Causes and consequences of inappropriate MRI of the lumbar spine

Andrea Nevedal, Jo Jacobs & Paul Barnett

VA Palo Alto Healthcare System

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Study Team

LS-MRI Team	
Name	Role
Andrea Nevedal, PhD	PI / qualitative lead
Jo Jacobs, PhD	Co-I / quantitative lead
Paul Barnett, PhD	Co-I / quantitative methods (initial PI)
Eleanor Lewis, PhD	Co-I / qualitative methods
Derek Boothroyd, PhD	Biostatistician
Jeanie Lo, MPH	Statistical Programmer
Justina Wu, MPH	Qualitative Analyst
Samantha Illarmo (Murrell), MPH	Project Manager
Yoko Ogawa, BS	Administrative Officer

Advisors

| Name	Role
Lucile Burgo, MD	Yale University School of Medicine Primary Care, VA Connecticut Healthcare System National Co-Director Post Deployment Integrated Care Initiative Patient Care Services, VHA
Roger Chou, MD	Departments of Medical Informatics & Clinical Epidemiology Oregon Health Sciences University
Jerry Jarvik, MD	Departments of Radiology, Neurological Surgery & Health Services University of Washington School of Medicine
Ajo John, MD	Neuroradiologist, Department of Radiology Augusta VA Medical Center
Friedhelm Sandbrink, MD	Deputy National Director for Pain Management Member of VA Choosing Wisely Committee
Kate Stanitski, MD	Neuroradiologist, Department of Radiology Augusta VA Medical Center
Suzanne Tharin, MD	Department of Neurosurgery Stanford University School of Medicine & VA Palo Alto Health Care system

Audience Poll

Which category best describes your occupation? (Check all that apply)

- ■ Health services researcher
- ■ Health care provider
- ■ Health care manager
- ■ Other

Background: Unneeded LS-MRI

- Costs $300 million/year to the U.S. healthcare system

- Costs $14 million to the Veterans Affairs

- Does not improve patient outcomes

- Can lead to unnecessary surgeries and procedures

- In 2012, 31% of 111,661 VA LS-MRI were inappropriate

Lumbar Vertebrae
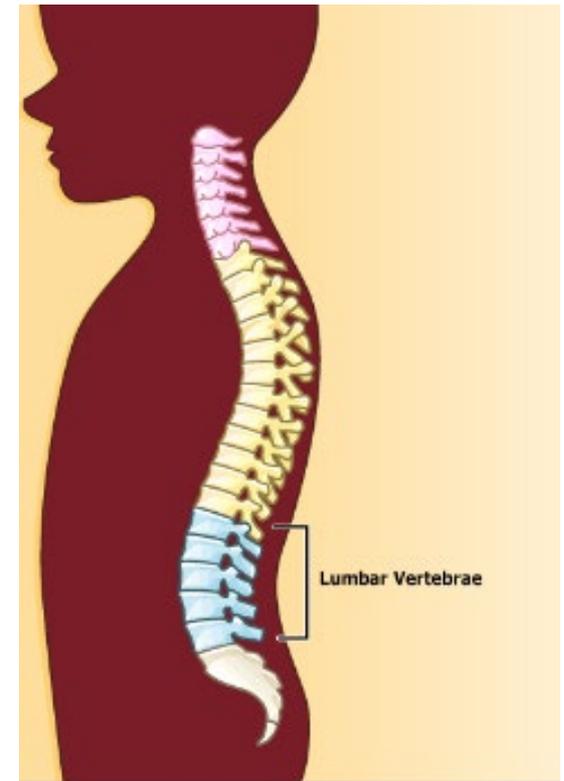
Study Aims

- **Aim 1: Identify new low back pain episodes and inappropriate use of Lumbar Spine-MRI (LS-MRI)**
  - Identify providers with high and low rates of inappropriate LS-MRIs
  - Determine if history of past orders can predict providers who frequently order inappropriate scans in subsequent years
- **Aim 2: Interview primary care providers to identify the factors contributing to appropriate and inappropriate LS-MRIs**
- **Aim 3: Measure downstream consequences of inappropriate MRI**

Quantitative Study Results
Aims 1 & 3

Predicting inappropriate MRI scans

- MRI not indicated during first 6 weeks of episode of non-specific back pain without red flag conditions

- Can recent history of inappropriate imaging predict providers who will frequently order MRI?

