Official title: Usability Testing of Affordable Haptic Robots for Stroke Therapy (Theradrive)

NCT number: NCT02772809

Document date: July 14, 2020

Modification

Basic Info

Confirmation Number:	**chcbiijd**
Protocol Number:	**819787**
Created By:	**VIVIO, NICHOLAS**
Principal Investigator:	**JOHNSON, MICHELLE J**
Protocol Title:	**Usability Testing of Affordable Haptic Robots for Stroke Therapy**
Short Title:	**Theradrive Usability**
Protocol Description:	**Stroke survivors with hemiplegia will be evaluated by rehabilitation professionals and asked to perform a battery of assessments to test the viability and usability of a force-feedback robot that adapts to each individual subject's performance. Subsequently, they will be asked to complete post-assessment questionnaires that provide feedback to the researchers on their observations and thoughts about the therapy devices.**
Submission Type:	**Biomedical Research**
Application Type:	**EXPEDITED Category 4**

PennERA Protocol Status

Approved (No CR)

Resubmission*
No

Are you submitting a Modification to this protocol?*

Yes

Current Status of Study

Study Status

Closed to subject enrollment (remains active)

If study is currently in progress, please enter the following

Number of subjects enrolled at Penn since the study was initiated

23

Actual enrollment at participating centers

0

If study is closed to further enrollment, please enter the following

Number of subjects in therapy or intervention

0

Number of subjects in long-term follow-up only

0

IRB Determination
If the change represents more than minimal risk to subjects, it must be reviewed and approved by the IRB at a convened meeting. For a modification to be considered more than minimal risk, the proposed change would increase the risk of discomfort or decrease benefit. The IRB must review and approve the proposed change at a convened meeting before the change can be implemented unless the change is necessary to eliminate an immediate hazard to the research participants. In the case of a change implemented to eliminate an immediate hazard to participants, the IRB will review the change to determine that it is consistent with ensuring the participant′s continued welfare. Examples: Convened Board Increase in target enrollment for investigator initiated research or potential Phase I research Expanding inclusion or removing exclusion criteria where the new population may be at increased risk Revised risk information with active participants Minor risk revisions that may affect a subject′s willingness to continue to participate Expedited Review Increase in target enrollment at Penn where overall enrollment target is not exceeded or potentially sponsored research Expanding inclusion or removing exclusion where the new population has the same expected risk as the previous, based on similarities of condition Revised risk information with subjects in long-term follow-up Minor risk revisions with no subjects enrolled to date
Expedited Review

Modification Summary
Please describe any required modification to the protocol. If you are using this form to submit an exception or report a deviation, enter 'N/A' in the box below.
Adding Kristine Lima as study contact, updating Kevin Bui, Carol Wamsley and Sam Gaardsmoe human cert, and removing Suneet Sharma, who is no longer involved in the study. The protocol will also be changed to allow for the inclusion of data only, from protocol 823511, which has similar recruitment population.

Risk / Benefit
Does this amendment alter the Risk/Benefit profile of the study?
No

Change in Consent
Has there been a change in the consent documents?
No

If YES, please choose from the options below regarding re-consenting

Deviations

Are you reporting a deviation to this protocol?*

No

Exceptions

Are you reporting an exception to this protocol?*

No

Protocol Details

Resubmission*
Yes

Study Personnel

Principal Investigator

Name:	**JOHNSON, MICHELLE J**
Dept / School / Div:	**4482 - RM-Rehabilitation Medicine**
Campus Address Mail Code	**4283**
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Pager:	
Email:	**johnmic@pennmedicine.upenn.edu**
HS Training Completed:	**Yes**
Training Expiration Date:	**09/07/2015**
Name of course completed :	**CITI Protection of Human Subjects Research Training - ORA**

Study Contacts

Name:	**TORRES, WILSON O**
Dept / School / Div:	**4482 - RM-Rehabilitation Medicine**
Campus Address Mail Code	**4283**
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Phone:	**215-893-2695**
Fax:	**-**
Pager:	
Email:	**Wilson.Torres@uphs.upenn.edu**
HS Training Completed:	**Yes**
Training Expiration Date:	**04/17/2019**
Name of course completed :	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**LIMA, KRISTINE S**
Dept / School / Div:	**4482 - RM-Rehabilitation Medicine**
Campus Address Mail Code	**4283**
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Phone:	**215-893-2679**
Fax:	**-**
Pager:	
Email:	**kristine.lima@uphs.upenn.edu**
HS Training Completed:	**No**
Training Expiration Date:	
Name of course completed :	

Other Investigator

None

Responsible Org (Department/School/Division):

