



# A “NIMBLE” Approach to Antimicrobial Stewardship

---

DR. LARISSA M. MATUKAS, MD, FRCPC

ASSOCIATE PROFESSOR, UNIVERSITY OF TORONTO

MAY 7, 2026 – TIBDN DAYS

# Learning Objectives

1. Define antimicrobial stewardship and its core components
2. Explain the benefits of antimicrobial stewardship
3. Describe activities that microbiology can play in ASP
  - “NIMBLE” susceptibility reporting to influence prescriber behaviour

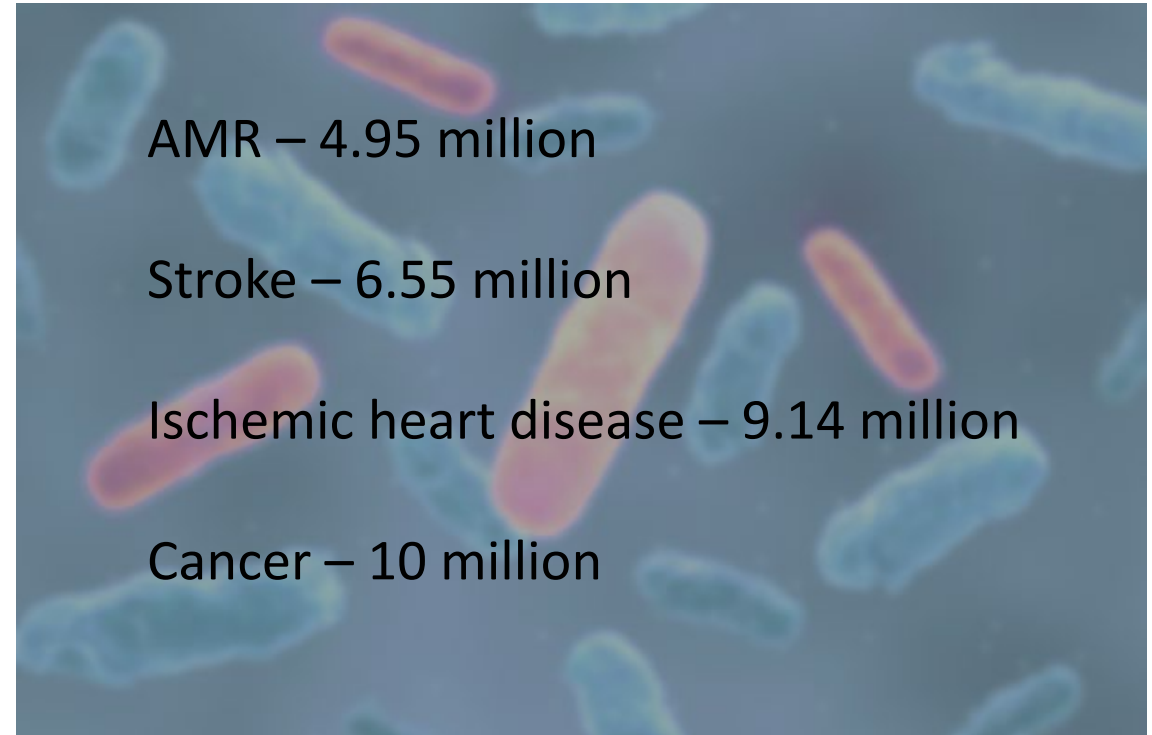
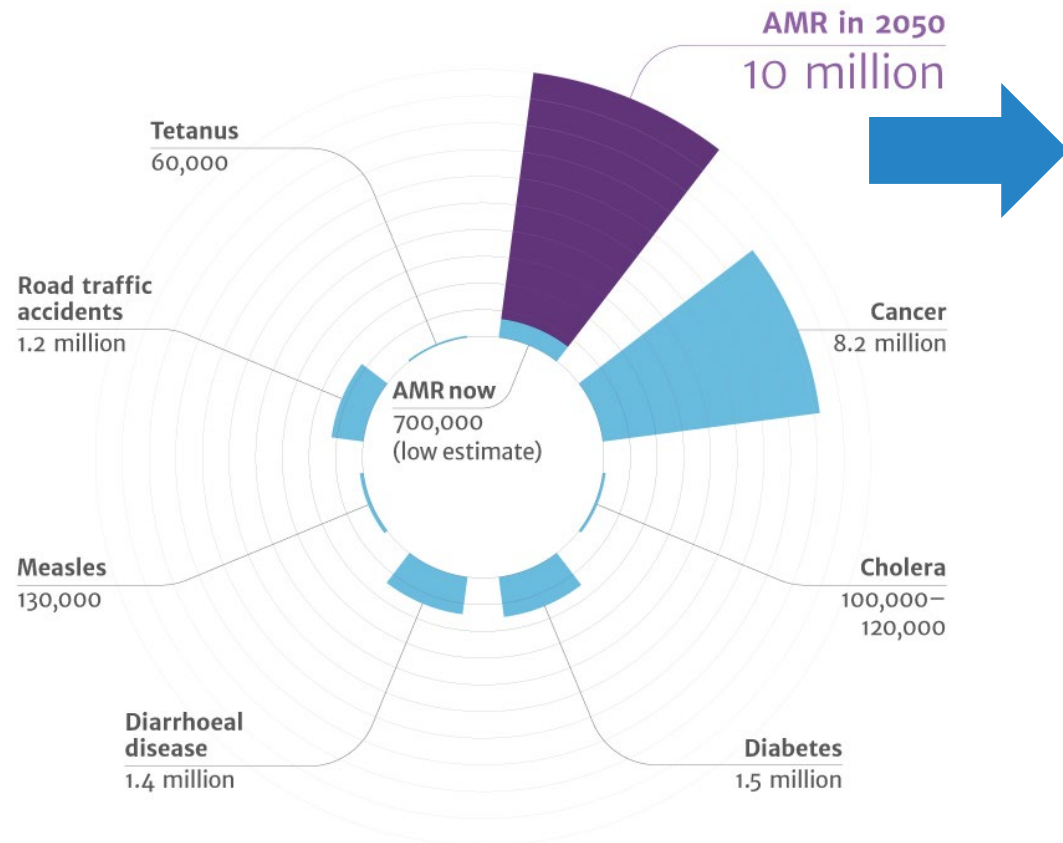
# Conflict of Interest

