TITLE: Reducing disability following hospital discharge in vulnerable older adults: the CAPABLE intervention

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PROTOCOL SUMMARY

Purpose and Specific Aims

Currently, there is no evidence-based approach to improve post-hospitalization functional decline. CAPABLE uses a novel inter-professional team involving an occupational therapist, nurse, and handyman to improve ADLs in older adults post-hospitalization. In a Center for Medicare & Medicaid Innovation (CMMI) demonstration project, CAPABLE demonstrated a 45% reduction of ADL difficulties in older adults from baseline to five months. The significance of this improvement could make the difference between aging at home independently and relocating to institutional care. While these results are encouraging, CAPABLE needs evaluation in real world health delivery contexts with more ethnic diversity. The purpose of this study is to test the effectiveness of CAPABLE in older adults in an active community health care program.

Interventions:

CAPABLE Intervention: Participants in the treatment group will receive up to 10 in-home sessions (≤6 visits with an occupational therapist and ≤4 visits from a nurse) – and up to $1500 in safety and modification services from a licensed handyman. Each treatment participant will receive each intervention component (education, assessment, and identification of functional goals, specific strategies tailored to goals and based on protocols).

Usual Care Group: Participants in the usual care group will not receive visit from study clinicians and will continue to receive their usual VNSNY CHOICE benefits and health care.

After baseline, all study participants will be reassessed at 20 weeks and possibly a third interview at 52 weeks. Assessments will be completed by a research assistant masked to treatment condition.

Sample Size and Population

Participants will be community dwelling older adults who agree to participate in the study. We will enroll approximately 268 patients over a 3 year period. Eligible patients will be recruited from active enrollees of the VNSNY CHOICE Medicare Advantage Health Plan who received skilled home health care following an acute hospitalization. We will recruit 60 days after the hospital discharge so that we are capturing residual ADL difficulty after the initial healing and strengthening has occurred.

Study Methods

This study is a single-masked, two-group, randomized trial to test the effectiveness of CAPABLE in reducing ADL difficulties compared to those randomized to usual care. The experimental group will receive CAPABLE services, which include visits from an Occupational Therapist, a Registered Nurse, and a licensed Handyman. The usual care group will not receive additional visits from study clinicians. All participants will be interviewed at 20 and 52 weeks post-baseline. Re-admission to skilled home health care, acute care hospitalization, skilled nursing facility, and nursing home admission will be assessed via VNSNY CHOICE claims data at 90 days (33 weeks) post follow up assessment. We will evaluate overall health care costs at 52 weeks (long-term impact). Outcome measures will be assessed by interviewers and analysts masked to treatment assignment and without interventionist contact.

STUDY PROTOCOL

A. Purpose and Specific Aims

The overall goal of this rigorous experimental study is to test the effectiveness of a multi-component homebased intervention to enhance physical function of patients who have ADL difficulties and have been recently hospitalized. We will conduct a pragmatic effectiveness trial in the skilled home health setting to evaluate CAPABLE in approx. 268 racially and ethnically diverse older adults with ADL difficulties following hospitalization and skilled home health care.

Primary Aim:
Hypothesis: those receiving CAPABLE will have fewer ADL difficulties
1) Test the effectiveness of CAPABLE in reducing the number of ADLs performed with difficulty at 20 weeks post-randomization
2) Estimate CAPABLE's economic impact on subsequent health care utilization and costs over 52 weeks post-randomization compared to CAPABLE program cost.

Secondary Aim:
1) Testing CAPABLE effectiveness on ADL function at 52 weeks
2) Testing effects for key subgroups (gender, ethnicity)
3) Examining theoretically-driven mediation pathways for treatment mechanisms

B. Background

Seven million older adults are hospitalized each year in the U.S. Of those discharged, 25-50% of them cannot perform the Activities of Daily Living (ADLs) that they could prior to hospitalization.[1,2] These difficulties are caused by multiple interacting factors experienced during hospitalization, such as immobility,[3,4] sleep disturbance, delirium,[5] and infection as well as the original cause of admission.[6,7] Alarmingly, 67% of these older adults do not return to baseline function by three months post discharge.[4] This impairs quality of life, furthers functional decline, and increases fall risk. Decreased physical function increases odds of hospital readmission by 320%[8] and is the most common modifiable risk factor for nursing home admission.[5] The cost of nursing home care in the US is $155 billion per year[9], most of it publicly funded through Medicaid and Medicare. Thus, testing novel approaches that improve functional recovery following hospital discharge have the potential for substantial individual, financial, social, and policy benefits.

There is no evidence-based approach to improve post-hospitalization functional decline. The focus within post-hospital care transition programs is on disease-specific needs such as medication reconciliation and disease education. This approach does not focus on improving daily functional abilities at home. Nor does it identify and address the constraints imposed by older adults' living environments that impact everyday activities of living. A challenging home environment such as uneven flooring, toilets that are too low, and stairs without banisters, can lead to further functional decline. In turn, this may be exacerbated by polypharmacy, poor balance and strength, depression, fear of falling, and unsafe ADL performance.