4482 - RM-Rehabilitation Medicine

Key Study Personnel

Name:	**WAMSLEY, CAROL**
Department/School/Division:	**Health System**
HS Training Completed:	**Yes**
Training Expiration Date:	**02/08/2017**
Name of course completed:	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**DEKERLEGAND, JENNIFER**
Department/School/Division:	**Health System**
HS Training Completed:	**Yes**
Training Expiration Date:	**07/24/2014**
Name of course completed:	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**BUI, KEVIN**
Department/School/Division:	**Health System**
HS Training Completed:	**Yes**
Training Expiration Date:	**08/11/2018**
Name of course completed:	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**RAIZEN, SARAH F**
Department/School/Division:	**School of Engineering**
HS Training Completed:	**Yes**
Training Expiration Date:	**11/02/2020**
Name of course completed:	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**LYN, BREANNA**
Department/School/Division:	**School of Engineering**
HS Training Completed:	**Yes**
Training Expiration Date:	**10/21/2020**
Name of course completed:	**CITI Protection of Human Subjects Research Training - ORA**

Name:	**GAARDSMOE, SAMUEL**
Department/School/Division:	**Health System**
HS Training Completed:	**No**
Training Expiration Date:	
Name of course completed:	

Disclosure of Significant Financial Interests*
Does any person who is responsible for the design, conduct, or reporting of this research protocol have a **FINANCIAL INTEREST**?
No

Penn Intellectual Property*
To the best of the Principal Investigator's knowledge, does this protocol involve the testing, development or evaluation of a drug, device, product, or other type of intellectual property (IP) that is owned by or assigned to the University of Pennsylvania?
Yes

If yes, please provide any readily available information on such IP. For example, a brief description of the IP, any relevant docket number (if disclosed to the Penn Center for Innovation (PCI), patent application or patent numbers, inventor's names, and/or other relevant details.*
Dr. Michelle Johnson is one of the inventors of the system in question

Certification
I have reviewed the *Financial Disclosure and Presumptively Prohibited Conflicts for Faculty Participating in Clinical Trials* and the *Financial Disclosure Policy for Research and Sponsored Projects* with all persons who are responsible for the design, conduct, or reporting of this research; and all required Disclosures have been attached to this application.
Yes

Biomedical Research

Clinical Trial*
Is this a clinical trial?
Yes

If Yes, please be aware that for each clinical trial conducted or supported by a Federal department or agency, one IRB-approved informed consent form used to enroll subjects must be posted by the awardee or the Federal department or agency component conducting the trial on a publicly available Federal Web site that will be established as a repository for such informed consent forms.

Investigator Initiated Trial*
Is this an investigator initiated trial?
Yes

If Yes, please be aware that the investigator may be required to create and manage a record of this trial in https://clinicaltrials.gov.

Drugs or Devices*
Does this research study involve Drugs or Devices?
Yes: Investigational devices that may qualify as Non-Significant Risk.

IND Exemption

For studies that fall under an IND exemption, please provide the number below

For studies including IND or IDE's, please provide the number(s) below

IDE Review*
NOTE: For research involving investigational devices, you are required to review the guidance on Managing Research Device Inventory. Consult the Penn Manual for Clinical Research: https://somapps.med.upenn.edu/pennmanual/secure/pm/investigational-product-management Please check the box Yes if you have reviewed the guidance.
Yes

Research Device Management*
Please indicate how research device(s) will be managed.
The device receipt, storage and dispensing is being conducted by the research team (please provide information in the protocol summary as to how this will be conducted)

Drug, Herbal Product or Other Chemical Element Management *
Please indicate how drugs, herbal products or other chemical entities will be managed.
Not Applicable (no drugs, herbal products or other chemical entities)

Radiation Exposure*
Are research subjects receiving any radiation exposure (e.g. X-rays, CT, Fluoroscopy, DEXA, pQCT, FDG, Tc-99m, etc.) that they would not receive if they were not enrolled in this protocol?
No

Gene Transfer*
Does this research involve gene transfer (including all vectors) to human subjects?
No

Human Source Material*
Does this research include collection or use of human source material (i.e., human blood, blood products, tissues or body fluids)?
No

CACTIS and CT Studies*
Does the research involve Center for Advanced Computed Tomography Imaging Services (CACTIS) and CT studies that research subjects would not receive if they were not part of this protocol?
No

CAMRIS and MRI Studies*
Does the research involve Center for Advanced Magnetic Resonance Imaging and Spectroscopy (CAMRIS) and MRI studies that research subjects would not receive if they were not part of this protocol?
No

Investigational Agent or Device within the Operating Room*
Does the research project involve the use of an investigational agent or device within the Operating Room?
No

Cancer Related research not being conducted by an NCI cooperative group*
Does this protocol involve cancer-related studies in any of the following categories?
No

Processing of Materials*
Will the research involve processing (such as over encapsulating, or compounding)?
No

In-House Manufacturing of Materials*
Will the research involve processing (such as over encapsulating, or compounding)?
No

Medical Information Disclosure*
Does the research proposal involve the use and disclosure of research subject's medical information for research purposes?
No

