling (and prevention thereof) is a key indicator of QoL for elderly and physically impaired patients [8,11]. Risks for and prevention of falling have been well studied in geriatric patients [19] and cardiorespiratory fitness objectives for CR have been well characterized in cardiac patients [7,9]. A retrospective cohort study examining cardiorespiratory fitness and musculoskeletal fitness positively associated older adults' inability to rise from the floor with increased all-cause mortality [20]. Even though most falls do not cause serious injuries, deconditioned people who fall may nonetheless struggle or fail to stand up independently [10]. Multiple functional limitations and factors can contribute to falling risk including impaired balance or coordination, loss of flexibility and mobility, medication side effects, visual and proprioceptive function deficits, strength diminution and sarcopenia, joint disorders, obesity, and generalized physical deconditioning affecting cardiopulmonary and strength endurance [8,9,12]. 'Frailty' is a term that encompasses many of these functional limitations [21].

The role of and need for tertiary preventive rehabilitation for accidental falling after post-cardiac procedures remains largely anecdotal, particularly post-TAVR and post-completion of a Phase 2 CR program [8,11,12,22]. Extensive patient and clinical educational information are available from governmental and non-governmental agency sources on falling risk factors, prevention, safeguards to soften the landing, and complications and consequences resulting from falls. However, a dearth of formal research or consensus exists on how patients can efficiently and independently stand up from a fall without the assistance of a chair or other object, i.e., 'fall recovery' [23]. Furthermore, some generic falling-related exercises may not be applicable or may be too difficult for patients with limited mobility, flexibility, or strength, thereby rendering the exercises either ineffective or avoided altogether. Figure 1 summarizes the post-cardiac intervention, rehabilitation and fall recovery continuum.



**Figure 1:** Post-cardiac intervention, rehabilitation and fall recovery continuum.

## A structured model for fall recovery and clinical implications

No single standard method for fall recovery is universally

accepted or prescribed to patients either in the continuum of the CR framework or for other conditions treated with physical therapy (PT). Table 1 summarizes fall recovery methods' attributes and limitations, with example references.

**Table 1:** Fall recovery attributes and limitations.

| Attribute/Limitation                                                                                                                                                                                                                                                                                                 | Reference                                                                                                                                                                      | URL                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Information from senior citizen and cardiology web sites on this specific topic is mostly generic and untested.                                                                                                                                                                                                      | The Safest Way to Get Up from a Fall (AARP Health, Dec 19, 2023)                                                                                                               | <a href="https://www.aarp.org/health/healthy-living/how-to-safely-get-up-from-falls/">https://www.aarp.org/health/healthy-living/how-to-safely-get-up-from-falls/</a>                                                                                                                                                                                                                               |
|                                                                                                                                                                                                                                                                                                                      | Tips for getting on and off the floor for your exercises (Shelly Rizzo, Mayfield Brain & Spine, Jan 3, 2024)                                                                   | <a href="https://mayfieldclinicblog.com/tips-for-getting-on-and-off-the-floor-for-your-exercises/">https://mayfieldclinicblog.com/tips-for-getting-on-and-off-the-floor-for-your-exercises/</a>                                                                                                                                                                                                     |
| Physical therapists (PT) offer clinical guidance in their practice, but PT is not typically incorporated into CR. Personal trainers similarly offer preventive exercises but not actual methods for getting up from the floor unassisted after a fall, and such exercises may not be feasible for frail individuals. | I teach this simple three-move routine to senior clients so they can always get up off the floor unassisted, even after a bad fall (Jennifer Rizzuto, Fit and Well, Oct 2025). | <a href="https://www.fitandwell.com/exercise/bodyweight-exercises/i-teach-this-simple-three-move-routine-to-senior-clients-so-they-can-always-get-up-off-the-floor-unassisted-even-after-a-bad-fall">https://www.fitandwell.com/exercise/bodyweight-exercises/i-teach-this-simple-three-move-routine-to-senior-clients-so-they-can-always-get-up-off-the-floor-unassisted-even-after-a-bad-fall</a> |
| Basic 'survival' maneuvers after a fall to the ground (or floor) involve crawling, scooting and dragging the lower extremities on the floor until a chair or couch can be reached are commonly recommended, often in conjunction with isolated strengthening or flexibility exercises.                               | Master the Art of Getting Up from a Fall Without Kneeling (Knee Pain Centers of America, Feb 28, 2025)                                                                         | <a href="https://www.kneepaincentersofamerica.com/blog/how-to-get-up-from-a-fall-without-kneeling">https://www.kneepaincentersofamerica.com/blog/how-to-get-up-from-a-fall-without-kneeling</a>                                                                                                                                                                                                     |
|                                                                                                                                                                                                                                                                                                                      | How to Get Up from a Fall (Jacklyn Jefferson, Brooks Rehabilitation, Oct 31, 2024)                                                                                             | <a href="https://brooksrehab.org/resources/how-to-get-up-from-a-fall/">https://brooksrehab.org/resources/how-to-get-up-from-a-fall/</a>                                                                                                                                                                                                                                                             |
| All methods for getting up from the floor share common elements and requirements such as rolling over from the supine position into the prone position or on both hands and both knees ('table top') and then bringing one knee forward and pushing down with the feet and hand(s) to stand up.                      | How to Get up From a Fall (Margaret Martin, updated Nov 28, 2023).                                                                                                             | <a href="https://melioguide.com/activities-of-daily-living/how-to-get-up-from-a-fall/">https://melioguide.com/activities-of-daily-living/how-to-get-up-from-a-fall/</a>                                                                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                                                                      | 3 Exercises to Help You Get Up Off the Floor, Ages 50+ (Will Harlow, Jul 8, 2024)                                                                                              | <a href="https://www.youtube.com/watch?v=Cd60Bivmyk0">https://www.youtube.com/watch?v=Cd60Bivmyk0</a>                                                                                                                                                                                                                                                                                               |
|                                                                                                                                                                                                                                                                                                                      | How to Get Up from the Floor: A Guide from Physical Therapists (Hinge Health, Mar 28, 2025)                                                                                    | <a href="https://www.hingehealth.com/resources/articles/how-to-get-up-from-the-floor/">https://www.hingehealth.com/resources/articles/how-to-get-up-from-the-floor/</a>                                                                                                                                                                                                                             |
|                                                                                                                                                                                                                                                                                                                      | Seniors: Get up from a fall without help (Doug Weiss, Feb 21, 2024)                                                                                                            | <a href="https://www.youtube.com/watch?v=As4evchixto">https://www.youtube.com/watch?v=As4evchixto</a>                                                                                                                                                                                                                                                                                               |
|                                                                                                                                                                                                                                                                                                                      | The Life-Saving Trick to Get Up After a Fall! (Bob Schrupp and Brad Heinick, Feb 15, 2025)                                                                                     | <a href="https://www.youtube.com/watch?v=3H7eSlvife4">https://www.youtube.com/watch?v=3H7eSlvife4</a>                                                                                                                                                                                                                                                                                               |

