


BMJ Open Identifying patterns of health care utilisation among physical elder abuse victims using Medicare data and legally adjudicated cases: protocol for case-control study using data linkage and machine learning

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ABSTRACT

Introduction Physical elder abuse is common and has serious health consequences but is under-recognised and under-reported. As assessment by healthcare providers may represent the only contact outside family for many older adults, clinicians have a unique opportunity to identify suspected abuse and initiate intervention.

Preliminary research suggests elder abuse victims may have different patterns of healthcare utilisation than other older adults, with increased rates of emergency department use, hospitalisation and nursing home placement. Little is known, however, about the patterns of this increased utilisation and associated costs. To help fill this gap, we describe here the protocol for a study exploring patterns of healthcare utilisation and associated costs for known physical elder abuse victims compared with non-victims.

Methods and analysis We hypothesise that various aspects of healthcare utilisation are differentially affected by physical elder abuse victimisation, increasing ED/hospital utilisation and reducing outpatient/primary care utilisation. We will obtain Medicare claims data for a series of well-characterised, legally adjudicated cases of physical elder abuse to examine victims' healthcare utilisation before and after the date of abuse detection. We will also compare these physical elder abuse victims to a matched comparison group of non-victimised older adults using Medicare claims. We will use machine learning approaches to extend our ability to identify patterns suggestive of potential physical elder abuse exposure. Describing unique patterns and associated costs of healthcare utilisation among elder abuse victims may improve the ability of healthcare providers to identify and, ultimately, intervene and prevent victimisation.

Ethics and dissemination This project has been reviewed and approved by the Weill Cornell Medicine Institutional Review Board, protocol #1807019417, with initial approval on 1 August 2018. We aim to disseminate our results in peer-reviewed journals at national and

Strengths and limitations of this study

- We explore patterns of healthcare utilisation and associated costs for known physical elder abuse victims, about common and serious phenomenon about which little is known.
- We use Medicare claims data for a series of well-characterised, legally adjudicated cases of physical elder abuse to comprehensively examine victims' healthcare utilisation before and after the date of abuse detection in comparison with non-victimised older adults algorithmically selected from Medicare claims.
- We use machine learning approaches to better identify patterns suggestive of potential physical elder abuse exposure.
- Though using legally adjudicated cases solves the important methodological challenge of ensuring that case subjects are actually victims of abuse, these cases represent a small percentage of all elder abuse cases, and their experience of abuse may differ in important ways from other victims.
- Subjects must have been enrolled in Medicare Fee-for-Service rather than Medicare Advantage or another insurance for us to be able to examine their healthcare utilisation.

international conferences and among interested patient groups and the public.

INTRODUCTION

Elder abuse is common and has serious health consequences but is under-recognised and under-reported. As many as 10% of US older adults experience elder abuse each year.¹⁻⁶ This maltreatment may include

physical abuse, sexual abuse, neglect, psychological abuse or financial exploitation, and many victims suffer from multiple types of abuse concurrently.^{1–5} Evidence suggests that elder abuse is associated with adverse health outcomes, including disability,⁷ dementia,⁸ depression⁸ and mortality.^{9–11} Despite its frequency, many elder abuse victims endure it for years before having it discovered or dying. Studies suggest that as few as 1 in 24 cases of elder abuse is reported to the authorities,^{13 12} and some of the associated morbidity and mortality is likely due to this delay in identification and intervention.¹³

As assessment by healthcare providers may represent the only outside contact for many older adults, so clinicians have a unique opportunity to identify suspected elder abuse and initiate intervention.^{14–20} Elder abuse victims have increased rates of emergency department (ED) use,^{14 17} hospitalisation²¹ and nursing home placement.^{22 23} Little is known, however, about the patterns of this increased utilisation and associated costs.^{5 24} Influential research in child abuse^{25–30} and intimate partner violence^{31 32} has focused on healthcare utilisation before identification, highlighting that many victims had multiple previous visits for likely abuse-related issues, suggesting ‘missed opportunities’ for identification and early intervention. Child abuse researchers have found that minor abusive injuries, ‘sentinel injuries’, are commonly found in children who are subsequently victims of severe child abuse but rare in those who are not.^{33 34} Strategies are being developed to capitalise on these findings to prevent morbidity and mortality for victims. Additionally, research has found that healthcare costs were significantly higher for victims of child abuse and intimate partner violence both in the short term^{35 36} and long term,^{35 37–40} compared with costs incurred by non-victims. These increased costs

represent a key component of the overall economic burden of these phenomena,^{41–44} and related research findings have been critical in revealing the scope and impact of child abuse and intimate partner violence and in driving policymaking decisions. We know of no analogous research in elder abuse.

