



THE SOCIAL LIFE OF NUMBERS: ADVANCING A RELATIONAL APPROACH TO PERFORMANCE FEEDBACK IN ANTIBIOTIC STEWARDSHIP

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DISCLOSURES

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OBJECTIVES

To recognize the social nature of quantification

To highlight the importance of considering the people who are receiving feedback and the context in which they are embedded

To provide practical suggestions about human-centered design considerations when implementing feedback-based antibiotic stewardship interventions

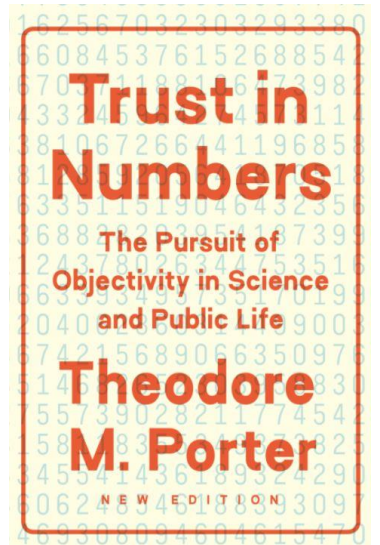
THE SOCIAL LIFE OF NUMBERS IN HEALTHCARE

NUMBERS ARE SOCIAL

People make them

Classification is a negotiated process

Allure of objectivity can mask this

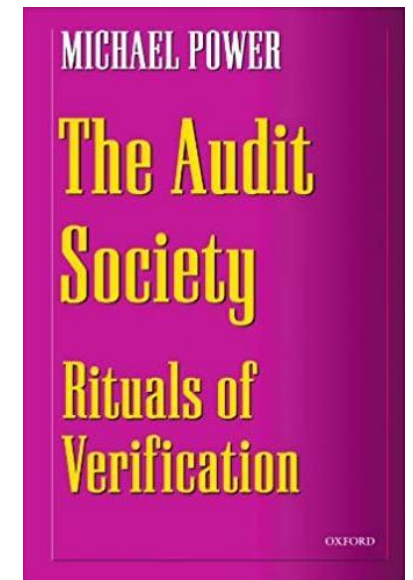
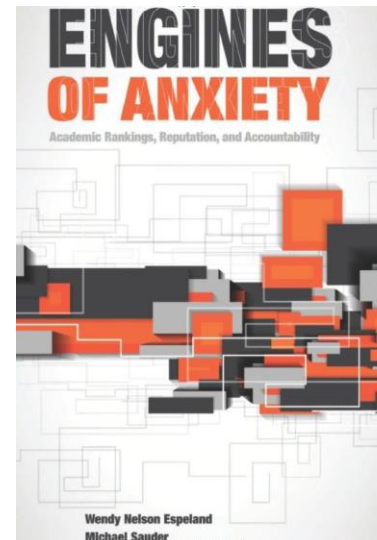


People use numbers to do things

Define a situation

Promote accountability

Change behavior



Numbers shape collective attention

“What gets measured gets managed”

Provoke emotions

Mennicken and Espeland (2019) *Annu Rev Sociol* 45:223-45.

“The messiness of Omicron data – record-high cases! but much milder illness! – has deepened our COVID *Rashomon*, in which different communities are telling themselves different stories about what’s going on, and coming to different conclusions about how to lead their lives.”

Derek Thompson, “Omicron Has Created Two New COVID Attitudes” *The Atlantic*, January 10, 2022



Getty; The Atlantic



“Feedback Swarm” *BMJ* 2020; 368.

“We're always trying to make the health system happy, too, as well as patients happy. So, the same way I'm trying to close my charts on time and do stuff like that, I'm like, okay. This is one more thing I have to think about....of all the things that get counted the health system that I'm doing. Like Big Brother watching stuff. Do you know what I mean? Just monitoring all the reports we get about, I don't know, like Press Ganey, likely to recommend, and then percent of charts that are closed, how many patients you see, RVUs.”

Physician Assistant
Community Practice

Szymczak et al. (2026) *Antimicrobial Resistance & Infection Control*.

CLINICAL PERFORMANCE FEEDBACK

Audit and feedback reports, dashboards are widely deployed approaches across clinical domains

Demonstrated to improve quality of care, BUT

- Sometimes it doesn't work as well as we'd like
- Sometimes it doesn't work at all
- Impact not always sustained
- It can have negative unintended consequences

Evidence of effects with substantial heterogeneity

Foy R, Skrypak M, Alderson S, et al. *BMJ*. Feb 27, 2020;368:m213.
Ivers NM, Sales A, Colquhoun H, et al. *Implement Sci*. Jan 17, 2014;9:14.
Grimshaw JM, Ivers N, Linklater S, et al. *BMJ Qual Saf*. May 2019;28(5):416-423
Brehaut JC, Colquhoun HL, Eva KW, et al. *Ann Intern Med* 2016;164:435-41.

PERFORMANCE FEEDBACK IN ANTIBIOTIC STEWARDSHIP: THE IMPORTANCE OF RELATIONSHIPS

AUDIT AND FEEDBACK IN STEWARDSHIP

Performance audit and feedback combined with peer comparison is a commonly used outpatient antibiotic stewardship strategy

Has been demonstrated to reduce inappropriate antibiotic prescribing in outpatient settings

- Variation in impact across studies
- Impact not always sustained

Avent et al *BMC Family Practice* 2020

Meeker et al. *JAMA* 2016

Guilliford et al. *BMJ* 2019

Hemkens et al. *JAMA Intern Med* 2017

Gerber et al. *JAMA* 2014

Linder et al. *JAMA* 2017

RESEARCH

Open Access



The influence of social relationships on clinician interpretation of performance data in an outpatient antibiotic stewardship intervention

Julia E. Szymczak^{1*}, Lindsay W. Glassman², Brandi M. Muller¹, Ebbing Lautenbach^{2,3}, Keith W. Hamilton³, Lauren Dutcher³ and for the CDC Prevention Epicenters Program