A model physician-administered and supervised program for fall recovery would have three (3) main components:

**Prognostic Tool (Screening and Assessment):** The clinical recognition and measurement of fall risk ('risk assessment') entails several physical, mental and psychological factors that can be effectively evaluated through clinical questions or questionnaires ('subjective'), and/or physical examination and observation of functional behavior ('objective') [24]. Risk assessment metrics may be applied a priori as selection criteria and a posteriori to measure clinical prognosis. An in-person assessment is preferable to ensure accurate patient selection, allocation of resources, risk stratification, and (if applicable) customization [18]. Prognostic tools that help clinicians qualify patients for cardiac interventions and assess pre- versus post-CR health status include questionnaires such as the Kansas City Cardiomyopathy Questionnaire (KCCQ-12) [6,25]. A relative dearth of research has been conducted to determine to what extent these questions and scoring algorithms predict the likelihood of CR participation or long-term post-intervention outcomes [26].

**Technique (Maneuver and Exercises):** Prescribed, self-administered strengthening exercises have been demonstrated

to be effective even in frail individuals [27]. However, post-CR exercises that can be both demonstrated and objectively observed by a health professional are rarely practiced outside of standard PT. Didactic patient education of exercises, such as a presenting a brief lecture topic during CR, also has significant limitations. To increase patient compliance and efficacy, the maneuver and exercises collectively, the 'technique'-should be fun and stimulating to learn and practice, and it should contribute to the prevention, slowing or reversal of sarcopenia [7]. An engaging approach to hands-on learning appeals to patients with low motivation as well as to those with the aforementioned functional limitations [11,17,28].

**Performance and outcome metrics:** Scoring methods and prognostic interpretation guidelines can be incorporated to objectively measure the feasibility and execution of prescribed exercises and maneuvers [9,19]. Comparative (pre-vs. post-) subjective metrics can be administered either as stand-alone responses to formal questions or incorporated into a standardized questionnaire such as the KCCQ-12 [6,25]. Objective metrics of performance akin to the Timed Up and Go (TUG) test [29] can be administered and reported using registries for standardized outcome tracking and reporting [18,22].

The recent focus on the need for increasing CR accessibility and scope [18] presents a timely opportunity to incorporate fall recovery training as an adjunctive area of clinical practice. All three components can be readily designed to be physician-prescribed and -supervised. They can be delivered either in person, remotely, or a hybrid combination at home by CR-trained nurses or other health care team staff to maximize quality, accessibility, participation, efficiency, cost-effectiveness, and compliance with governmental payor requirements [7,14,18]. From a practical perspective, the exercises and maneuvers can be taught or assessed by a nurse or medical assistant, or taught using a readily accessible, easy-to-follow video as an extension of an existing CR program [13,30].

## Conclusion

Phase 3 CR is an under-utilized clinical tool to address important long-term patient outcome risks, notably accidental falling, in the post-TAVR patient population. Fall recovery-the ability to independently stand up from a ground level fall-can and should become a standard part of a structured, physician-prescribed and supervised, home-based Phase 3 CR program. By integrating innovative, evidenced-based approaches and alternative models of delivery for fall recovery into CR practice, cardiologists could substantively improve their elderly and frail patients' clinical outcomes and functional resilience after TAVR and other cardiac and non-cardiac procedures.

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