

Behavioral Economic Principles to Understand and Change Physician Behavior

NIH Collaboratory Grand Rounds

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- ***Honoraria:*** SHEA (supported by Merck)

Outline

- Antibiotic prescribing
- Behavioral science
- Preliminary behavioral interventions
- BEARI (Behavioral Economics/Acute Respiratory Infection) Trial

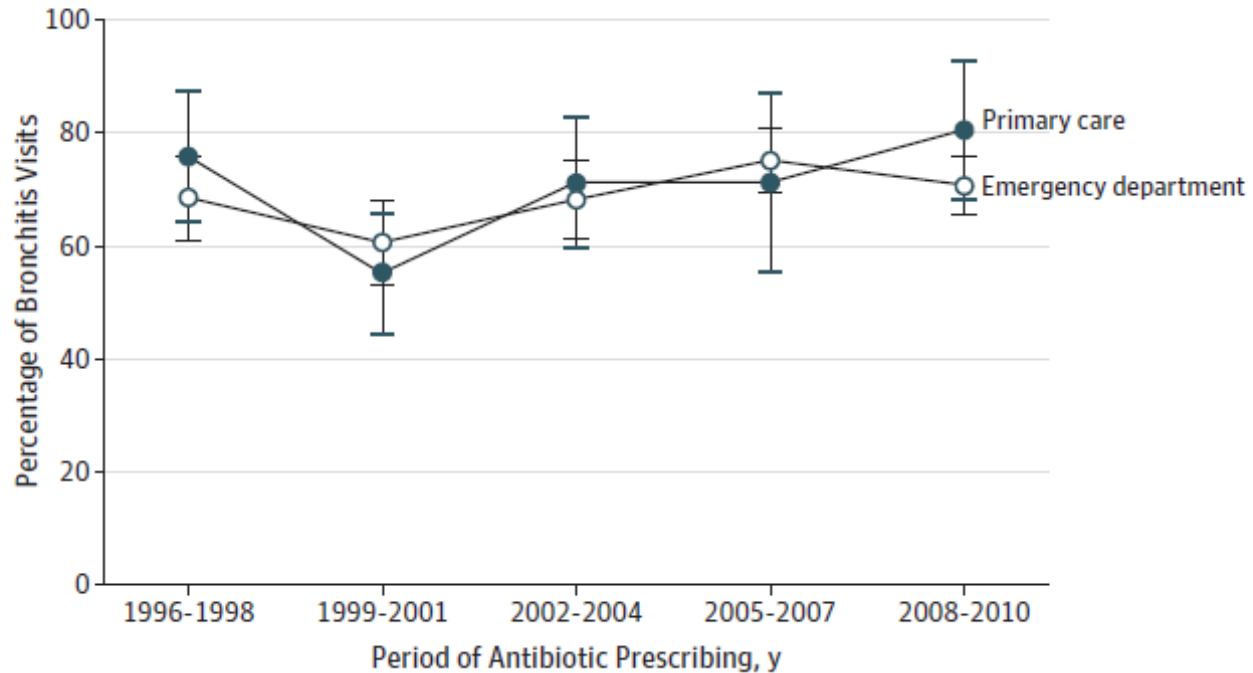
Background: Acute Respiratory Infections

- 10% of all ambulatory visits
- 44% of antibiotics

- Inappropriate antibiotic prescribing
 - Costs
 - Antibiotic-resistant bacteria
 - Changing the microbiome
 - Adverse drug events

Antibiotic Prescribing in the US

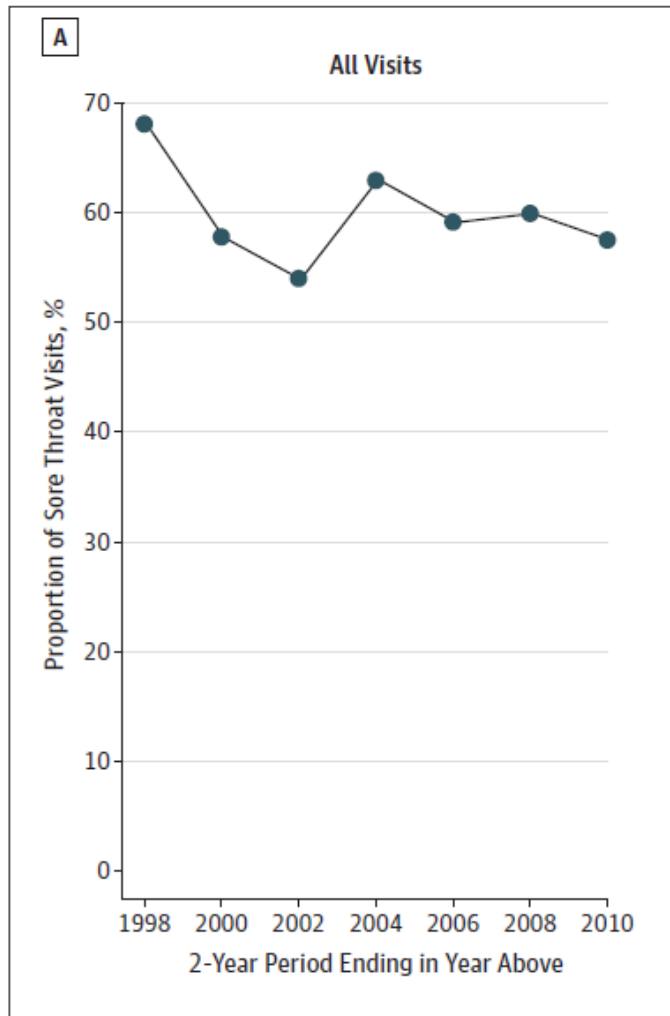
Figure. Antibiotic Prescribing for Acute Bronchitis in the United States by Site of Care, 1996-2010



- N = 3153 representing 31 million visits

Barnett and Linder. JAMA 2014

Antibiotic Prescribing in the US



- Adults with sore throat, 1997-2010
- N = 8191 representing 92 million visits

Barnett and Linder. JAMA Intern Med 2014

Antibiotic Prescribing

Original Investigation

Prevalence of Inappropriate Antibiotic Prescriptions Among US Ambulatory Care Visits, 2010-2011

Katherine E. Fleming-Dutra, MD; Adam L. Hersh, MD, PhD; Daniel J. Shapiro; Monina Bartoces, PhD; Eva A. Enns, PhD; Thomas M. File Jr, MD; Jonathan A. Finkelstein, MD, MPH; Jeffrey S. Gerber, MD, PhD; David Y. Hyun, MD; Jeffrey A. Linder, MD, MPH; Ruth Lynfield, MD; David J. Margolis, MD, PhD; Larissa S. May, MD, MSPH; Daniel Merenstein, MD; Joshua P. Metlay, MD, PhD; Jason G. Newland, MD, MEd; Jay F. Piccirillo, MD; Rebecca M. Roberts, MS; Guillermo V. Sanchez, MPH, PA-C; Katie J. Suda, PharmD, MS; Ann Thomas, MD, MPH; Teri Moser Woo, PhD; Rachel M. Zetts; Lauri A. Hicks, DO

- 506 antibiotic prescriptions per 1000 people
 - 30% unnecessary
 - 50% of ARI prescribing unnecessary
- **US:** 833 per 1000 people
- **Sweden:** 388 → 250 per 1000 people

Changing Behavior

- Limited success of prior interventions
- ***Implicit model:*** clinicians reflective, rational, and deliberate
 - “Educate” and “remind” interventions
- ***Behavioral model:*** decisions fast, automatic, influenced by emotion and social factors
 - Use cognitive biases
 - Appeal to clinician self-image
 - Consider social motivation