MOTIVATION FOR THE STUDY

Need to understand **how** to optimize audit and feedback to drive improved antibiotic prescribing in outpatient settings

Examine prescriber response to audit and feedback-based stewardship interventions

Focus on

- Setting in which social interaction occurs
- The specific, unique meanings and interpretations assigned to a phenomenon by the research subject

METHODS

Stepped wedge study of 32 University of Pennsylvania Health System affiliated primary care practices to assess impact of education + audit and feedback-based intervention on antibiotic prescribing for ARTIs

Decreased antibiotic prescribing for Tier 3 diagnoses (antibiotics never indicated) by ~8%, but variation seen across practices and prescribers

Post-intervention qualitative study to understand prescriber perceptions of the feedback reports

Dutcher et al. *Clinical Infectious Diseases* 2022

Subject: Antibiotic Prescribing Performance

Dear Dr. XXXXXX,

Penn Medicine has begun an initiative to optimize antibiotic prescribing for respiratory infections in adult patients.

We are measuring prescriber performance on two metrics:

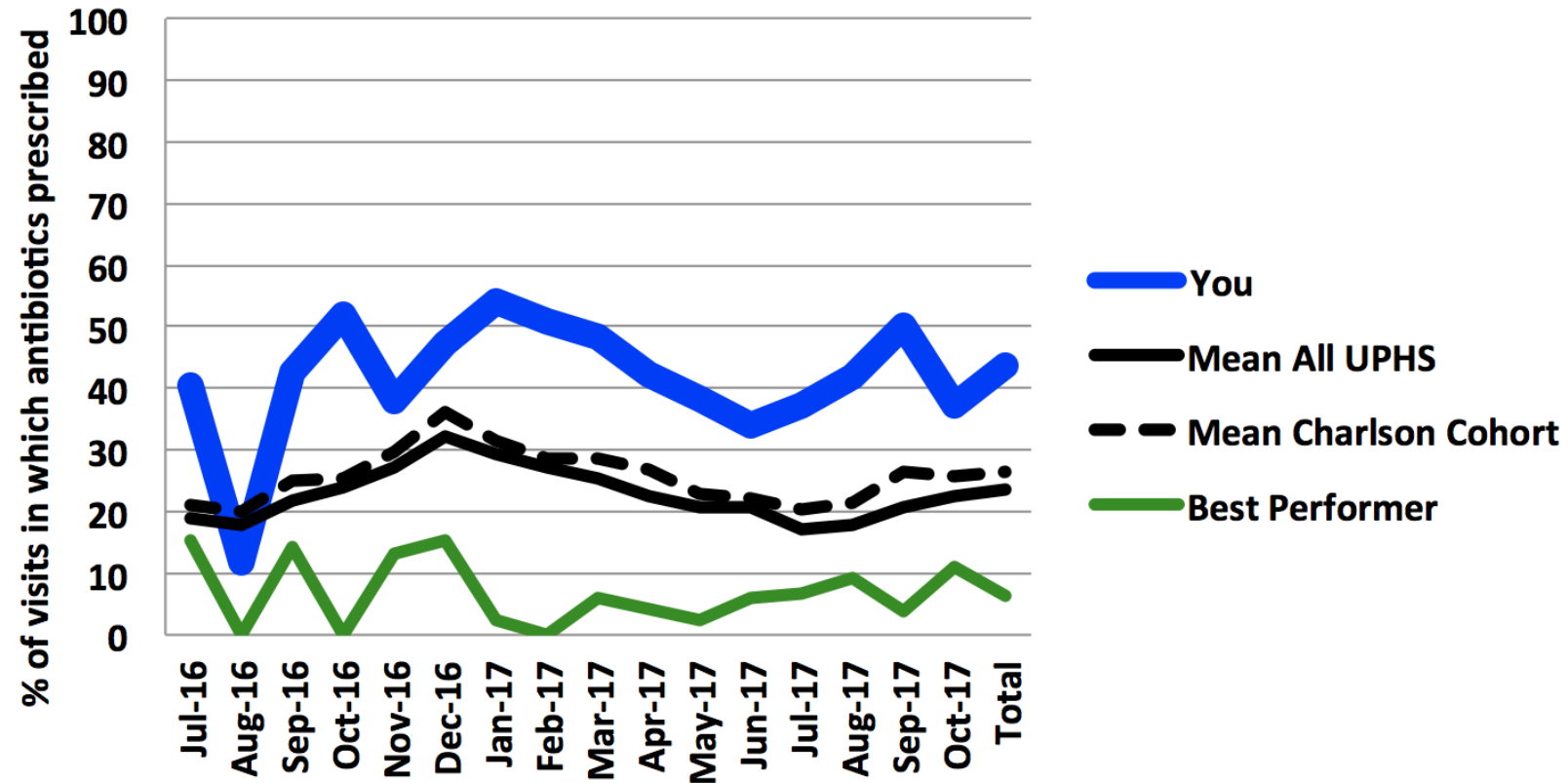
- 1) Percent of visits with a **respiratory tract infection diagnosis** in which an antibiotic is prescribed
- 2) Percent of visits with a **respiratory tract infection diagnosis that usually does not require an antibiotic** (bronchitis, viral infections, non-streptococcal pharyngitis, etc.) in which an antibiotic is prescribed

We have found that both of these metrics **correlate strongly with unnecessary antibiotic prescribing.**

Included below you will find **your** monthly performance on both of these metrics. Each chart compares your performance to the mean performance for all prescribers in Penn Medicine primary care practices (**Mean All UPHS**) and the mean performance for prescribers with patients that have similar severity of illness scores (Charlson Comorbidity index) (**Mean Charlson Cohort**) as well as the **Best Performer** in your Charlson cohort.

