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14. ABSTRACT **Post amputation pain (PAP) is highly prevalent and a prominent factor in disability, yet we know little about the specific pathophysiology. The number of amputees in the United States is over 450,000 with an estimated 1,300 from Operations Iraqi and Enduring Freedom. Studies indicate an incidence of PAP ranging between 64- 100% and prevalence over 80%. Conversely, only 1% of veterans with PAP reported lasting benefit from any treatment attempted. It is very likely that this failure to identify effective treatments stems from the lack of a coherent or comprehensive theory of pathophysiology; thus the rationale for this proposal. Based on our preliminary data we hypothesized that there is distinct and measurable pathophysiology(s) of the peripheral, central and sympathetic nervous systems that occur in response to the amputation of a limb. New technologies and novel implementation of standard techniques allowed us to clarify these explicit mechanisms. The study was designed using validated psychometric, psychophysical and biometric testing correlated with standard (afferent) regional nerve/neuroma and (efferent) sympathetic nerve blocks, in the final results, we will report descriptive statistics and pain reports, and report on brain anatomical reorganization with phantom limb pain.**

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Table of Contents

Page

1. **INTRODUCTION:** Post amputation pain (PAP) is highly prevalent and a prominent factor in disability, yet we know little about the specific pathophysiology. The number of amputees in the United States is over 450,000 with an estimated 1,300 from Operations Iraqi and Enduring Freedom. Studies indicate an incidence of PAP ranging between 64-100% and prevalence over 80%. Conversely, only 1% of veterans with PAP reported lasting benefit from any treatment attempted. It is very likely that this failure to identify effective treatments stems from the lack of a coherent or comprehensive theory of pathophysiology; thus the rationale for this proposal. Based on our preliminary data we hypothesized that there is distinct and measurable pathophysiology(s) of the peripheral, central and sympathetic nervous systems that occur in response to the amputation of a limb. New technologies and novel implementation of standard techniques allowed us to clarify these explicit mechanisms. The study was designed using validated psychometric, psychophysical and biometric testing correlated with standard (afferent) regional nerve/neuroma and (efferent) sympathetic nerve blocks, in the final results, we will report descriptive statistics and pain reports, and report on brain anatomical reorganization with phantom limb pain.

2. **KEYWORDS:** Post amputation pain, pathophysiology, peripheral nervous system, afferent nervous system, central nervous system, sympathetic nervous system

3. **ACCOMPLISHMENTS:**
   - **What were the major goals of the project?**
     - **Year one**: Regulatory documents completed recruitment schemes developed and implemented
     - Database developed
     - Logistics of experiment and scheduling
     - All devices synched standardized as to process and field tested
     - Pilot subject enrolled and analyzed
     - Begin experimentation

       Year two:
     - The main body of experimentation
     - Data analysis
     - Report, abstracting ,and publication of results
   - **What was accomplished under these goals?**

     Major activities included:
     - Final recruitment for the experiment
     - Training of residents and staff for final push of recruitment
     - Scheduling of experiment for subjects
     - Ordering of new supplies for injections
     - Recruitment analysis
     - Implementation for final recruitment push
     - Planning meetings for data analysis
     - Analysis meeting and plan for data of fMRI
     - Analysis meeting for the rest of the data

- Data base cleaning and calculating of all total scores
- Final report and analysis

