Clinical Pathways Reimagined: Harnessing Implementation Science, Clinical Decision Support, Artificial Intelligence, and Behavior Nudges for Smarter Clinical Impact

Leigh Anne Bakel MD MSc, John Chuo MD MS, Jack Stevens PhD,
& Amy Tyler MD MSCS

Nationwide Children's
When your child needs a hospital, everything matters.

Children's Hospital of Philadelphia

Children's Hospital Colorado
Here, it's different.

Disclosures

- Leigh Anne Bakel:
  - Funding sources:
    - Colorado Department of Health and Environment
- Jack Stevens:
  - Stock ownership:
    - Procter and Gamble; Colgate Palmolive
  - Funding sources:
    - National Institute of Health
    - Administration for Children and Families
    - Patient-Centered Outcomes Research Institute
    - Worthington Industries Foundation
    - Centers for Disease Control and Prevention
- Amy Tyler:
  - Stock ownership:
    - BioFire

Introductions and Ice Breaker

- At your table
  - Name
  - Institution
  - Share 1 challenge to implementing clinical pathways at your institution

Learning Goal

Equip participants with practical, ready-to-use tools to design and sustain effective clinical pathways that overcome real-world implementation barriers.

Session Objectives

Explain what a Clinical Pathway is and articulate why it serves as an effective strategy for translating evidence into practice.

Describe how Implementation Science can enhance the success of Clinical Pathway development and implementation

Identify novel pathway implementation strategies—such as clinical decision support, artificial intelligence, and behavioral nudges—to facilitate the uptake of Clinical Pathways.

Why Clinical Pathways to implement evidence?

Clinical Practice Guidelines vs. Clinical Pathways

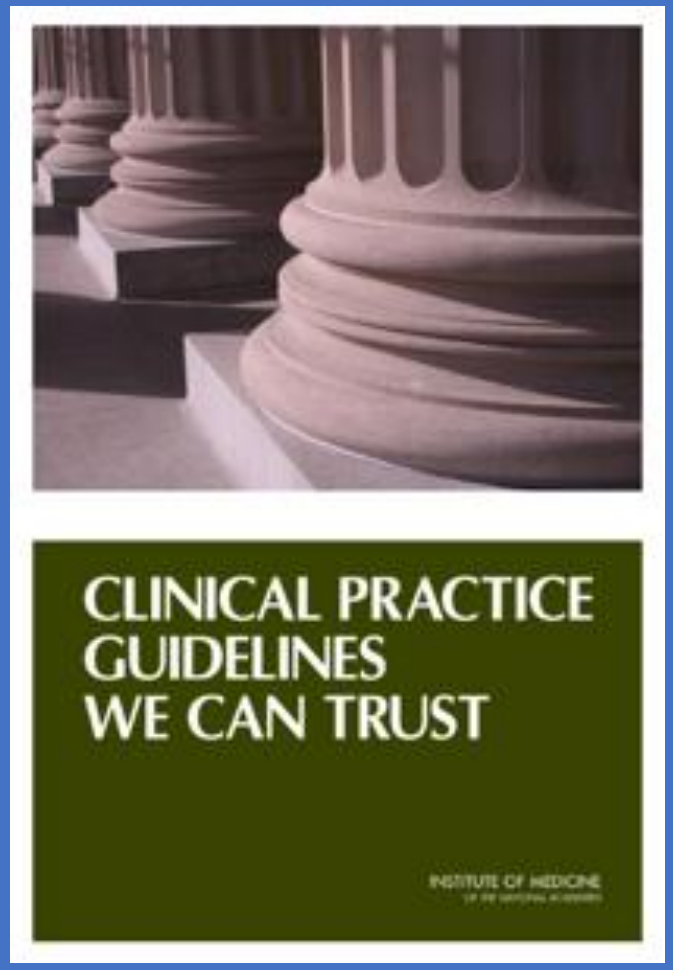
Evidence Based Practice (EBP) is the "What"

Ex: Clinical Practice Guidelines-Asthma SMART therapy

Clinical Pathways are the "How"

Ex: Asthma Clinical Pathway

Guidelines



"Statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options."

Institute of Medicine. *Clinical Guidelines We Can Trust*. The National Academies Press; 2011

Clinical Pathways

1. Structured multidisciplinary care plan
2. Used to translate guidelines or evidence into **local context**
3. Details steps in treatment or care
4. Aims to standardize care for a specific population or clinical problem

Lawal et al. BMC Medicine (2016) 14:35

Cochrane Library

Cochrane Database of Systematic Reviews

Clinical pathways for secondary care and the effects on professional practice, patient outcomes, length of stay and hospital costs

Thomas Rotter, Leigh D Kinsman, Agnès Alsius, Shannon D Scott, Adegboyega Lawal, Ulrich Ronellenfitsch, Christopher Plishka, Gary Groot, Phil Woods, Chloe Coulson, Leigh Anne Bakel, Kim Sears, Amanda Ross-White, Andreas Machotta, Timothy J Schultz Authors' declarations of interest

Stand-alone clinical pathway c/w usual care

	Usual Care	Stand-alone Clinical Pathway	Meta-Analysis (95% CI)	*Participants & Quality of evidence*
Inhospital mortality	**156** per 1,000 patients	**127** per 1,000 patients	OR 0.79 (0.53 to 1.20)	4,603 participants (7 RCTs) Quality of evidence **Low**
Mortality (up to 6 months)	**32** per 1,000 patients	**43** per 1,000 patients	OR 1.37 (0.72 to 2.60)	805 participants (3 RCTs) Quality of evidence **Low**
Inhospital Complications (rate of infections, pressure injuries, pain, uncontrolled bleeding)	**169** per 1,000 patients	**104** per 1,000 patients	★ OR 0.57 (0.41 to 0.80)	3,368 participants (11 RCT's) Quality of evidence **Moderate**
Hospital Readmission (up to 6 months)	**131** per 1,000 patients	**92** per 1,000 patients	OR 0.67 (0.44 to 1.03)	1,578 participants (9 RCTs) Quality of Evidence **Very low**
Length of Hospital Stay (from admission to discharge)	Not calculated due to absence of baseline data	**1.12** days lower	★ MD 1.12 days lower (1.6 lower to 0.65 lower)	5,201 participants (21 RCTs) Quality of evidence **Moderate**
Hospital Costs and Charges	Nine studies reported reductions in hospital costs and charges One study reported an increase in hospital costs		Results from 10 RCTs were too heterogeneous to combine in a meta-analysis	2,113 participants (10 RCTs) Quality of evidence **Very low**
Adherence to recommended practice	Six studies reported that clinical pathways increase adherence. One study reported no evidence of a difference.		Results from 3 comparable randomized studies were too heterogeneous to combine in a meta-analysis	2874 participants (7 studies) Quality of evidence **Low**

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- Implementation Strategies
  - Limited by poor reporting
  - Need more studies

Why Clinical Pathways?

Medical Care Research and Review
2017, Vol. 74(5) 507–550

DOI: 10.1177/1077558716656970
journals.sagepub.com/home/mcr
SAGE

Interventions Aimed at Reducing Use of Low-Value Health Services: A Systematic Review

Carrie H. Colla[1], Alexander J. Mainor[1], Courtney Hargreaves[1], Thomas Sequist[2,3,4], and Nancy Morden[1,5]

Interventions

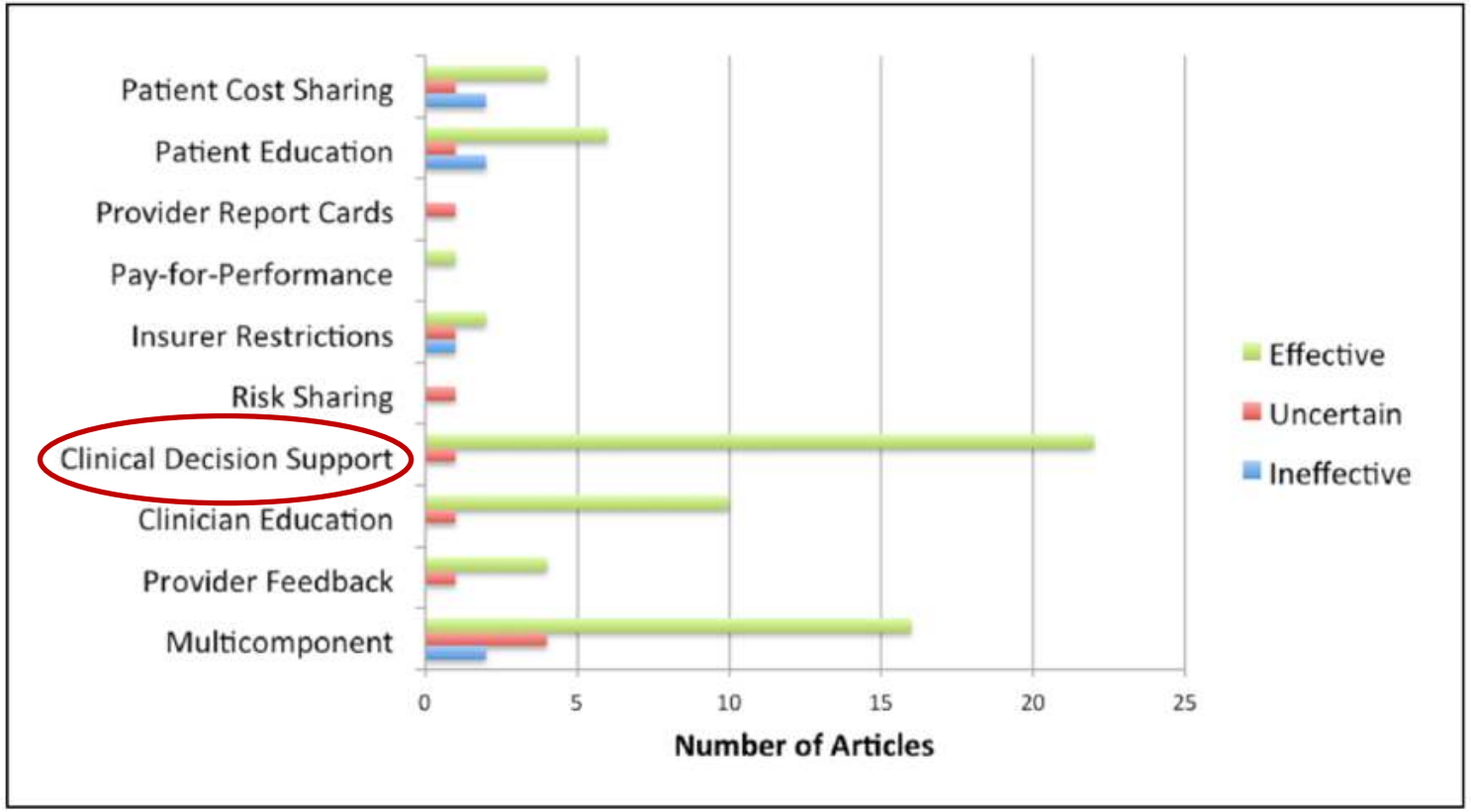
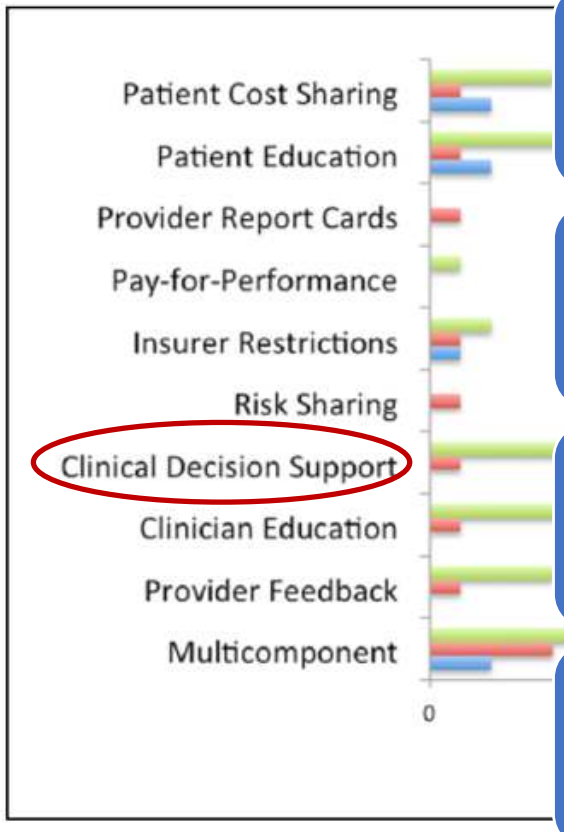