If the answer is YES, indicate which items is is provided with this submission:

CTRC Resources*
Does the research involve CTRC resources?
No

Pathology and Laboratory Medicine Resources*
Will samples be collected by hospital phlebotomy and/or processed or analyzed by any of the clinical laboratories of the University of Pennsylvania Health System?
No

Research Involves Apheresis, Cell Collection, and/or Blood Product Collection*
Does this research involve collection of blood products in the Penn Donor Center and/or the use of apheresis for treatment or collection of cells or other blood components?
No

Research involving blood transfusion or drug infusions*
Will your research involve blood transfusion or infusion of study drug in 3 Ravdin Apheresis Unit for research purposes?
No

Trial in Radiation Oncology
Is this research a prospective trial being done in Radiation Oncology, and if so, has this protocol been approved by the Radiation Oncology Protocol committee?
N/A

Study in Radiation Oncology
Is this research a retrospective study being done in Radiation Oncology, and if so, has this project been reviewed by the Radiation Oncology Clinical Research Group?
N/A

Use of UPHS services*
Does your study require the use of University of Pennsylvania Health System (UPHS) services, tests or procedures*, whether considered routine care or strictly for research purposes?
No

Primary Focus*
Clinical Trial (prospectively assigning subjects to health-related interventions to evaluate outcomes)

Protocol Interventions

	Sociobehavioral (i.e. cognitive or behavioral therapy)
	Drug
x	**Device - therapeutic**
	Device - diagnostic (assessing a device for sensitivity or specificity in disease diagnosis)
	Surgical
x	**Diagnostic test/procedure (research-related diagnostic test or procedure)**
	Obtaining human tissue for basic research or biospecimen bank
x	**Survey instrument**
	None of the above

The following documents are currently attached to this item:

There are no documents attached for this item.

Department budget code

None

Multi-Site Research

Other Sites

No other sites

Management of Information for Multi-Center Research

The following documents are currently attached to this item:

There are no documents attached for this item.

Protocol

Abstract
TheraDrive is a low-cost robotic system for post-stroke upper extremity rehabilitation. The system uses off-the-shelf computer gaming wheels with force feedback to help reduce motor impairment and improve function in the arms of stroke survivors. Preliminary results from various studies have shown that the original TheraDrive system lacked a robust mechanical linkage which could withstand the forces exerted by patients, lacked a patient-specific adaptive controller to deliver personalized therapy, and was not capable of delivering effective therapy to severely low-functioning patients. A new low-cost, high-force haptic robot with a single degree of freedom has been developed to address these concerns. This study has two purposes: first, to test the viability and usability of the new robot system alongside the original TheraDrive system; and second, to test if low-functioning patients benefit, and if so how much, from using force-feedback therapy as opposed to devices with zero impedance. This will be done by recruiting approximately 36 human subjects. Exercises will be performed by study subjects and an adaptive controller will monitor patient performance to ensure that exercises are difficult but doable, which is important for maintaining patient motivation. We hypothesize that not only will the new system be viable, but that it will provide better robot-assisted therapy to a large variety of patients, especially low-functioning stroke survivors with hemiplegia.

Objectives

Overall objectives
This study is being performed to assess the usability of affordable force-feedback devices for stroke rehabilitation. For this pilot study, subjects will use two or more devices (a commercial force-feedback

joystick, commercial force-feedback wheel, and a custom force-feedback device) to complete games and exercise tasks to determine the ease of using these devices and their impact on motor performance and function. The long-term goal of this project is to develop an inexpensive high-force haptic rehabilitation robot that can safely be used by patients at home without therapist supervision. A sub-goal was to simulate the human-machine interaction. We will use our assessment tools to determine upper arm kinematic and dynamic workspace recovery

Primary outcome variable(s)
The primary outcomes are motor control, as measured by the upper extremity Fugl-Meyer; ADL function; and grip strength as measured by a dynamometer; a custom metric to determine Kinematic workspace and dynamic workspace will be employed. Customized metrics will be defined such as movement time, movement velocity, and accuracy. New outcome variables related to MRI: fiber density and hemisphere activation

Secondary outcome variable(s)
The secondary variables for motor impairment are upper extremity coordination, finger dexterity, and spasticity - the Box and Block and Ashworth assessments will be used to evaluate these.