Non-Specific Low-Back Pain Cohort

- Identified in VA primary care clinics 2014-2016 (3 years)
  - 3.5 million visits
  - 1.5 million unique patients
  - 1.3 million episodes without specific cause or red-flag condition
- MRI in first 6 weeks in 2.4% of episodes

Patient-level predictors of inappropriate scans

- Younger

- Higher pain score at initial presentation

- No visit for back pain in prior 24 months

- Male

- No significant association with:
  - Having an opiate Rx in prior year, having a primary care assignment, seeing the assigned primary care provider

Provider-level predictors of inappropriate scans

- Smaller panel (<172 index LBP visits in 3 years)

- Hospital-based clinic

- Younger provider

- No significant association with:

  - Type of provider (MD, NP, PA, resident), provider gender

Does past activity predict future performance?

- Does ordering in 2014-2015 predict performance in 2016?

- Predictions for individual primary care providers vs. clinics sites

Statistical methods

- Risk adjustment
  - Adjusts for differences in patients
- Shrinkage adjustment
  - Adjusts risk adjusted rates for reliability
    - Number of observations per provider
    - Variation between providers
  - "Shrinks" less reliable values towards mean

Prediction of 10% least concordant providers
(c statistic for area under ROC curve)

Measure	Primary care providers (n=6,302)	Primary care sites (n=923)
Raw rate (two years)	0.6826	0.8046
Risk adjusted rate	0.6784	0.8044
Shrinkage and risk adjusted rate	0.6971*	0.8100
Raw rate (one year)	0.6641	0.7447

Use of early MRI for low-back pain, in cohorts identified by past performance

Cohort selected using baseline data	Characteristics of cohort in follow-up period	
	Early MRI in this cohort (as % total)	Visits for low-back pain in this cohort (as % total)
Primary care providers with highest use at baseline		
5%	11.0	3.8
10%	19.0	8.1
20%	33.7	17.7
Primary care clinics with highest use at baseline		
5%	5.1	2.0
10%	10.9	5.4
20%	27.2	15.5

Conclusions

- It is possible to identify primary care providers and clinics likely to order inappropriately

- Useful means to focus an intervention

- Analysis includes 14.0% of primary care providers who had no baseline data

Downstream Consequences (Aim 3)

- Study of 442,284 index visits in 2016

- Follow-up period: 43-365 days after index visit

- Association of early scan and subsequent:
  - Surgery of the lumbar spine
  - Opioid use
  - Total cost and cost related to low back pain care
  - Pain scores

Audience Poll

How would you control for observable differences between treatment and control groups in studies without random assignment? (Check all that apply)

- Multivariable regression models
- Matching
- Propensity scores
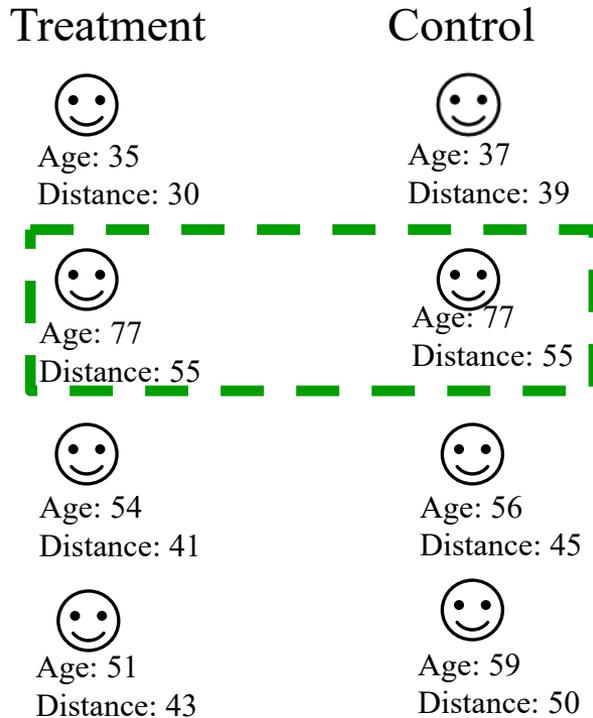- Coarsened exact matching
- **All of the above**

Coarsened Exact Matching

■ Matches on broad categories (coarsened values) of key variables

  – Age, sex, index pain score, assigned primary care provider, distance to the nearest VA facility, hx of a pain condition, hx of a mental health condition, and opioids prescription.