Figure 1. Overall effectiveness by category of intervention (N = 84).

Why Clinical Pathways?



Integration within the electronic health record

Order restrictions

Third party consultation (Antimicrobial Stewardship)

Widespread use of clinical pathways or guidelines

Figure 1. Overall effectiveness by category of intervention (N = 84).

Colla CH, Mainor A, Hargreaves C et al., Interventions Aimed at Reducing Use of Low-Value Health Services: A Systematic Review, *Medical Care Research and Review* 2017, Vol. 74(5) 507–550

Session Objectives

- Explain what a Clinical Pathway is and articulate why it serves as an effective strategy for translating evidence into practice.
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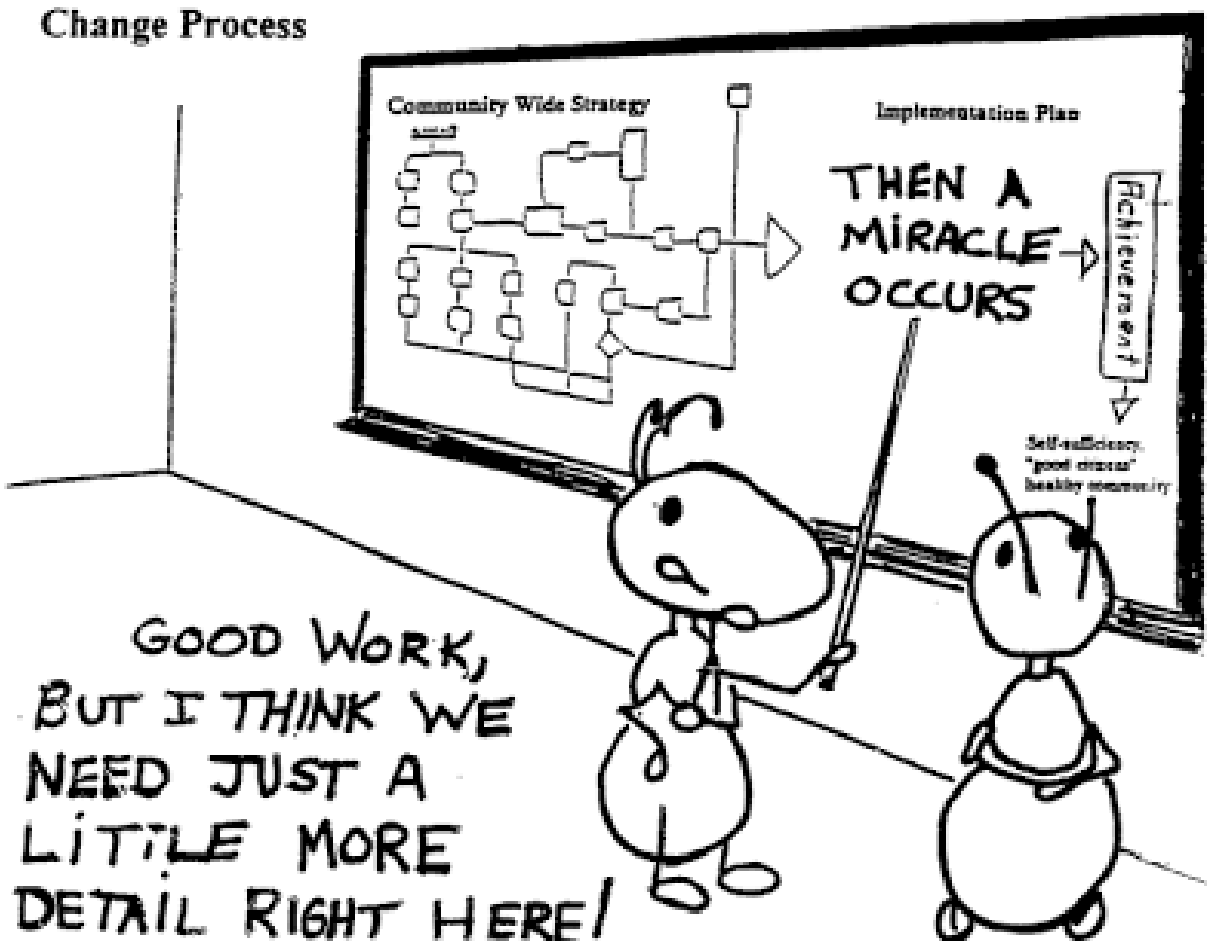
How Can Implementation Science Help with Clinical Pathways?


Evidence
Clinicians
Improved health

Evidence + Clinicians = Improved health

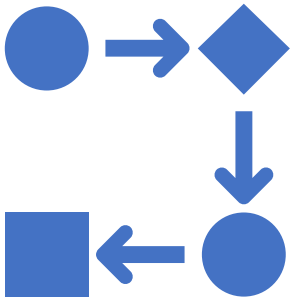


Implementation Science

- Definition
- The study of methods to promote the **integration** of research findings and evidence **into healthcare policy and practice**. – NIH

- Focus:
- Developing approaches to **close the gap** between what is known (research findings) and what is practiced (by clinicians).

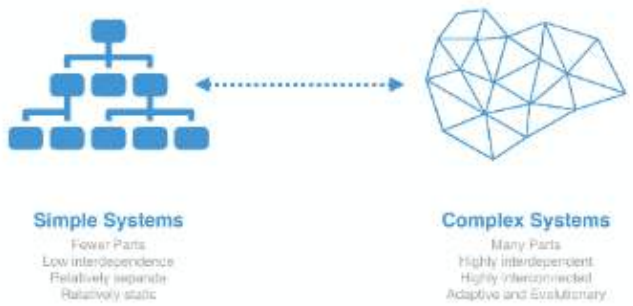
Implementation Science



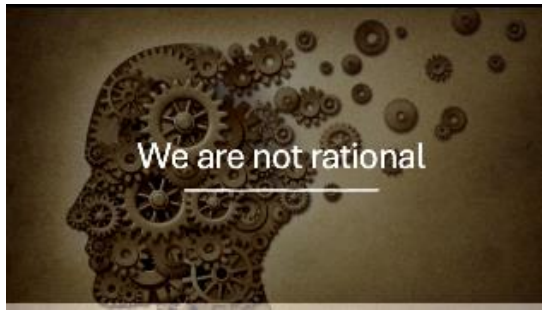
“We built a pathway” → “The pathway changed care.”