Our team has tested a program, CAPABLE, designed to improve ADLs in older adults with ADL difficulties. CAPABLE uses a novel inter-professional team involving an occupational therapist, nurse, and handyman. The intervention provides ≤10 person-directed, home-based sessions over five months which includes: 1) an assessment by an occupational therapist for functional difficulties, home safety risks, and personal functional goals, as well as by an assessment by a registered nurse for medication complexity, pain, depression, balance and strength, and ability to communicate with a primary care provider; 2) the development of a plan to address participants' identified functional goals; 3) training in task simplification and compensatory strategies, balance and strength exercises, pain management, behavioral activation for depressive symptoms, and medication simplification; and 4) home repairs, assistive devices and home modifications managed by a handyman.

In a Center for Medicare & Medicaid Innovation (CMMI) demonstration project, the program resulted in a 45% reduction of ADL difficulties in older adults from baseline to five months.[10] The magnitude of reductions occurred for both those with and without a hospitalization in the year prior to program enrollment. The significance of this improvement could make the difference between aging at home independently and relocating to institutional care. While these results are encouraging, CAPABLE needs evaluation in real world health delivery contexts with more ethnic diversity.

C. Study Design and Methods

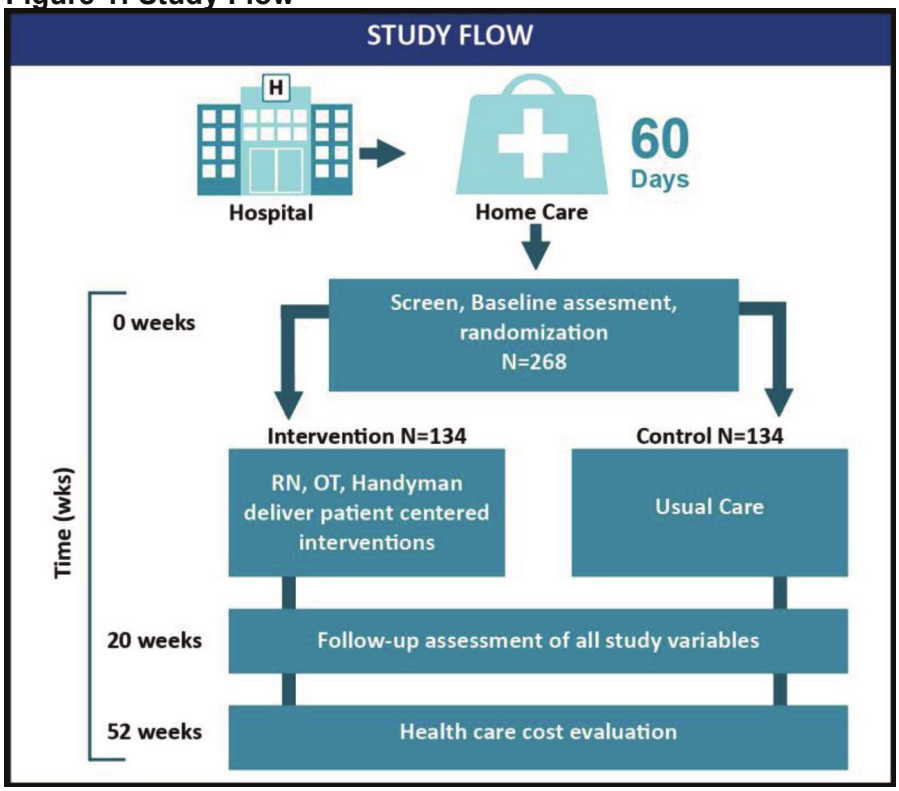
C1. Study Design

This study is a single-masked, two-group, randomized trial to test the effectiveness of CAPABLE in reducing ADL difficulties compared to those randomized to usual care. We will enroll approx. 268 older adults at 60 days after home care admission.

The experimental group will receive CAPABLE services. These include ≤10 sessions: ≤ 6 with an Occupational Therapist (OT) and ≤ 4 sessions with a Registered Nurse (RN) and up to ≤ $1,500 of home safety and home modifications from a licensed handyman who is guided by the OT. OT and RN sessions will target participants' self-identified functional goals (e.g., getting safely into the tub, getting upstairs to sleep in own bed).

The usual care group will not receive additional visits from study clinicians. All participants will be re-evaluated at 20 and 52 weeks. Re-admission to skilled home health care, acute care hospitalization, skilled nursing facility, and nursing home admission will be assessed via VNSNY CHOICE claims data at 90 days (33 weeks) post follow up assessment. We will evaluate overall health care costs at 52 weeks (long-term impact). Outcome measures will be assessed by interviewers and analysts masked to treatment assignment and without interventionist contact. Each design component is described below.

Figure 1: Study Flow



C2. Characteristics of study population

Participants will be community dwelling older adults who agree to participate in the study. We will enroll approx. 268 patients over a 3 year period, enrolling about 100 participants per year. Eligible patients will be VNSNY CHOICE Medicare Advantage Health Plan members who received skilled home health care following an acute hospitalization. We will recruit 60 days after the hospital discharge so that we are capturing residual ADL difficulty after the initial healing and strengthening has occurred. Inclusion criteria include: 1) age 65 or older; 2) 60 days after an acute care hospitalization followed by VNSNY home care episode; 3) Difficulty with at least 1 ADL; 4) Member of the VNSNY CHOICE Medicare Advantage Health Plan; 5) Are able to stand with or without assistance; 6) Are available during the study timeframe. Exclusion criteria includes: 1) Significant cognitive impairment based on the Callahan 6-item cognitive screening tool; 2) Does not speak English or Spanish as their primary language; 3) Is actively receiving cancer treatment; 4) Plans to move in less than 1 year.