Dutcher et al. *Clinical Infectious Diseases* 2022

% Prescribing for Diagnoses that Almost Never Require Antibiotics



You are in the **lowest performing** (4th) quartile of all prescribers for this metric.

Dutcher et al. *Clinical Infectious Diseases* 2022

METHODS

Prescribers **purposively sampled by performance** in 3 groups (8-12 months post-intervention)

- Maintained high performance (“consistent high performers”)
- Improved as a result of intervention (“improved performers”)
- Did not improve as a result of intervention (“did not improve”)

Open-ended interviews intended to elicit prescriber perceptions of intervention and stewardship in primary care

Blinded comparative thematic analysis across performance groups

Szymczak et al. (2026) *Antimicrobial Resistance & Infection Control*.

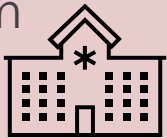
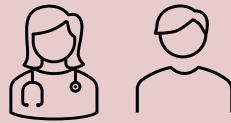
RESULTS

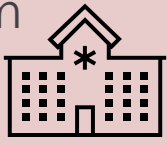
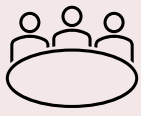
Table 1 Characteristics of interview respondents by performance group

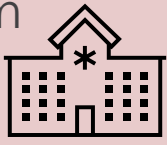
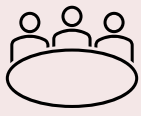
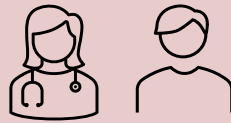
	Consistent high performers (n = 13)	Did not improve (n = 10)	Improved performers (n = 7)	Not exposed to intervention (n = 2)
<i>Degree</i>				
MD	12	3	5	1
DO	0	1	0	0
NP	0	5	2	1
PA	1	1	0	0
<i>Health system practice location*</i>				
City	13	1	2	0
Community	0	9	5	2
<i>Gender</i>				
Male	8	4	2	0
Female	5	6	5	2

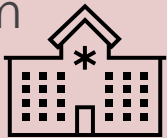
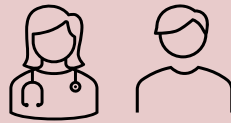
*Health system practices are in the greater Philadelphia, Pennsylvania region. This includes practices located in the city of Philadelphia, where the health system headquarters is located (anchored by the health system's large teaching hospital). There are also practices located in suburban and rural communities outside the city. We refer to practices located in Philadelphia as "City" practices and those practices located outside of the city as "Community" practices

Szymczak et al. (2026) *Antimicrobial Resistance & Infection Control*.

	Consistent High Performers & Improved Performers	Did Not Improve
Relationship with Health System 		
Relationship with Practice 		
Relationship with Patients 		

	Consistent High Performers & Improved Performers	Did Not Improve
Relationship with Health System 	→ Accepted and understood role of health system surveillance → Acknowledged health system as source of legitimate authority → Identified self with health system	→ Dismissive of health system influence → Distrust of health system leaders → Belief that health system promoted incompatible goals
Relationship with Practice 		
Relationship with Patients 		

	Consistent High Performers & Improved Performers	Did Not Improve
Relationship with Health System 	→ Accepted and understood role of health system surveillance → Acknowledged health system as source of legitimate authority → Identified self with health system	→ Dismissive of health system influence → Distrust of health system leaders → Belief that health system promoted incompatible goals
Relationship with Practice 	→ Very aware of colleague's prescribing practices → Talked to colleagues about feedback reports, antibiotic prescribing, patient demand → Described unified prescribing culture	→ Did not talk to colleagues about feedback reports → Perception of practice being particularly lenient about antibiotics
Relationship with Patients 		

	Consistent High Performers & Improved Performers	Did Not Improve
Relationship with Health System 	→ Accepted and understood role of health system surveillance → Acknowledged health system as source of legitimate authority → Identified self with health system	→ Dismissive of health system influence → Distrust of health system leaders → Belief that health system promoted incompatible goals
Relationship with Practice 	→ Very aware of colleague's prescribing practices → Talked to colleagues about feedback reports, antibiotic prescribing, patient demand → Described unified prescribing culture	→ Did not talk to colleagues about feedback reports → Perception of practice being particularly lenient about antibiotics
Relationship with Patients 	→ Able to handle patient demand for unnecessary antibiotics – articulated specific strategies to counter → Acknowledge clinician responsibility in patient demand → Pride in “not giving in”	→ Struggled to handle patient demand for unnecessary antibiotics, reported “giving in” → Believed risks of denying antibiotics > risks of unnecessary antibiotics

CONCLUSIONS

Prescribers drew on their social relationships to make sense of performance feedback data

Relational embeddedness matters

- Influence of prior relationships on achieving goals
- Trust, identification, obligation
- Relationships as resources for individual contributions to collective action

The health system and “intervention architects” matter

Szymczak et al. (2026) *Antimicrobial Resistance & Infection Control*.