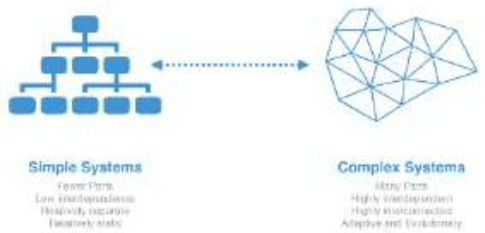

Evidence
Clinicians
Improved health

Evidence + Clinicians = Improved health



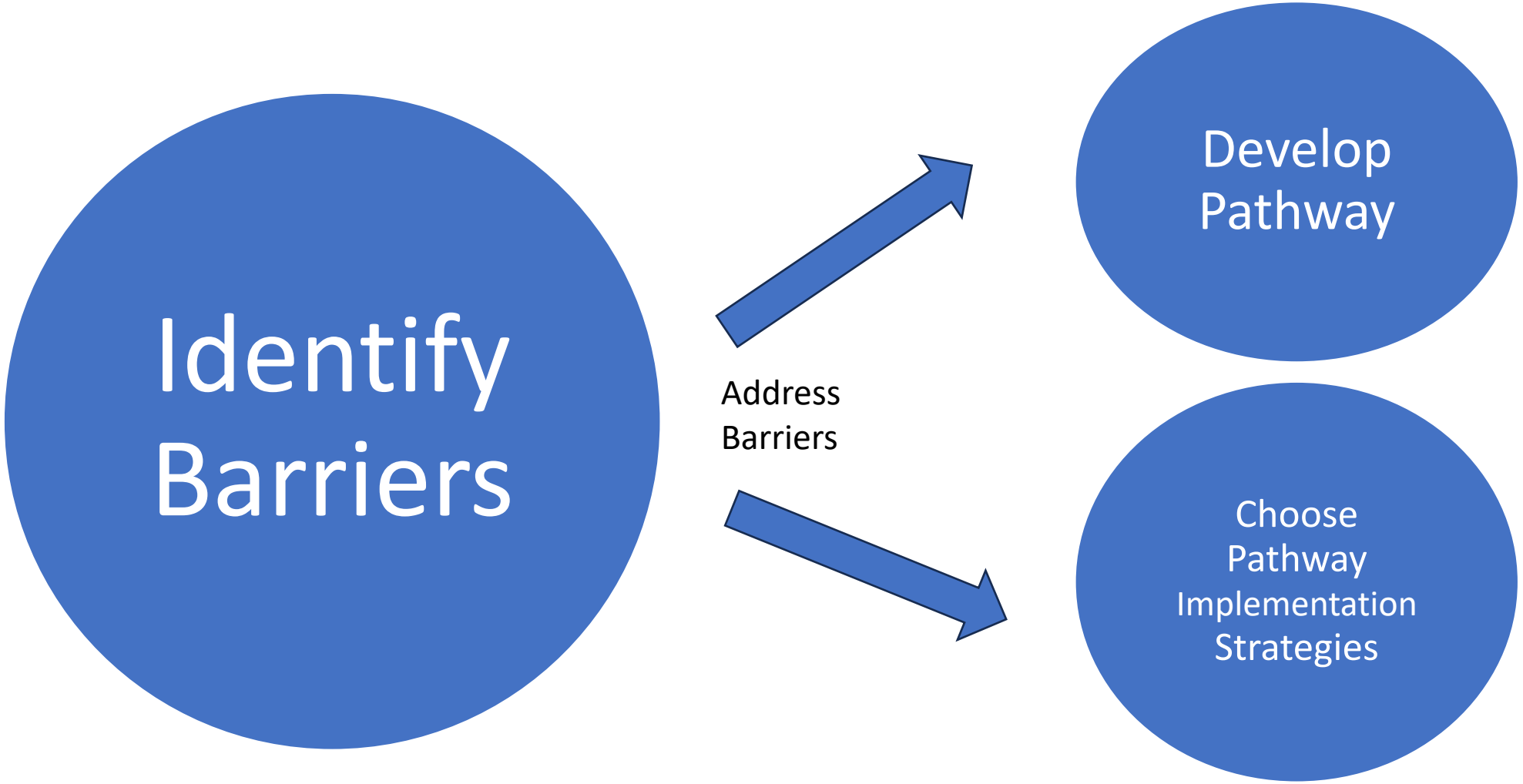
Barriers


We are not rational


Simple Systems
Complex Systems


Culture
How we do things here

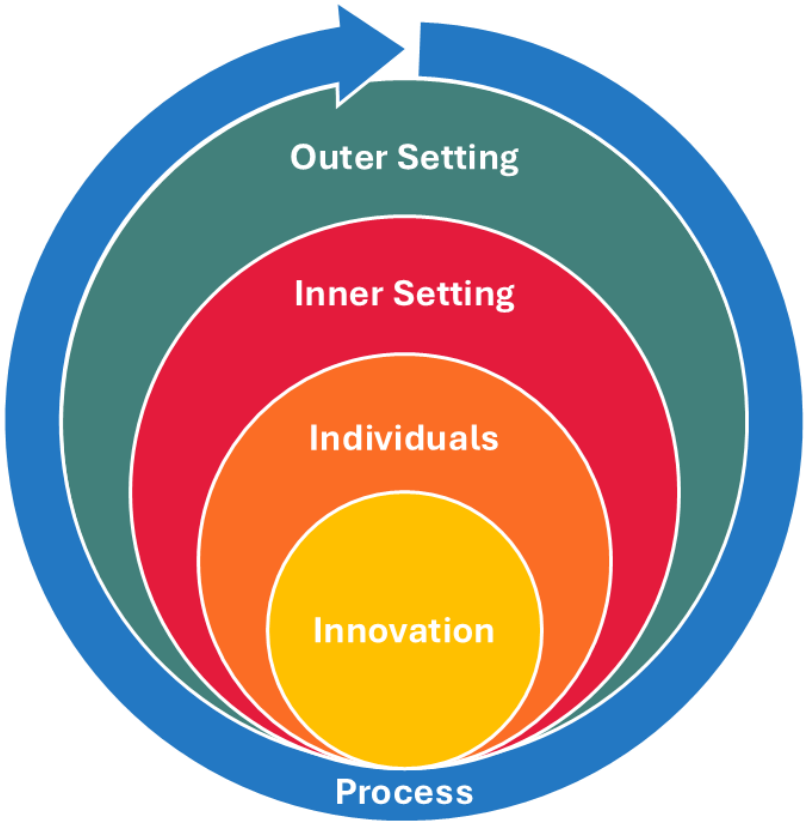
Implementation Science for Pathways



Identify Barriers

Implementation Science Frameworks

Understand how context/barriers affect a desired change

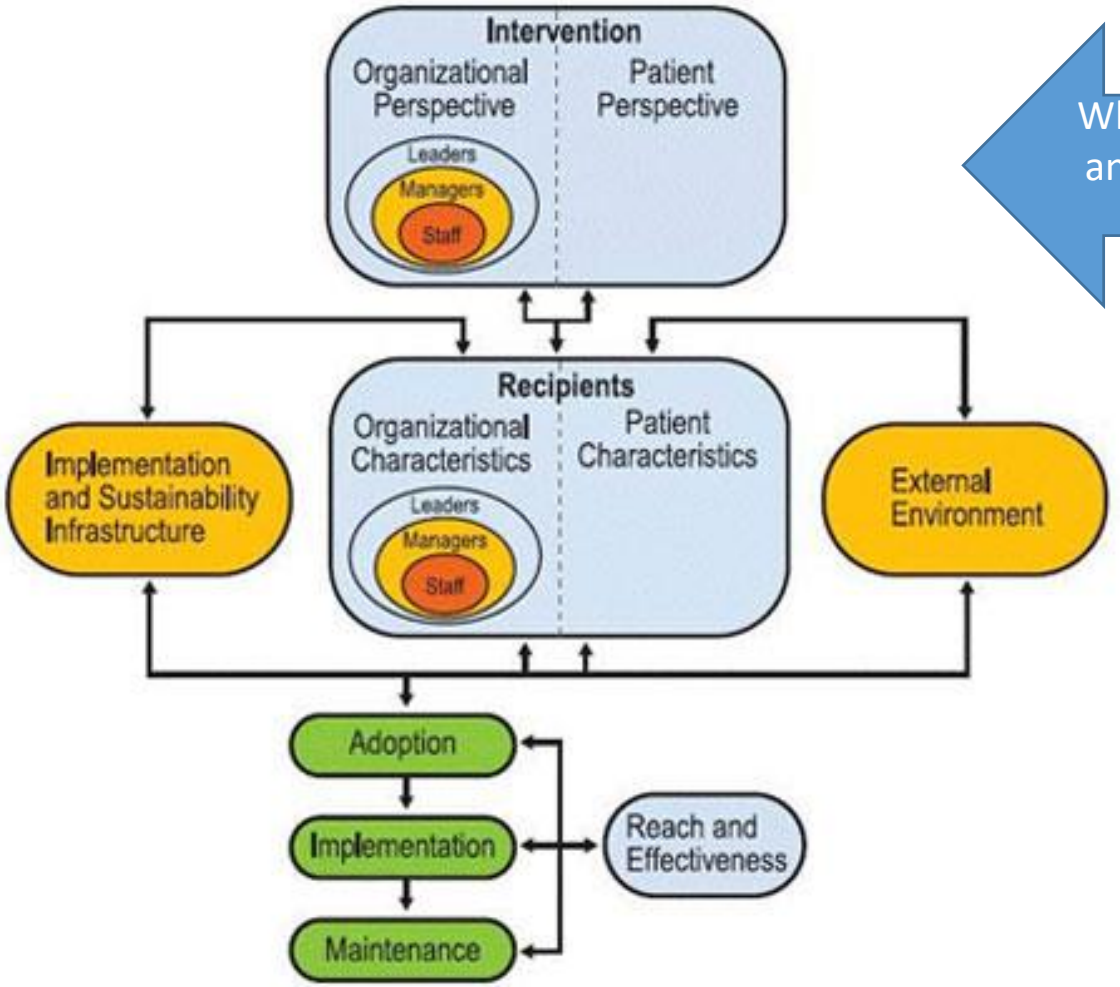


Consolidated Framework for Implementation Science (CFIR)

integrated - Promoting Action on Research Implementation in Health Services (i-PARIHS)

Practical Robust Implementation and Sustainability Model (PRISM)

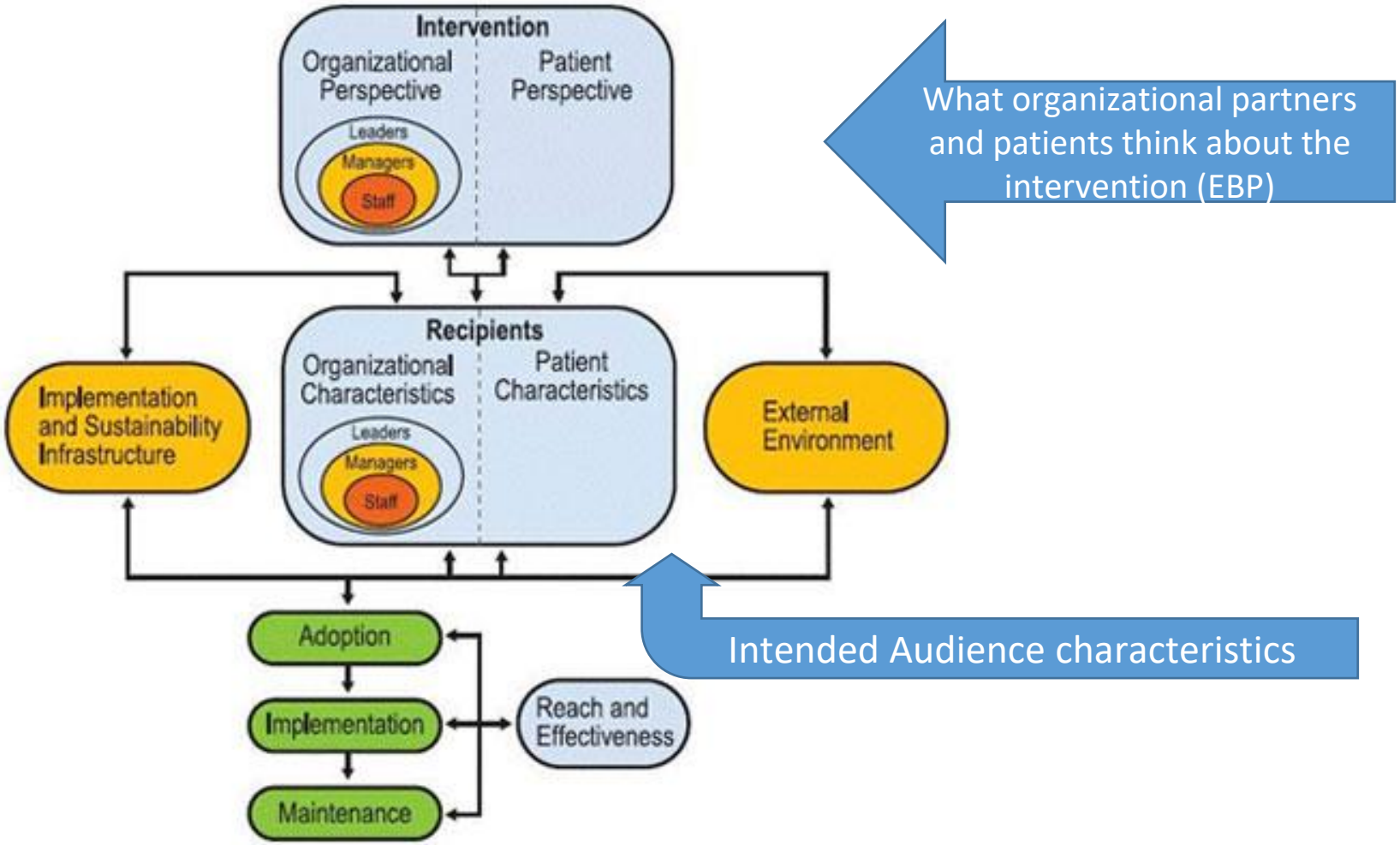
Practical, Robust Implementation and Sustainability Model (PRISM)