Imbalance in Factors Related to Antibiotic Prescribing

Factors Driving Antibiotic Prescribing: Immediate and Emotionally Salient

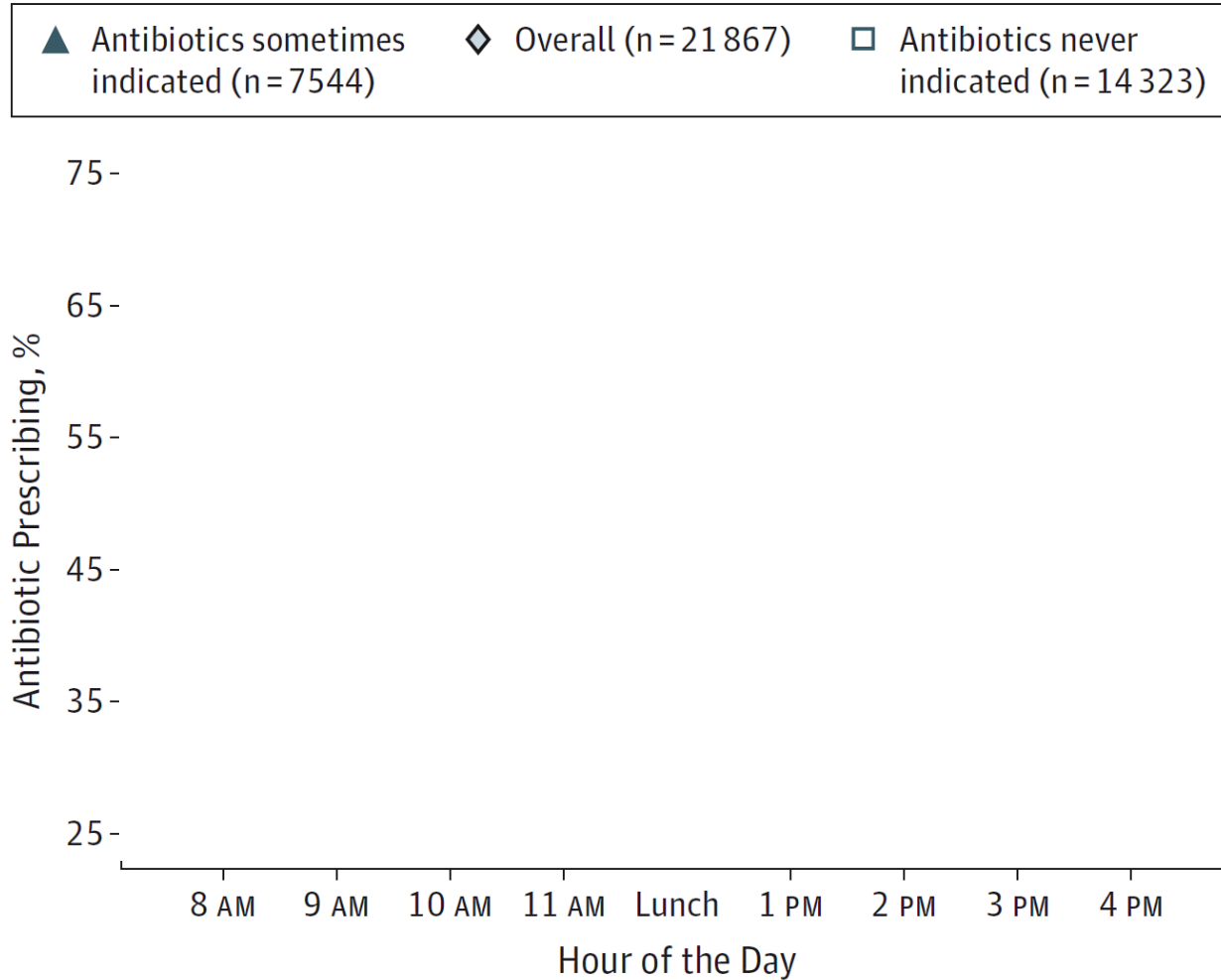
- Belief that a patient wants antibiotics
- Perception that it is easier and quicker to prescribe antibiotics than explain why they are unnecessary
- Habit
- Worry about serious complications and “just to be safe” mentality

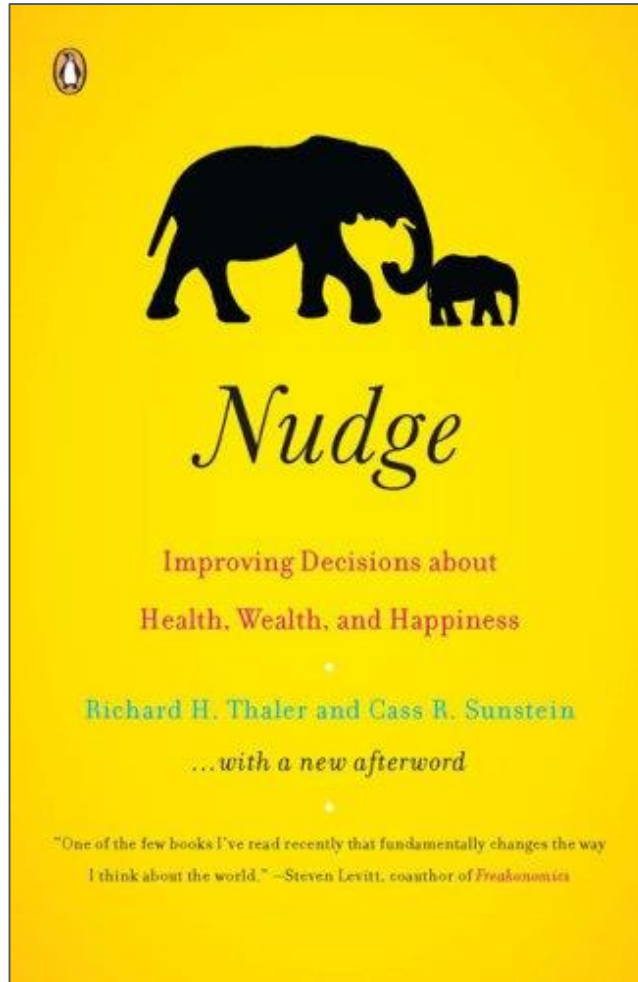
Factors Deterring Antibiotic Prescribing: More Remote and Less Emotionally Salient

- Risks of adverse reactions and drug interactions
- Recognizing the need for antibiotic stewardship
- Desire to deter low-value care and decrease unnecessary health care spending
- Prefer to follow guidelines

Mehrotra and Linder. JAMA Intern Med 2016

Antibiotic Prescribing by Hour of the Day





Nudges Target Automatic Thinking

- ***Nudge***: gentle, non-intrusive persuaders which influence choice in a certain direction
 - Different frames, default rules, feedback mechanisms, social cues
 - Can be ignored
 - A good nudge will only affect choice when there are not strong reasons for the decision
 - “Libertarian paternalism”

Original Investigation

Nudging Guideline-Concordant Antibiotic Prescribing A Randomized Clinical Trial

Daniella Meeker, PhD; Tara K. Knight, PhD; Mark W. Friedberg, MD, MPP; Jeffrey A. Linder, MD, MPH;
Noah J. Goldstein, PhD; Craig R. Fox, PhD; Alan Rothfeld, MD; Guillermo Diaz, MD; Jason N. Doctor, PhD

IMPORTANCE “Nudges” that influence decision making through subtle cognitive mechanisms have been shown to be highly effective in a wide range of applications, but there have been few experiments to improve clinical practice.

OBJECTIVE To investigate the use of a behavioral “nudge” based on the principle of public commitment in encouraging the judicious use of antibiotics for acute respiratory infections (ARIs).