- **What opportunities for training and professional development has the project provide**d
  This project has provided methodology to perform studies in the future with post amputation pain. Using the fMRI was a unique component and there are no studies currently that have looked at post amputation in the same way. The study coordinators are now better equipped to recruit for this population having plans in place that pinpoint the targeted subject population and are effective The coordination of the study was between several different teams at different locations, the study was able to be executed between all of these teams in a timely manner and can provide methodology for future consortium studies that are similar.
- **How were the results disseminated to communities of interest**?
  Results will be presented at American Pain Society, American Academy of Pain Medicine, Midwest Pain Society, American Academy of Physical Medicine and Rehabilitation. The results will be published in *Pain, Pain Medicine* and *Journal of Pain* as well as specialty journals interested in specifics of methodology (e.g. fMRI)
- **What do you plan to do during the next reporting period to accomplish the goals?**
  This is the final report; we are analyzing data and preparing for dissemination, as above.
- **What was the impact on the development of the principal discipline(s) of the projec**t?
  This project developed the methodology of brain scans in the post amputation pain population and the use of ultrasound guided neuroma injection. We also explored the impact of sympathetically maintained pain in PAP, methods for defining that and safety of sympathetic blocks in this population. Systems, consortium research, and statistical methods we created and preliminarily validated.
- **What was the impact on other discipline**s?
  Teams from different backgrounds and institutions came together to collaborate and fulfill a common goal**.** Many other members of the scientific team were trained and volunteered their time. This experiment has provided the knowledge that collaboration was one of the most important factors in providing a successful outcome. Professionals from Physical Medicine and Rehabilitation, Neurology, Anesthesiology and Brain Imaging worked together, and will publish results in their respective areas.
- **What was the impact on technology transfer?** New methods of ultrasound and brain imaging technology were developed

4. **What was the impact on society beyond science and technology**
   This study provided insight into an underserved population where treatments are needed and very little is known. Developing concepts of mechanisms of disease is pre-imminent to developing effective therapy. The brain imaging that was completed will provide

information about the brain in a unique population, perhaps assisting in the conceptualization of human pain in general.

5. **CHANGES/PROBLEMS:** Nothing to report.
6. **PRODUCTS:** Nothing to report

Other Products:

Results from the basic aims of the experiment will be discussed in this report. Psychometric, psychophysical and biometric data will be assessed and correlated in this underserved diagnosis. These results will establish a framework for near term publications and academic debate as well as methodology for future experiments.

Methods:

Four groups randomly generated determined the treatment injection that the subject received during the second visit: 1) sympathetic nerve block of bupivacaine located in either the neck or lower back (depending on where the participant's amputation is located), or 2) dry needling located in either the neck or lower back (depending on where the participant's amputation is located), or 3) neuroma injection of bupivacaine or 4) dry needling at the neuroma. Baseline psychometric measures included: McGill Pain Questionnaire - Short Form (MPQ), Center for Epidemiological Studies Depression Scale (CES-D 10), Pain and Anxiety Symptoms Scale, short version (PASS-20), and the Pain Disability Index (PDI). Independent samples t-tests were used to analyze the short term efficacy of the medication in terms of change in Visual Analogue Scale (VAS) and Numeric Rating Scale (NRS) pain scores before and 15 minutes, and 1 hour after the injection. Long term efficacy was analyzed by independent samples t-test comparing McGill Pain Questionnaire – Short Form (MPQ), VAS, Pain Anxiety Symptoms Scale (PASS), Center for Epidemiological Studies Depression Scale (CESD10) and Pain Disability Index *(*PDI) scores at visit 2 and visit 3 (2 weeks post injection). The MPQ was filled out with two forms to differentiate between phantom limb pain (PL) and residual limb pain (RL).

Demographics and Pain Levels

Subjects were selected according to the inclusion/exclusion criteria and basic demographic information was collected. The minimum age is 28 years old and maximum is 82 years old, with a mean of 53.38 years old (Table 1). Pain levels were measured using the numeric rating scale (NRS). Subjects would be asked on their pain level now, on a scale of 0-10, with 0 being no pain at all, and 10 being the worst pain imaginable. Subjects were asked to differentiate between phantom limb pain and residual limb pain. NRS is used to establish a baseline for comparison after intervention. The averages for the first visit are 3.87 for residual limb pain and 3.60 for phantom limb pain (Table 1). The maximum pain level for residual limb was an 8/10, and phantom limb pain was 7/10, with the minimum for both residual and phantom being 0/10 (Table 1). The reason that pain may have been a zero and subject were still included is because the pain they had was episodic or able to be reproduced by stimulating parts of their amputated limb.

Other demographics collected included race, ethnicity and sex. Of the 16 patients, 56% were African/African American, 37% were Caucasian/Russo-European, and 6% classified themselves as other (Table 2). There were more males in the study than females (Table 2). There was only one patient of Hispanic/Latino descent in this study.