Background
Recently published literature in top publications such as The New England Journal of Medicine, Stroke, and scientific statements from the American Heart Association's (AMA) Council on Clinical Cardiology, all recognize that robots have a long-term role to play in the rehabilitation of stroke survivors. One possible role is as a therapy assistant in rural areas that are a considerable distance from hospitals and inpatient rehabilitation centers. Another is in the development of more affordable haptic robot systems for nursing homes and adult daycare centers. For these reasons, there is a trend towards creating less expensive systems that can acheive functional treatment outcomes. Past examples of low-cost therapy systems inform the limitations, and thus the novel development solutions needed to advance the field of neurorehabilitation. Game therapy with low-cost systems can reduce motor impairment. For example, Palanca, an early mechanotronic system that automated the rehabilitation process by having users play Pong, 30 minutes per day, five days per week, for a total of 13 sessions, showed significant functional improvements in the impaired extremity. Another low-cost force-feedback system called Driver's Seat, introduced a driving simulator interface for rehabilitation robots. It used a force-feedback split-steering wheel with a force sensor for each hand that enabled the robot to respond differently to force inputs from each hand. In this case, the robot resisted forces applied by a stroke patient's unimpaired arm, forced the patient to use the impaired arm to assist in the completion of steering tasks. In addition, several commercial force-feedback joysticks such as UniTherapy, JavaTherapy, and the TheraJoy system have been developed to investigate viability as therapy robots in an under supervised environment. UniTherapy software includes a web-based interface that allows both the therapists and the patient to design and execute tracking exercises; the joystick is used to perform positioning and tracking exercises.

Study Design

Phase*
Not applicable

Design
Part A Usability Study: Cross-sectional study comparing outcome variables for stroke survivors with varying levels of motor deficit impairment in their upper extremity. Subjects with mild motor deficits will be compared against stroke survivors with severe motor deficits after completing exercises with both commercial and custom therapy devices. Therapy exercises will be performed in random order, decided prior to the session. It will be randomly determined which robot the patient will use first, the order of operating modes used for the new robot, and the order of therapy exercises performed in each mode. Surface Electromyography (EMG) will be used in order to detect the small electric currents, or signals, which are generated by muscle activity. The collection of the strength and pattern of the signals will permit us to verify muscle activity over time. Part B Therapy Study: Pre-post study looking at change in outcome variables over 12 therapy sessions (three times a week for one month). Only low and mid functioning stroke survivors will be asked to participate in Part B of the study, and only the custom haptic device will be used by the study subjects. Pre-post evaluations will be administered at session 1 and 12. Surface Electromyography (EMG) will be used in order to detect the small electric currents, or

signals, which are generated by muscle activity. The collection of the strength and pattern of the signals will permit us to verify muscle activity over time.

Study duration
1) We estimate that it will take 3 years from the date of IRB approval to enroll all subjects and complete the study. 2) Part A - The subect's participation in the study will be limted to approximately 4 hours; 1-2 hours to be evaluated by a therapist with expertise in stroke rehabilitation and 2-3 hours of assessing the viablity and usabilty of the various therapy devices. Part B - Subjects enrolled in Part B will be asked to return 3 times a week for 1 month (12 sessions). All sessions will last approximately 1.5 hours. 3) Projected date of the proposed study: 3/1/14 to 7/1/17.

Resources necessary for human research protection
Describe research staff and justify that the staff are adequate in number and qualifications to conduct the research. Describe how you will ensure that all staff assisting with the research are adequately informed about the protocol and their research related duties. Please allow adequate time for the researchers to conduct and complete the research. Please confirm that there are adequate facilities for the research.
All staff have taken the human subject certification and HIPAA training. The PI will have regular meetings with the research team to ensure that the team is adequately trained. We will recruit from our therapy services.

Characteristics of the Study Population

Target population
Stroke survivors greater than 18 years of age with hemiplegia and varying levels of impairment.

Subjects enrolled by Penn Researchers
56

Subjects enrolled by Collaborating Researchers
0

Accrual
Various Penn and Good Shepherd Penn Partners (GSPP) databases will allow the research team to search the respective systems within the parameters of the inclusion/exclusion criteria. Given the number of stroke survivors over the age of 18 with hemiplegia served by the Penn and GSPP communty, recruitment of 56 (total for parts A, B) stroke survivors three months post event should be obtainable within the time frame specified. Justification for the sample size is based on the fact that this is a pilot study. Also, we expect that in Part A, not all willing participants will be able to continue post evaluation by a therapist (more than mild depression or cognitive impairment will be detected). Ideally, all low-functioning stroke subjects who participated in Part A would participate in B; however, we expect some attrition from the original group, requiring more subjects to be recruited. Subjects may also participate in Part A.

Key inclusion criteria
Part A: Stroke survivors greater than 18 years of age with hemiplegia and varying levels of impairment. The subject's stroke must have occurred at least 3 months prior to enrollment in the study. Part B: Low-functioning stroke survivors greater than 18 years of age with hemiplegia. The subject's stroke must have occurred at least 3 months prior to enrollment in the study.