Granovetter (1992) *Networks and Organizations*

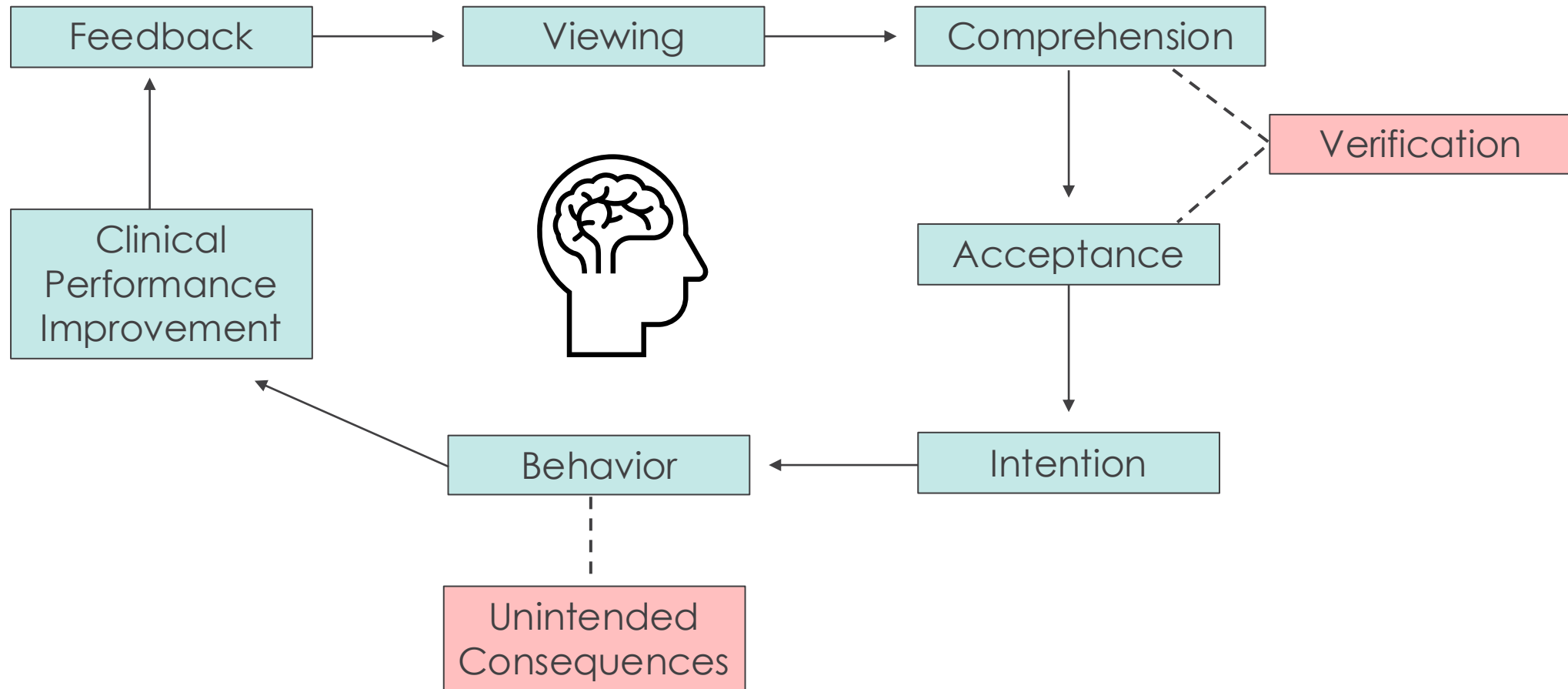
Blatt (2009) *Academic Management Review*

IMPLEMENTING AUDIT & FEEDBACK: DETAILS AND DESIGN MATTER

Fox CR et al. *BMJ*. 2020 Sep 15;370:m3256.

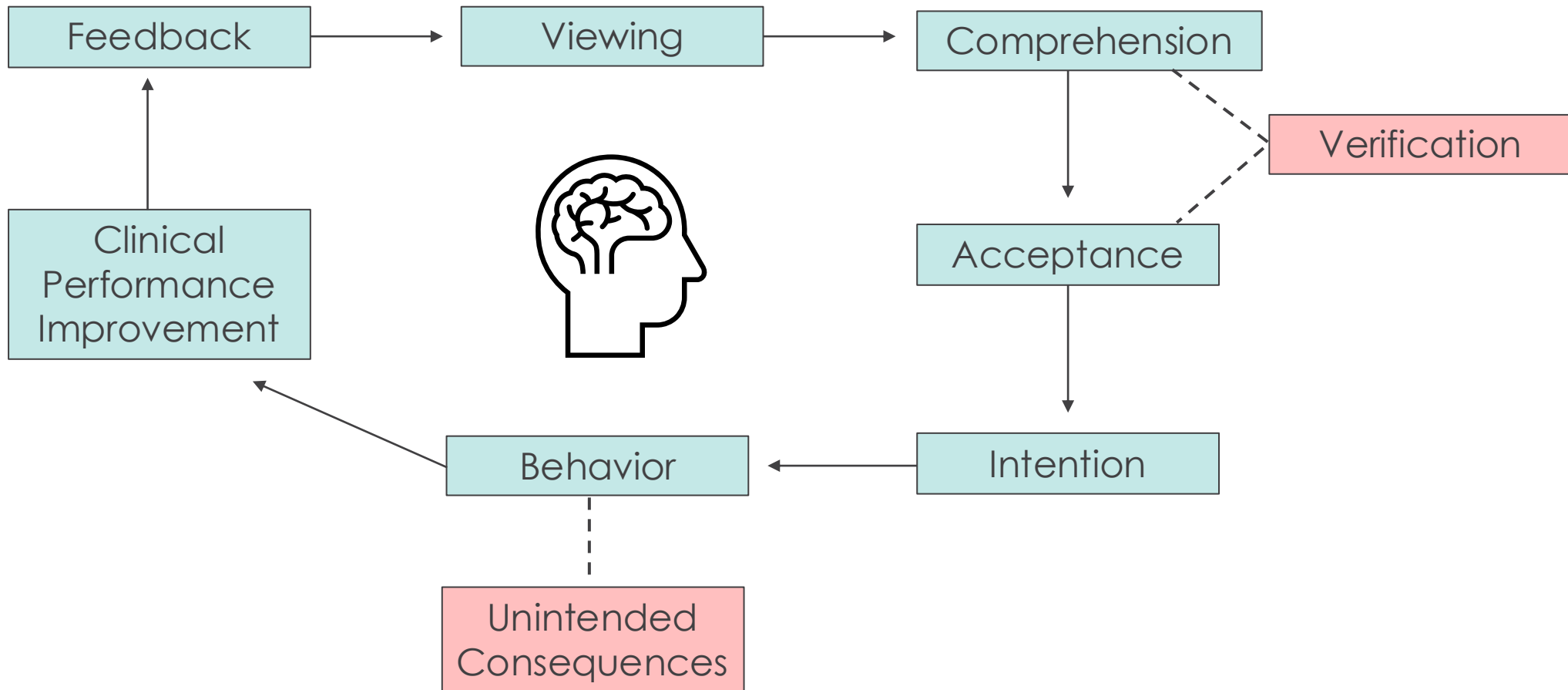
Linder JA, Fox CR. *JAMA Intern Med*. 2023 Mar 1;183(3):220-222.