	N	Minimum	Maximum	Mean	Std. Deviation
Age	16	28	82	53.38	13.817
NRS residual limb V1	15	0	8	3.87	2.446
NRS phantom limb V1	15	0	7	3.60	2.501

Table 1: Age and Pain Levels

	Total	Percent
African American	9	57%
Caucasian/Russo-European	6	37%
Other	1	6%
Total	16	100%

Table 2: Race

	Total	Percent
Females	5	32%
Males	11	68%

Table 3: Sex

Psychometrics and Pain Levels:

A total of 16 participants were enrolled in the study. Of those, 9 received a neuroma injection and 5 received a sympathetic block. 9 subjects received an injection of bupivicaine, while 5 received sham (placebo) injections. No differences between treatment and control conditions reached statistical significance, but participants receiving treatment evidenced better outcomes in several measures.

All subjects who received a sympathetic block showed a decrease in NRS scores. The placebo group showed a non-significant decrease in average phantom limb pain NRS compared to drug (-2.0 and -.33 respectively p=.404) at 15 minutes post injection. However, the injection/drug group showed a non-significant decrease in phantom limb pain at 1 hour post injection compared to placebo (-3.5 vs -1.0, respectively p=.155). For residual limb pain, drug group showed a larger decrease in NRS compared to placebo at both 15 minutes (-1.67 and -1.0, respectively p=.658) and 1 hour post injection (-2.0 and -.5, respectively p=.543). (See table 4)

In the neuroma injection group, phantom limb pain decreased in the drug group, while pain increased in the placebo group at 15 minutes post injection (-1.0 and 1.33 p=.151).At 1 hour post injection, subjects in the drug group reported lower phantom limb pain, while pain was unchanged in the placebo group (-.33 and 0.0, p=.495). Residual limb pain decreased in the drug group, while pain increased in the placebo group
at 15 minutes post injection (-2.2 and .667 p=.221). However, both group showed a non-significant increase in pain after 1 hour (.33 and 3.0 p=.366). (see table 4)

Participants in the treatment group generally experienced greater improvements in self reported psychometric measures from V2-V3 when compared to controls, although no statistically significant differences were observed between groups. The drug group reported greater reductions on the PDI (-8.4 and -0.80, p=.510), CES-D (-2.0 and 0.40 p=.482), MPQ-PL (-0.9 and -0.09, p=.442), VAS-RL (-5.5 and 3.3 p=.635), and VAS-PL (-5.9 and -1.3 p=.687) compared to the placebo group. The placebo group reported greater reductions in only one outcome, the PASS (-7.8 and -1.5, p=.626). Both drug and placebo groups reported non significant decreases in MPQ-RL (-0.87 and -0.83 p=.961).(see table 5)

Table 4: Change in Pain after Sympathetic block.

			mean	SD	p-value
VAS-Residual Limb Pain	placebo	2	-12.25	6.71751	0.161
	drug	3	8	13.85641	
VAS-Phantom Limb Pain	placebo	2	-7.5	4.94975	0.317
	drug	3	20	30.61046	
NRS-Phantom Limb Pain (15 minutes post)	placebo	2	-2	0	0.404
	drug	3	-0.3333	2.3094	
NRS-Phantom Limb Pain (1 hour post)	placebo	2	-1	1.41421	0.155
	drug	3	-3.5	0.70711	
NRS-Residual Limb Pain (15 minutes post)	placebo	2	-1	1.41421	0.658
	drug	3	-1.6667	1.52753	
NRS-Residual Limb Pain (1 hour post)	placebo	2	-0.5	0.70711	0.543
	drug	3	-2	2.82843	

Table 5: Change in Pain after Neuroma Injection.