Key exclusion criteria
1) An expert in stroke rehabilitation therapy will administer the Montreal Cognitive Assessment (MoCA) to each study participant. After the administration of the MOCA, the PI and therapist will use their to expertise and discretion to determine whether the participant scored well enough on particular components of the MOCA that are of particular concern to this study, e.g. visuospatial acuity and concentration. 2) No greater than mild depression. A member of the research team will administer Beck's Depression Inventory (BDI) to each study participant over the phone. If the participant is found to have greater than mild depression, as measured by the BDI , they will not qualify for the study. 3)

Participants must be able to sit upright for 4 hours at a time in Part A of the study; and 2 hours at a time, 3 days a week, for Part B of the study. 4) Participants enrolled in Part B cannot currently be receiving rehabilitation. 5) Participants cannot have received Botox injections within the past 3 months. 6) Participants cannot be suffering from contractures (chronic loss of joint motion) or debilitating spasticity in the upper extremity. 7) If a participant is experiencing greater than mild pain, and/or the PI determines that the participant should no longer continue working with the novel therapy devices, the study will be stopped.

Vulnerable Populations

	Children Form
	Pregnant women (if the study procedures may affect the condition of the pregnant woman or fetus) Form
	Fetuses and/or Neonates Form
	Prisoners Form
	Other
x	**None of the above populations are included in the research study**

The following documents are currently attached to this item:

There are no documents attached for this item.

Populations vulnerable to undue influence or coercion
The study does not include any vulnerable populations.

Subject recruitment
Stroke survivors over the age of 18 with hemiplegia, who are three months post event, and have varying levels of impairment in the upper extremities will be recruited. All use of the TheraDrive system will take place at the Rehabilitation Robotics Lab on the first floor of Penn Rittenhouse. A member of the Rehabilitation Robotics Lab using various databases such as Epic, Sunrise, Penn Data Store, and the Uniform Data System (UDS) that is particular to Penn Rittenhouse, will be used to identify potential subjects. After identifying subjects via the study's inclusion/exclusion criteria, a flyer will be mailed out, and then if necessary, direct follow-up by phone or email will follow. Dr. Lenrow, M.D., a study investigator and expert on stroke rehabilitation, will provide guidance to the PI should questions arise regarding the enrollment of a particular study subject. Conversely, physicians with significant stroke populations as patients will be approached by a member of the Rehabilitation Robotics Lab and asked to participate in the recruitment of study subjects. Physicians will be asked to refer any interested subjects to the lab's research coordinator. The coordinator will then reach out directly, either by phone or email, and schedule a time for the patient to come to the lab. More broadly, a flyer will be posted both at the Penn Institute for Rehabilitation Medicine and Good Shepherd Penn Partners Penn Therapy and Fitness outpatient therapy practices with the contact information of the lab's research coordinator. Additionally, an advertisement will be placed in a university-wide newsletter - Express Weekly - with information regarding the study and how to contact a member of the lab. Possible study participants will also be directly solicited at the monthly Stroke Support Group meeting, which takes place in the dining hall on the third hall of Penn Rittenhouse. A member of the Rehabilitation Robotics Lab will briefly explain the research, and a handout with contact information, will be provided should they want to contact our team for further information. In addition, data from protocol #823511 may be included for analysis, as they have similar recruitment population. Protocol #823511 allows the subjects to have their data available for analysis in this study.

Will the recruitment plan propose to use any Penn media services (communications, marketing, etc.) for outreach via social media avenues (examples include: Facebook, Twitter, blogging, texting, etc.) or does the study team plan to directly use social media to recruit for the research?
Yes

Please identify which method(s) of social media you will utilize, the content of the text to be used, and the method(s) for posting this information (i.e., using Penn supported communication services). When

proposing the text to utilize, please be aware of any social media limitations (i.e., number of characters allowed in a tweet) and any appropriate confidentiality practices necessary to be compliant with posting research recruitment text.*
One way we play on advertising the study is via the Express Weekly newsletter. See attached for language to be used.

The following documents are currently attached to this item:

There are no documents attached for this item.

Subject compensation*
Will subjects be financially compensated for their participation?
Yes

The following documents are currently attached to this item:

There are no documents attached for this item.

If there is subject compensation, provide the schedule for compensation per study visit or session and total amount for entire participation, either as text or separate document

15 dollars will be provided to study participants for each visit they make to the lab during Part A (i.e. two visits equals 30 dollars). Participants who complete Part B will receive an additional 75 dollars. Participants who enroll in Part C will also receive 50 dollars.