■ Pros:

  – More feasible than exact matching on a large set of potential confounders

  – Less model dependence, lower bias, and increased efficiency relative to propensity score matching
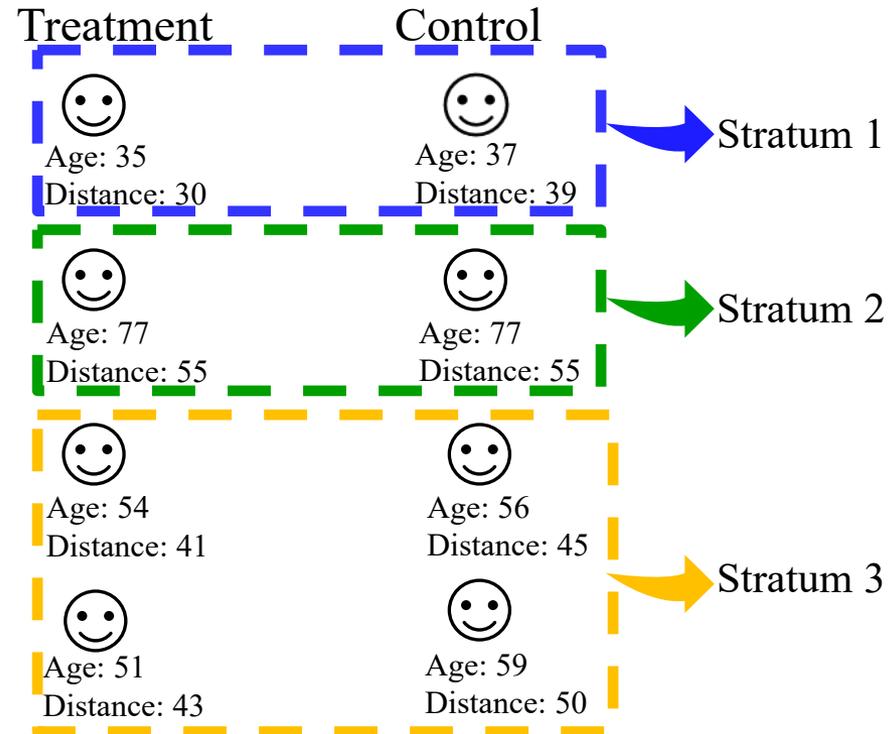
Garrido, 2018; King et al., 2009

Coarsened Exact Matching

Exact Matching
Age, Distance to nearest VA

Treatment

Control

☺
Age: 35
Distance: 30

☺
Age: 37
Distance: 39

☺
Age: 77
Distance: 55

☺
Age: 77
Distance: 55

☺
Age: 54
Distance: 41

☺
Age: 56
Distance: 45

☺
Age: 51
Distance: 43

☺
Age: 59
Distance: 50

Coarsened Exact Matching
10 year age buckets
Distance to nearest VA ≥40 miles

Treatment

Control

☺
Age: 35
Distance: 30

☺
Age: 37
Distance: 39

→ Stratum 1

☺
Age: 77
Distance: 55

☺
Age: 77
Distance: 55

→ Stratum 2

☺
Age: 54
Distance: 41

☺
Age: 56
Distance: 45

☺
Age: 51
Distance: 43

☺
Age: 59
Distance: 50

→ Stratum 3

Garrido, 2018

20

Coarsened Exact Matching

■ Weights:

– Unmatched units: 0

– Matched treatment members: 1

– Matched control member weights calculated for each stratum:

$$\left(\frac{\text{\# Matched treatment members in stratum}}{\text{\# Matched control members in stratum}}\right) \times \left(\frac{\text{Total \# matched controls}}{\text{Total \# matched treatment}}\right)$$

Iacus et al., 2011

Downstream Consequences (Aim 3) Methods

- Statistical analyses

  - Standardized differences (CEM weighted/unweighted)

  - Logistic regression (CEM weighted): surgery, use of opioids

  - Generalized linear models (CEM weighted): costs

  - Two-part models (CEM weighted): pain score, quantity of opioids

Downstream Consequences: Lumbar Surgery

- **Surgery ↑ likely amongst early scan cohort**
  - **Adjusted mean (risk of lumbar surgery):**