			mean	SD	p-value
VAS-Residual Limb Pain	placebo	3	-4.8333	34.79344	0.812
	drug	5	-10.1	25.7449	
VAS-Phantom Limb Pain	placebo	3	12.6667	17.03917	0.164
	drug	5	0.14	5.51797	
NRS-Phantom Limb Pain (15 minutes post)	placebo	3	1.3333	0.57735	0.151
	drug	5	-1	2.34521	
NRS-Phantom Limb Pain (1 hour post)	placebo	3	0	0	0.495
	drug	5	-0.3333	0.57735	
NRS-Residual Limb Pain (15 minutes post)	placebo	3	0.6667	0.57735	0.141
	drug	5	-2.2	3.49285	
NRS-Residual Limb Pain (1 hour post)	placebo	3	3	4.24264	0.533
	drug	5	0.3333	1.52753	

	Control (n=5)	**Treatment** (n=9)	**p-value**
PDI	-0.8	-8.4	0.51
PASS	-7.8	-1.5	0.626
CES-D	0.4	-2	0.482
MPQ RL	-0.83	-0.87	0.961
MPQ PL	-0.09	-0.9	0.442
VAS RL	3.3	-5.5	0.635
VAS PL	-1.3	-5.9	0.687

Table 6: Control and treatment groups with self reported outcomes

Brain anatomical reorganization with phantom limb pain:

Brain anatomy was examined in 9 patients with right or left leg amputations, with the time since amputation ranging from 1.6 to 18.3 years (Mean ± SD: 9.6±6.5 years). All patients reported phantom limb symptoms, including phantom limb pain. Given that phantom limb sensations reflect aberrant sensory processes in the central nervous system, and may be accompanied by altered motor function related either to the affected limb or other intact limbs, we turned our attention to the ample brain imaging evidence that has identified distinct sensory and motor regions mediating the subjective representation and motor control of the lower limbs. Specifically, we hypothesize that the brain communication patterns and anatomy that characterize these sensory and motor regions of the brain are fundamentally altered by abnormal sensory input and motor output at the residual limb. The identification of these key regions in brain anatomy will thus allow us to evaluate altered brain function that correlates with clinically relevant symptoms that can be assessed by physicians.

To investigate the gray matter (neuronal) brain characteristics of these patients, we used magnetic resonance brain imaging to obtain T1-weighted anatomical images. Given that gray matter is known to atrophy with increasing age, we identified T1 images from sex- and age-matched healthy individuals to serve as the control group (control age range: 28-78, Mean ± SD: 53.2±15.6; patient age range: 28-82, Mean ± SD: 54.8±17.2; 7 males, 2 females in each group). Group differences in gray matter density were evaluated using the voxel based morphometry toolkit provided by the FMRIB Software Library (FSL).