[← Invited Commentary page 432](#)

Safe Antibiotic Use: A Letter From Your Medical Group

Dear Patient,

We want to give you some important information about antibiotics.

Antibiotics, like penicillin, fight infections due to bacteria that can cause some serious illnesses. But these medicines can cause side effects like skin rashes, diarrhea, or yeast infections. If your symptoms are from a virus and not from bacteria, you won't get better with an antibiotic, and you could still get these bad side effects.

Antibiotics also make bacteria more resistant to them. This can make future infections harder to treat. This means that antibiotics might not work when you really need them. Because of this, it is important that you only use an antibiotic when it is necessary to treat your illness.

How can you help? Carefully follow your doctor's instructions on when you should or should not take antibiotics.

When you have a cough, sore throat, or other illness, ask your doctor for the best possible treatments. If an antibiotic is necessary, your doctor will explain this to you, and

Your health is very important to us. As your doctors, we promise to treat your illness in the best way possible. We are also dedicated to avoid prescribing antibiotics when they are likely to do more harm than good.

If you have any questions, please feel free to ask your doctor, nurse, or pharmacist.

Sincerely,



El Uso Seguro de Antibióticos: Una Carta de su Grupo Médico

Estimado Paciente:

Queremos compartir información importante con usted sobre los antibióticos.

Los antibióticos como la penicilina ayudan a combatir infecciones debido a bacterias que pueden causar serias enfermedades. Pero estas medicinas también tienen efectos secundarios como erupciones de la piel, diarrea, o infecciones por hongos de levadura. Si sus síntomas son debidos a un virus y no por una bacteria, no se mejorará con un antibiótico, y usted aún puede obtener estos efectos secundarios no deseables.

Los antibióticos también pueden hacer la bacteria más resistente a ellas. Esto hará que infecciones en el futuro sean más difíciles de tratar. Eso significa que los antibióticos no trabajarán cuando ustedes en realidad necesitan que funcionen. Por esto, es importante que usted sólo use un antibiótico cuando sea necesario para su

Your health is very important to us. As your doctors, we promise to treat your illness in the best way possible. We are also dedicated to avoid prescribing antibiotics when they are likely to do more harm than good.

mejor para usted.

Su salud es importante para nosotros. Como sus doctores, nosotros prometemos tratar su enfermedad en la mejor manera posible. También nos comprometemos a evitar recetar antibióticos cuando sean probables de hacer más daño que bien.

Si tiene cualquier pregunta, pregúntele a su doctor, enfermera, o farmacéutico.

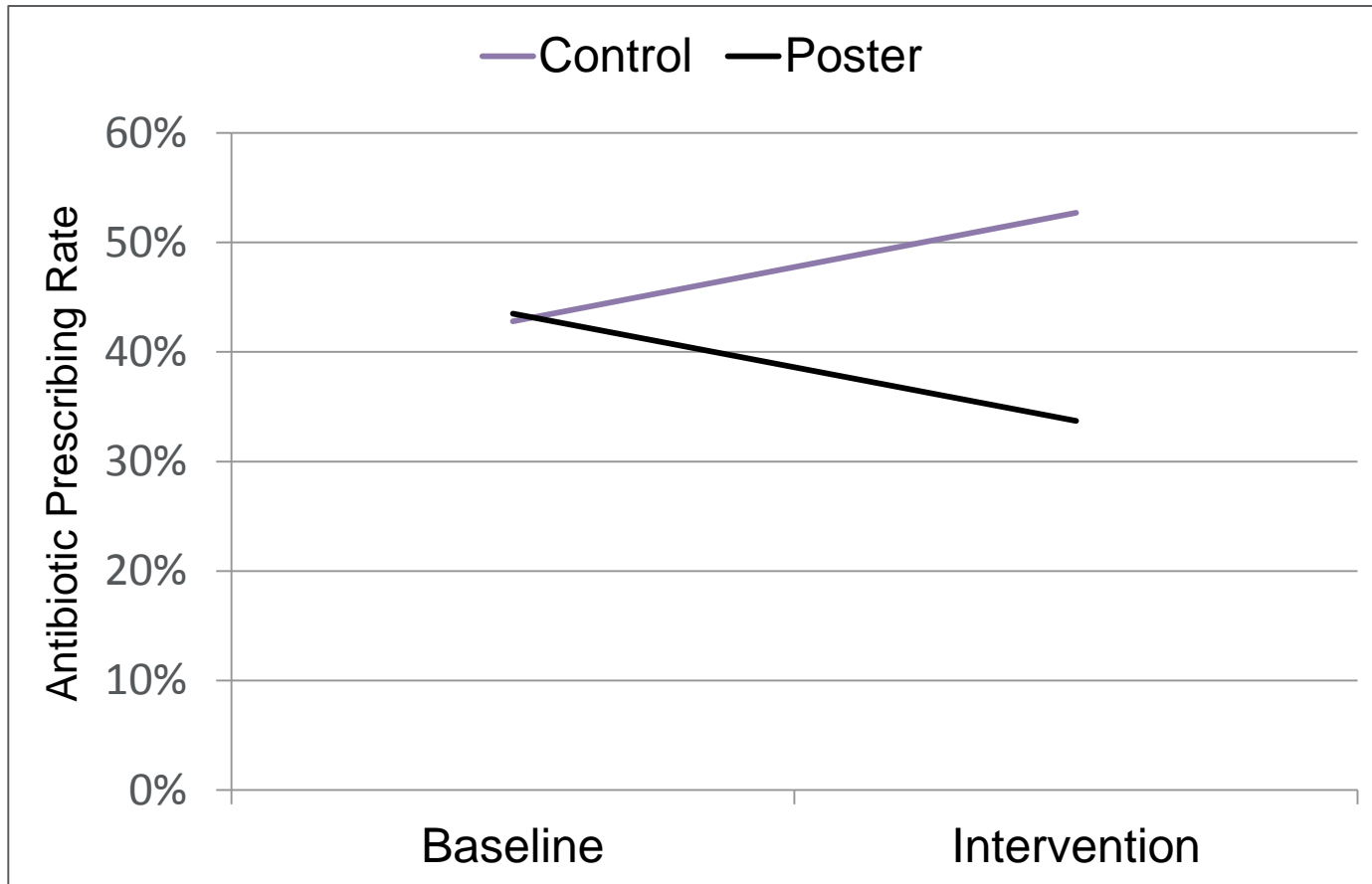
Atentamente,



Public Commitment: Methods

- Randomized 14 clinicians
 - Stratified by high and low-prescribing
- 48 week baseline
- 12 week intervention
- 954 non-antibiotic-appropriate ARI visits

Public Commitment: Results



Adjusted difference-in-differences: -20% (-6% to -33%)

CDC funded Replications: IDPH & NYSDH



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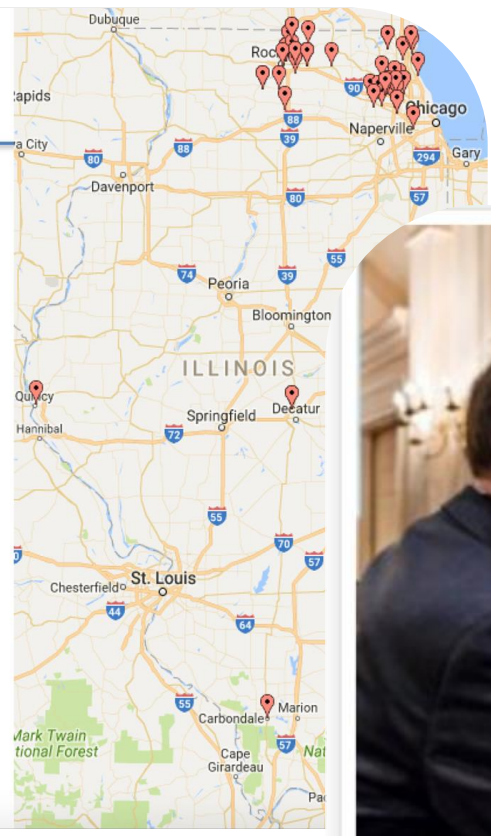
PDSB Campaign Goals

- Increase **provider and patient knowledge** & provide **resources** about antibiotic resistance and use

Phase I Participation



- 55 practices representing > 385 providers



CDC Core Elements Outpatient Antibiotic Stewardship (2017)

EU Draft Guidelines for Antibiotic Stewardship

The NYS Department of Health recently rolled out a "Get Smart Guarantee" poster for healthcare providers to pledge to only prescribe antibiotics when they are needed.