---

Cepheid

bioMerieux

# Antimicrobial Resistance is a Public Health Threat



The Review on Antimicrobial Resistance, Chaired by Jim O’Neill, 2016

Murray CJL et al., The Lancet, Volume 399, Issue 10325, 12–18, 2022

# What is Antimicrobial Stewardship?

---

*“coordinated interventions designed to improve and measure the appropriate use of [antibiotic] agents by promoting the selection of the optimal [antibiotic] drug **regimen** including **dosing, duration** of therapy, and **route** of administration”*

Fishman N. Policy statement on antimicrobial stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). *Infection Control & Hospital Epidemiology*. 2012 Apr 1;33(04):322-7.



Antibiotic Stock Photos- Getty Images

## What Does Success Look Like?



---

unnecessarily broad-spectrum, expensive  
and/or more toxic antimicrobials



---

antimicrobial resistance



---

*C. difficile* infections



---

antimicrobial stewardship prospective  
audit and feedback interventions



## Core Elements of Hospital Antibiotic Stewardship Programs



### Hospital Leadership Commitment

Dedicate necessary human, financial, and information technology resources.



### Accountability

Appoint a leader or co-leaders, such as a physician and pharmacist, responsible for program management and outcomes.



### Pharmacy Expertise (previously "Drug Expertise"):

Appoint a pharmacist, ideally as the co-leader of the stewardship program, to help lead implementation efforts to improve antibiotic use.



### Action

Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.



### Tracking

Monitor antibiotic prescribing, impact of interventions, and other important outcomes, like *C. difficile* infections and resistance patterns.



### Reporting

Regularly report information on antibiotic use and resistance to prescribers, pharmacists, nurses, and hospital leadership.



### Education

Educate prescribers, pharmacists, nurses, and patients about adverse reactions from antibiotics, antibiotic resistance, and optimal prescribing.



## Action

Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.

## Microbiology-based Interventions

The microbiology lab in consultation with the stewardship program often implement the following interventions:

- Selective reporting of antimicrobial susceptibility testing results: tailoring hospital susceptibility reports to show antibiotics that are consistent with hospital treatment guidelines or recommended by the stewardship program
- Comments in microbiology reports: for example, to help providers know which pathogens might represent colonization or contamination

# Guideline Recommendations

## IDSA “**Weak**” Recommendations

“We suggest **selective and cascade reporting** of antibiotics over reporting of all tested antibiotics (*weak recommendation, low-quality evidence*).