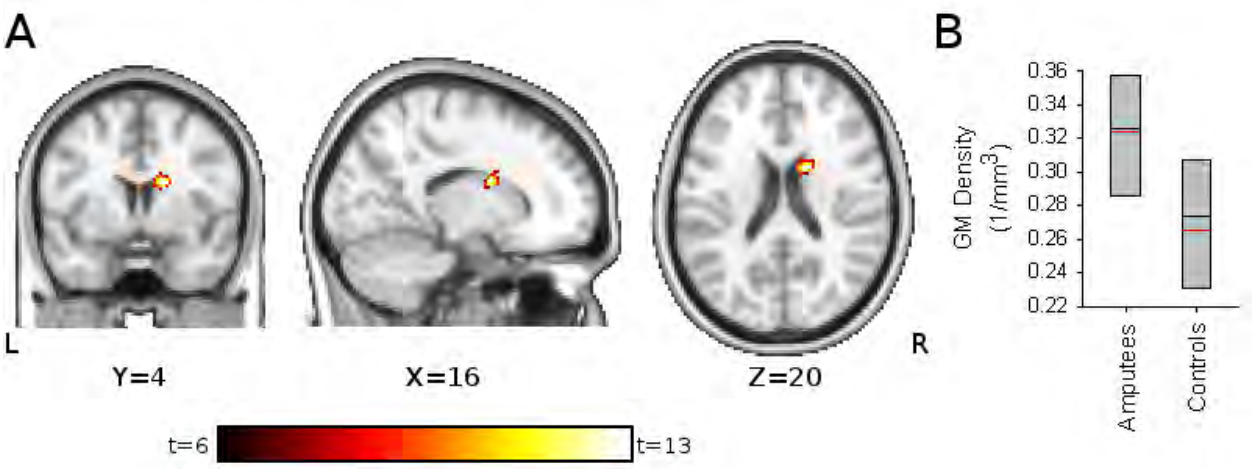

Figure 1 – (A) Gray matter density in the caudate nucleus is greater in amputees (n = 8, age: 54.8 ± 17.2 s.d.) than in sex and age matched controls (n = 8, age: 53.2 ± 15.6 s.d.) ipsilateral to the site of amputation. Three individuals with left side amputation had their brains reflected along the left-right axis to align amputation related abnormalities across subjects, and the same procedure was applied to their paired controls. The statistically significant region of peak differences is shown (permutation test $t > 2.3$, cluster $p < 0.05$) (B) Post-hoc examination of the gray matter density of the cluster in (A) illustrates the robust difference between amputees and controls. Median (black line), mean (red line) and interquartile range of gray matter density are shown, corrected for age and brain volume. There were no outliers. Gray matter density is represented as the volume fraction constituted by gray matter rather than white matter or cerebral spinal fluid.

Findings revealed increased gray matter density in the ipsilateral caudate nucleus in patients compared to healthy controls, and this increased density may reflect growth of dendrites, neuronal hypertrophy, local recruitment of glial cells, and/or changes in vasculature. The caudate nucleus is involved in involuntary and voluntary directed movement that facilitates accurate movements and body posture; for example, caudate anatomy is altered in patients with Parkinson's disease who progressively lose voluntary motor control. However, the presence of increased gray matter density ipsilateral (rather than contralateral) to the side of amputation suggests these changes may not directly relate to the phantom sensations. Rather, this observation may represent other brain processes that lead to and are reinforced by compensatory motor behavior of the residual limb. Therefore, in an effort identify brain anatomical changes more directly associated with the amputated limb, we performed a second statistical analysis targeting primary motor and somatosensory cortices contralateral to amputation, as well as areas within these regions that correlated with duration since amputation (i.e., regions that reflect the chronic impact of amputation including phantom sensations).