Original Investigation

Effect of Behavioral Interventions on Inappropriate Antibiotic Prescribing Among Primary Care Practices A Randomized Clinical Trial

Daniella Meeker, PhD; Jeffrey A. Linder, MD, MPH; Craig R. Fox, PhD; Mark W. Friedberg, MD, MPP;
Stephen D. Persell, MD, MPH; Noah J. Goldstein, PhD; Tara K. Knight, PhD; Joel W. Hay, PhD; Jason N. Doctor, PhD

IMPORTANCE Interventions based on behavioral science might reduce inappropriate antibiotic prescribing.

← Editorial page 558

+ Supplemental content at
jama.com



CDS and HIT often Disappoint

- Electronic health records with clinical decision support
 - Touted as a solution to problems of medical safety, cost, and quality
- Many EHR/CDS implementations
 - Do not achieve expected improvements
 - Implicitly assume clinicians follow a standard economic/behavioral model

Specific Aim

- To evaluate 3 behavioral interventions to reduce inappropriate antibiotic prescribing for acute respiratory infections
 - 3 health systems using 3 different EHRs

Interventions

1. Suggested Alternatives
2. Accountable Justification
3. Peer Comparison

Intervention 1: Suggested Alternatives

20567913 (BWH) 01/01/1960 (54 yrs.) F BIMA

Home Select Desktop Pt Chart: Medications Custom Reports Admin Sign Results ? Resource Popup

Allergies: ACE Inhibitors - Angioedema, Rash / Morphine - Dystonia

Unknown No Insurance Found

Patient Info As of 11/07/13 Refresh

Add New Medication

Medication: **Amoxicillin** Route: Search Favorites Cancel

Found in Practice Favorites

U Rx-Gen	Unknown	AMOXICILLIN 2000 MG PO X1	PO	Alternatives
U Rx-Gen	Unknown	AMOXICILLIN 250 MG PO TID 7 day(s)	PO	Alternatives
U		AMOXICILLIN 500MG, 1 PO TID	PO	

Found in Medication Dictionary

Type	Retail Copy	Medication	Route	Restrictions	Alternatives
U Rx-Gen	Unknown	AMOXICILLIN	PO		Alternatives
U Rx-Gen	Unknown	AMOXICILLIN EXTENDED RELEASE	PO		Alternatives
U Rx-Gen	Unknown	AMOXICILLIN/CLAV. SUSP 400 MG/57 MG (5 ML)	PO		Alternatives
U Rx-Gen	Unknown	AMOXICILLIN/CLAV.ACID 250/125 (AMOX./CLAV.ACID ...	PO		Alternatives
U Rx-Gen	Unknown	AMOXICILLIN/CLAV.ACID 500/125 (AMOX./CLAV.ACID ...	PO		Alternatives
U Rx-Gen	Unknown	AMOXICILLIN/CLAV.ACID 875/125	PO		Alternatives

Intervention 1: Suggested Alternatives

The screenshot displays a medical software interface for a patient with ID 20567913 (BWH) and birth date 01/01/1960 (54 yrs.) F. The patient's allergies are listed as ACE Inhibitors - Angioedema, Rash / Morphine - Dystonia. The interface includes a navigation menu with options like Home, Select, Desktop, Pt Chart: Medications, Custom, Reports, Admin, Sign, Results, ? Resource, and Popup. A dialog box titled "BEARI Study -- Webpage Dialog" is open, asking: "Are you prescribing this antibiotic for an acute respiratory infection (ARI)?" with "Yes", "No", and "Cancel" buttons. The background shows a medication list with entries like "U Rx- AMOXICILLIN/CLAV. ACID 87.5/12.5" and "U Rx- AMOXICILLIN/CLAV. ACID 87.5/12.5".

Intervention 1: Suggested Alternatives

The screenshot displays a medical software interface with a patient record at the top: 20567913 (BWH), 01/01/1960 (54 yrs.) F, and BIMA. A navigation bar includes Home, Select, Desktop, Pt Chart: Medications, Custom, Reports, Admin, Sign, Results, ?, Resource, and Popup. A sidebar on the left contains sections for Allergies, Medications, and a list of Rx-Ger items. A central dialog box titled 'BEARI Study -- Webpage Dialog' prompts the user to 'Please select Principal ARI diagnosis:'. The options are: Non-specific upper respiratory infection, Sinusitis, Pharyngitis, Acute bronchitis, Otitis media, Influenza, Pneumonia, and Other with an adjacent text input field. 'Ok' and 'Cancel' buttons are at the bottom of the dialog. Below the dialog, a medication entry is visible: 'U Rx-Gen Unknown AMOXICILLIN/CLAV.ACID 875/125 PO Alternatives'.

Intervention 1: Suggested Alternatives

20567913 (BWH)	01/01/1960 (54 yrs.) F									BIMA	
Home	Select	Desktop	Pt Chart: Medications	Custom	Reports	Admin	Sign	Results	?	Resource	Popup
Warning											
You are ordering: AMOXICILLIN											
Alert Message:											
Antibiotics are not generally indicated for non-specific upper respiratory infections. Please consider the following alternative prescriptions, treatments, and materials to help your patient.											
Alternatives											
Over-the-counter medications											
Decongestants											
<input type="checkbox"/> Oxymetazoline HCL (0.05 % SPRAY) 2 SPRAY (0.05 % SPRAY) NAS BID or PRN but no more frequently than every 6 hours. Do not use more than 3 days. Dispense: 1 Bottle(s) Refills: 0											
<input type="checkbox"/> Pseudoephedrine (30 MG TABLET) 60 MG (30 MG TABLET Take 2) PO Q6H PRN as needed for nasal congestion. Dispense: 50 Tablet(s) Refills: 0											
Antihistamines											
<input type="checkbox"/> Diphenhydramine ORAL (25 MG TABLET) 25 MG (25 MG TABLET Take 1) PO Q6H PRN not to exceed 6 doses in 24 hours. Dispense: 24 Tablet(s) Refills: 0											
<input type="checkbox"/> Loratadine (10 MG TABLET) 10 MG (10 MG TABLET Take 1) PO QD PRN Dispense: 30 Tablet(s) Refills: 0											

Intervention 1: Suggested Alternatives

20567913 (BWH)		01/01/1960 (54 yrs.) F				BIMA					
Home	Select	Desktop	Pt Chart: Medications	Custom	Reports	Admin	Sign	Results	?	Resource	Popup
fever. Dispense: 28 Tablet(s) Refills: 0											
Cough suppressants and expectorants											
<input type="checkbox"/> Benzonatate (100 MG CAPSULE) 100 MG (100 MG CAPSULE Take 1) PO Q4H PRN for cough. Do not take more than 6 capsules in 1 day. Dispense: 30 Capsule(s) Refills: 0											
<input type="checkbox"/> Guaifenesin AC (100-10MG/5 LIQUID) 5 ML (100-10MG/5 LIQUID) PO Q4H PRN for cough Dispense: 180 ML(s) Refills: 0											
Bronchodilators											
<input type="checkbox"/> Albuterol INHALER HFA (90 MCG HFA AER AD) 2 PUFF (90 MCG HFA AER AD) INH Q6H PRN for cough Dispense: 1 Inhaler(s) Refills: 0											
"Excuse from work" Patient Letter.											
Select patient's Days Off work <input type="text" value="4"/>											
<input type="checkbox"/> Save As Note											
<input type="button" value="Preview"/> <input type="button" value="Print"/>											
Print patient educational materials.											
<input type="button" value="Preview"/> <input type="button" value="Print"/>											
<input type="checkbox"/> If you still want to prescribe an antibiotic, please check the box.											