What organizational partners and patients think about the Evidence/Pathway

Feldstein, et al, 2008

Practical, Robust Implementation and Sustainability Model (PRISM)



Feldstein, et al, 2008

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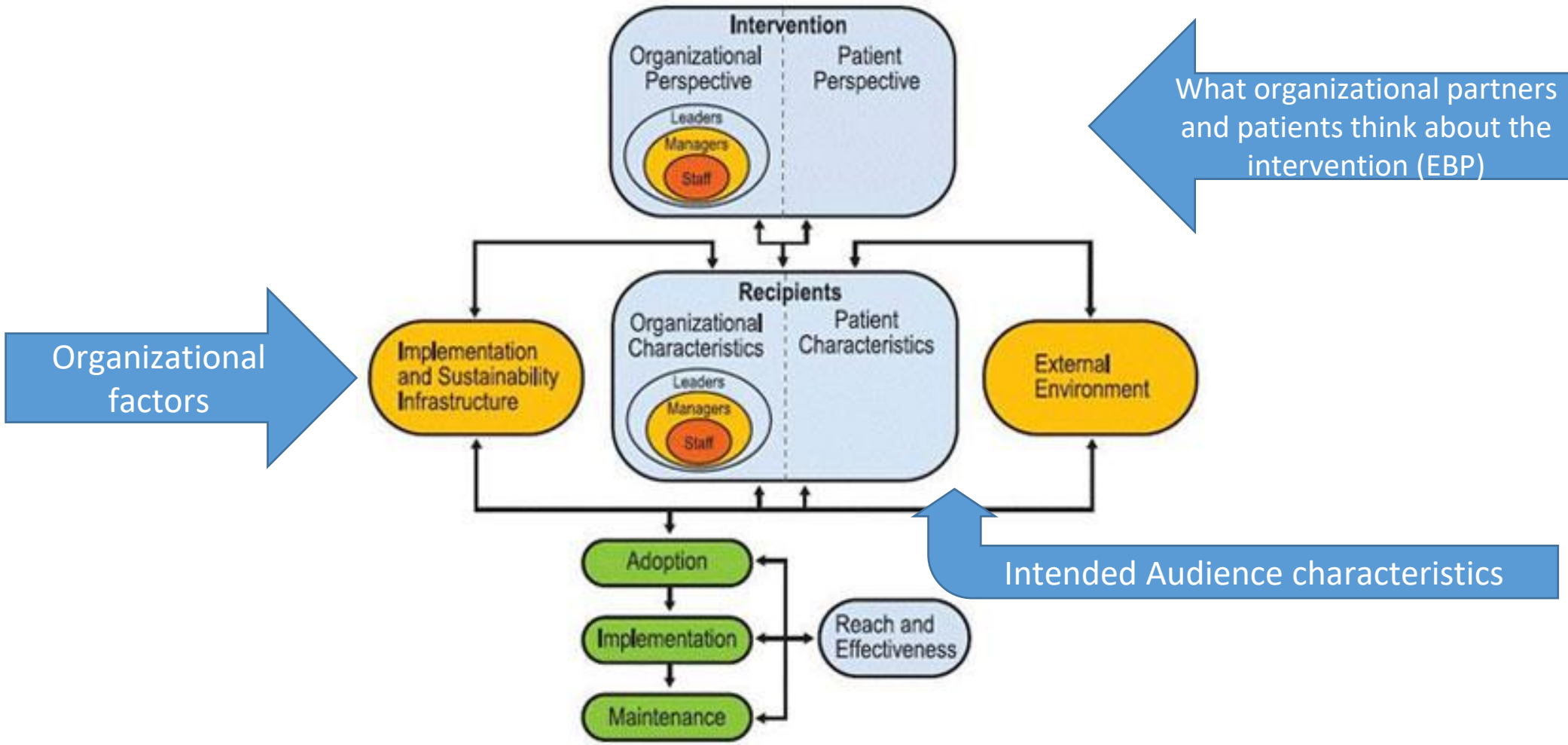
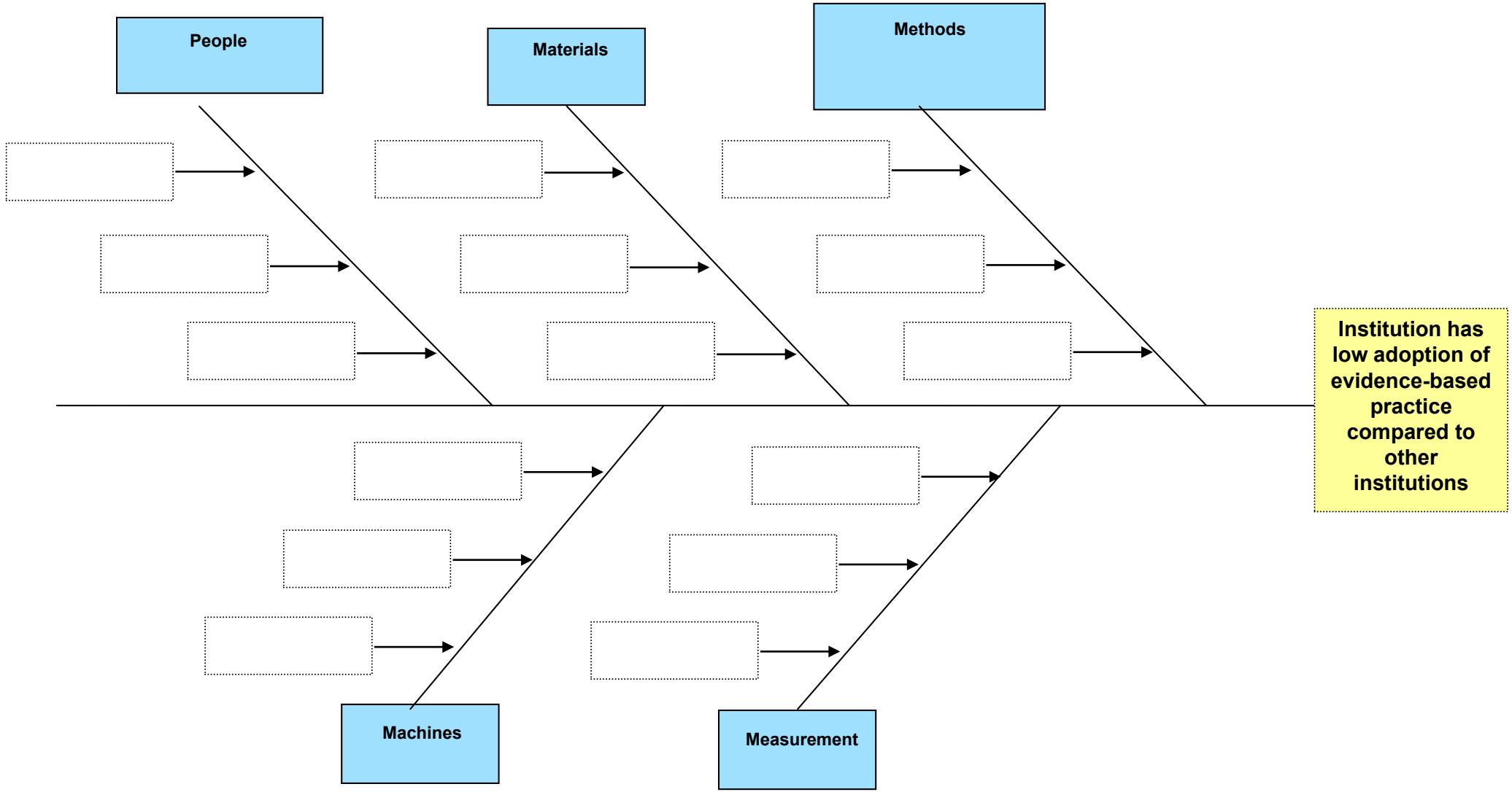
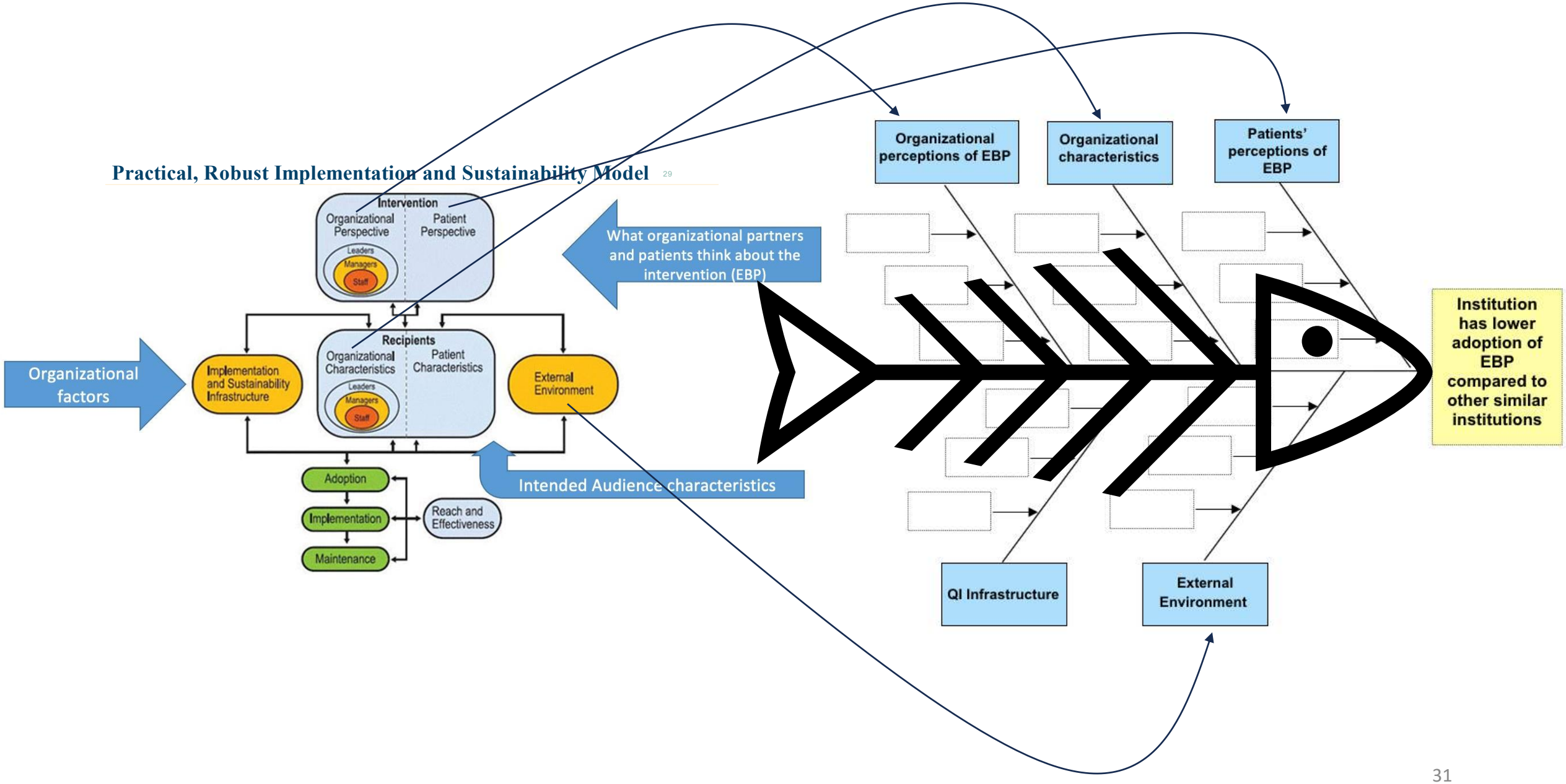