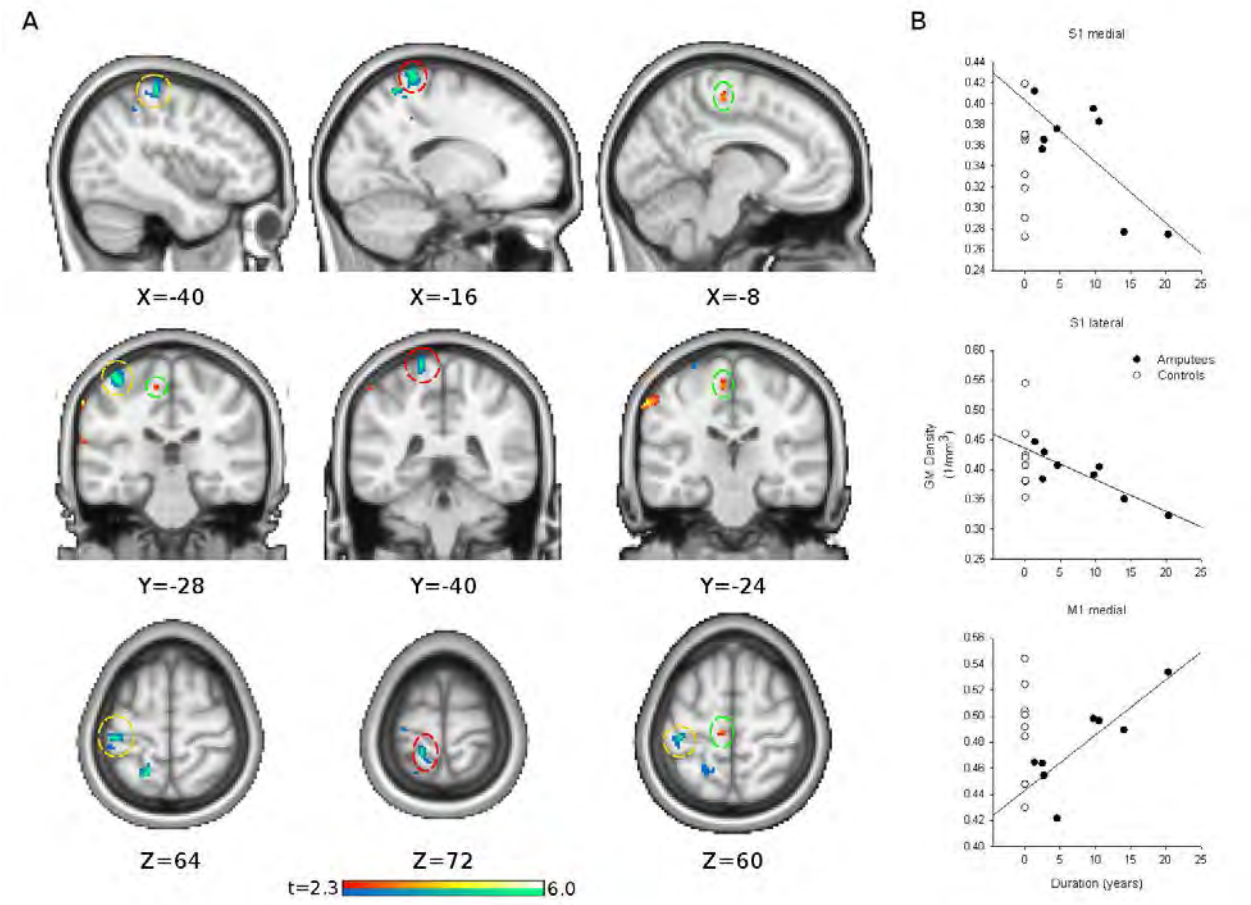

Figure 2 Patients (n = 8) show areas in primary somatosensory and motor cortices that correlate (red) and anticorrelate (blue) with duration since amputation. (A) Four prominent clusters are visible in the hemisphere contralateral to amputation which show positive or negative correlations with duration since amputation in lower limb amputees (voxel-wise t>2.3, no cluster correction). The two most prominent of these are in regions of the somatosensory cortex in the vicinity of the somatotopic mapping of upper or lower limb regions (yellow and blue circles, resp). Additionally a region of the motor cortex in the vicinity of foot region is highlighted (green circle) because we have strong *a priori* reasons to expect reorganization in this region. (B) Post-hoc examination of gray matter in these three regions of interest illustrates an especially robust correlation with duration in the lateral S1 region. Controls are shown as a reference, but regression lines represent the relationship among patients alone, since this most accurately reflects the analysis in (A). Data corrected for age and brain volume.

To determine the clinical relevance of these anatomical alterations, we performed planned post-hoc analyses that revealed a correlation between pain intensity and gray matter density of medial M1 (the putative foot motor region) and the caudate (table I). The relationship between clinical pain intensity and altered brain anatomy provides strong support that our findings are clinically meaningful to this patient population.

	Variable	t	p-value
Caudate GM	*Age*	9.85	0.001
	brain volume	0.13	0.904
	Phantom Pain NRS	2.76	0.051
Medial M1 GM	*Age*	-6.26	0.008
	brain volume	-5.31	0.013
	Duration	2.93	0.061
	Phantom Pain (NRS)	-3.20	0.049

Table I Correlation between phantom pain intensity and previously identified regions of interest. Ipsilateral caudate shows a borderline correlation with phantom pain intensity (after controlling for confounding covariates). Medial M1 also shows a significant correlation with phantom pain after controlling for confounding covariates (age and brain volume) and the prior covariate of interest (duration; if we don't control for phantom pain, duration has $p = 0.03$, consistent with results in figure 2).