To help fill this gap in the literature, we describe here the protocol for a study designed to explore in detail patterns of healthcare utilisation and associated costs for known physical elder abuse victims compared with non-victims using analytic techniques including machine learning.

METHODS AND ANALYSIS

Conceptual framework and hypotheses

We hypothesise that various aspects of healthcare utilisation are differentially affected by physical elder abuse victimisation. Many issues related to physical elder abuse potentially increase ED/hospital utilisation and reduce outpatient/primary care utilisation. We have developed a conceptual framework (figure 1) to explain this pattern. This framework is informed by a model for elder abuse research that members of our team developed as part of the National Institutes of Health Workshop ‘Multiple Approaches to Understanding and Preventing Elder Abuse and Mistreatment: Prevention and Intervention’.⁴⁵

As shown in figure 1, we further hypothesise that physical elder abuse victims, due to their poor connection to primary care, will have increased utilisation of EDs/hospitals for ambulatory care-sensitive conditions (ACSCs) and for non-urgent issues. ACSCs are conditions that, if treated in a timely fashion with adequate primary care and managed properly on an outpatient basis, should not

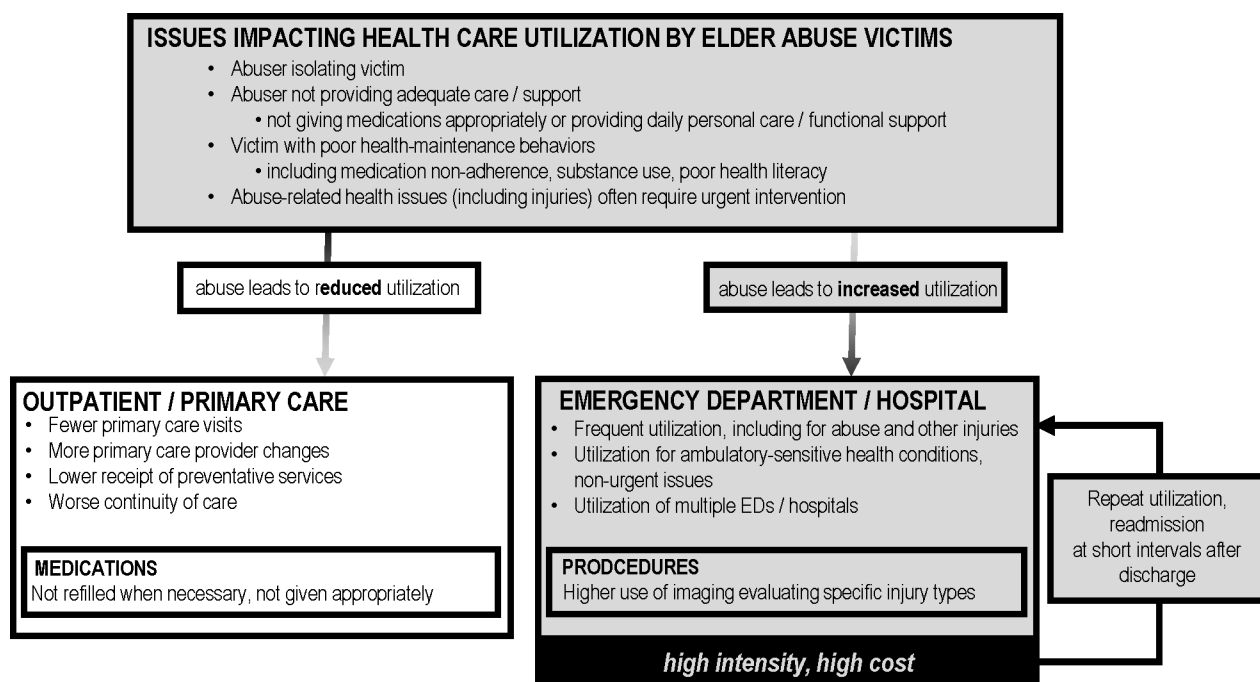


Figure 1 Conceptual framework for healthcare utilisation by elder abuse victims. EDs, emergency departments.

advance to the point where an ED visit or hospitalisation is required.⁴⁶ Measuring the rate of use of high-intensity, high-cost services to treat these conditions is common in health services research to assess access to and quality of primary care.^{46–49} Similarly, use of the ED for non-urgent issues suggests inappropriate use in the absence of primary care.