Intervention 2: Accountable Justification

BestPractice Advisory - Zztest,Bearistudyfive


▼ Text Alerts (1 Advisory)

Antibiotics are not generally indicated for acute bronchitis

▼ Justifications (1 Advisory)

You have prescribed antibiotics for a likely viral diagnosis. Please click the Enter Justification button below and write your justification for prescribing antibiotics in the comment box. This justification will be entered into the patient's record.

If you do not enter a justification into the comment box, the phrase "No justification for prescribing antibiotics was given." will appear in the patient's record. Click Accept when you are finished.

Acknowledge reason: Not Done-Medical Reason  [Close](#)

Patient has asthma.

Click this box and enter ARI justificati...

Accept & Stay Accept Cancel

Interventions 1 and 2: Combined

BestPractice Advisory - Zztest ,Bearistudyfive

▼ Text Alerts (1 Advisory)

Antibiotics are not generally indicated for acute bronchitis

▼ Justifications (2 Advisories)

Please consider the symptomatic treatment options and patient instructions for this condition

Open SmartSet: VIRAL ACUTE RESPIRATORY INFECTION AP1 WITHOUT FLU [preview](#)

You have prescribed antibiotics for a likely viral diagnosis. Please click the Enter Justification button below and write your justification for prescribing antibiotics in the comment box. This justification will be entered into the patient's record.

If you do not enter a justification into the comment box, the phrase "No justification for prescribing antibiotics was given." will appear in the patient's record. Click Accept when you are finished.

Acknowledge reason: [Close](#)

[Click this box and enter ARI justificati...](#)

Intervention 3: Peer Comparison

“You are a Top Performer”

You are in the top 10% of clinicians. You wrote 0 prescriptions out of 21 acute respiratory infection cases that did not warrant antibiotics.

“You are not a Top Performer”

Your inappropriate antibiotic prescribing rate is 15%. Top performers' rate is 0%. You wrote 3 prescriptions out of 20 acute respiratory infection cases that did not warrant antibiotics.

Interventions: Summary

***EHR-based
Nudges***

***Social
Motivation***

Suggested
Alternatives

Accountable
Justification

Peer
Comparison

Methods: Practices and Randomization

47 Primary Care Practices

3 Health Systems, 3 EHRs

Los Angeles: 25

Boston: 22

Methods: Enrollment

- ***Invited:*** 355 clinicians
- ***Enrolled:*** 248 (70%)
 - Consent
 - Education
 - Practice-specific orientation to intervention
 - Honorarium

Methods: Primary Outcome

- ***Antibiotic prescribing for non-antibiotic-appropriate diagnoses***
 - Non-specific upper respiratory infections
 - Acute bronchitis
 - Influenza
- ***Excluded:*** chronic lung disease, concomitant infection, immunosuppression
- ***Data Sources:*** EHR and billing data

Methods: Analysis

- ***Piecewise hierarchical model***
 - Clinician and practice-level clustering
 - 18-month baseline period
 - 18-month intervention
 - Modeled differences in the trajectory of antibiotic prescribing starting at month zero
 - Evaluated interactions

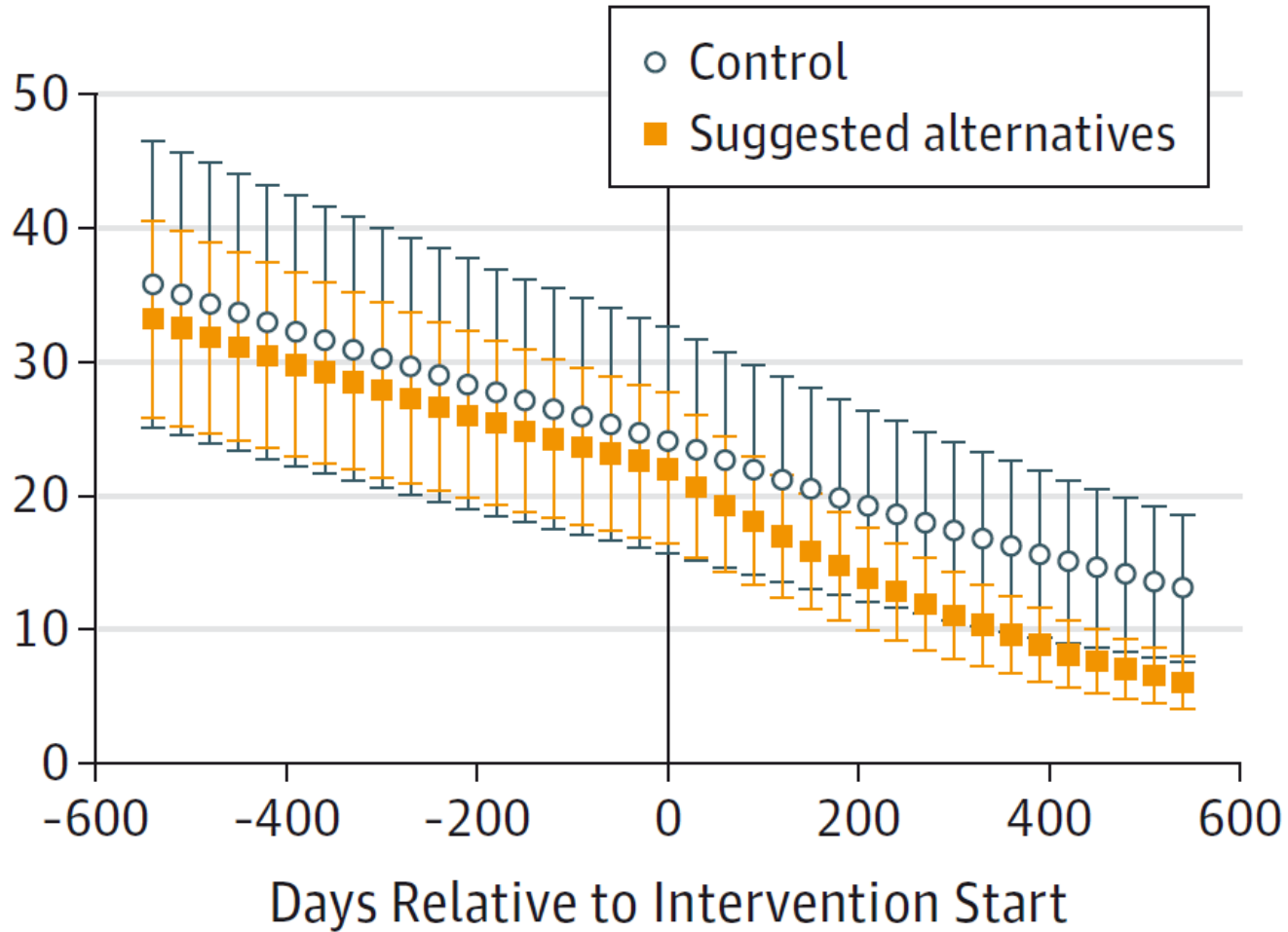
Results: Clinicians (N = 248)