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

- **What individuals have worked on the project?**

Example:

Elias Abousaad	Study Team Member
A. Vania Apkarian	Co-Investigator
Sally Cocjin	Study Team Member
Kelly Comstock	Study Team Member
Sara Connolly	Study Team Member
Melissa Farmer	Study Team Member
Joseph Graciosa	Study Team Member
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Harden	
Andrew Hendrix	Study Team Member
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Lejian Huang	Study Team Member
Danny Issa	Study Team Member
Katherine Khazey	Study Team Member
Amy Kirsling	Study Team Member
Maxine Kuroda	Study Team Member
Taif Mukhdomi	Study Team Member
Monica Rho	Study Team Member
Meryem Saracoglu	Study Team Member
Natalie Simak	Study Team Member
Steven Stanos	Study Team Member
Peng Yu	Study Team Member

- **Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**

  No

  What other organizations were involved as partners?

  Northwestern University

8. **SPECIAL REPORTING REQUIREMENTS:** No collaborative awards were used, and Quad charts were not used in this trial

9. **APPENDICES:**

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Appendix:

CES-D 10

Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the past week.

0= Rarely or none of the time (less than 1 day)
1= Some or a little of the time (1-2 days)
2= Occasionally or a moderate amount of time (3-4 days)
3= Most or all of the time (5-7 days)

1. I was bothered by things that usually don't bother me.	0	1	2	3
2. I had trouble keeping my mind on what I was doing.	0	1	2	3
3. I felt depressed.	0	1	2	3
4. I felt that everything I did was an effort.	0	1	2	3
5. I felt hopeful about the future.	0	1	2	3
6. I felt fearful.	0	1	2	3
7. My sleep was restless.	0	1	2	3
8. I was happy.	0	1	2	3
9. I felt lonely.	0	1	2	3
10. I could not get "going."	0	1	2	3

PASS

Individuals who experience pain develop different ways to respond to that pain. We would like to know what you do and what you think about when in pain. Please use the rating scale below to indicate how often you engage in each of the following thoughts or activities. Circle any number from 0 (NEVER) to 5 (ALWAYS) for each item.

NEVER *ALWAYS*

1.	I think that if my pain gets too severe, it will never decrease	**0**	**1**	**2**	**3**	**4**	**5**
2.	When I feel pain I am afraid that something terrible will happen	**0**	**1**	**2**	**3**	**4**	**5**
3.	I go immediately to bed when I feel severe pain	**0**	**1**	**2**	**3**	**4**	**5**
4.	I begin trembling when engaged in activity that increases pain	**0**	**1**	**2**	**3**	**4**	**5**
5.	I can't think straight when I am in pain	**0**	**1**	**2**	**3**	**4**	**5**
6.	I will stop any activity as soon as I sense pain coming on	**0**	**1**	**2**	**3**	**4**	**5**
7.	Pain seems to cause my heart to pound or race	**0**	**1**	**2**	**3**	**4**	**5**
8.	As soon as pain comes on I take medication to reduce it	**0**	**1**	**2**	**3**	**4**	**5**
9.	When I feel pain I think that I may be seriously ill	**0**	**1**	**2**	**3**	**4**	**5**
10.	During painful episodes it is difficult for me to think of anything else besides the pain	**0**	**1**	**2**	**3**	**4**	**5**
11.	I avoid important activities when I hurt	**0**	**1**	**2**	**3**	**4**	**5**
12.	When I sense pain I feel dizzy or faint	**0**	**1**	**2**	**3**	**4**	**5**
13.	Pain sensations are terrifying	**0**	**1**	**2**	**3**	**4**	**5**
14.	When I hurt I think about the pain constantly	**0**	**1**	**2**	**3**	**4**	**5**
15.	Pain makes me nauseous (feel sick)	**0**	**1**	**2**	**3**	**4**	**5**
16.	When pain comes on strong I think I might become paralyzed or more disabled	**0**	**1**	**2**	**3**	**4**	**5**
17.	I find it hard to concentrate when I hurt	**0**	**1**	**2**	**3**	**4**	**5**
18.	I find it difficult to calm my body down after periods of pain	**0**	**1**	**2**	**3**	**4**	**5**
19.	I worry when I am in pain	**0**	**1**	**2**	**3**	**4**	**5**
20.	I try to avoid activities that cause pain	**0**	**1**	**2**	**3**	**4**	**5**

Pain Disability Index

In order to determine how effective your treatment is, we need to know how much pain is interfering in your normal activities. For the 7 areas listed below, please circle the number on the scale which describes the level of disability you have experienced in each area OVER THE PAST WEEK. A score of "0" means no disability at all, and a score of "10" indicates that all of the activities which you would normally do have been totally disrupted or prevented by your pain over the past week. Circle "0" if a category does not apply.