With early MRI (N=9,977)	Without early MRI (N=395,718)	P
1.48%	0.12%	<0.001

  - **Absolute difference [95% CI]:** 1.36 [1.12-1.60]

  - **Relative difference [95% CI]:** 12.7 [10.3-15.5]

Downstream Consequences: Opioids

■ Opioid use ↑ likely amongst early scan cohort

   – **Adjusted mean (risk of opioid use)**:

With early MRI (N=9,977)	Without early MRI (N=395,718)	P
35.1%	28.6%	<0.001

   – **Absolute difference [95% CI]**: 6.8 [6.0-7.8]

   – **Relative difference [95% CI]**: 1.23 [1.20-1.27]

Downstream Consequences: Opioids

- Quantity of opioids ↑ amongst early scan cohort

  - **Adjusted mean (1000 mg of morphine equivalents)**:

With early MRI (N=9,977)	Without early MRI (N=395,718)	P
1.90	1.81	0.03

  - **Absolute difference [95% CI]**: 0.13 [0.01-0.24]

  - **Relative difference [95% CI]**: 1.06 [1.00-1.13]

Downstream Consequences: Costs

■ Costs ↑ amongst early scan cohort

   – **Adjusted mean ($US 43-365 days post-index visit)**:

Cost category	With early MRI (N=9,977)	Without early MRI (N=395,718)	P
Total acute costs	$8,082	$5,560	<0.001
Back pain care	$2,054	$706	<0.001

Total acute costs:
Absolute difference [95% CI]:
$2,522 [2202-2841]

Relative difference [95% CI]:
1.37 [1.33-1.41]

Back related costs:
Absolute difference [95% CI]:
$1,347 [1198-1497]

Relative difference [95% CI]:
2.07 [1.99-2.14]

Downstream Consequences: Pain

■ Pain ↑ amongst early scan cohort

– **Adjusted mean (last recorded pain score)**:

With early MRI (N=8,639)	Without early MRI (N=305,561)	P
3.99	3.87	<0.001

– **Absolute difference [95% CI]**: 0.15 [.09-.22]

– **Relative difference [95% CI]**: 1.04 [1.02-1.06]

Conclusions

- MRIs for uncomplicated LBP are associated with:

  – Increased surgery

  – Greater use of opioids

  – Increased costs

  – Worse pain outcomes

Audience Poll

Why do providers order LS-MRI inappropriately for new onset low back pain? (Check all that apply)

- Unfamiliar with guidelines
- Specialty care requirements
- Time constraints
- Imaging adds value
- Patient pressure

Aim 2
Qualitative Study Results

Why do providers order inappropriate LS-MRI for acute low back pain

Qualitative Methods

- Purposeful criterion sampling[1]

- Semi-structured telephone interviews

- Directed content analyses[2] by adapting Cabana et al.'s framework[3]