*Comment: Although data are limited that demonstrate direct impact of those strategies on prescribing, some form of selective or cascaded reporting is reasonable. After implementation, ASPs should review prescribing to ensure there are no unintended consequences.”*

Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, Srinivasan A, Dellit TH, Falck-Ytter YT, Fishman NO, Hamilton CW. Implementing an antibiotic stewardship program: guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clinical Infectious Diseases*. [2016 Apr 13;62\(10\):e51-77.](#)

# Guideline Recommendations

---

## Clinical Laboratory Standards Institute (CLSI) Recommendations

“Each laboratory **should** consider **developing selective and/or cascade reporting rules** in consultation with the antimicrobial stewardship team...is done to encourage appropriate antimicrobial agent use.”

“**Selective reporting** involves reporting results for specific antimicrobial agents **based on defined criteria** unrelated to results obtained from AST”

# Guideline Recommendations

---

## Institute for Quality Management in Healthcare (IQMH) Recommendations

Laboratories **should** incorporate some form of **selective antimicrobial testing and reporting** in collaboration with its institutional stakeholders.

...laboratories **should report at least two different classes** of antimicrobial agents (with preferably at least one oral agent) to which the organism is susceptible

## Challenges of Selective/Cascading Reporting

---

Variability in reporting from one lab to another based on availability of expertise and degree of collaboration

---

Initially labour-intensive to set rules for reports, additionally resource intensive if not automated in lab information system (LIS)

---

May need additional resources to sustain rules in LIS during IT upgrades

---

Unnecessary broad-spectrum prescriptions may continue if cascading algorithms are based on cost alone

---

Misinterpretation that an unlisted antimicrobial equals resistance

---

Use of specific cascade reporting algorithms may be more difficult, expensive or even impossible if an institution's microbiology laboratory services are outsourced

## Requirements for Success

Collaborative relationship between the antimicrobial stewardship team, microbiologist and microbiology laboratory and other key healthcare providers

Automation of cascading rules/algorithm

Regular review of cascading rules and choice of reported antimicrobial susceptibilities.

Education of health care professionals on interpretation of the reports and knowing when to call the microbiology laboratory for additional susceptibilities.

# Organizations in Ontario with Microbiology related strategies

Hospital Type	Antibiograms (%)	Cascading microbiology susceptibility reporting (%)	Promotion of timely & appropriate microbiologic sampling (%)	Improved diagnostics (%)	Strategic microbiology results reporting (%)
Acute Teaching	93	79	64	79	79
Large Community	93	80	61	57	70
Small Community	69	15	42	31	27
CCC & Rehab	45	18	18	18	27
Overall 2016	82	55	52	48	55
Overall 2018	91	81	64	54	77

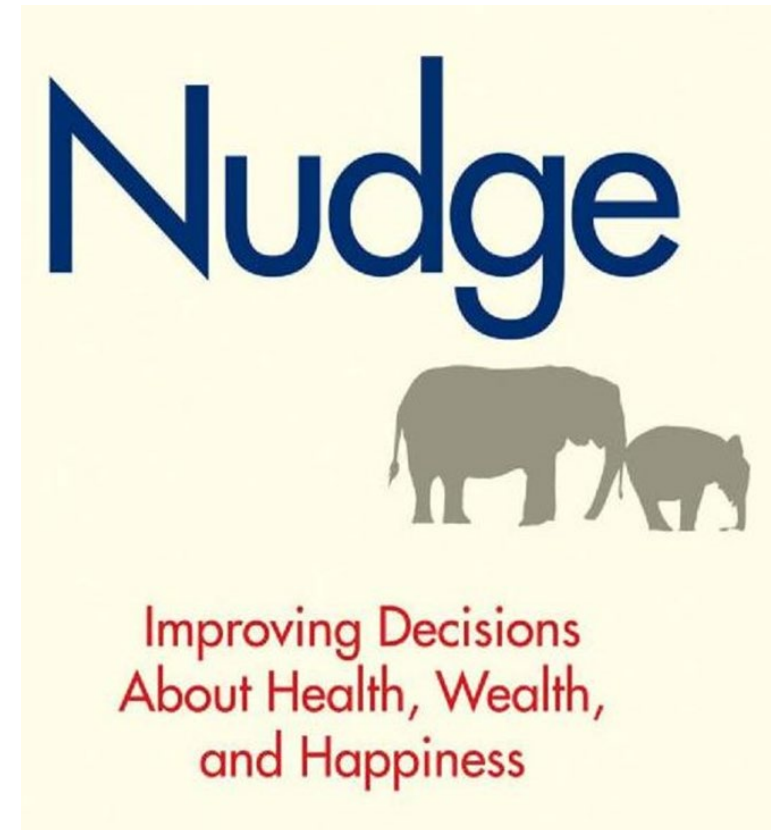
Public Health Ontario.  
Antimicrobial Stewardship  
Landscape Survey. 2016  
(denominator = 95) & 2018  
(denominator = 70)

# Nudging from the Behavioural Science Perspective

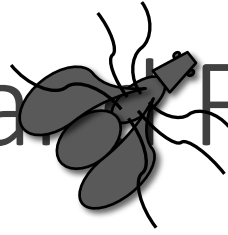
---

“A nudge... is any aspect of the **choice architecture** that **alters people’s behavior** in a predictable way **without forbidding any options** or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid.”