Feldstein, et al, 2008

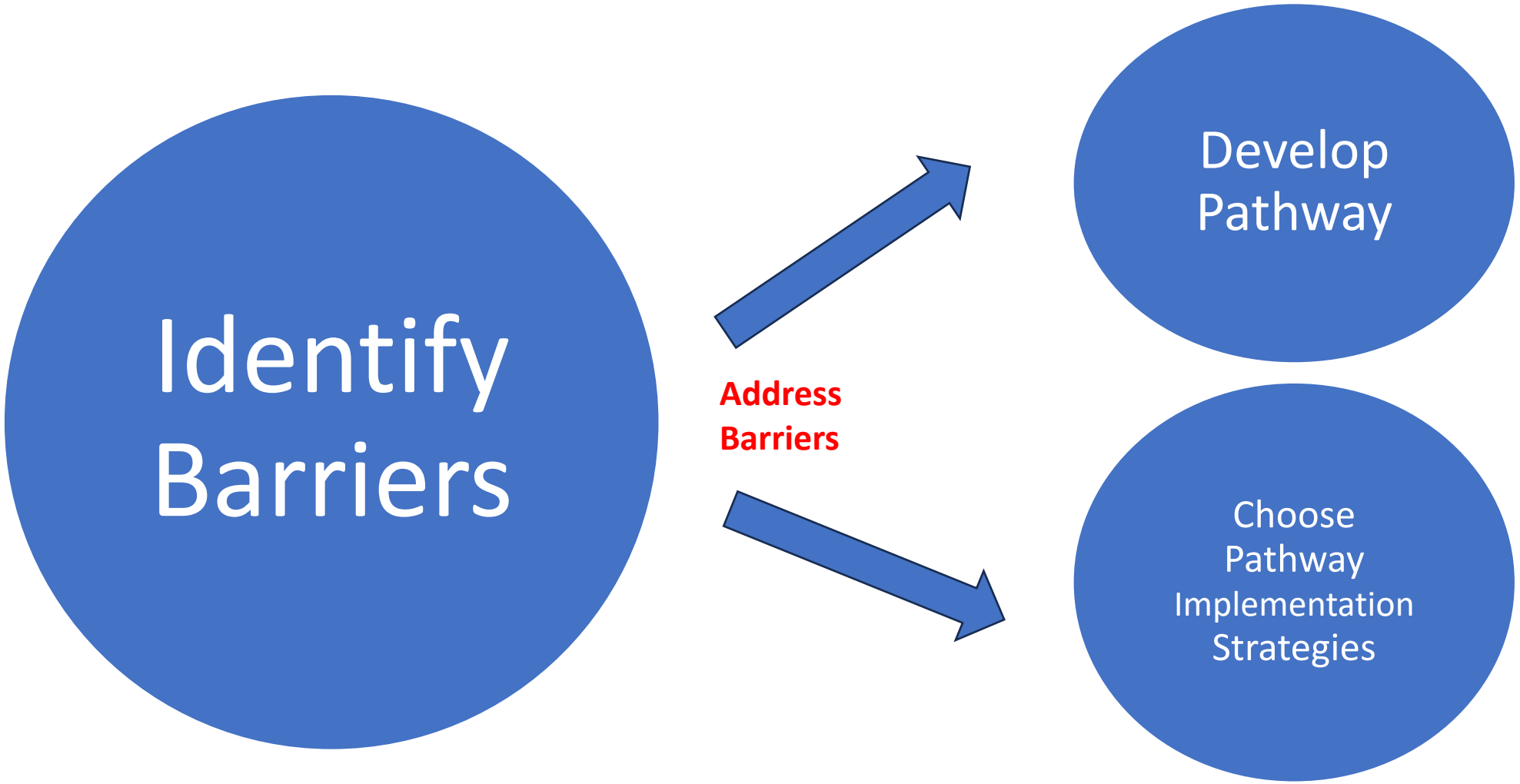
Fishbone Diagram



Merging the Fish Bone Diagram with PRISM Framework



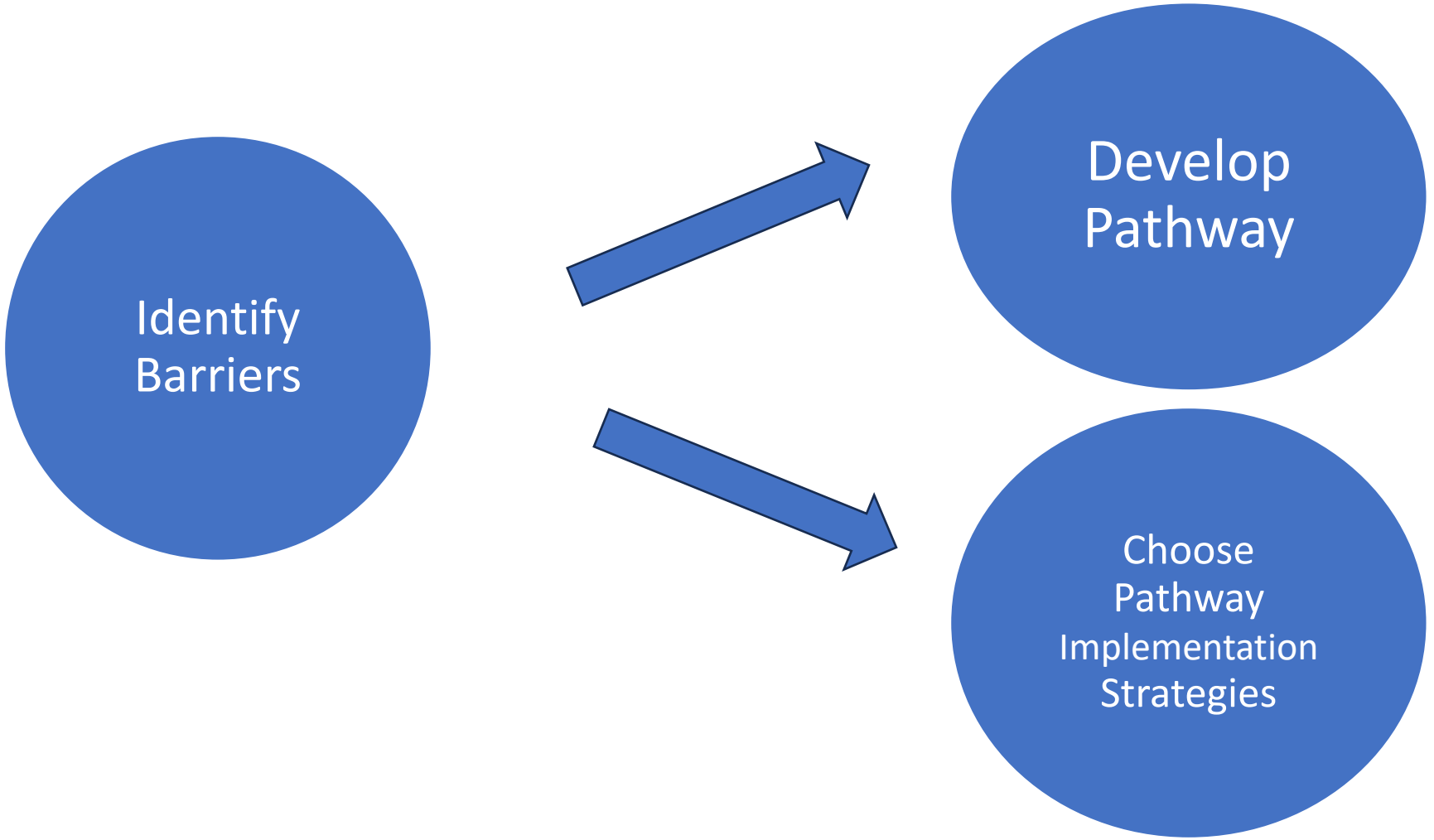
Addressing the Barriers



Barriers Inform Choice of Pathway Implementation Strategies

- There are no universally effective strategies
- More research needs to be done to understand which strategies are most effective for which barriers
- We rely on the “tried and true” methods (e.g., audits/feedback, education)

Implementation Science for Pathways



What do we need for strategy to work?

What would overcome the barrier?

- What is feasible and impactful?

Why would it overcome the barrier?

- **Theory about how strategies overcome barriers**

How would it work?