Study Procedures

Suicidal Ideation and Behavior
Does this research qualify as a clinical investigation that will utilize a test article (ie- drug or biological) which may carry a potential for central nervous system (CNS) effect(s)?
No

Procedures
Part A: Participation in this part of the study will include the following steps: 1) Informed Consent: After arrival, subjects will review and sign the consent form with study personnel present. 2a) Pre-Assessments: A member of the research team will evaluate the subjects' affected arm and assess their ability to use it. Subjects will be evaluated using a battery of assessments in order to determine their level of impairment such as the Beck Depression Inventory, Upper Extremity Fugl-Meyer, Montreal Cognitive Assessment, Jebson Taylor, Box in Block, Modified Ashworth, and grip strength using a dynamometer, etc. 2b) Workspace Assessment: The protocol for the kinematic workspace would entail of moving patients upper extremity in a series of motions that mark the key points of their workspace. This would include movement with extended elbow to manipulate the shoulder joint in the cardinal directions (e.g. horizontal movements at the abdominal and shoulder levels, and vertical movements at 0, 45, 90 and 135 degrees), internal/external rotation of the shoulder, as well as functional movements of the arm. For the functional movements the patient would be asked to touch six points on their body, the left and right sides of their hips, their left and right shoulders, their mouth and the top of their head while being monitored by a Kinect camera. These actions are chosen as they cover areas necessary for ADLs such as eating, grooming and toileting and covers motion in clinically relevant planes. Each participant would be also given the standard clinical score. The movement protocols would be repeated under a loading condition where light weights (0.5-1lb) would be attached to subjects wrist. Given the additional mass, we would determine the change in the kinematic workspace space as well as the change in the joint torques. The protocol for recovery of dynamics would entail of the a series of motions using the TheraDrive systemas described in Theriault, A.,Nagurka,M.,Johnson,M.J:Therapeutic Potential of Haptic TherDrive: An Affordable Robot/Computer System for Motivating Stroke rehabilitation, in:5th IEEE RAS&EMBS International Conference,pp.415-420, 2014. The TheraDrive would be positioned at various locations in the subjects workspace (e.g. closer to the torso, away from the torso, higher/lower). The ability to exert specific torques at these locations would provide information on the dynamic capacity of the muscles within various points of the workspace. 3) Break:

Subjects will be given a 15 minute break. 4) First Therapy Device: Subjects will be introduced to several robots: a wheel, joystick, and custom crank chosen randomly (like the flip of a coin). First, they will be trained in the use of all robots and their safety features. Following training, they will be asked to move each robot into different positions, first without pressure applied to the handle, and then with pressure applied to the handle. After each exercise they will be asked about their level of exercise and level of pain discomfort. After subjects finish all exercises with a robot, they will be given a survey about the robot. They will also be given surveys to discuss their experience with the device and their level of motivation for use of them. The surface EMG may be utilized during the entirety of the participant's interaction with the novel therapy device. Prior to its placement on the subject, the reason for its use will be thoroughly explained. 5) Break: Subjects will be given a 15 minute break. 6) Subsequent Therapy Device: Subjects will be instructed in the use of another robot. The same procedure will be followed as in the first evaluation. The surface EMG may be utilized during the entirety of the participant's interaction with the novel therapy device. Prior to its placement on the subject, the reason for its use will be thoroughly explained. 7) Final Survey: Subjects will be given a survey asking them to evaluate the robots and indicate which robot they prefer. Part B: For subjects invited to participate in Part B of the study - only low functioning stroke surviviors are eligible - participation in this part of the study will include the following steps: 1) Informed Consent: After arrival, subjects will review and sign the consent form with study personnel present. 2a) Pre-Assessments: If subjects are only participating in Part B of the study, at their first visit, a member of the research team will evaluate their affected arm and assess their ability to use it. Subjects will be evaluated using a battery of assessments in order to determine their level of impairment such as the Beck Depression Inventory, Upper Extremity Fugl-Meyer, Montreal Cognitive Assessment, Jebson Taylor, Box in Block, Modified Ashworth, and grip strength using a dynamometer, etc. If a study subject participated in Part A, they will not be reevaluated by a therapist. 2b) Workspace Assessment: Same as in Part A 2) Custom Therapy Device: Subjects will be introduced to the custom robot. They will be trained in the use of this robot and its safety features (1st session). Following training, they will be asked to move the robot into different positions. After each exercise subjects will be asked about their level of exercise and level of pain discomfort. Subjects will continue to work with the custom therapy device for 12 sessions over the course of one month. The surface EMG may be utilized during the entirety of the participant's interaction with the novel therapy device. Prior to its placement on the subject, the reason for its use will be thoroughly explained. 3) Motivation Questionnaire: At the end of their 1st and 12th sessions, subjects will be asked to complete a questionnaire assessing their level of motivation. 4) Post-Study Survey: After their last session, subjects will be asked to complete a survey assessing the robot. 5) Post-Study Assessment: After their last session, a certified therapist will evaluate the participants' affected arm and assess their ability to use it. In addition, they will also be evaluated for depression and a mental health assessment will be given.

The following documents are currently attached to this item:

There are no documents attached for this item.