Thaler RH, Sunstein CR. Nudge: improving decisions about health, wealth and happiness. New Haven, CT: Yale University Press; 2008.






# What do Cheerios and Flies Have in Common?



They both steer behaviour to aim into the toilet and not onto the floor

Decals of flies placed near the drains of urinals, resulted in ~80% reduction of spillage on the bathroom floor

# “Nudging” in Microbiological Reports: A Strategy to Improve Prescribing

	“Nudge” strategy	Possible use in microbiological reporting
	Putting choices at “eye level”	Emphasizing certain antimicrobials by using bold or larger font and/or placing them at the top of the list (“at eye level”)
	Default choice (selective)	Restricting reports to selected antimicrobials and providing further data on request only
	Framing	Changing the context of data presentation, e.g. by providing interpretation (colonization versus infection) or information on substances (broad or narrow spectrum, pharmacokinetics, adverse events, costs, etc.)

Katchanov J, Kluge S, MacKenzie CR, Kaasch AJ. “Nudging” in microbiological reports: a strategy to improve prescribing. *Infection*. 2016:1-5.

## Scoping Review Purpose

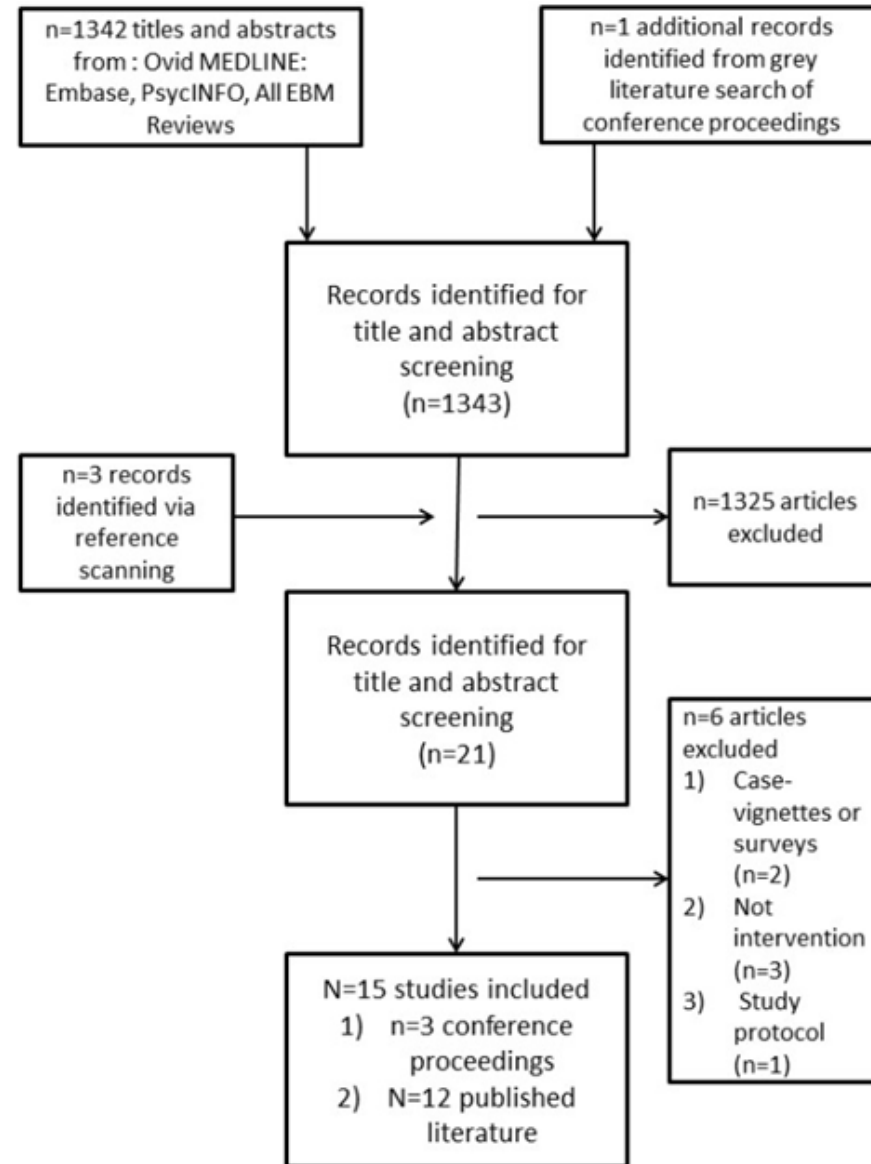
- to identify the evidence that exists to demonstrate the effectiveness of nudging strategies in microbiology to improve appropriate antimicrobial use

Langford BJ et al., Nudging In MicroBiology Laboratory Evaluation (NIMBLE): A scoping review. ICHE. Cambridge University Press; 2019;40(12):1400–1406.