  – Provider factors
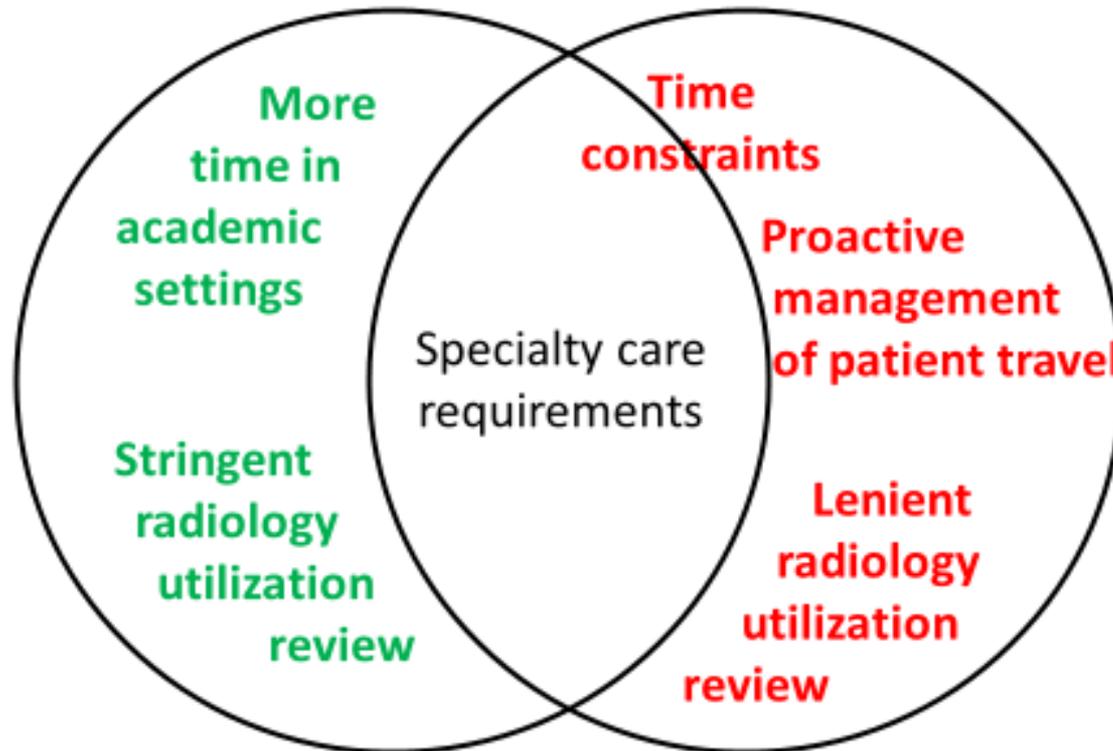
  – Patient factors

  – Environmental factors

Primary Care Provider Characteristics

Primary Care Providers (n=55)	High Guideline Concordant (n=22)	Low Guideline Concordant (n=33)
Provider type, No. (%) -Physician -Nurse Practitioner -Physician Assistant	19(86) 3(14) --	16(49) 15(45) 2(6)
Facility type, No. (%) - VA Medical Center -Community-based clinic	8(36) 14(64)	11(33) 22(64)
Gender, No. (%) - Female	12(55)	20(61)
VA regional service networks (VISNs)	11 of 18	17 of 18

Environmental Factors

High guideline concordant — Low guideline concordant

More time in academic settings

Stringent radiology utilization review

Specialty care requirements

Time constraints

Proactive management of patient travel

Lenient radiology utilization review

Environmental Factors Influence LS-MRI Orders

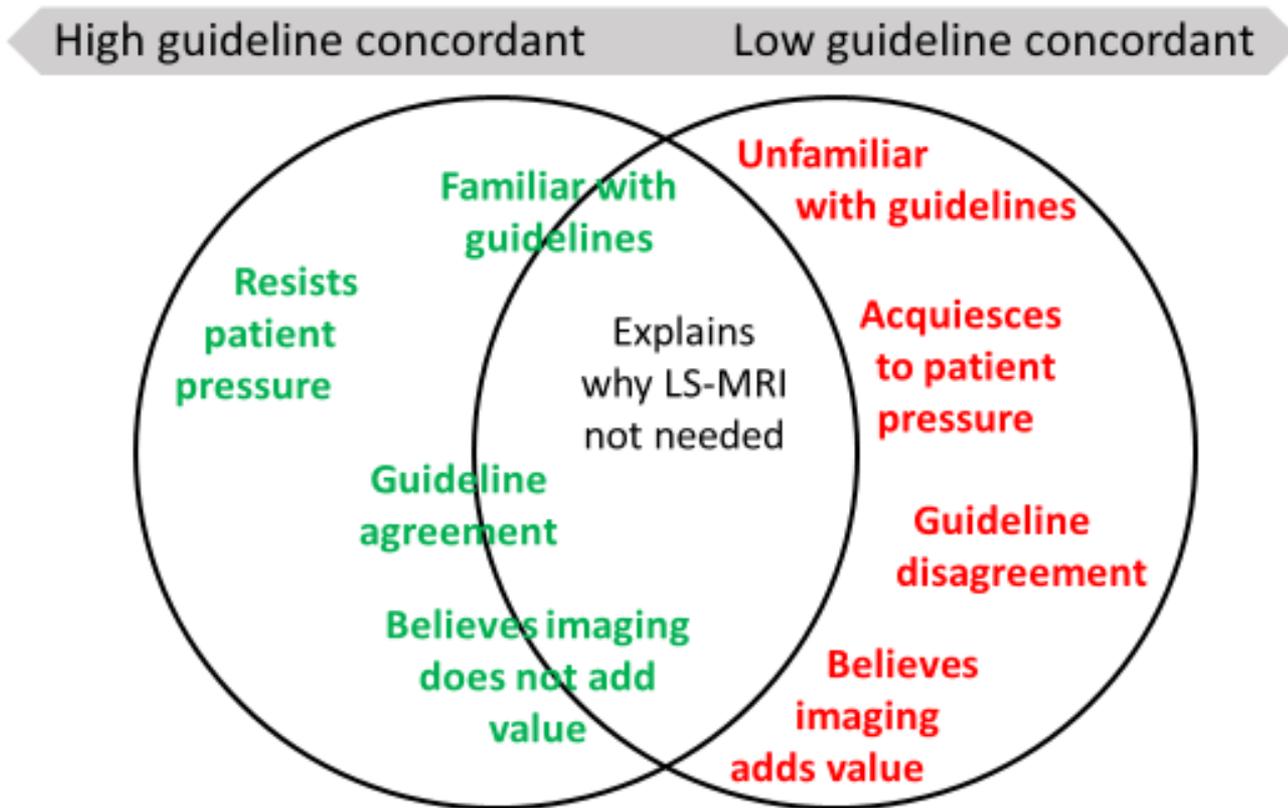| High Concordance	Low Concordance
More stringent radiologist oversight, fewer time constraints	Less radiologist oversight, more time constraints, proactive management of access challenges
"For me to get the MRI approved, I have to show that they've done all the physical therapy, they've used pain relief, they've used muscle relaxers."	"We're pressed for time, it's a six-minute walk-in visit, pinched nerve, pain going down leg, I need to know what's going on and may not have time to elaborate, sometimes it's easier to order the test."