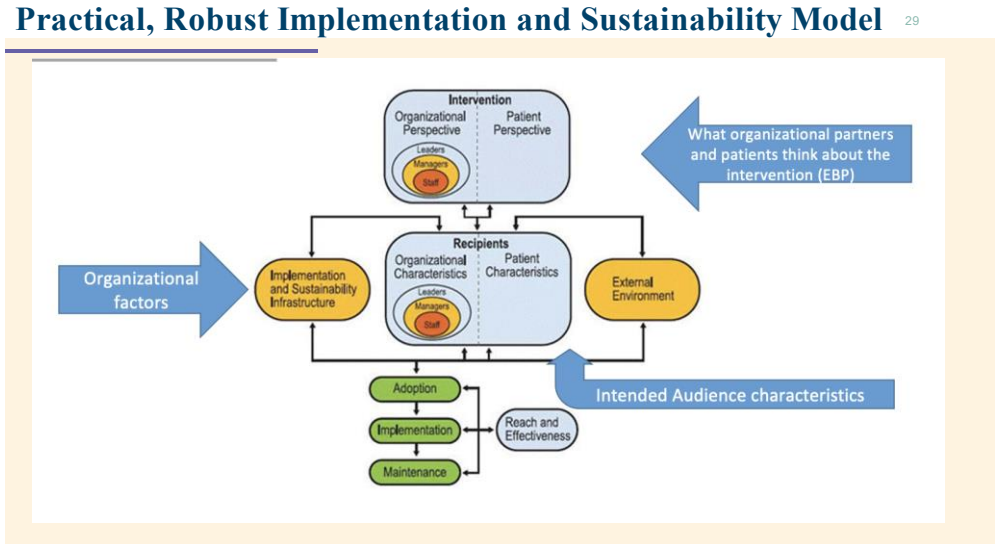
- **Process through which it may work**

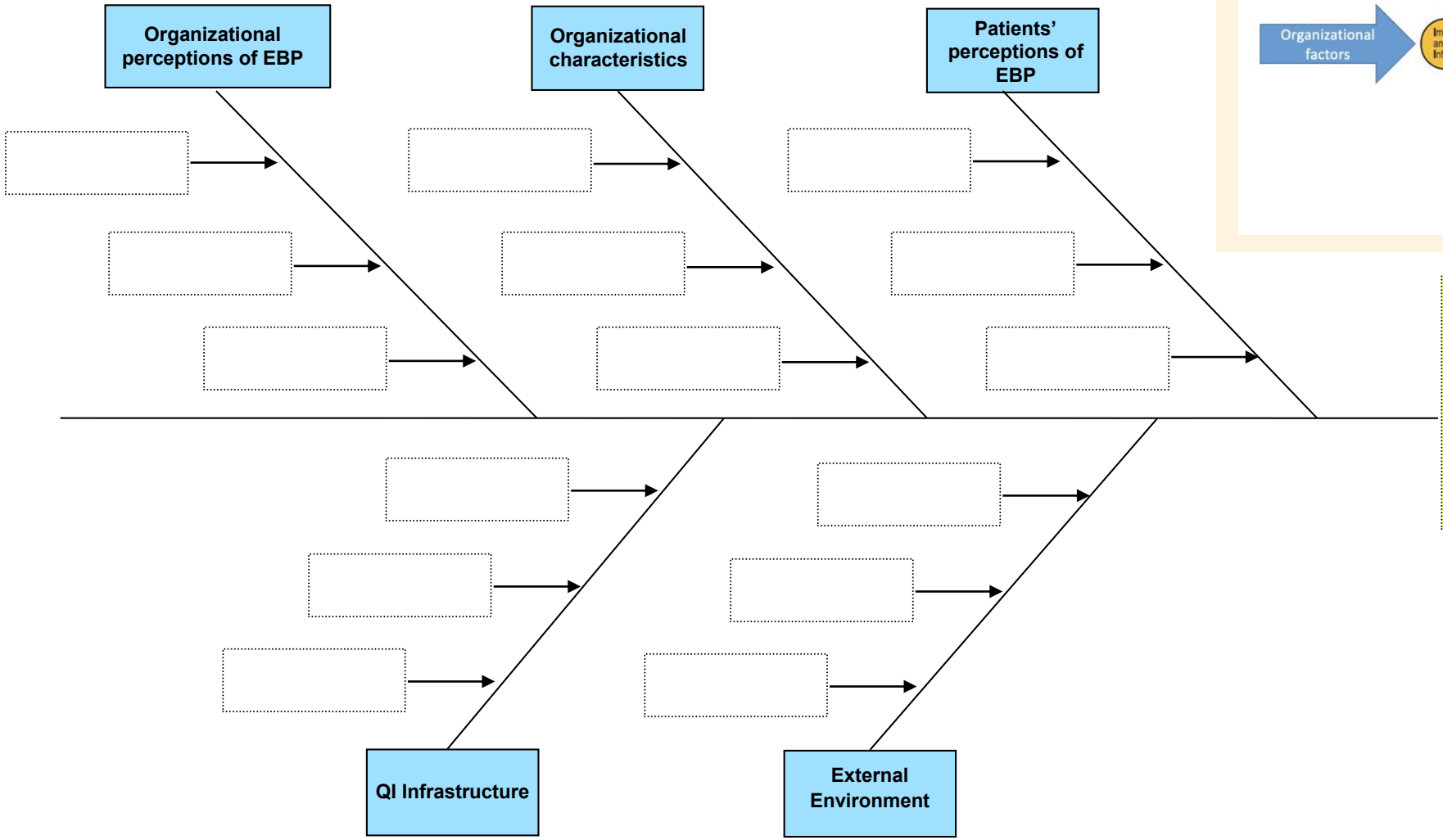
- **Light Switch (Preconditions):** Strategy works **only if present**
- Resources, Authority to change practice, Leadership support
- **Dimmer Switch (Moderators):** Influence **how strongly a strategy works**
- Culture, Team engagement, Competing priorities

Breakout 1

Using Implementation Science Frameworks to identify and address barriers influencing development and implementation of your Clinical Pathway

Breakout 1: PRISM Cause-Effect Diagram





Institution has lower adoption of guidelines compared to other similar institutions

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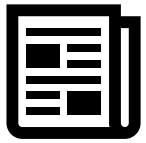
Clinical Decision Support

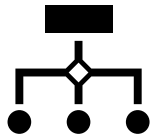
Logistical Barrier

6 Rights of Clinical Decision Support (CDS)



Right information

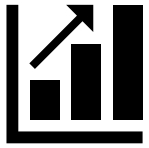
Right person



Right format

Right channel

Right time



Right purpose

Miller, S. The Six Rights of Clinical Decision Support at the Dawn of the AI Era. Oct 20, 22025

Asthma Pathway

- https://agile.md/a/3zwxTmHnkEGA411E5rFR7bP1oZY9z44aqDfrdyJhmyTCXhcgxc

Artificial Intelligence

Logistical Barrier

KEY PRINCIPLES OF AI ENGAGEMENT

YOU REMAIN THE EXPERT

AI IS A SUPER SMART **ASSISTANT** WHO THINKS IT KNOWS EVERYTHING

WORK **SMARTER, NOT HARDER** (MORE EFFICENCY)

GARBAGE IN, GARBAGE OUT (WHO IS TEACHING AI?)

CHECK AND DOUBLE CHECK (AI IS VERY CONVINCING)

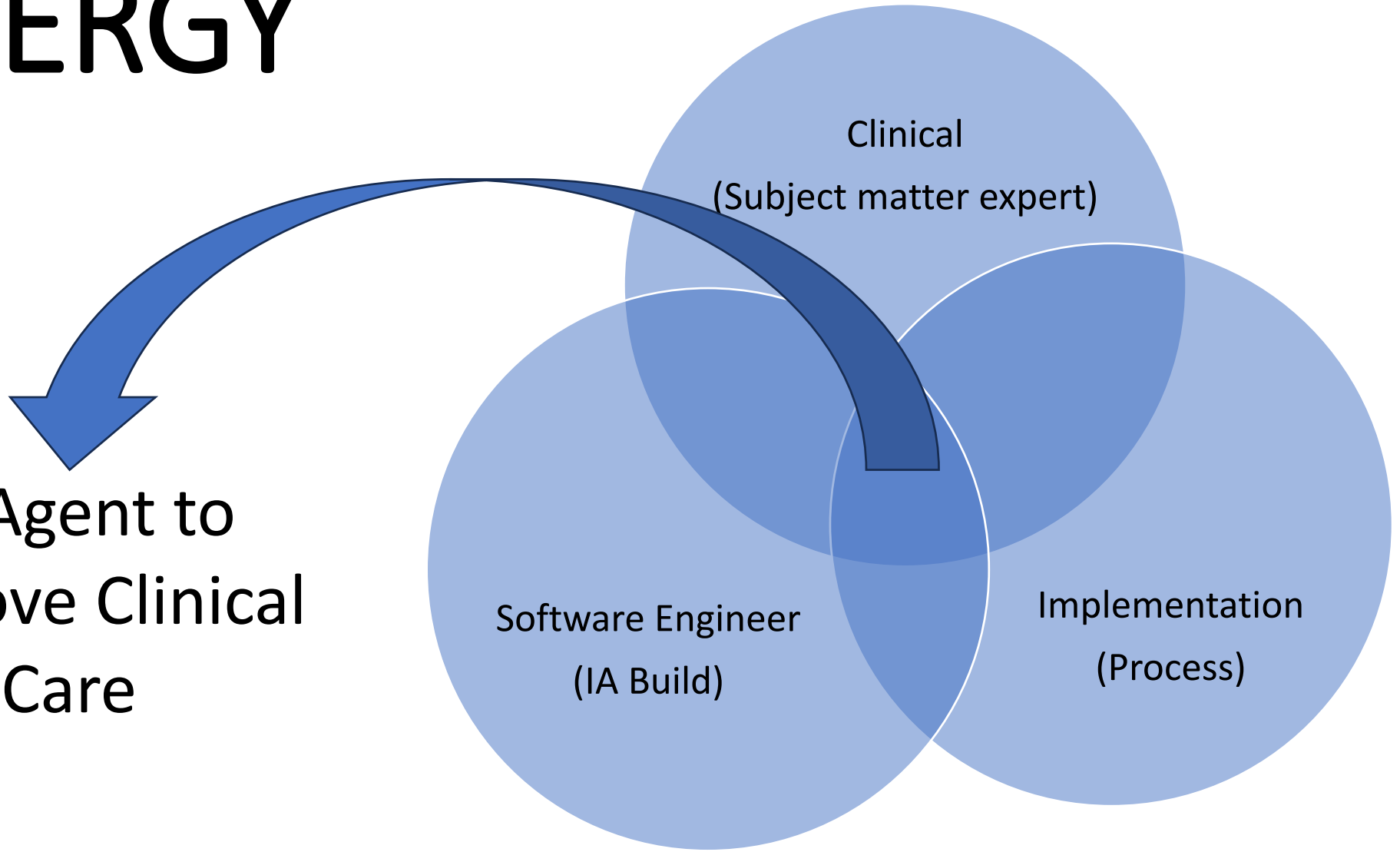
BEWARE OF PUBLIC GPT

DO NOT USE IDENTIFIERS

(CHECK WITH YOUR INSTITUTION)