	Control	Suggested Alternatives	Accountable Justification	Peer Comparison
Age, mean	47	49	48	48
	%			
Female	48	68	61	61
Clinician Type				
Physician	81	79	81	80
PA or NP	19	21	19	20
Baseline Inappropriate Antibiotic Prescribing Rate	39	31	32	25

Results: Visits (N = 16,959)

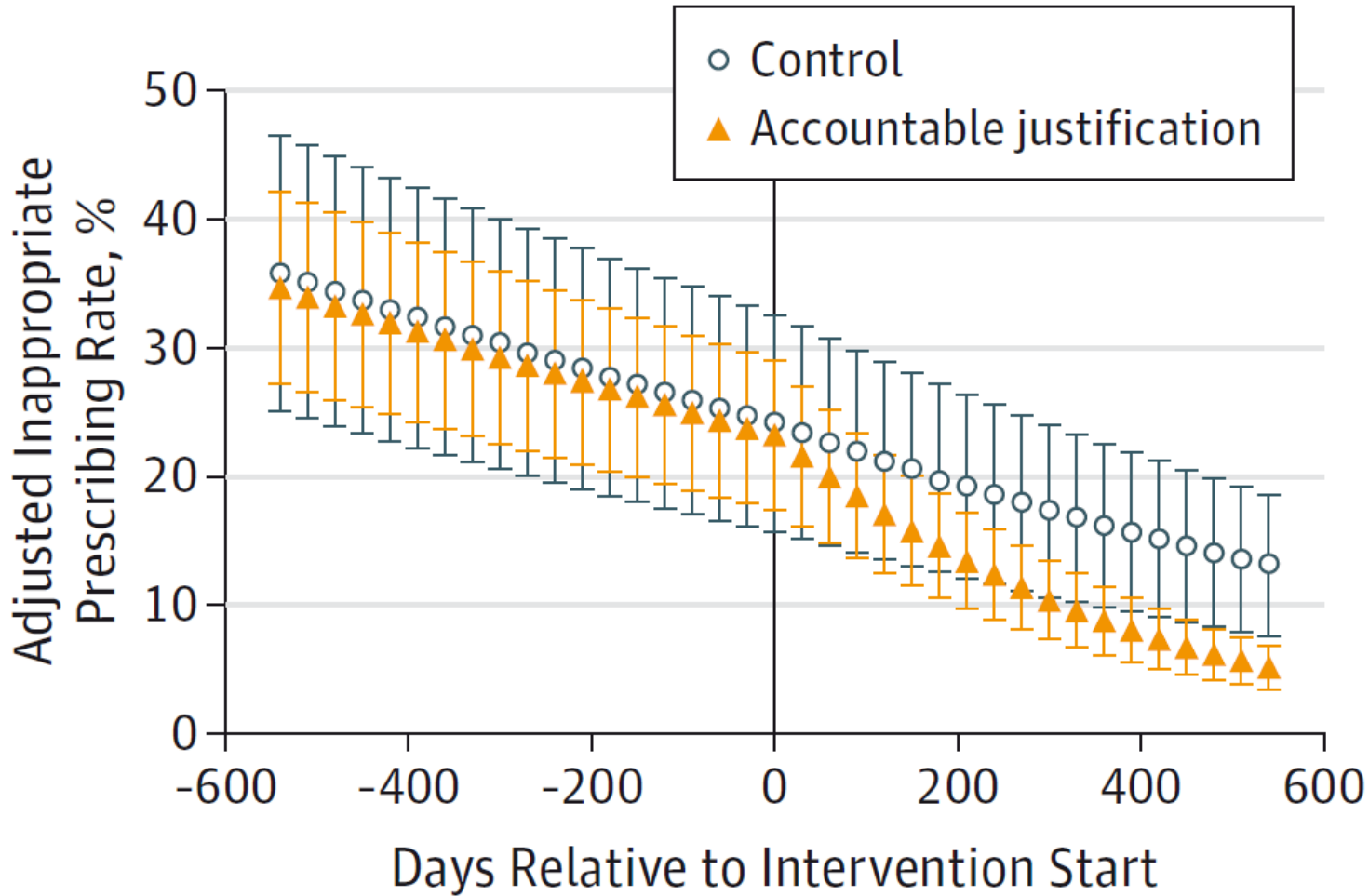
	Control	Suggested Alternatives	Accountable Justification	Peer Comparison
Age, mean	49	47	48	46
	%			
Female	65	70	66	68
White	88	86	88	87
Latino	35	32	30	36
Private insurance	60	59	58	58