(1) Family/Home Responsibilities: This category refers to activites related to the home or family. It includes chores or duties performed around the house (e.g., yard work, house cleaning) and errands or favors for other family members (e.g., driving the children to school).

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(2) Recreation: This category includes hobbies, sports, and other similar leisure time activities.

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(3) Social Activity: This category refers to activites which involve participation with friends and acquaintances other than family members. It includes parties, theater, concerts, dining out, and other social functions.

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(4) Occupation: This category refers to activites that are a part of or directly related to one's job. This includes non-paying jobs as well, such as housewife or volunteer worker.

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(5) Sexual Behavior: This category refers to the frequency and quality of one's sex life.

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(6) Self-Care: This category includes activities which involve personal maintenance and independent daily living (e.g., taking a shower, driving, getting dressed).

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

(7) Life-Support Activity: This category refers to basic life-supporting behaviors such as eating and sleeping.

0 1 2 3 4 5 6 7 8 9 10

No Disability — Mild — Moderate — Severe — Total Disability

Short-Form McGill Pain Questionnaire-2 (Modified) (SF-MPQ-2)

This questionnaire provides you with a list of words that describe some of the different qualities of pain and related symptoms. Please put an X through the numbers that best describe the intensity of each of the pain and related symptoms you felt during the past week. Use 0 if the word does not describe your pain or related symptoms.

1. Throbbing pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
2. Shooting pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
3. Stabbing pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
4. Sharp pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
5. Cramping pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
6. Gnawing pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
7. Hot-burning pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
8. Aching pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
9. Heavy pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
10. Tender	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
11. Splitting pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
12. Tiring-exhausting	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
13. Sickening	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
14. Fearful	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
15. Punishing-cruel	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
16. Electric-shock pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
17. Cold-freezing pain	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
18. Piercing	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
19. Pain caused by light touch	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
20. Itching	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
21. Tingling or 'pins and needles'	none	0	1	2	3	4	5	6	7	8	9	10	worst possible
22. Numbness	none	0	1	2	3	4	5	6	7	8	9	10	worst possible

Fill in the bubble for the word below which best describes the intensity of your pain NOW:

0 ○ **NO PAIN**

1 ○ **MILD**

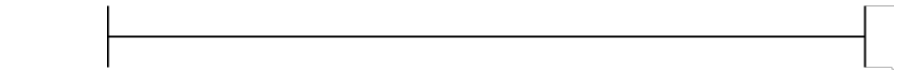
2 ○ **DISCOMFORTING**

3 ○ **DISTRESSING**

4 ○ **HORRIBLE**

5 ○ **EXCRUCIATING**

Put a mark through the line below to indicate the intensity of your pain NOW:



No Pain Worst

Possible Pain mm: _____

FINAL REPORT

1. Award No.: **W23RYX1133N601** 2. Report Date: **December 24, 2014**

3. Reporting period from **September 26, 2011** to **October 25, 2014**

4. PI: **R. Norman Harden, MD** 5. Telephone No.: **(312) 238-7878**

6. Institution: **The Rehabilitation Institute of Chicago**

7. Project Title: **Pathophysiology of Post Amputation Pain**

8. Total staff, with percent effort of each on project.

Norman Harden, MD	33%
Bruni Hirsch	7%
Amy Kirsling	47%
Max Kuroda, PhD	3%

9. Award expenditures to date (as applicable):

	Cumulative		**Cumulative**
Personnel		Travel	
Fringe Benefits		Equipment	
Supplies		Other	

	Cumulative
Subtotal	
Indirect Costs	
Fee	**N/A**
Total	

10. Comments on administrative and logistical matters.