We also hypothesise that physical elder abuse victims will have high rates of repeat ED visits and rehospitalisations within short intervals. This results from poor connections to primary care and poor adherence to outpatient follow-up care recommendations.^{50–53} We anticipate that physical elder abuse victims will also have higher use of the ED/hospital for issues directly related to abuse, including presentation for injuries and use of imaging to evaluate specific injury types. Based on anecdotal experiences by elder abuse experts,⁵⁴ we also hypothesise that, compared with other older adults, physical elder abuse victims will more likely be seen at multiple EDs and hospitals. This ‘hospital hopping’ often occurs to avoid abuse detection.⁵⁵

Conversely, we hypothesise that poor access to and less frequent use of primary care will be associated with more primary care provider changes, lower receipt of preventative services and worse continuity of care. More frequent changes in primary care providers result in fractured care and have been shown in previous claims-based research to be associated with child abuse.⁵⁶ Receipt of preventative services has been used in previous studies to assess level of primary care utilisation among Medicare beneficiaries and has been shown to be lower in older adults with low primary care access including excess alcohol use and poor health literacy.^{57–61} We anticipate that physical elder abuse victims will have lower continuity of care, which has been shown in Medicare beneficiaries to be associated with increased rates of frequent ED use.⁶² Continuity of care assesses the dispersion of outpatient evaluation and management visits, examining how many unique doctors a patient visits within a specific timeframe.⁶³

Finally, we also hypothesise that victims of physical elder abuse, partially due to poor connection to primary care, will have poorer adherence to medications for chronic conditions, such as diabetes medications and antihypertensives, which has been shown to impact high-intensity healthcare utilisation and cost.^{64 65}

Study design

In this retrospective study, we will obtain Medicare claims data for a series of legally adjudicated cases of physical elder abuse to comprehensively examine victims’ healthcare utilisation before and after the date of abuse detection. We will also compare physical elder abuse victims to other non-victimised older adults. We will algorithmically select this comparison group from Medicare claims data to be matched to the physical elder abuse victims.

We will compare victims’ ED/hospital and outpatient primary care utilisation to that of the control groups. We will use machine learning approaches to extend our

ability to identify patterns suggestive of potential physical elder abuse exposure.

This project has been reviewed and approved by the Weill Cornell Medicine Institutional Review Board, protocol #1807019417 (initially approved on 1 August 2018). The Institutional Review Board approved waiving the requirement to obtain informed consent from subjects in this retrospective study.

Study subjects

For this research, we plan to use a well-characterised series of 204 legally adjudicated cases of physical elder abuse from Brooklyn, New York, and Seattle, Washington. The methodological advantage of this series of cases is unique: because the perpetrators have pled guilty or been convicted, the presence of elder abuse has been verified and the time of detection is known. This dataset includes rich information about the abuse victims and perpetrators as well as details about the abuse history, when and how it was detected, and the surrounding circumstances. It was constructed using information from the legal case files, including: medical records, descriptions of emergency medical services personnel and police interactions with the victim and perpetrator, victim statements, adult protective services files, court documents and photographs of injuries.

Medicare data linkage

We will link these legally adjudicated cases to Medicare claims data using identifying information including social security numbers and/or a combination of last name, date of birth and residential ZIP code. Fee-for-service Medicare data are the largest single repository of patient healthcare data for US older adults,⁶⁶ offering comprehensive information on utilisation of a broad range of healthcare services for continuously enrolled individuals. Medicare claims data have been used successfully to analyse healthcare utilisation and costs and to inform interventions and policies for a variety of chronic diseases.^{67–70} Additionally, claims data have been used to examine the impact on utilisation and cost of sociomedical issues^{71 72} including excessive alcohol use.^{47 57 73} Medicare claims data have also been employed to provide insight into the characteristics of frequent users of specific health services, such as the ED^{62 74} and hospital.⁷⁵