We will recruit CAPABLE participants from the Visiting Nurse Service of New York VNSNY CHOICE Medicare Advantage Health Plan. VNSNY CHOICE Health Plan is a non-profit managed care organization that helps people remain in their homes rather than moving to nursing facilities. VNSNY CHOICE builds on VNSNY's expertise in coordinating all the health and support services that older and frail New York residents need to stay healthy and independent in their own homes. Selecting participants from this population allows us to target lower-income, Hispanic, and African American older adults from four New York City boroughs, including Manhattan, Brooklyn, Queens, and the Bronx. Preliminary analyses revealed that a large proportion of health plan members experienced a loss of functioning following their stay in hospitalization and home care (41%; n=615) and most had at least some remaining level of activity limitations at the time they were discharged from home care (92%; n=1,382).

C3. Intervention

C3.1. CAPABLE Program

CAPABLE is informed by theory and evidence-based practices. It involves up to 10 home sessions each of 60 minutes duration over a 5-month period. It draws upon clinical approaches to enhance uptake and adoption of intervention strategies by study participants such as patient-centered care and motivational interviewing. **Every participant receives each component of the intervention (assessment, goal setting, interactive problem-solving, and training) but interventionists clinically tailor content to each participant's functional goal.**

C3.2. Intervention Delivery Characteristics

The delivery characteristics of CAPABLE consist of an assessment driven, tailored package of interventions delivered by an OT (≤ 6 home visits for ≤ 1hour), an RN (≤ 4 home visits for ≤ 1hour) and a handyman (HM) team. The RN meets with participants for up to 4 sessions during the same 5 months as the OT sessions. Sessions are spaced so that participants have opportunities to practice new strategies or activities on their own after learning them with the OT or RN. Communication between the OT, Nurse, and HM will be enhanced by a secure share site which can be remotely logged into by the interventionists and also enable electronic documentation that can be reviewed for fidelity and contribute to understanding intervention costs. The OTs and RNs will be bilingual and all intervention materials will be available in Spanish and English. The OT will be responsible for ordering the supplies and home repairs/modifications. Bi-monthly meetings of the OTs and RNs with the site Research Coordinator and the PI will ensure smooth communication, supervision, and adherence to intervention fidelity.

C3.3. Intervention Protocol

Occupational Therapist Visits

Sessions 1 & 2: OT meets with participants and conducts a semi-structured clinical interview using the Client-Clinician Assessment Protocol (C-CAP) tested for its psychometric properties for use in home

based and home modification programs. The C-CAP provides a systematic approach from which to identify and prioritize performance areas that are problematic to participants. For each area identified, the OT observes the participant's performance and evaluates safety, efficiency, difficulty, and presence of environmental barriers and supports. The OT provides a 3-ring CAPABLE notebook that contains evidence based educational materials, contact information, and a calendar to integrate the sessions by the RN and HM interventionists that the participant keeps for reference. During the first OT session, the OT assesses the environmental home safety for holes in walkways, uneven carpeting, and absent railings or banisters. Based on the environmental assessment, observation of ADL activities, and identification of the participant's goals, the OT and participant discuss possible environmental modifications. The OT then provides a list of assistive devices and housing repairs in participant-prioritized order to the HM coordinator via email.

Sessions 3-5: OT engages the participant in problem-solving to identify behavioral and environmental contributors to performance difficulties and strategies for attaining functional goals. The OT trains participants to use specific strategies such as energy conservation techniques, simplifying tasks and the environment, and using assistive devices. Also, the OT provides balance and fall recovery techniques to decrease fear of falling. In each session, the OT reinforces strategy use, reviews problem-solving, refines strategies, and provides education and resources to address future needs. Home modifications (grab bars, rails, and raised toilet seats) are coordinated with the HM to assure that they are provided in a timely manner and meet the needs of the participant. The OT follows up with training in their use.

Session 6 (final session): OT reviews all techniques, strategies and devices, and helps the participant to generalize success to other situations.

Registered Nurse Visits
Session 1: The first RN session follows the first OT session within 10 days. In this session, the RN assesses the participant using the C-CAP RN developed specifically for CAPABLE30,70 (Appendix D) in which the RN focuses on how and whether pain, depression, strength and balance, medication management and communication with PCP impact daily function. In this assessment, the RN and the participant identify and prioritize goals, and make plans to achieve those goals. The RN also adds educational resources to the CAPABLE notebook to reinforce its use as a resource.

Sessions 2 & 3: RN and the participant work on the goals identified through the C-CAP RN. In each session, the RN reinforces strategy use, reviews problem-solving, refines strategies (such as Go4Life exercises or pain management), and provides education and resources to address future needs (e.g., pill box for medication management).

Session 4 (final session): RN reviews the participants' strategies and helps to generalize them to other possible challenges.

Handyman Services
A handyman (HM) service specializing in NYC dwellings will be engaged by the study intervention staff as needed. Under the direction of the OT, the HM coordinates the ordering of the assistive devices as well as the repair and modification supplies. The budget for this work is $1500 per household based on our previous studies (mean $1099, range $71-$1398) and adjusted for inflation and New York region. This is enough for multiple small projects such as installing grab bars, tightening carpet, installing shower chairs, and adding lighting to stairs. Structural work to the home is beyond the focus of the CAPABLE protocolto facilitate function. Participants with larger needs will be referred to other resources.