Provider Factors

High guideline concordant | Low guideline concordant

Familiar with guidelines

Unfamiliar with guidelines

Resists patient pressure

Explains why LS-MRI not needed

Acquiesces to patient pressure

Guideline agreement

Guideline disagreement

Believes imaging does not add value

Believes imaging adds value

Provider Factors Influence LS-MRI Orders

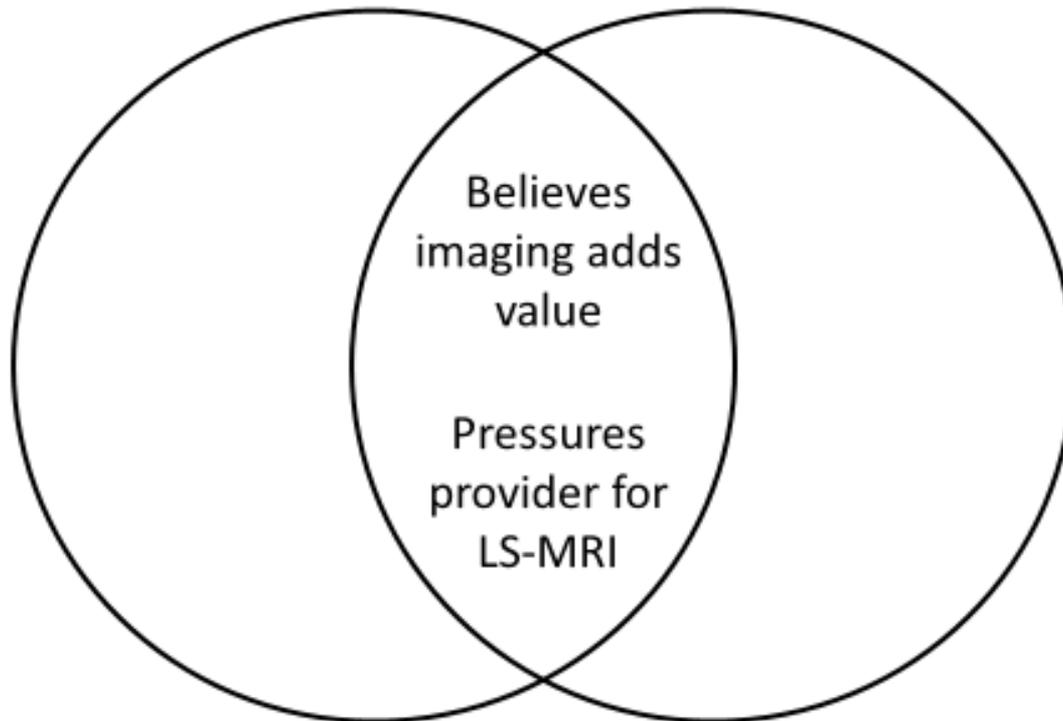| High Concordance	Low Concordance
More factors contributing to _appropriate_ LS-MRI (less autonomy, rarely order early LS-MRI, does not acquiesce to patient requests)	More factors contributing to _inappropriate_ LS-MRI (more autonomy, numerous rationales for ordering early LS-MRI, acquiesces to patient requests)
"A guy wanted an MRI now. I said, what have you done to get better? He had done nothing. I said, if you're an NFL quarterback who sustained a big hit, they might do an acute MRI right now. For the rest of us, that's not the guideline, that's not the recommendation. I share evidence-based stuff with them. And generally guys are agreeable."	"If there's someone that's anxious and they feel like, "Oh my God, this is the end of the world for me. I can't cope with this." I have no problem. That's a low threshold. I'll order it."