We plan to examine Medicare claims data for each case from 3 years before to 3 years after detection of elder abuse and will compare with controls. We will use files including: the Master Beneficiary Summary File (enrollee demographics, monthly enrolment information, chronic conditions, annual summary of costs and service utilisation), Medicare Provider Analysis and Review file (events of inpatient hospital and skilled nursing facility stays), Outpatient Claims, Carrier File (claims of physician services), Home Health Claims and the Part D (prescription drug) Event File.⁷⁶

Measures

We describe the key measures of utilisation we plan to use in [table 1](#). We intend to focus primarily on utilisation of

Table 1 Selected key measures of healthcare utilisation

Site/type	Utilisation measure
Emergency department (ED)	<ul style="list-style-type: none"> ▶ Injury-related visits. ▶ Total visits, including identification of high-frequency users. ▶ Low urgency visits, visits for ambulatory care sensitive conditions. ▶ Repeat visits to the ED within 3 days, 7 days and 30 days of initial visit. ▶ Visits to multiple EDs.
Hospital	<ul style="list-style-type: none"> ▶ Injury-related hospitalisations. ▶ Total hospitalisations. ▶ Visits for ambulatory care sensitive conditions. ▶ Repeat hospitalisations within 30 days and 90 days of initial hospitalisation. ▶ Visits to multiple hospitals.
Outpatient	<ul style="list-style-type: none"> ▶ Injury-related visits to primary care provider. ▶ Total visits to primary care provider. ▶ Receipt of preventative services. ▶ Periods with no primary care provider selected. ▶ Changes to primary care provider. ▶ Continuity of care (via Continuity of Care Index). ▶ Medication adherence (via proportion of days covered).

high-intensity, high-cost healthcare services including ED visits and hospitalisations by elder abuse victims and non-victim control subjects. We will examine overall utilisation of these services and will also look at several characteristics of this utilisation. We will examine the frequency of ED use and hospitalisation among victims and compare utilisation of these services of victims and non-victim controls. We will focus on injury-related utilisation, using ICD codes and external cause of injury codes^{77 78} similar to previous work in child abuse.^{56 79} We will also examine frequent ED use, defined as four or more visits in a year, the cut-off accepted in the literature and used in previous Medicare research.^{62 74 80 81} We plan to measure the number of potentially avoidable low-urgency ED visits^{82 83} as well as ED visits and hospitalisations for ACSCs. We will define low urgency visits similar to previous literature^{82 83} using Medicare Current Procedural Terminology billing codes (99281 and 99282) indicating low severity and no additional procedures billed. For this research, we will use the 11 ACSCs established for use in Medicare data.⁴⁶ We will also examine repeat ED visits and rehospitalisations within short intervals. Consistent with previous research, we will examine visits to the ED within 3 days, 7 days and 30 days of initial visit^{50 52} as well as repeat hospitalisations within 30 days and 90 days of initial hospitalisation.⁵¹ Additionally, we will explore use of multiple EDs and hospitals.

For outpatient care, we will examine the number of primary care visits and focus on injury-related visits for victims and controls. We will also examine changes in primary care providers. We plan to evaluate the continuity of care using the widely employed Continuity of Care Index (COCI).⁶³ Given that the COCI requires multiple outpatient visits to be meaningfully calculated, we will only examine this variable for subjects with three or more outpatient visits, consistent with previous literature.^{62 84 85} We will measure whether physical elder abuse victims and

control subjects received preventative services, including influenza vaccination, glaucoma screening, pneumonia vaccination and mammogram.⁵⁷ We plan to examine adherence to medication for chronic conditions. To do this, we will measure the proportion of days covered^{86 87} and determine adherent versus non-adherent using 0.80 as a cut-off, a common research strategy in administrative claims data.^{87 88}

We will examine demographic data, including age, gender and race/ethnicity. We will also use claims data for key health-related covariates to allow for further characterisation of physical elder abuse victims and comparison of subgroups. These include medical comorbidities, psychiatric comorbidities, dementia and frailty. For medical comorbidities, we plan to use chronic condition indicators within the Medicare Master Beneficiary file, and we will use psychiatric diagnoses within claims data. We will use an established approach^{35 89 90} to identify dementia. To identify frailty, we will use a recently developed algorithm designed for use in Medicare claims data.^{91 92}