Deception
Does your project use deception?
No

Analysis Plan
1) Clinical data will be analyzed to determine how subjects low versus high function perform on metrics developed using the robots. 2) Trajectory tracking using a baseline with zero resistance will be established for each patient. The root mean square metric will be used to assess accuracy in tracking tasks and subjects' performance across groups (low versus high) and devices in Part A, and across time in Part B. Using a 2-way ANOVA test for Part A, and an alpha of 0.05, significant difference across groups will be detected. A paired t-test, and an alpha of 0.05, will detect significant difference across time pre-post the 12 sessions. 3) Data collected from the surface EMG will be analyzed to verify muscle activity over time. 4) Data results will be used to build a simulation model of the human-robot tracking and determine a prediction of the joint and muscle forces that are used in Part A and Part B. 5) Data collected with the kinect will be assessed for kinematic and dynamic workspace. The data will be fitted to a computerized model of the upper limb to extract forces and positions defining dynamic and kinematic workspace.

The following documents are currently attached to this item:

There are no documents attached for this item.

Are you conducting research outside of the United States?
No

Data confidentiality

x **Paper-based records will be kept in a secure location and only be accessible to personnel involved in the study.**

x **Computer-based files will only be made available to personnel involved in the study through the use of access privileges and passwords.**

Prior to access to any study-related information, personnel will be required to sign statements agreeing to protect the security and confidentiality of identifiable information.

x **Wherever feasible, identifiers will be removed from study-related information.**

A Certificate of Confidentiality will be obtained, because the research could place the subject at risk of criminal or civil liability or cause damage to the subject's financial standing, employability, or liability.

A waiver of documentation of consent is being requested, because the only link between the subject and the study would be the consent document and the primary risk is a breach of confidentiality. (This is not an option for FDA-regulated research.)

Precautions are in place to ensure the data is secure by using passwords and encryption, because the research involves web-based surveys.

Audio and/or video recordings will be transcribed and then destroyed to eliminate audible identification of subjects.

Subject Confidentiality
All study personnel will have access to a locked file cabinet containing consent forms, evaluation assessments, and post-survey data. The locked file cabinet will be located at Penn Rittenhouse, Rehabilitiation Robotics Lab, 1800 Lombard Street, Philadelphia, PA, 19146. Both electronic data and hard-copy records will be kept for 10 years; they will be kept on password protected computers. After 10 years, documents will be destroyed by secure shredding at Penn Rittenhouse and electronic data will deleted from computers. Research subjects will be identified in the research data by code, and at no time will a direct link exist between collected data and research subjects. When data results are reported they will be presented in aggregate form (i.e. group characteristics only) and no individual identifiers will be used.

Sensitive Research Information*
Does this research involve collection of sensitive information about the subjects that should be excluded from the electronic medical record?
No

Subject Privacy
Privacy refers to the person's desire to control access of others to themselves. Privacy concerns people, whereas confidentiality concerns data. Describe the strategies to protect privacy giving consideration to the following: The degree to which privacy can be expected in the proposed research and the safeguards that will be put into place to respect those boundaries. The methods used to identify and contact potential participants. The settings in which an individual will be interacting with an investigator. The privacy guidelines developed by relevant professions, professional associations and scholarly disciplines (e.g., psychiatry, genetic counseling, oral history, anthropology, psychology).
As described in our recruitment strategy, flyers will be posted in outpatient rehabilitation facilities with the research coodinator's contact information. At support group meetings, a brief description of the research study will be introduced, and contact information for the Rehabilitation Robotics Lab provided should the person be interested in participating. Various Penn Databases will be used to search for stroke survivors who meet our inclusion/exclusion criteria. If the subject is still undergoing treatment at Penn, the patient's treating physician will then be contacted. A physical flyer describing the research study will be sent via mail, and possibly followed up with a phone call 1-2 weeks later. Only the PI and research coordinator will be contacting the patient directly by phone, thereby avoiding any overlap, or

multiple calls by the research team.

Data Disclosure
Will the data be disclosed to anyone who is not listed under Personnel?
Yes. Caspar Nguyen, a high school student interning at the Rehabilitation Robotics Lab will have access to the data. Caspar will mainly be working on data input and retrospectively analyzing data under the guidance of a senior research team member.

*Data Protection**

- x **Name**
- x **Street address, city, county, precinct, zip code, and equivalent geocodes**
- x **All elements of dates (except year) for dates directly related to an individual and all ages over 89**
- x **Telephone and fax number**
- x **Electronic mail addresses**
- **Social security numbers**
- **Medical record numbers**
- **Health plan ID numbers**
- **Account numbers**
- **Certificate/license numbers**
- **Vehicle identifiers and serial numbers, including license plate numbers**
- **Device identifiers/serial numbers**
- **Web addresses (URLs)**
- **Internet IP addresses**
- **Biometric identifiers, incl. finger and voice prints**
- x **Full face photographic images and any comparable images**
- **Any other unique identifying number, characteristic, or code**
- **None**

Does your research request both a waiver of HIPAA authorization for collection of patient information and involve providing Protected Health Information ("PHI") that is classified as a "limited data set" (city/town/state/zip code, dates except year, ages less than 90 or aggregate report for over 90) to a recipient outside of the University of Pennsylvania covered entity?
No