HOW FEEDBACK WORKS TO DRIVE IMPROVEMENT



Brown, B., et al. *Implementation Sci* 14, 40 (2019).

IN CONTEXT



Brown, B., et al. *Implementation Sci* 14, 40 (2019).

FOR FEEDBACK TO ACHIEVE ITS DESIRED EFFECT

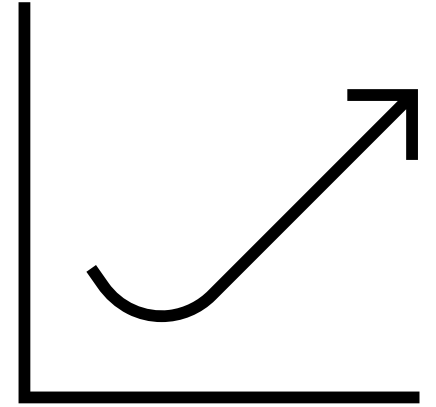
Clinicians need to:

- See the data

- Understand the data

- Believe the data

- Find the data clinically relevant and personally actionable



Cognitive burden needs to be minimized

USER JOURNEY: FEEDBACK TO BEHAVIOR CHANGE



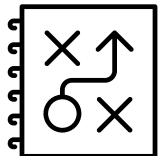
Viewing



Comprehending



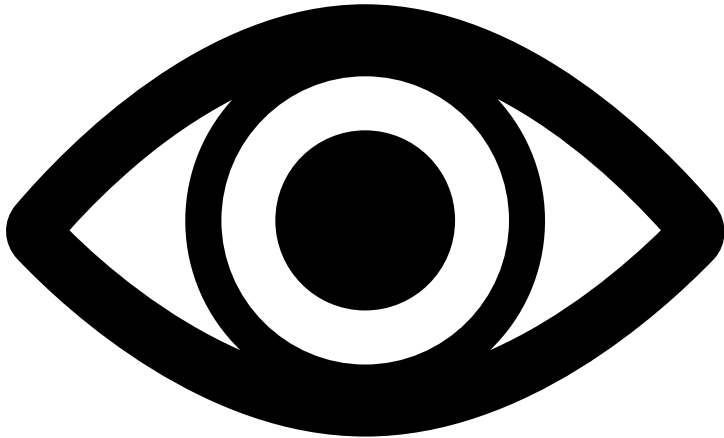
Accepting



Forming an Intention to Act

FEEDBACK DESIGN CONSIDERATIONS BY STEP

Viewing



Ensuring clinicians see and read the feedback report or dashboard

- HOW will you deliver it?
- HOW will it integrate into existing workflows?
- HOW will it intersect with competing attentional priorities?

Brehaut JC et al. *Ann Intern Med*. 2016 Mar 15;164(6):435-41.

FEEDBACK DESIGN CONSIDERATIONS BY STEP

Comprehending

Minimize extraneous cognitive load

- Link visual and summary message
- Short, actionable messages → optional detail
- Meaningful comparators that reinforce desired behavior change (and not >1)
- Eliminate unnecessary graphical elements; increase white space



Brehaut JC et al. *Ann Intern Med*. 2016 Mar 15;164(6):435-41.

FEEDBACK DESIGN CONSIDERATIONS BY STEP

Accepting



Address credibility of the information

- Trusted local champion or colleague
- Authority figure
- Transparency about data sources

Prevent defensive reactions to feedback

- Don't catch people off guard
- Tone of messaging around data
- Construct feedback through social interaction

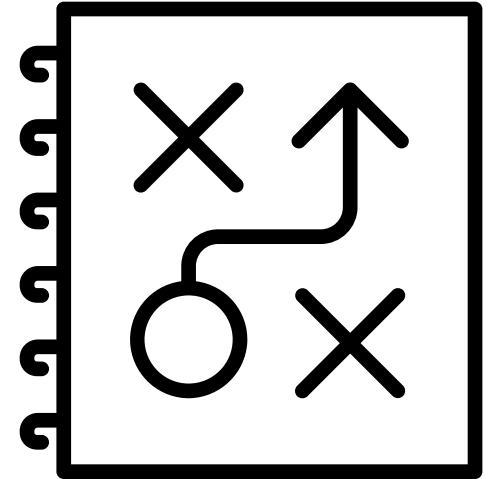
Brehaut JC et al. *Ann Intern Med*. 2016 Mar 15;164(6):435-41.

FEEDBACK DESIGN CONSIDERATIONS BY STEP

Forming an Intention to Act

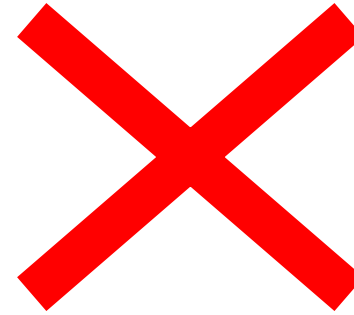
Recommend actions that the clinician can improve and are under their control

- Specify actions in messaging based on current data
- Guide clinicians to an understanding of where specific gaps occur
- Provide resources to help with improvement



Brehaut JC et al. *Ann Intern Med*. 2016 Mar 15;164(6):435-41.

EXAMPLES



The flu season has started

How many antibiotics have you prescribed compared to your colleagues?

On this page you will find key figures from completely anonymous data from the health insurers Helsana, CSS and Sanitas.