C3.4 Usual Care
To provide a comparator with insurance and policy implications, and because it is a pragmatic trial, the group randomized to control will receive usual care. There is no standard of care post skilled home care episode. The usual care group will receive quarterly newsletters with tips on aging and function to keep them engaged with the study. Service utilization data will be collected from the electronic record for all study participants to describe services received by both groups. These data will include the number, frequency and duration of home care visits by discipline (i.e., RN, Physical Therapy, OT, Home Health Aide), number, frequency and duration of provider visits, use of assistive devices and any home repair or modification participants or family members had done to the home environment. Because all participants in both groups are members of the same Medicare Advantage insurance group, we will be able to track components and cost of usual care.

C4. Procedures for Recruiting study subjects

We will recruit CAPABLE participants from the VNSNY CHOICE Medicare Advantage Health Plan who receive skilled home care following an acute hospitalization. Included in this package is a HIPAA Waiver of Authorization to access identifiable patient information for study subject screening and recruitment purposes. We will employ a 2 tier eligibility screening process. We will first screen patients with administrative data and then conduct a phone screen of those potentially eligible (see telephone screener included with this IRB package). Based on VNSNY experience with prior randomized trials,[11,12] and on our preliminary studies, we will be able to enroll a sample size of approx. 100 patients per year (268 needed over 3 years) from the 1,578 patients who are discharged from hospital to home care each year. A preliminary study of 118 eligible participants at the VNSNY revealed that 48% were reachable and interested in participating in the study. In previous CAPABLE trials, 71% have made it through enrollment from the point of initial interest. Based on these data, we estimate a 34% overall enrollment rate of those screened.

C4.1. Inclusion/Exclusion Criteria:

Inclusion criteria:
Participants who meet the following criteria will be included in this study:
- Aged ≥ 65 years old;
- Who are 60 days post-hospitalization in an acute care setting and who have had a Visiting Nurse Service of New York (VNSNY) visit;
- Have difficulty with at least one activity of daily living (ADL);
- Are a member of the VNSNY CHOICE Medicare Advantage Health Plan;
- Able to stand with or without assistance; and
- Are available during the intervention period

Exclusion criteria:
Participants with the following characteristics will be excluded from the study:
- Significant cognitive impairment identified by the Callahan screening tool;
- Do not speak English or Spanish;
- Have had more than 3 hospitalizations within the past 12 months;
- Are actively receiving radiation or chemotherapy
- Have plans to relocate in less than one year
- Diagnoses of: Dementia, Alzheimer's, Other Cerebral Degeneration, and serious cognitive impairment or OASIS assessment level 3 response on M1034 "serious progressive conditions that could lead to death within a year".

C4.2. Initial electronic Screen
VNSNY Administrative data and patient OASIS records will be used to pre-screen patients to meet the following criteria:

- Aged ≥ 65 years old
- 60-days post-hospitalization in an acute care setting
- Have had a VNSNY visit in the last 60 days
- Current CHOICE Medicare Advantage Health Plan member
- Has difficulty with one or more ADL
- Speaks English or Spanish
- Diagnoses of: Dementia, Alzheimer's, Other Cerebral Degeneration, and serious cognitive impairment or OASIS assessment level 3 response on M1034 "serious progressive conditions that could lead to death within a year."

C4.3. Telephone Screen
Telephone Eligibility Screener will ask questions about the following criteria:

- Patient self-reports ability to stand with or without assistance
- Patient is available during study time frame
- Confirm that patient still has difficulty with one or more ADL
- Is not currently receiving radiation or chemotherapy
- Has had fewer than three hospitalizations in the past 12 months
- Confirm appropriate cognitive function using the Callahan 6-item cognitive screener

C5. Informed Consent Process

The consent process informs a potential participant about what they will be asked to do to take part in this study, indicates the participation is voluntary and he/she has the right to stop at any time. The possible risks are described in the informed consent form and trained field staff will explain the risk to the participants during the consent process. The potential risk of loss of confidentiality will be addressed with participants during the informed consent process. Field interviewers will be trained to perform teach-back techniques with the study participants at the time of consent. All personnel involved in the study will be fully trained and certified in the protection of human subjects and HIPAA regulations. This certification will be kept current throughout the study. As part of the informed consent process, participants will be notified of their rights pertaining to protected health information. Study participants also will be provided with the name and telephone number of the VNSNY IRB administrator should they have any questions or concerns about their participation in this study.

Participants will be informed that during any study interview or intervention visit, they can stop and rest at any time. As in the informed consent checklist, they will be told the duration of the participation, any foreseeable risks, and a description of the confidentiality of the records. They will be told who to contact with questions and concerns.

The consent form will be translated into Spanish and submitted the IRB once it is ready. A copy of the English consent form is attached with this IRB package.

C6. Randomization

After a home visit to consent and collect baseline data, patients will be randomized in a 1:1 ratio, to receive either: (1) CAPABLE intervention or (2) usual care. The schedule will be stratified by surgical vs. non-surgical hospital admission due to the marked difference in functional recovery.[13] Cases will be randomized within variable-sized blocks from 4 to 8 participants. These procedures will maintain allocation concealment throughout the trial, consistent with the CONSORT recommendations.[14] No research staff or investigator interacting with potential participants will be able to anticipate treatment allocation of the next assignment because of variable block sizes.