Tissue Specimens Obtained as Part of Research*
Are Tissue Specimens being obtained for research?
No

Tissue Specimens - Collected during regular care*
Will tissue specimens be collected during regulator clinical care (for treatment or diagnosis)?
No

Tissue Specimens - otherwise discarded*
Would specimens otherwise be discarded?
No

Tissue Specimens - publicly available*
Will tissue specimens be publicly available?
No

Tissue Specimens - Collected as part of research protocol*
Will tissue specimens be collected as part of the research protocol?
No

Tissue Specimens - Banking of blood, tissue etc. for future use*
Does research involve banking of blood, tissue, etc. for future use?
No

Genetic testing
If genetic testing is involved, describe the nature of the tests, including if the testing is predicative or exploratory in nature. If predictive, please describe plan for disclosing results to subjects and provision of genetic counseling. Describe how subject confidentiality will be protected Note: If no genetic testing is to be obtained, write: "Not applicable."
Not applicable.

Consent

1. Consent Process

Overview
Subjects will receive a consent form at least 24 hours in advance of the study session. This will allow subjects sufficient time to read over the form on their own, and come up with any questions or concerns prior to the commencement of the session. Before the session begins, study personnel will review the consent form and experimental procedure with the subject and answer any questions. The subject will then be given the opportunity to sign the consent form, with study personnel witnessing. Any subjects that decline to sign the consent form will be dismissed at that time. In addtion to the written informed consent that patients will sign prior to commencing their first session in the Rehabilitation Robotics Lab, an oral informed consent will be read to all prospective participants over the phone. When a subject is either contacted by a a member of the research team or calls our lab inquiring about the study, the oral consent will be read prior to asking questions from the phone screening form or the Beck Depression Inventory.

Children and Adolescents
Not applicable.

Adult Subjects Not Competent to Give Consent
Yes. In fact, one of the exclusion criteria for this study is cognitive impairment. Thus, all subjects will be competent. See section on exclusion criteria for more details.

2. Waiver of Consent

Waiver or Alteration of Informed Consent*
No Waiver Requested

Minimal Risk*

Impact on Subject Rights and Welfare*

Waiver Essential to Research*

Additional Information to Subjects

Written Statement of Research*
No

If no written statement will be provided, please provide justificiation

The following documents are currently attached to this item:

There are no documents attached for this item.

Risk / Benefit

Potential Study Risks
Subjects may experience fatigue or muscle strain if exercises are too intense. In the event of a robot malfunction, subjects may experience muscle strain or minor bruises. To minimize risk of injuries due to exercise, the intensity will be kept in the mild to moderate range. Exercise intensity must also be kept low in order to reduce the confounding effect of fatigue on experimental results. After each exercise, subjects will be questioned regarding the difficulty of the task, exercise intensity, and their discomfort level. At that time, the protocol will be adjusted accordingly. Subjects will be given ample time to rest as part of the experiment protocol. Risk of injury from the robot stems from its ability to exert large forces. Therefore, we have implemented several layers of protection to prevent the robot from exerting forces that might cause injury. For example, the software permits the robot's commanded force to be limited and a stop command to be issued to the robot. In addition, the current to the motor that determines the forces is limited by a current limiter that will maintain current to a preset level. As a backup, there is a limit switch that will cut power to the motor if excessive forces are detected. And as a final level of backup, another mechanical method (torque limiter) has been put in place that limits forces and is capable of physically disengaging the motor from the handle that the patient is griping. A spring inside the robot allows it to be compliant, which reduces the ability of patients to feel sudden starts or stops of the motor, and reduces the risk of injury in the event of a robot-patient collision. Padding on the robot provides further protection against any impacts. Furthermore, an emergency stop switch will be made available to both the subject and operator; it will cut power to the motor when triggered. If a subject is experiencing a level of pain great than three (mild) on the Visual Analog Pain Scale, the session will be stopped.

Potential Study Benefits
There are no direct, major benefits to a particular subject. Participation will help advance rehabilitation robotics research.

Alternatives to Participation (optional)

Data and Safety Monitoring
The principal investigator will monitor this protocol. See attached for the D&SM Plan.

The following documents are currently attached to this item:

There are no documents attached for this item.

Risk / Benefit Assessment
The risks involved in A and B are minimal - fatigue, frustration, minor bruising. There are no immediate direct benefits to study participants. Possible benefits to society are significant, as according to the American Heart Association, every year, 15 million people suffer a stroke. Most people survive the stroke, but have subsequent problems and many require assistance for activities of daily living.

General Attachments

The following documents are currently attached to this item:

Additional forms (kristinelima-citicompletionreport.pdf)

Additional forms (carolwamsley-citicertificate.pdf)

Additional forms (kevinbui-citirefresher-2018.08.29.pdf)

Additional forms (samgaardsmoe-citirefresher2018.08.08.pdf)