Non-victim control subjects

We will select a group of non-victim control subjects matched to the cases on age, race, gender and residential zip code at the time of detection of each elder abuse case. This control group will allow us to compare healthcare utilisation of elder abuse victims with that of a general older adult population. We will construct a second control group who, in addition to being matched to the cases on age, race, gender and ZIP code, visited the ED for an unintentional injury within 1 week of the victim's abuse detection by law enforcement. This second control group will allow us to explore potential differences between older adults presenting to the ED for abuse-related injuries and those presenting with unintentional injuries, a key focus of our previous research.^{93 94} Findings

from such comparisons may assist healthcare providers, particularly in the ED, to differentiate between physical elder abuse and unintentional injuries, informing future development of clinical algorithms to assist in this identification. Because we may have more controls than needed meeting the selection criteria within the first control cohort outlined above, we will further conduct propensity score matching to select controls that more closely match with the cases.

We recognise that older adults selected as control subjects may actually be victims of physical elder abuse. To minimise the likelihood of this, we will ensure that all selected controls have never received any elder maltreatment-related diagnosis within Medicare claims data.

Focus on physical abuse

Though physical elder abuse may occur less frequently than other types of mistreatment, we think that focusing on these cases is a strength of our approach. Researchers have recognised that elder mistreatment is not a monolithic phenomenon and that aetiologies, victim and perpetrator characteristics, risk factors, clinical features and sequelae likely differ in important ways between mistreatment types.⁹⁵ An important reason that previous research has yielded inconsistent findings and little clinically useful information is likely that heterogeneous cases were analysed together. We have chosen to focus on physical abuse because this violent mistreatment may be particularly dangerous for an older adult. Our research focuses on healthcare utilisation for abuse victims and the potential for improving early identification in healthcare settings such as the ED. Given that physical abuse often causes acute injury that may trigger healthcare visits more commonly than other types of elder mistreatment, healthcare providers may have a particular opportunity to identify it. Linking known elder abuse cases to Medicare claims data to describe rates and patterns of healthcare utilisation may also be used to examine victims of other types of elder mistreatment though, and we plan to explore this in the future.

Analysis

We will conduct descriptive longitudinal analysis of healthcare utilisation up to 3 years before and 3 years after the detection of elder abuse (and among control cohorts). For each elder abuse case, we will determine the calendar month in which the case was detected (the 'index month'). We will then group months before and after the index month into 3 month intervals/quarters. Our unit of analysis will be patient-quarter. We will plot measured outcomes over time (centred around the index month) and visualise level of utilisation in time blocks in relationship to the index month.

We will compare utilisation between physical elder abuse cases and non-victim control subjects using the key measures described above, focusing on identifying important differences. Comparisons will also specifically

focus on rates of radiographic utilisation of maxillofacial CT scan and forearm X-rays as well as diagnoses including acute or chronic facial or chronic ulnar fracture, and chronic rib fracture as they have been found to be potential predictors of physical elder abuse.⁹⁶ We will compare total costs between cases and controls and then examine in detail contributing costs associated with each type of utilisation.

We will also conduct statistical modelling of longitudinal healthcare utilisation outcomes to estimate adjusted differences between physical elder abuse victims and non-victims at various time points before and after the index month. For example, for the dichotomous outcome of any ED or inpatient admission in a quarter, we will estimate a mixed logistic regression where major covariates include victim status, time (relative to index month) and interaction of victim status and time, controlling for individual demographics and comorbidities. Random effects will be specified at the patient level (to account for repeated measures of the same individual) and zip code (to account for clustering of patients within the same zip code) levels.

We have conducted power calculations with these cases and controls, incorporating assumptions about Medicare linking rate (50% of cases), number of quarters of data contributed by each individual (six quarters), percentage of subjects with ≥ 1 ED visit in a quarter (12% of elder abuse victims and 6% of controls) and intraclass correlation (0.2, to account for clustering of quarters within the same individual). Using these assumptions, we have a power of 0.82, which is adequate to identify important differences in utilisation between cases and controls.