Patient Factors

High guideline concordant   Low guideline concordant

Believes
imaging adds
value

Pressures
provider for
LS-MRI

Patient Factors Influence LS-MRI Orders

High Concordance	Low Concordance
Patient pressure for LS-MRI is similar for both groups	
"They [patients] request imaging often."	[A patient will say,] "Look at what they're getting on the outside. These people are getting their backs cured. Why can't you just give me an MRI to see if something like that would be good for me?"

Qualitative Conclusions

- High and low guideline concordant PCPs report differences in environmental and provider factors influencing their LS-MRI decision making

- Low concordant PCPs are not likely to benefit from single standalone interventions because of competing factors, including guideline disagreement, patient pressure, time constraints, and patient travel burden

Potential Impact of Findings

- Need for action
  - Low concordance associated with
    - downstream costs in addition to cost of imaging
    - potential adverse effects: opioid use, surgery, pain

Potential Impact of Findings

- Targets for action
  - Low-concordance providers can be selected for implementation intervention

Potential Impact of Findings

- Multifaceted de-implementation strategies are needed to address competing provider and environmental factors
    - Radiology review and/or collaboration with providers
    - Education on how guidelines apply to high risk Veterans
    - Offer better pathways into conservative therapy, including access to same day alternatives (e.g. physical therapy)
    - When scans are required for specialty care, assess if low concordant providers are referring more often or inappropriately

Publications

1. Nevedal A, Lewis E, Wu J, Jacobs J, Jarvik J, Chou R, Barnett P. Factors Influencing Primary Care Providers' Unneeded Lumbar Spine MRI Orders for Acute, Uncomplicated Low-back Pain: A Qualitative Study. *Journal of General Internal Medicine* (2019): 1-8. doi: 10.1007/s11606-019-05410-y

2. Wu J, Lewis E, Barnett P, Nevedal A**.** Instant messaging: An innovative way to recruit primary care providers for qualitative research. *Journal of General Internal Medicine* (2019): 1-3 doi:10.1007/s11606-019-05533-2

3. Barnett P, Jacobs J, Jarvik J, Chou R, Boothroyd D, Lo J, Nevedal A. (under review) Identification of providers and clinics that use MRI early in episodes of non-specific low-back pain

4. Jacobs J, Jarvik J, Chou R, Boothroyd D, Lo J, Nevedal A, Barnett P. (under review) Observational study of the downstream consequences of inappropriate MRI of the lumbar spine

Presentations

1. 2019 HSR&D National Meeting (poster): "Learning from primary care providers to inform de-implementation of unneeded lumbar spine magnetic resonance imaging for new onset low back pain."

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Shrinkage Adjustment

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Contact Information

Paul G. Barnett, PhD

Health Economist at Palo Alto Veterans Institute for Research

Former Director of the VA Health Economics Resource Center

E-mail: Paul.Barnett@va.gov

Josephine C. Jacobs, PhD

Health Economist at the VA Health Economics Resource Center

Investigator at the Center for Innovation to Implementation, VA Palo Alto

E-mail: Josephine.Jacobs@va.gov

Andrea L. Nevedal, PhD

Anthropologist

Investigator & Senior Qualitative Methodologist at the Center for Innovation to Implementation, VA Palo Alto

E-mail: Andrea.Nevedal@va.gov

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