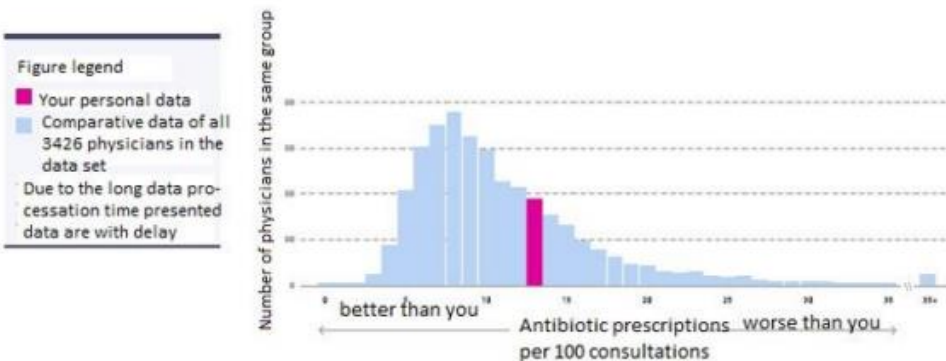
Details on the composition and origin of the data, evidence-based guidelines, information sheets from the BAG for patients and further information on optimizing the use of antibiotics can be found on our study website.

www.ceb-institute.org/nfp-72/antimikrobielle_resistenz

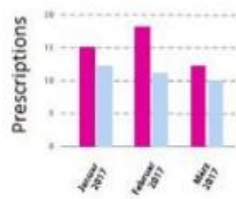
StudyID: *****
Passcode: ***_***_***

We believe that providing patients with good information can have a positive impact on antibiotic prescriptions.

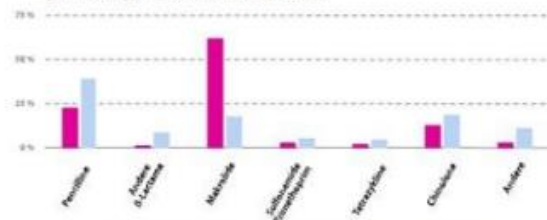
Help keep antibiotics effective:
- Prescribe antibiotics with restraint
- Use the BAG information sheet to discuss the problem with your patients



Your monthly prescription rate per 100 consultations



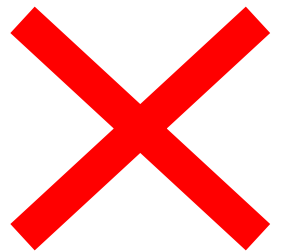
Distribution of antibiotic prescriptions by ATC group, period April 2016 to March 2017



Effect of Antibiotic Prescription Audit and Feedback on Antibiotic Prescribing in Primary Care A Randomized Clinical Trial

Soheila Aghlmandi, PhD; Florian S. Halbeisen, PhD; Ramon Saccolotto, MD; Pascal Godet; Andri Signorelli; Simon Sigrist; Dominik Glinz, PhD; Giusi Moffa, PhD; Andreas Zeller, MD; Andreas F. Widmer, MD, MSc; Andreas Kronenberg, MD; Julia Bielicki, MD, PhD; Heiner C. Bucher, MD, MPH

- ~3400 high antibiotic utilizing PCPs and pediatricians across Switzerland
- 24-month intervention
- Dashboard figure created from claims data from 3 large insurers (time lag)
- Quarterly postal mailings sent to clinician
- First mailing included letter explaining the intervention, opt-out card, evidence-based guidelines on prescribing
- Second mailing include information on regional resistance data



Aghlmandi S et al. JAMA Intern Med. 2023;183(3):213–220.



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[GP_Name]

[Address 1]

[Address 2], [Address 3]

[Address 4], [Address 5]

29th September 2014

NOTE TO PRACTICE MANAGERS: PLEASE FORWARD IMMEDIATELY TO GP ADDRESSED

Dear Dr [GP_Surname]

Antibiotic usage in your practice

Antimicrobial resistance is a serious and growing threat to our health. Reducing unnecessary prescriptions in primary care may help prevent a public health catastrophe.

The great majority (80%) of practices in [NHS Area Team] prescribe fewer antibiotics per head than yours.*

Many practices are already taking action to reduce antibiotic prescriptions while safeguarding patients' health. Please join them by taking three simple actions:

1. Give patients advice on self-care instead – you can use the leaflet enclosed or search online for the "TARGET antibiotics toolkit".
2. Consider offering a back-up (delayed) prescription instead – this could be post-dated or collected by the patient a few days later if still necessary.
3. Talk to other prescribers in your practice to ensure they are also acting – data on prescribing is recorded at practice level.

I know that prescribers are aware of this problem and that prescribing is not a simple issue. But there are small changes we can all make that will have a big effect on everyone's health.

Please join us in reducing antibiotic use.

Yours,

**PROFESSOR DAME SALLY C DAVIES
CHIEF MEDICAL OFFICER**

* Your practice's prescribing data are available online. Data were taken from <http://www.hscic.gov.uk/gpprescribingdata> and adjusted to take into account patient load and demographics. The 80% figure excludes outliers judged to be created by measurement error and does not include out-of-hours services. For more information on the consequences of antimicrobial resistance, see the UK 5 Year Antimicrobial Resistance Strategy.