Using machine learning

The comparative statistical analysis described above will illuminate the trajectories of healthcare use one type at a time. It lacks the ability to integrate multidimensional data that, combined, forms unique patterns of care. Recent innovations in machine learning make it possible to use vast amounts of data, such as service utilisation, diagnoses received and procedures performed, to identify sequences and mix of clinical events likely to lead to particular outcomes or suggestive of an underlying disease process for different cohorts of patients.^{97–102}

For example, sequential pattern mining has been used in child abuse to examine patterns of services provided to victims.^{103 104} To supplement the proposed statistical analysis, we propose to search for features within claims data that may be suggestive that an older adult is a victim of abuse. We will use Sequential PAttern Discovery using Equivalence classes,¹⁰⁵ a well-established algorithm that identifies patterns that are observed more than a user-defined frequency threshold in a cohorts' sequences of event. In addition, we will use Markov modelling¹⁰⁶ to identify the probabilities of observed patterns and associated underlying status of abuse to better distinguish patterns that are unique to elderly abused patients. We may find, for example, that a significant percentage of

abuse victims have two ED visits and a hospitalisation within a 3-month period and receive forearm X-rays and are diagnosed with a fracture, but this pattern is never seen in controls.

Patient and public involvement

We plan to involve older adults including victims of elder mistreatment in the reporting and dissemination for this research.

Timeline

This research was initiated in 2018, and we plan to report results by 2023.

Discussion

This ongoing work will address a significant gap in current knowledge about elder abuse by improving understanding of how physical abuse victims use healthcare services differently than non-victims as well as associated costs. We anticipate insights from our findings will generate hypotheses that may be tested in future studies in different populations and among victims of different types of elder mistreatment. We also expect that this work will lead to additional uses of claims data to explore the health consequences of elder abuse and to identify utilisation patterns with 'red flags' suggestive of exposure. Ultimately, we anticipate that knowledge gleaned will support the future development of a health informatics tool to identify potential victims.

An important limitation of our approach is the use of legally adjudicated cases. Though using this source solves the important methodological challenge of ensuring that case subjects are actually victims of abuse, legally adjudicated cases represent a small percentage of all cases, and abuse victims included may differ in important ways from other victims. They may have experienced more acute or severe abuse allowing identification, and subtle cases of abuse that are more challenging to detect may not have been included. Additionally, other circumstances surrounding the case including the availability of evidence, the willingness of the victim to participate and jurisdiction's practice pattern may have impacted the decision to prosecute the perpetrator, significantly reducing potential generalisability. An important challenge in previous studies has been accurately classifying subjects as victims of mistreatment. This has likely contributed to inconsistent research findings. Our new potential approach will generate trustworthy results that may identify patterns and generate hypotheses that may be tested. We anticipate that rigorous studies such as ours will lay the necessary groundwork for future studies focused on identifying and examining more subtle cases.

Also, our research strategy relies on linking to Medicare Fee-for-Service records. If subjects were covered by Medicare Advantage or otherwise not covered by Medicare Fee-For-Service for any period, information about their healthcare utilisation would not be available during that period. We have incorporated this potential into our

power calculation assumptions, however, and believe we will be able to identify important differences in utilisation.

Another important limitation is that selected control subjects may actually be unidentified cases, reducing the accuracy of our conclusions. Using elder mistreatment diagnoses within Medicare data is not an ideal method for ensuring controls are not cases, given that these diagnoses are infrequently and unreliably included. We hope to overcome this limitation by selecting multiple control cohorts, each with large numbers of controls. Using this approach, and performing sensitivity analyses on our findings, will allow us to identify patterns and draw meaningful conclusions even if a small number of controls are actually abuse victims.

Although we believe that machine learning techniques have enormous potential to find subtle patterns, it is possible that we will not identify any that are clinically identifiable or meaningful. Despite these potential limitations, we believe this research offers a unique opportunity to use a large series of well-characterised cases of physical elder abuse to help us understand the health-related markers that can be used to more validly predict elder abuse and thereby prevent it.

Improved understanding of patterns and associated costs of healthcare utilisation among elder abuse victims, which likely differs substantially from that of other older adults, is potentially very valuable. It may improve the ability of healthcare providers to identify, intervene and prevent victimisation. Furthermore, it may inform policy changes to reduce costs and help this vulnerable population. The research described here represents an important step in exploring the potential of examining healthcare utilisation to provide insight into elder abuse and how to address it.

ETHICS AND DISSEMINATION

This project has been reviewed and approved by the Weill Cornell Medicine Institutional Review Board, protocol #1807019417, with initial approval on 1 August 2018. We aim to disseminate our results in peer-reviewed journals at national and international conferences and among interested patient groups and the public.

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