C7. Patient interviews

Study participants will be asked to participate in one interview at the start of the study, a second interview 20 weeks later and a possible third interview in about 52 weeks post study enrollment. Each interview visit will last about 1 hour. During each visit, a trained research interviewer will ask the participant questions about their daily activities, pain level, medical conditions and other questions about their health (see Table 1 below). At the very end of the study, after all of the interviews are completed, another member of the research team may call and speak to the patient briefly about how the study went. All study participants will receive $25 after each completed in-home interview.

Table 1. Data Sources

Measures (citation)	Measured when	Constructs and measurement attributes	Tested in Spanish speaking populations
Demographics	BL, 20, 52 weeks	Age, race, sex, insurance attributes, live with others, reason for hospital stay,	Yes
ADLS – Katz [72,73,75] 0-16	BL, 20,52 weeks	Bathing, dressing (upper and lower), toileting, transferring, toileting, feeding, walking across small room. Cronbach's alpha 0.87-0.94. [77]	Yes
IADL 0-16[76]	BL, 20,52 weeks	Ability to use the telephone, shop, prepare food, light housekeeping, wash laundry, take own medication, travel independently, and manage finances	Yes
Prior hx ADLs, IADLs	BL	ADL and IADL assessment prior to hospitalization	Yes
PROMIS Global 10	BL, 20,52 weeks	Overall health, quality of life, social activities, self-care, pain, fatigue, anxiety/depression, and mobility	Yes[77]
Home hazards- CDC Home Hazard Index 0-41	BL, 20 weeks	42 items- general household, kitchen, bathroom, bedroom and stairways. No psychometric data available.	Yes
Depression PHQ-9 [78,79] 0-27	BL, 20,52 weeks	Identification of Depression. Sensitivity 88%, specificity 78%	Yes[80]
Pain – Brief Pain Inventory [81]	BL, 20,52 weeks	Severity of pain, impact of pain on daily function, location of pain, pain medications and amount of pain relief in the past week	Yes
Patient Activation [82,83]	BL, 20 weeks	General preventive behaviors, disease-specific behaviors, and health fatalism Reliability 0.89, Cronbach alpha 0.87.Test-Retest reliability 93%	Yes[82]
Control Strategy Use [84,85]	BL, 20 weeks	Behavioral and cognitive processes that facilitate adaptation to life challenges Cronbach alpha = 0.69	Not yet—will do psychometric testing in this study
Charlson Comordity Index[86]	BL, 20,52 weeks	Co-morbidity, will ascertain from medical record	From medical chart[86,87]
Readmission rates	BL, 33 weeks	Purpose-built data collection form to be collected by research team	Yes
Medical utilization and costs	BL, 52 weeks	Purpose-built data collection form to be collected by research team	Yes
Formal and informal care	BL, 20, 52 weeks	Helpers section from National Health and Aging Trends Study[88]	Yes

C8. Spanish Translation

All data collection materials such as the patient survey, consent form, screener and scripts will be translated into Spanish via a professional translation service. Spanish copies with be submitted to the IRB prior to recruiting Spanish speaking study participants.

D. Data to be employed

D1. Data Sources

Data will be collected from the following sources:

- VNSNY CHOICE Medicare Advantage electronic medical record
- VNSNY electronic health record administrative variables
- OASIS data (start of care, transfers, resumption of care and discharge)

- Telephone screening recruitment calls
- In-home interviews

D2. Data Collection and Management
Field interviewers trained in quality data collection will directly enter data into the Redcap data entry and management system. With patient permission, the interviews will also be audiotaped. Intervention staff will also record periodic visits with patient permission. The project manager will check data from screening, intervention sessions, and final data collection for completeness and appropriateness and will listen to recordings based on quality control protocols. There will be a Data Safety and Monitoring Board (DSMB) of senior researchers external to the project with expertise in research methods, and older adults to assure subject safety and adherence to human subject protection policies. Evaluation will include periodic assessments of data quality, participant recruitment, accrual, and retention.

Participants are part of a Medicare Advantage (MA) Managed care plan. Claims from the VNSNY CHOICE Medicare Advantage database will be used to identify study participants who were admitted to a hospital (planned and unplanned), skilled nursing facility, and/or nursing home at 90 days and during the 52-week follow-up period. Services will be identified from claims using facility and Current Procedural Terminology (CPT) codes. We will use data from VNSNY administrative records to identify participants who were re-admitted to skilled home health care during the follow-up period.

E. Analytic Methods

E1. Analytic Approach. The overall goal of this rigorous experimental study is to test the effectiveness of a multi-component homebased intervention to enhance physical function of patients who have ADL difficulties and been recently hospitalized. We will use intention-to-treat analysis (ITT) as the primary method to analyze the results; data from all participants will be analyzed as members of their assigned study group. We may analyze post randomization data (e.g., treatment compliance) in supplementary analyses, such as complier-average causal effect (CACE) models. In addition to the primary outcome, numerous comparisons will be conducted for the secondary outcomes. P-values from these secondary outcomes will be considered descriptive indicators of the intervention impact, and not as absolute indicators for null hypothesis testing, which might require p-value adjustments for inflated type I error rate due to multiple comparisons. For our primary analyses, we will use cases with complete data. We will also conduct sensitivity analyses comparing the complete case analysis with analyses that use multiple imputation for missing data. Models will compare imputation done 1) for all people with missing data, including deceased cases, and 2) for only those who survived but dropped out.