SYNERGY

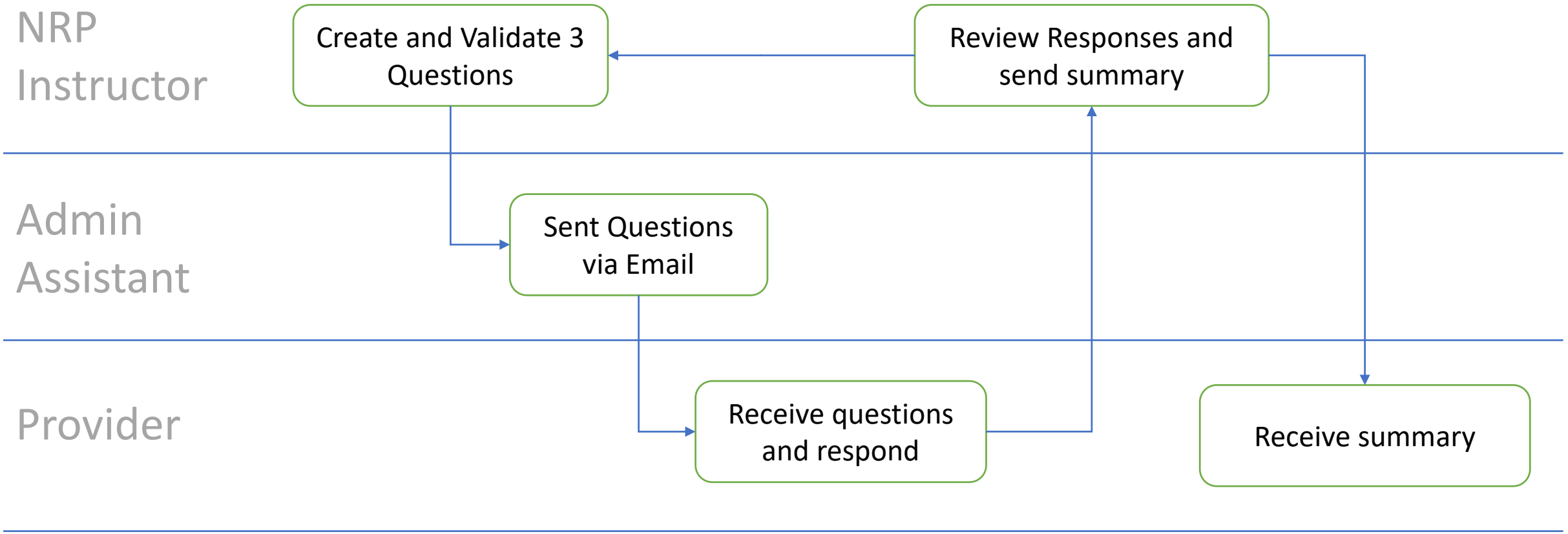
AI Agent to improve Clinical Care



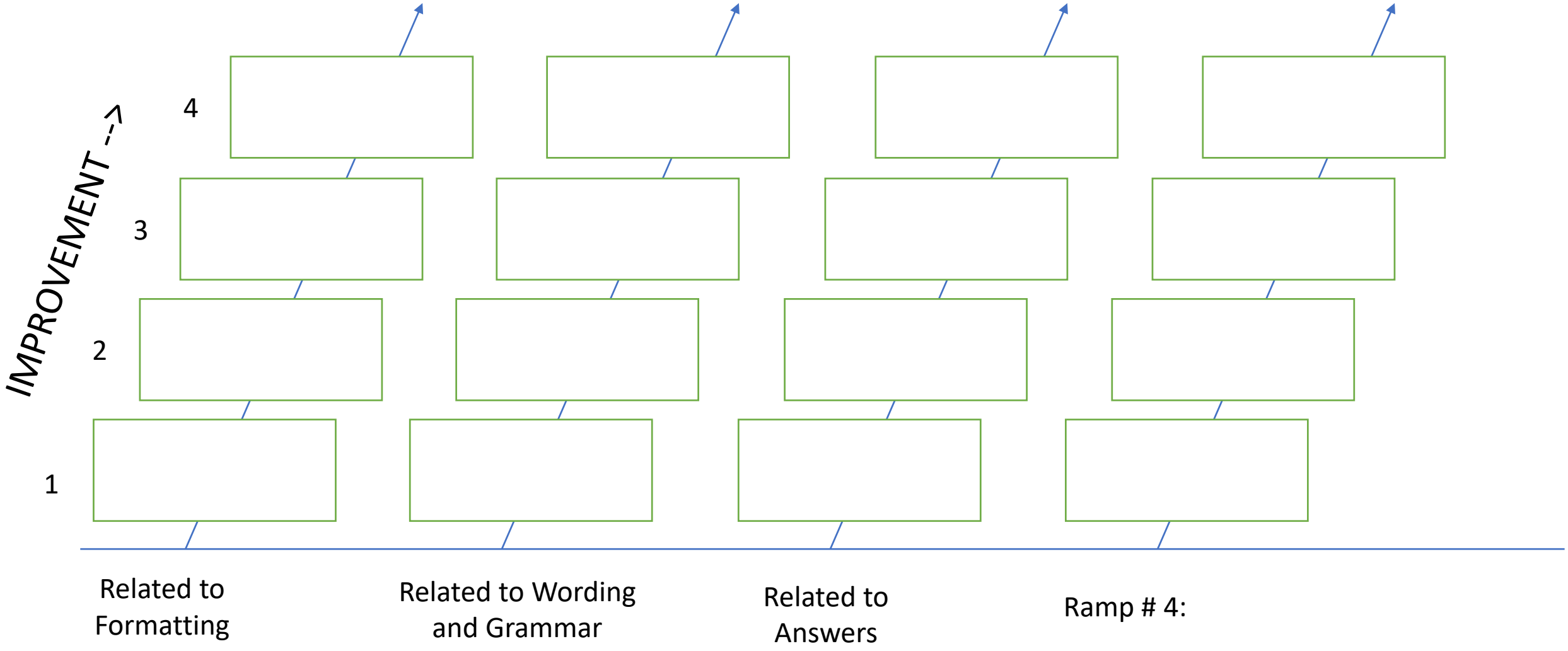
CASE Example
Neonatal Resuscitation Program, 9th Edition

- We created a Job Aid to highlight the new changes
- PDSA #1: disseminated via email to 105 providers
  - Observed poor practice uptake (persistent 8th edition practice)
- PDSA #2: "Contest game"
  - Divide provider into 4 groups
  - Weekly 3 questions X 6 weeks
  - Winning team goes to an Alaska cruise vacation.

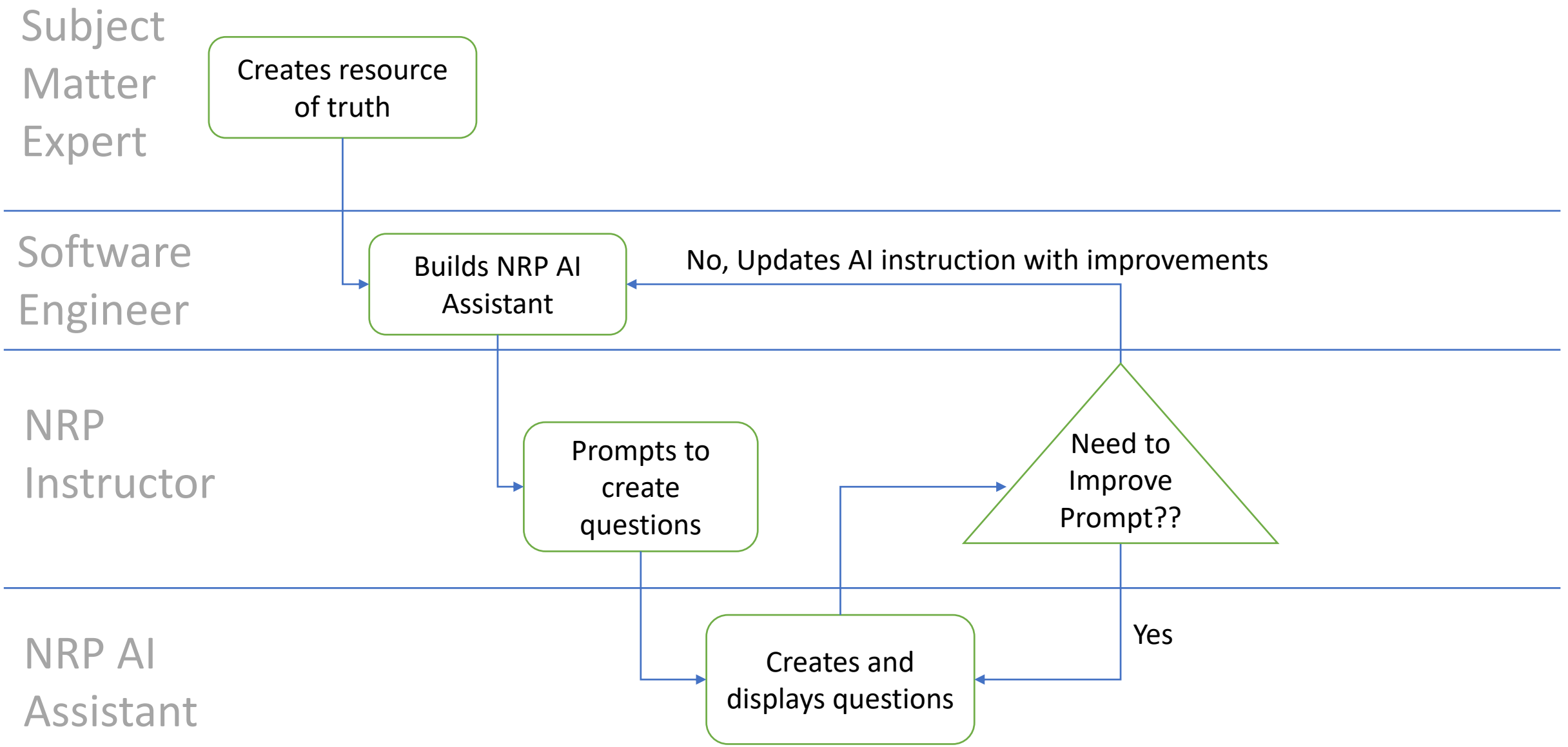
Swimlane of PDSA#2 – Contest game



Exercise - AI Agent Improvement PDSA Ramp



Swimlane of Collaboration between SME and Engineer to create AI Agent NRP Question Generator