Main Results: Suggested Alternatives



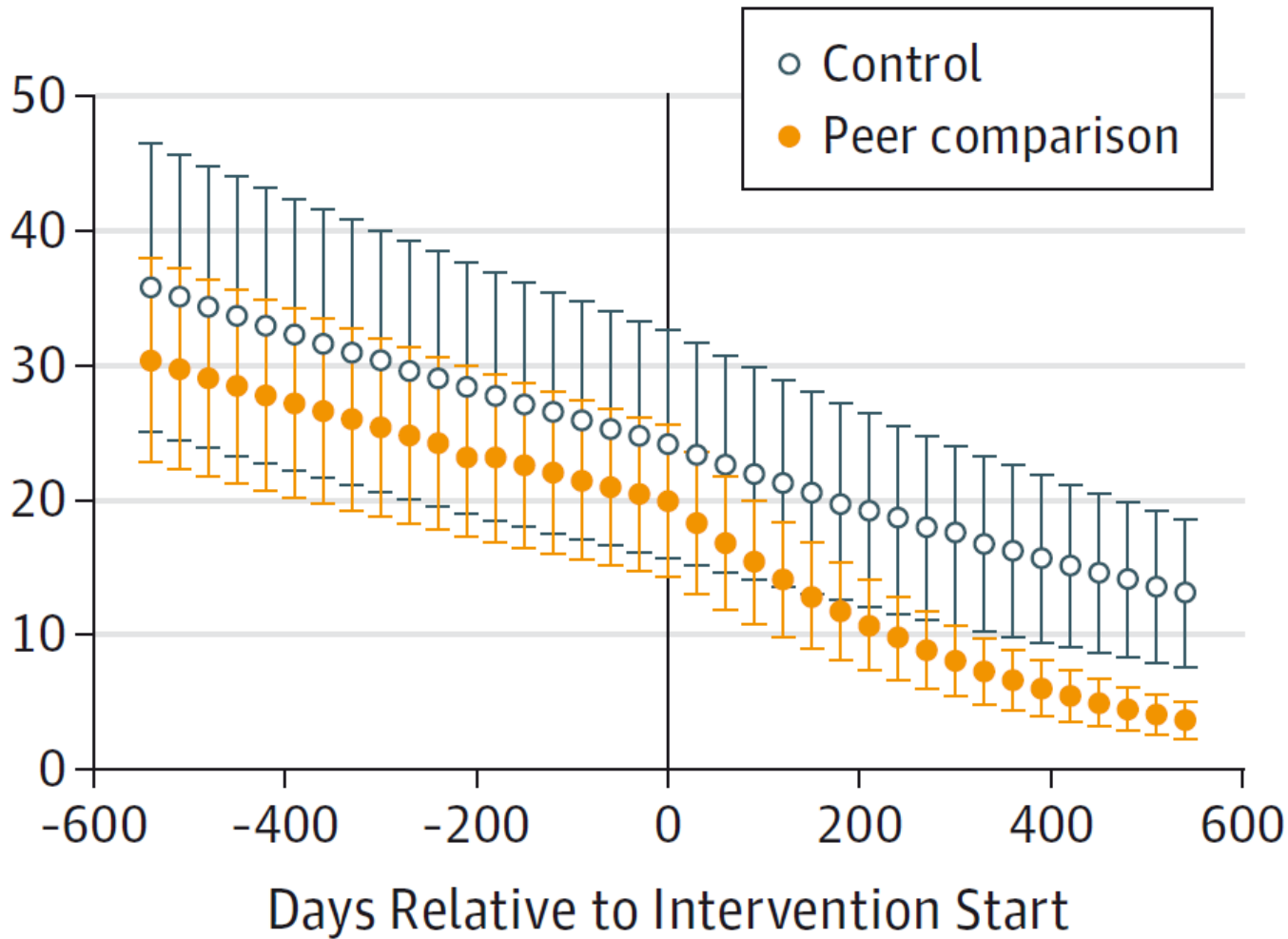
-5% $p = 0.66$

Main Results: Accountable Justification



-7% $p < .001$

Main Results: Peer Comparison



-5% $p = <.001$

Limitations

- Limited to enrollees
- Dependent on EHR and billing data

Strengths

- Randomized controlled trial
- Large size
- 3 different EHRs

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Persistence of Effects

Letters

RESEARCH LETTER

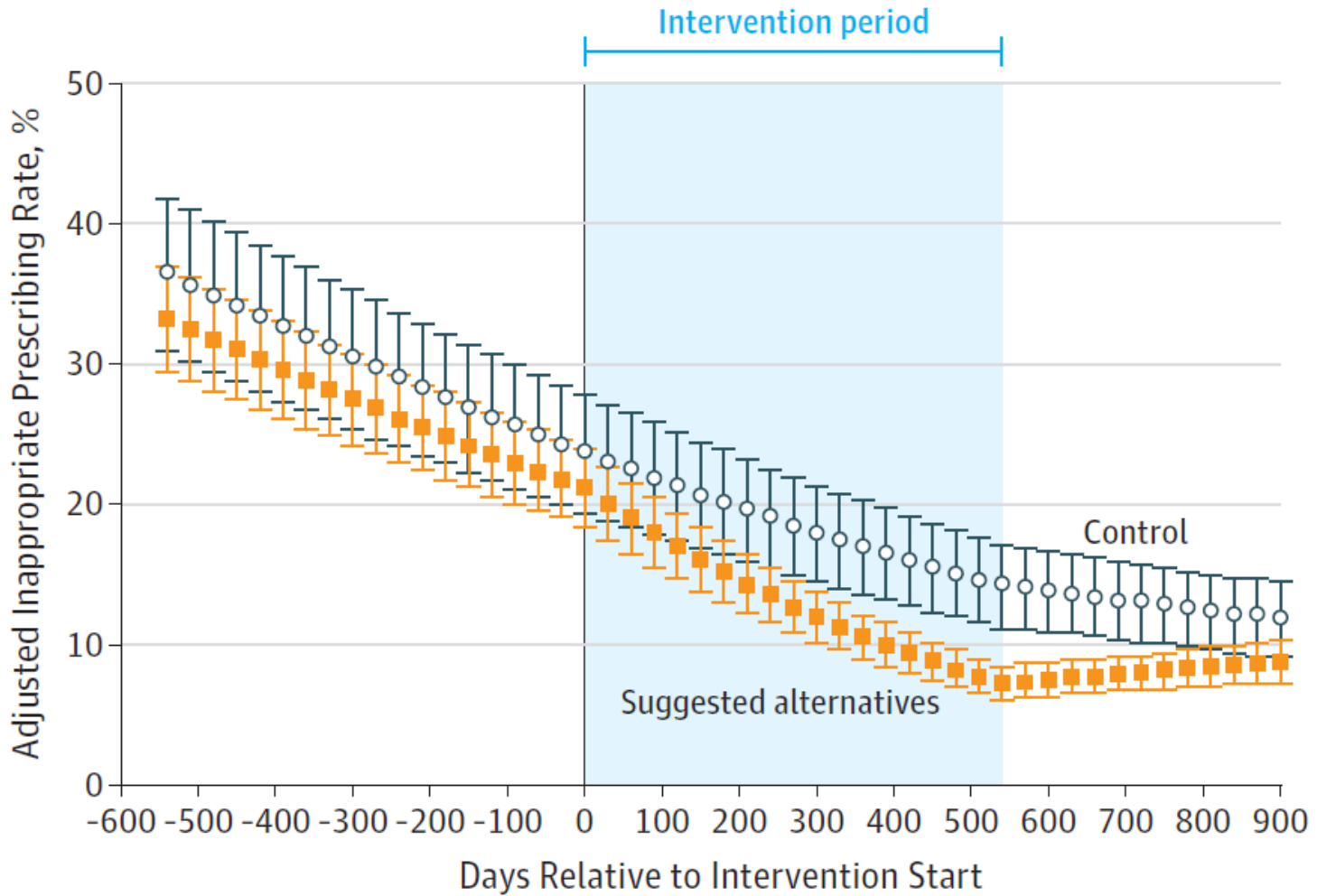
Effects of Behavioral Interventions on Inappropriate Antibiotic Prescribing in Primary Care 12 Months After Stopping Interventions

Inappropriate antibiotic prescribing contributes to antibiotic resistance and leads to adverse events.¹ A cluster-randomized trial of 3 behavioral interventions² intended to reduce inappropriate prescribing found that 2 of the 3 interventions were effective.³ This study examines the persistence of effects 12 months after stopping the interventions.

Methods | We randomized 47 primary care practices in Boston, Massachusetts, and Los Angeles, California, and