E2. Sample Size
Sample size calculations are based on our ability to detect clinically meaningful effect sizes for CAPABLE on the primary outcome of mean ADL difficulty score. All calculations are based on two-sided tests of 0.05 significance. Assuming a conservative attrition rate of 25% during the 20-week follow-up period, (we have consistently had 13% attrition in prior CAPABLE studies)[10] we would need to enroll 60, 85, and 134 participants per treatment arm to detect, with 80% power, an intervention effect size of 0.60, 0.50, and 0.40, standard deviation units, respectively, at 20 weeks after baseline. Preliminary data showed a 41% reduction in ADL difficulty *(0.76 standard deviation units)* in the post-hospitalized group.[10] Smaller effects of 0.57 to 0.60 standard deviation units were noted for other outcomes, and effect sizes of 0.63 for ADL difficulties and 0.62 for IADL difficulties were obtained in a small RCT pilot.[15] By enrolling at least 268 participants, we anticipate having 20-week outcome data (primary endpoint) on 200 participants after 25% attrition. This sample size will provide excellent power to detect clinically meaningful differences between intervention and usual care groups.

E3. Primary study aims:

1. **Test the effectiveness of CAPABLE in reducing ADL difficulties compared to usual care after 20 weeks of intervention.** We will address this aim using an analysis of covariance on the 20-week Katz summary disability score with treatment group as the primary independent variable and the baseline Katz score as the primary covariate. Other baseline demographic (e.g., gender) functional ability, and clinical variables (e.g., Charlson comorbidity index, pre-hospitalization ADL function) will be included as covariates if there are any random imbalances on those variables across intervention groups or if they are significantly correlated with the 20-week Katz score after adjustment for the baseline Katz score.
2. **Estimate the impact of CAPABLE on subsequent health care utilization and costs, including all cause admission to hospital, skilled nursing facility, inpatient rehabilitation, skilled home health care at 52 weeks compared to intervention costs;** We will use time to event (i.e., survival analysis) models to examine intervention impact on discrete outcomes. We will use proportional hazards models with intervention group as primary predictor variable, adjusting for covariates. We will use hazard ratios and 95% confidence intervals to interpret whether the intervention was successful in reducing the rates (or delaying) these discrete event outcomes. The overall intervention cost model is: [1] CTreat i (ingredientik × pricek) Where CTreat i is the total cost of intervention services delivered to the "i-th" participant and ingredientik is the sum of the 'k-th" type of ingredient supplied to the "i-th" participant and priceik is the price of the k-th type of ingredient. Ingredients for each participant will be measured by building cost tracking modules into the individual contact tracking forms. The price of each home modification will be on a work order. *Medical Costs* will be estimated using claims data from control and treatment cohorts. The consent process will include permission to view patients' annual electronic Medicare claims summaries for all claim types including inpatient, outpatient, home health, physician outpatient, and durable medical equipment. The medical cost model will be based on the following model: [2] CM i Serviceik where CM i is the annual medical cost of participant "i" and Serviceik is the Medicare/Medicaid allowable charge for the k-th service delivered to participant "i". The hypothesis that CAPABLE is cost-saving is a test that the (cost of treatment - costs of medical utilization) ≤0. The first term can be estimated as E(CTreatment i) and the second term as E(CM i | Control) - E(CM i | Treated). We propose to use a semi-parametric bootstrap estimator in which we will iteratively draw samples of [E(CTreatment i)] – [E(CM i | Control)- E(CM i |Treated)] and compute the proportion of the values below 0.

E4. Secondary study aims:

1) Test the effectiveness of CAPABLE for reducing ADL difficulties compared to usual care baseline to 52 weeks. Additional, multilevel longitudinal analyses will incorporate the 52-week outcome data to examine the maintenance of any intervention effects. In these models, time since randomization (20 vs. 52 weeks) will be examined as a within-person or repeated measures factor, and group*time interaction tests will determine whether there are different trajectories of change in ADL (primary outcome) and the other continuous secondary outcomes (IADL, depressive symptoms).

2) Explore whether the intervention has differential effectiveness across subgroups. We will explore subgroup effects and heterogeneity of intervention response. Key subgroups will include those defined by gender, ethnicity, living arrangement, (e.g., with vs. without a co-residing caregiver), type of hospitalization (e.g., surgical vs. nonsurgical) and medical complexity (e.g., high vs. low Charlson comorbidity scores). We will add interaction terms to the models to test empirically whether the intervention is more or less effective in one group compared to a reference group, and examine stratified analyses where we observe significant interaction effects.