Baseline data from sending out human made questions

(to be compared with AI generated questions in upcoming comparative study)

Date Sent	Question		Preferred Answer	# of respondents	% correct
1/7/2026	A. 8.1 Deferred Cord Clamping	You are reviewing the NRP 9th edition updates on deferred cord clamping (DCC) with your delivery team. Which statement is correct?	If the infant is vigorous, DCC should be performed for at least 60 seconds	80	96%
1/21/2026	8.2 NRP 9th DR PIP	According to the NRP 9th edition, when preparing for a 28-week gestational age delivery, what should the initial PIP be set at?	20-25 cm of H2O	83	83%
2/4/2026	A. 8.3 NRP 9th DR FiO2	According to the NRP 9th edition, when preparing for a 33-week gestational age delivery, what should the initial FiO2 be set at?	21%-30%	81	98%

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YOU REMAIN THE EXPERT

AI IS A SUPPER SMART ASSISTANT

WORK SMARTER, NOT HARDER

GARBAGE IN, GARBAGE OUT

CHECK AND DOUBLE CHECK

BEWARE OF PUBLIC GPT

DO NOT USE IDENTIFIERS

CHECK WITH YOUR INSTITUTION

Behavioral Economics

Behavioral Barrier

Patel, Volpp & Asch (January 2018 Perspective; New England Journal of Medicine) “Nudge Units”

- “The final common pathway for the application of nearly every advance in medicine is human behavior. No matter how effective a drug, how protective a vaccine, or how targeted a therapy may be, a clinician usually has to prescribe it, and a patient accept and use it as directed, for it to improve health” (pg. 214).
- *--Leaders of the USA’s first health care system “Nudge Unit” (established 2016 at UPenn Med)*

What is Behavioral Economics (BE)?

Interdisciplinary field featuring insights from psychology and economics

- Common focus of BE: financial well-being
- ***You*** may have novel applications of BE!

Two Branches of Behavioral Economics

Financial Incentives	• Optimal design of rewards and penalties
Messages; Choice Architecture	• Optimal presentation of opportunities "Nudges" (Thaler and Sunstein, 2021)

Example of a Nudge – Global Positioning System (GPS)

- Brief and firm instructions
- Helpful information (most of the time)
- Optional advice
- Respectful tone

•(partially based on Thaler and Sunstein, *Nudge*, 2021)

Empirical Support for Nudges

Last BS, Buttenheim AM, Timon CE, et al. Systematic review of clinician-directed nudges in healthcare contexts. BMJ Open **2021**; 11:e048801.

Wang SY, Groene O. The effectiveness of behavioral economics-informed interventions on physician behavioral change: A systematic literature review. PLoS ONE **2020**; 15(6): e0234149.

Talat U, Schmidtke KA, Khanal S, et al. A systematic review of nudge interventions to optimize medication prescribing. Frontiers in Pharmacology **2022**; 13: Article 798916

Tang MY, Rhodes S, Powell R, et al. How effective are social norms interventions in changing the clinical behaviours of healthcare workers? A systematic review and meta-analysis. Implementation Science 2021; 16(1): 8.

Example of a Nudge: Highlighting Social Norms – "Peer Comparisons"

- Social influences, not just biological facts, can encourage people to behave more optimally.
- The Hotel Towel Study (Goldstein et al., 2008)

Possible Mechanisms of Action for Peer Comparisons

- **Social proof:** "This behavior must be worthwhile and acceptable if others display it." (Deutsch M & Gerard HB., 1955 *J Abnorm Soc Psychol*)

- **Self-efficacy:** "I can display this particular behavior too."

  (Stok FM et al., 2014; *Appl Psychol Health Well Being*)

- **Superiority biases:** "I am as good (if not better) than others." (Hoorens V., 1993; *Eur Rev Soc Psychol*.)

Empirical Studies of Peer Comparisons to Nudge Medication Prescribers

1. Emergency department opioid prescribing

   Andereck et al. *The Joint Commission Journal on Quality and Patient Safety,* 2019.

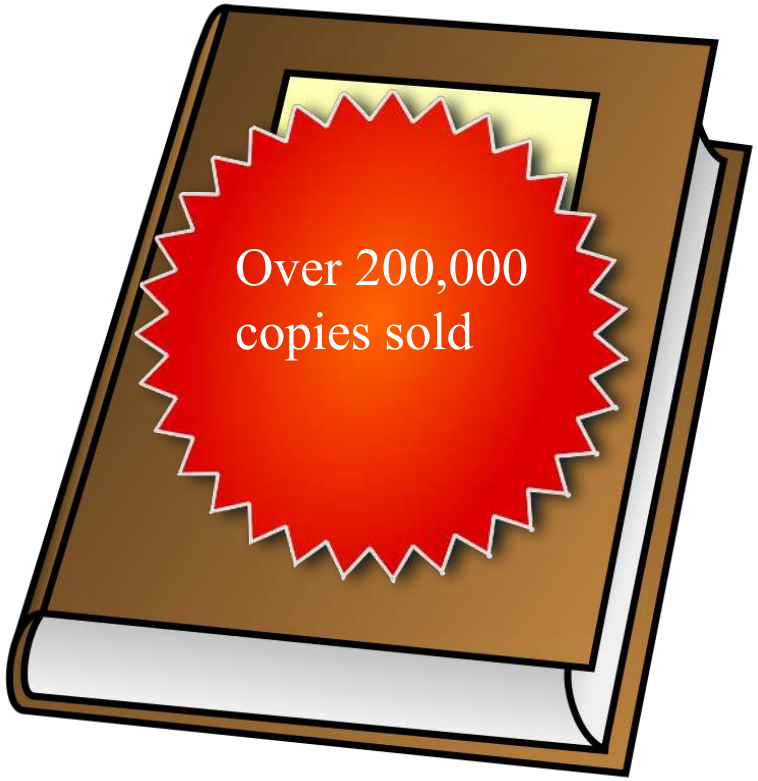
2. Primary care antipsychotic prescribing

   Sacarny et al. *JAMA Psychiatry*, 2018.

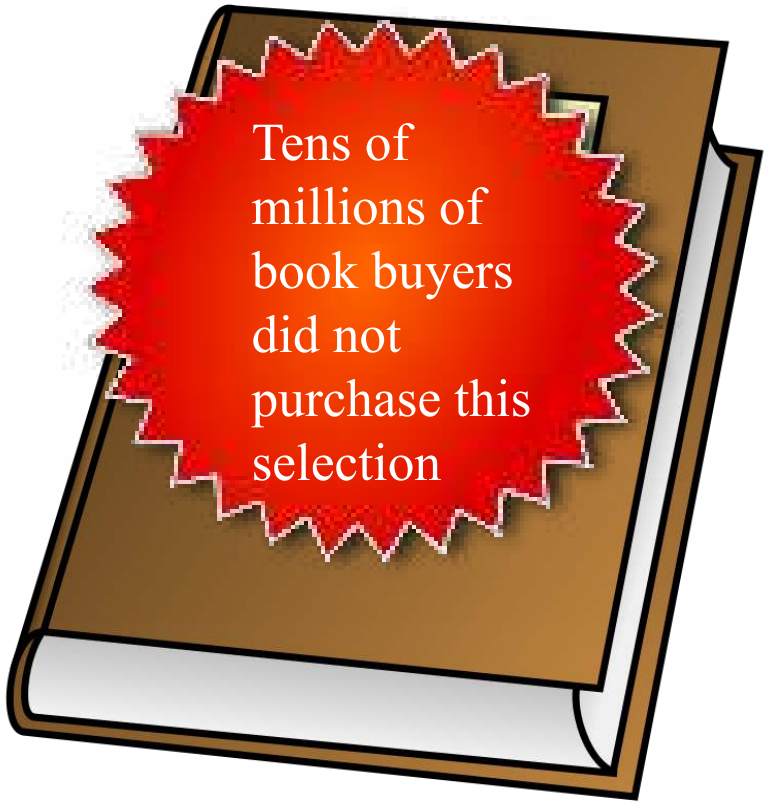
3. Primary care antibiotic prescribing

   Meeker et al. *JAMA*, 2016.

Highlighting Those Exhibiting the Desired Behavior



Avoid Highlighting The Many People Exhibiting the Opposite Behavior –The "Big Mistake" from Dr. Robert Cialdini



Descriptive norms probably work best when…

- people are unaware of the desired behavior exhibited by many ***similar*** individuals. Peers matter!
- an increasingly popular trend is highlighted (Mortensen et al., 2017; *Social Psychological and Personality Science*).
- “Many” is fine; “Most” is not required.

Don’t Forget Those Who Perform Well

Different from just “personalized feedback”

	Month 1	Month 2
Neighbor 1	$200	$190
Neighbor 2	$100	$110
TOTAL:	$300	$300

--based on Schultz et al. (2007) study on energy conservation

Peer Comparisons

	Month 1	Month 2
Neighbor 1	$200	$190
Neighbor 2	$100☺	$100
TOTAL:	$300	$290

“You are a top performer” (Meeker et al., *JAMA*, 2016)

Long-Term Benefits of Peer Comparisons

- Can lead to enduring changes in clinical practice

Linder JA, Meeker D, Friedberg MW, Persell SD, Goldstein NJ, Doctor JN. Effects of behavioral inter-interventions on inappropriate antibiotic prescribing in primary care 12 months after stopping interventions. *JAMA*. 2017;318:1391–2.

Checklist for Utilizing Social Norms

•Do:

- Highlight similar clinicians using the clinical pathway
- Highlight an increasingly popular trend
- Highlight peer comparisons to those who are ambivalent about the pathway or are busy/distracted but interested in the pathway

•Don't:

- Forget to praise high utilizers of the pathway
- Highlight that many clinicians fail to utility the pathway
- Bother to highlight norms to those clinicians who are "rebellious" or who are strongly opposed to the pathway

Whole Wheat Bread

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Please fill out the evaluation

Thank you!!!

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Book Chapter Reference

Stevens J (2020). Accountable justifications and peer comparisons as behavioral economic nudges to improve clinical practice. In R. Shah & S. Godambe (Eds.) Patient Safety and Quality Improvement in Healthcare: A Case-Based Approach. New York: Springer.

Extra Slides