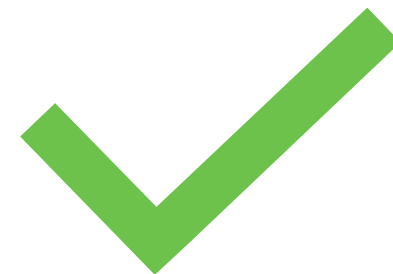
Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial

Michael Hallsworth, Tim Chadborn, Anna Sallis, Michael Sanders, Daniel Berry, Felix Greaves, Lara Clements, Sally C Davies

Summary

Background Unnecessary antibiotic prescribing contributes to antimicrobial resistance. In this trial, we aimed to [Lancet 2016; 387: 1743-52](#)

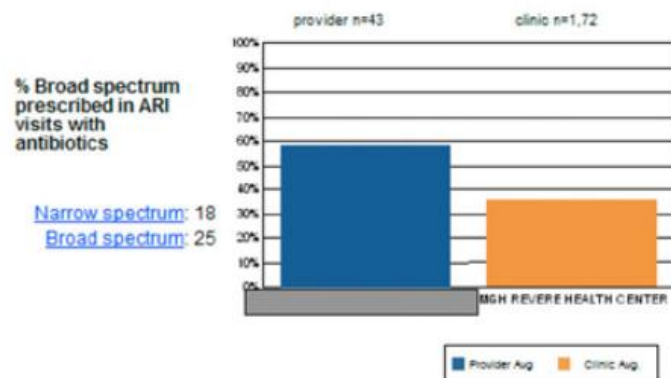
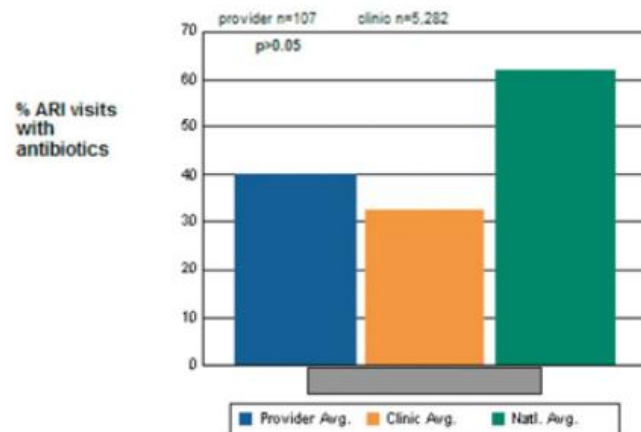
- 791 GP practices in England
- 6-month intervention
- Performance data obtained from NHS database
- 1 mailed letter accompanied by educational materials



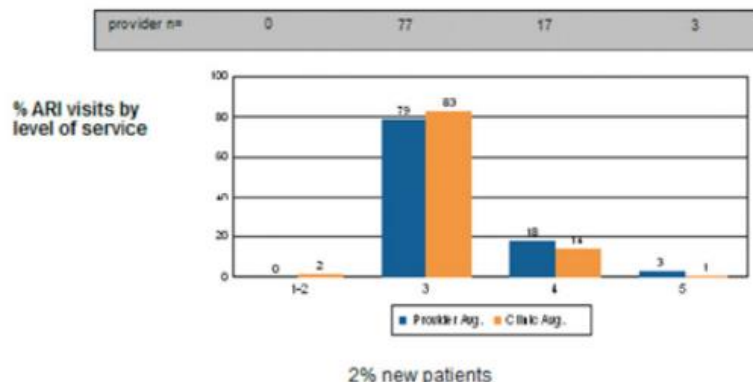
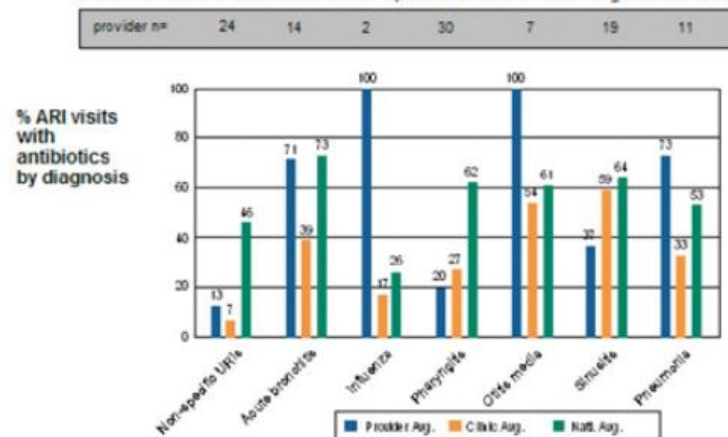
Hallsworth M et al. Lancet. 2016 Apr 23;387(10029):1743-52.

LMR Report Central - ARI Quality Dashboard
 Report: ARI dashboard - provider report
 Institution: MGH Clinic: MGH REVERE HEALTH CENTER
 Provider/PCP: [REDACTED]
 Report Run Date: 11/11/2006
 Reporting Period: From 10/27/2005 Thru 10/27/2006

Total ARI cases: 107
 Antibiotic prescribing total: 43
 Antibiotic prescribing: 40%



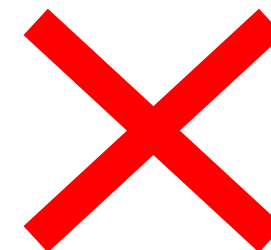
Note: For acute bronchitis and non-specific URIs the national guideline is zero.



Electronic Health Record Feedback to Improve Antibiotic Prescribing for Acute Respiratory Infections

Jeffrey A. Linder, MD, MPH; Jeffrey L. Schnipper, MD, MPH; Ruslana Tsurikova, Msc, MA;
 D. Tony Yu, MD, MPH; Lynn A. Volk, MHS; Andrea J. Melnikas, MPH; Matvey B. Palchuk, MD, MS;
 Maya Olsha-Yehiav, MS; and Blackford Middleton, MD, MPH, MSc

- 27 primary care practices in MA
- 9-month intervention
- Monthly emails reminding clinicians to look at dashboard
- No education
- No formal communication or release of information about dashboard