3) Examine theoretically-driven mediation pathways to identify potential mechanisms of intervention effectiveness. We hypothesize multiple intermediate variables as possible mediators of the intervention's impact including changes in depression, pain, and control strategy use. For each of these

proposed mediators, we will use models specifically developed for testing mediation effects in two-wave intervention trials and applied by our team for continuous outcome variables and for event outcomes. We will use structural equation modeling with baseline-adjusted changes in potential mediators regressed on the intervention condition to determine one leg of the mediation effect (a path) and baseline-adjusted changes in primary and secondary outcome variables regressed on changes in the mediator to estimate the second leg of the mediation effect (b path). The remaining adjusted intervention effect on the outcome variable represents the direct or unmediated effect (c' path). Mplus software calculates standard errors for mediation effect (a*b) using the Sobel or delta method and bootstrapping methods are also available to test the significance of the mediated effect. We will interpret and quantify significant mediation pathways to identify important intervention mechanisms. Furthermore, the proportion of the total intervention effect that can be attributed to any particular mediator will be calculated by (a*b)/((a*b)+c'). Multiple group structural equation models and associated nested comparisons of constrained and unconstrained models will also be employed to examine if mediation effects differ significantly by the subgroups listed above (secondary aim 4). Collectively, the analyses in secondary aim 4 will identify the pathways by which the intervention is delivering intended effects on outcomes and the patient subgroups that are particularly likely to benefit via specific pathways.

We have elected to not consider interim analyses in this study due to the extended time for recruitment and the low likelihood of a sufficiently large effect that would make it possible to stop early. However, we will revisit this decision with the DSMB at its first organizational meeting.

F. Risks

F1. Risks and Benefits to participants

i. **Potential Risks**: The study intervention does not pose risks greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests. However, this study involves exercise and discussion of changes of medication regimens with primary care providers. The potential risks to study participants include falls from increased exercise or participant changing own medication regimen after discussion of medications.

ii. **Potential Benefits**: Participants in the control group will not directly benefit. Participants in the intervention group will receive study visits from a Nurse, an Occupational Therapist, and a Handyman.

F2. Data Safety and Monitoring Plan

Please see the full DSMP included with this IRB package for additional information on the risks related to this study.

Early stopping rules: All Adverse events will be classified by severity and expectedness. Tracking reports will ensure that any statistically significant increases in death, hospitalization, or falls resulting in hospitalization are identified. Statistical tests of group difference will be conducted to determine if rates of serious adverse events differ between intervention and control groups. The DSMB will decide a threshold for the difference required between groups to consider stopping. Because there will be surveillance bias, as the control group participants will be much less likely to report adverse events on a regular basis, the DSMB may consider a difference in less than 50% increase in adverse events to be an acceptable difference.

G. Data Storage and Confidentiality

Data with identifiers will be used and stored by the research and intervention teams at VNSNY, all subject-identifying information on paper in the office will be kept in locked files accessible only to study staff at VNSNY, or, if in use in the field (assignment sheets to field interviewers and intervention staff), will be kept securely and destroyed at the earliest opportunity. Access to shared-drive network folders will be electronically restricted to the appropriate team members. Dates of birth and initials will be used along with the study IDs to confirm appropriate merging of data from different sources. All study staff have or will be thoroughly trained in the need to maintain strict confidentiality.

Legal Risks such as the risks that would be associated with a breach of confidentiality
In the unlikely event that a breach in confidentiality should occur, the study team will take the appropriate steps to inform the study participant and both VNS and Johns Hopkins University (JHU) IRBs that such an event has occurred.

Financial Risks
There are no anticipated financial risks to the participants, however, JHU will not cover any medical expenses resulting from a study related injury and any treatment will be the responsibility of the participant and their insurance provider. As such, patients are accountable for co-payments and any payments not covered by their insurance.

H. Payment and Remuneration. There are no penalties for not completing the protocol. Study participants will receive $25 for each completed in-home interview with our data collection staff.

I. Costs. There will be no costs for procedures or home visits. Because the visits occur in the participants' homes, there will be no transportation costs for them either.

References

1. Gill TM, Allore HG, Holford TR, Guo Z. Hospitalization, restricted activity, and the development of disability among older persons. *Jama.* 2004;292(17):2115-2124.
2. Gill TM, Allore HG, Holford TR, Guo Z. Hospitalization, restricted activity, and the development of disability among older persons. *JAMA.* 2004;292(17):2115-2124.
3. Bentley JP, Brown CJ, McGwin G, Sawyer P, Allman RM, Roth DL. Functional status, life-space mobility, and quality of life: a longitudinal mediation analysis. *Quality of Life Research.* 2013;22(7):1621-1632.
4. Boyd CM, Landefeld CS, Counsell SR, et al. Recovery of activities of daily living in older adults after hospitalization for acute medical illness. *Journal of the American Geriatrics Society.* 2008;56(12):2171-2179.
5. Barile JP, Thompson WW, Zack MM, Krahn GL, Horner-Johnson W, Haffer SC. Activities of daily living, chronic medical conditions, and health-related quality of life in older adults. *The Journal of ambulatory care management.* 2012;35(4):292-303.
6. Arnau A, Espaulella J, Serrarols M, Canudas J, Formiga F, Ferrer M. Risk factors for functional decline in a population aged 75 years and older without total dependence: A one-year follow-up. *Archives of gerontology and geriatrics.* 2016;65:239-247.
7. Henry-Sánchez JT, Kurichi JE, Xie D, Pan Q, Stineman MG. Do elderly people at more severe activity of daily living limitation stages fall more? *American journal of physical medicine & rehabilitation/Association of Academic Physiatrists.* 2012;91(7):601.
8. Bentley JP, Brown CJ, McGwin G, Jr., Sawyer P, Allman RM, Roth DL. Functional status, life-space mobility, and quality of life: a longitudinal mediation analysis. *Qual Life Res.* 2013;22(7):1621-1632.