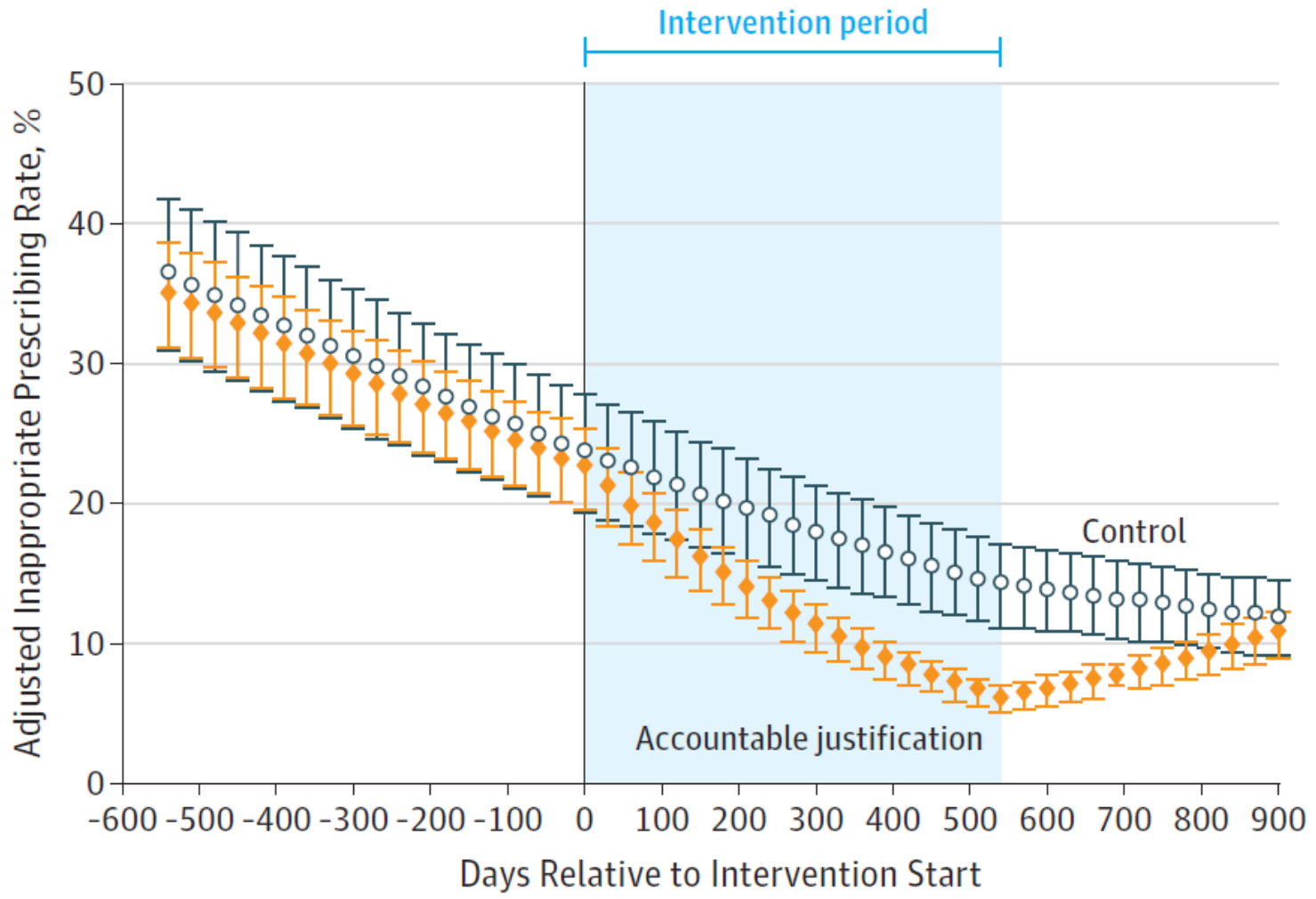
Results | There were 14 753 visits for antibiotic-inappropriate ARIs during the baseline period, 16 959 during the intervention period, and 7489 during the postintervention period. During the postintervention period, the rate of inappropriate antibiotic prescribing decreased in control clinics from 14.2% to 11.8% (absolute difference, -2.4%); increased from 7.4% to 8.8% (absolute difference, 1.4%) for suggested alternatives (difference-in-differences, 3.8% [95% CI, -10.3% to 17.9%]; $P = .55$); increased from 6.1% to 10.2% (absolute difference, 4.1%) for accountable justification (difference-in-differences, 6.5 [95% CI, 4.2% to 8.8%]; $P < .001$); and increased from 4.8% to 6.3% (absolute difference, 1.5%) for peer comparison (difference-in-differences, 3.9% [95% CI, 1.1% to 6.7%]; $P < .005$) (Figure). During the postintervention pe-

Persistence: Suggested Alternatives



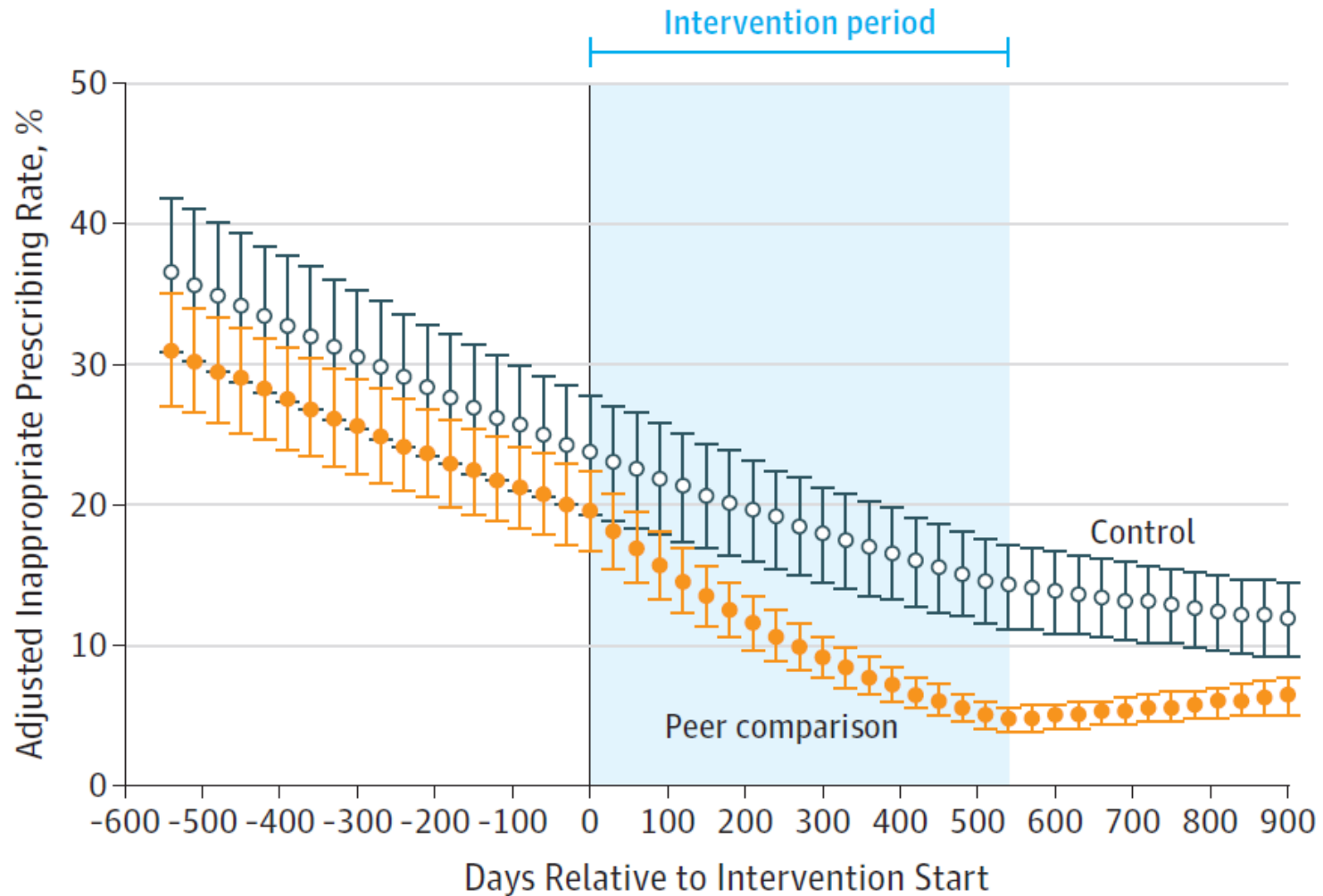
Linder. JAMA 2017

Persistence: Accountable Justification



Linder. JAMA 2017

Persistence: Peer Comparison



Linder. JAMA 2017

Imbalance in Factors Related to Antibiotic Prescribing

Factors Driving Antibiotic Prescribing: Immediate and Emotionally Salient

- Belief that a patient wants antibiotics
- Perception that it is easier and quicker to prescribe antibiotics than explain why they are unnecessary
- Habit
- Worry about serious complications and “just to be safe” mentality

Factors Deterring Antibiotic Prescribing: More Remote and Less Emotionally Salient

- Risks of adverse reactions and drug interactions
- Recognizing the need for antibiotic stewardship
- Desire to deter low-value care and decrease unnecessary health care spending
- Prefer to follow guidelines

Mehrotra and Linder. JAMA Intern Med 2016

Summary: Behavioral Interventions

- ***Doctors are people too***
- ***Doctoring is an emotional, social activity***

- ***Behavioral principles***
 - Decision fatigue
 - Pre-commitment
 - Accountable justifications
 - Peer comparison

Thank You

Questions? Conversation?

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