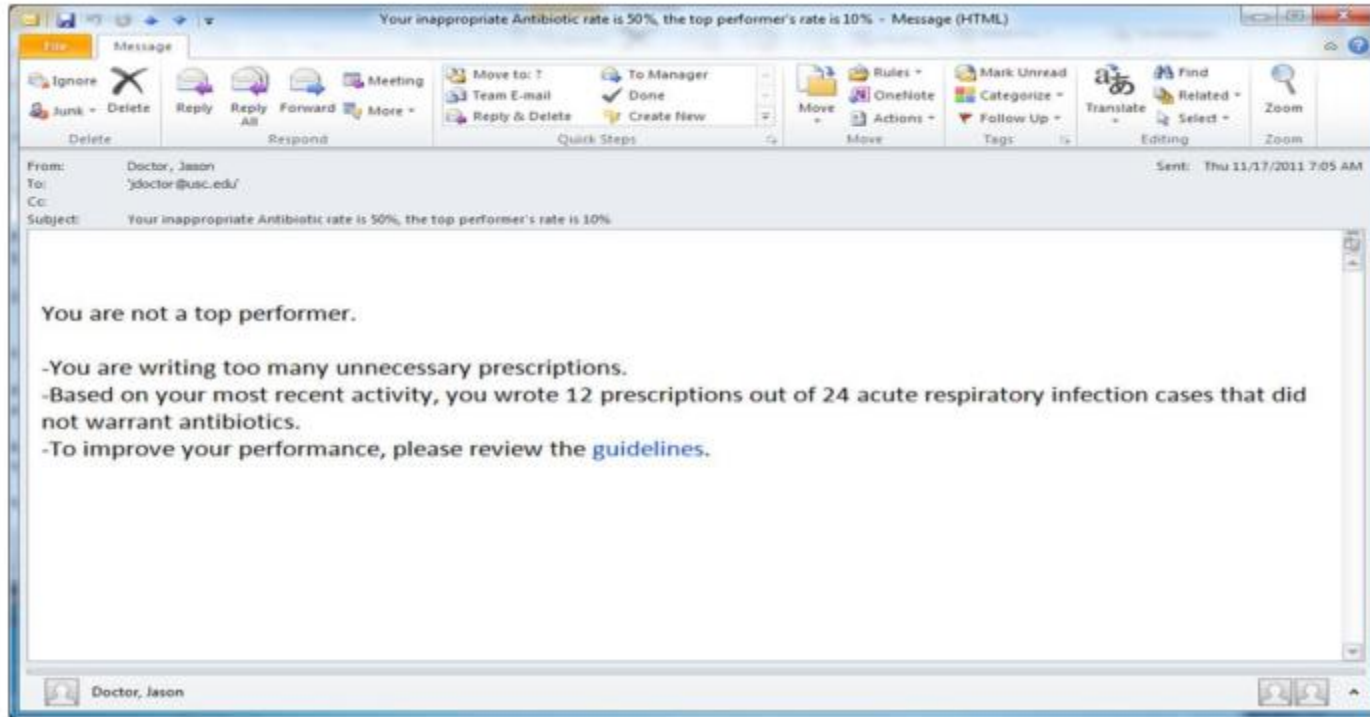


Linder JA et al. Am J Manag Care. 2010 Dec;16(12 Suppl HIT):e311-9.

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



- 47 primary care practices in MA, CA
- 18-month intervention
- Clinicians recruited via email and enrolled through educational module
- Peer comparison bundled with 2 other EHR-based behavioral interventions (accountable justification, suggested alternatives)
- Monthly emails



Meeker D. et al. JAMA. 2016 Feb 9;315(6):562-70.

COMMON PITFALLS

- ⚠ Too much visual clutter
- ⚠ Building it and expecting them to come
- ⚠ Not guiding people to a focal point or key message
- ⚠ Requiring people to spend >60 seconds to understand
- ⚠ Being vague about the message
- ⚠ Surprising people
- ⚠ Not bundling feedback with other strategies



CONCLUSIONS

A RELATIONAL APPROACH

- Measurements are social
 - Created by people
 - Shape how people think, feel, and act
- Consider *how* feedback work to change behavior
 - Design interventions so mechanisms are enacted
- Acknowledge the “feedback swarm”
 - Measures are competing for limited attention

A RELATIONAL APPROACH

Think beyond the technical, analytical, logistical:

Where will I get these numbers?

How will I keep the numbers secure?

How will I analyze these numbers?

How will I create measures from these numbers?

How will I display the measures?

To the relational:

Who are the people “around” the measures?

How might people use these measures?

What do these measures symbolize to people?

How do these measures fit into whatever else it is people are doing?

How do these measures help people achieve goals that are important to them?

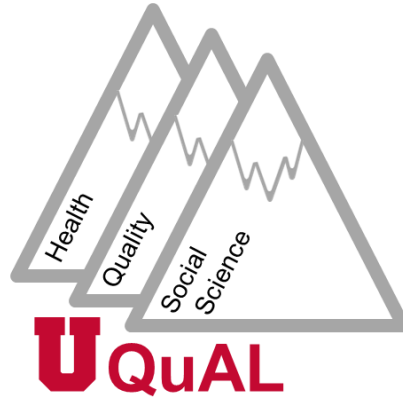
Who is making the measures? How are they perceived?

ACKNOWLEDGEMENTS



Social Sciences in Healthcare Epidemiology
and Antimicrobial Resistance

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Lindsey Laytner, PhD



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Adam Hersh, MD, PhD
Andrea White, PhD
Emily Spivak, MD, MHS
Hannah Imlay, MD, MS
Payal Patel, MD, MPH
Whitney Buckel, PharmD
Alistair Thorpe, PhD



Ebbing Lautenbach, MD, MSCE
Keith W. Hamilton, MD
Lauren Dutcher, MD



Laurel Redding, DVM, PhD
Sondra Lavigne, DVM, PhD



Susan E. Coffin, MD, MPH
Alexander Fiks, MD
Jeffrey S. Gerber, MD, PhD
Kathleen Chiotos, MD, MSCE



Agency for Healthcare
Research and Quality



Jeffrey Linder, MD, MPH

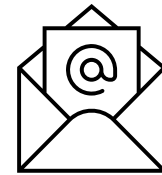


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THANK YOU



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