9. Martin AB, Hartman M, Benson J, Catlin A, National Health Expenditure Accounts T. National Health Spending In 2014: Faster Growth Driven By Coverage Expansion And Prescription Drug Spending. *Health Aff (Millwood).* 2016;35(1):150-160.
10. Szanton SL, Leff B, Wolff JL, Roberts L, Gitlin LN. Home-based care program reduces disability and promotes aging in place. *Health Affairs.* 2016;35(9):1558-1563.
11. Russell D, Rosati RJ, Sobolewski S, Marren J, Rosenfeld P. Implementing a Transitional Care Program for High-Risk Heart Failure Patients: Findings from a Community-Based Partnership Between a Certified Home Healthcare Agency and Regional Hospital. *Journal for Healthcare Quality.* 2011;33(6):17-24.
12. Feldman PH, Murtaugh CM, Pezzin LE, McDonald MV, Peng TR. Just-in-Time Evidence-Based E-mail "Reminders" in Home Health Care: Impact on Patient Outcomes. *Health services research.* 2005;40(3):865-886.
13. Gaugler J, Roth DL, Haley WE, Mittelman MS. Modeling trajectories and transitions: results from the New York University caregiver intervention. *Nursing research.* 2011;60(3 Suppl):S28.
14. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMC medicine.* 2010;8(1):18.
15. Szanton SL, Thorpe RJ, Boyd C, et al. Community aging in place, advancing better living for elders: A bio-behavioral-environmental intervention to improve function and health-related quality of life in disabled older adults. *Journal of the American Geriatrics Society.* 2011;59(12):2314-2320.

Statistical Analysis Overview

The overall goal of this rigorous experimental study is to test the effectiveness of a multi-component home-based intervention to enhance physical function of patients who have ADL difficulties and have been recently hospitalized compared to a usual care control group. We will use an intention-to-treat (ITT) analysis to compare these two conditions; data from all participants will be analyzed as members of their randomly assigned treatment group. The primary outcome will be the Katz measure of difficulties with activities of daily living (ADLs). Scores on this measure range from 0 to 16, with higher scores indicating greater disability. In addition to the primary outcome, several additional comparisons will be conducted on secondary outcome variables. Because there is only one primary outcome measure, no adjustment for type I error is made for multiple comparisons, and a statistically significant finding will be indicated if the p-value is less than 0.05 for the treatment effect. This would indicate a type I error rate of less than 5% for rejecting the null hypothesis of no difference between treatment groups if the null hypothesis is, in fact, true. Two-tailed tests will be used for all statistical comparisons. P-values will also be reported the secondary outcome analyses but these p-values from the secondary analyses will be considered descriptive indicators of the intervention impact on those measures and not as absolute indicators for null hypothesis testing.

Comparison Group Selection

This is a two group comparison. A total of 268 participants will be enrolled and randomized in a 1 to 1 ratio to either the intervention condition or to a usual care control group, with 200 participants expected to provide outcome data after accounting for 25% attrition. A total of 200 participants for analysis will provide 80% power to detect a clinically meaningful difference of 0.40 standard deviation units between intervention and usual care groups on the primary outcome measure of ADL difficulty.

Type of Statistical Test

This two group comparison will be a test of **superiority**. A two-tailed test will be used with the type I error rate set at 0.05.

Statistical Test of Hypothesis (Primary Outcome)

The **method** to be used to calculate the p-value given the null hypothesis of no difference between the two treatment groups is an analysis of covariance (ANCOVA). The outcome variable will be the 20-week Katz summary disability score. Treatment group (intervention vs. usual care control) will be the primary independent variable. The baseline (pre-treatment) Katz summary disability score will be the primary covariate. Other baseline demographic (e.g., gender), functional ability, and clinical variables (e.g., Charlson comorbidity index, pre-hospitalization ADL function) may be included as additional covariates if there are any random imbalances on those variables across intervention groups or if they are significantly correlated with the 20-week Katz score after adjustment for the baseline Katz score.

Method of Estimation (Primary Outcome)

An ordinary least squares estimate of the mean difference, adjusted for covariates, will be used. Consistent with the pre-specified type I error rate of 0.05, 95% confidence intervals will be reported for this covariate-adjusted mean difference.

Parameter Dispersion Type (Primary Outcome)

The standard error of the mean will be used to characterize dispersion and to calculate the 95% confidence interval.

Statistical Tests of Hypotheses (Secondary Outcomes)

Secondary outcomes include discrete events such as hospitalization and admission to skilled home health care, skilled nursing facility, and nursing home. Time to event (i.e., survival analysis) models will be used to examine intervention impact on these discrete outcomes. Cox regression (proportional hazards) models will be conducted with intervention group as the primary predictor variable and baseline demographic (e.g., gender), functional ability, and clinical variables (e.g., Charlson comorbidity index, pre-hospitalization ADL function) included as covariates.

Method of Estimation (Secondary Outcomes)

Hazard ratios (with usual care as the reference group) will determine the degree to which the intervention was effective in reducing the rates of (or delaying) these discrete event outcomes. All hazard ratios will be accompanied with 95% confidence intervals to aid interpretation and to characterize potential variability of the true intervention effect.