# Results

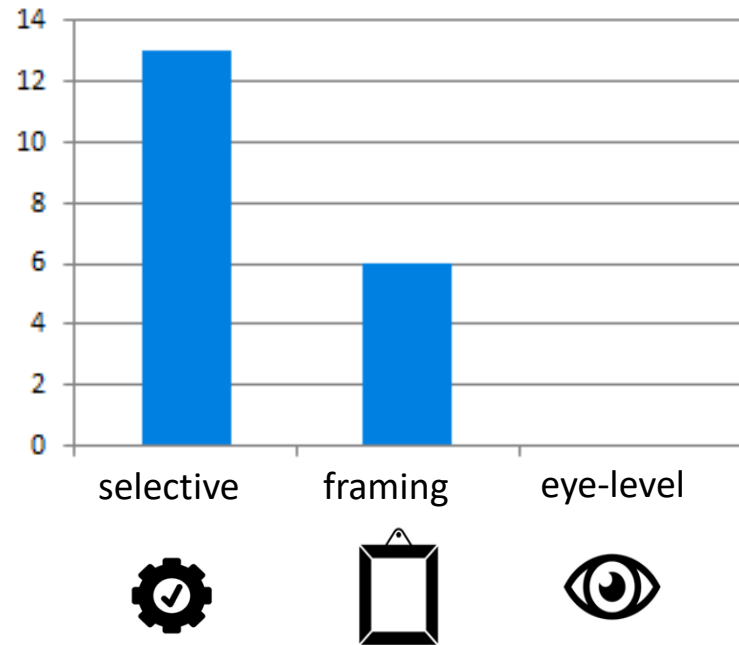
1346 studies reviewed

15 studies included

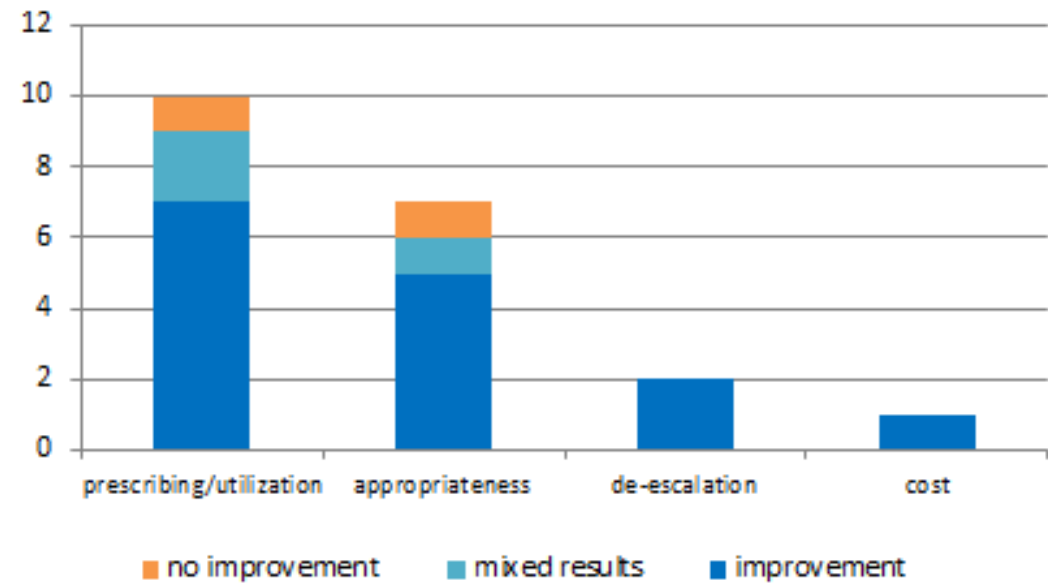


# NIMBLE: Nudging In MicroBiology Laboratory Evaluation

## Nudging Strategy



## Study Outcomes



# Impact of Nudging on Appropriate Antibiotic Prescribing

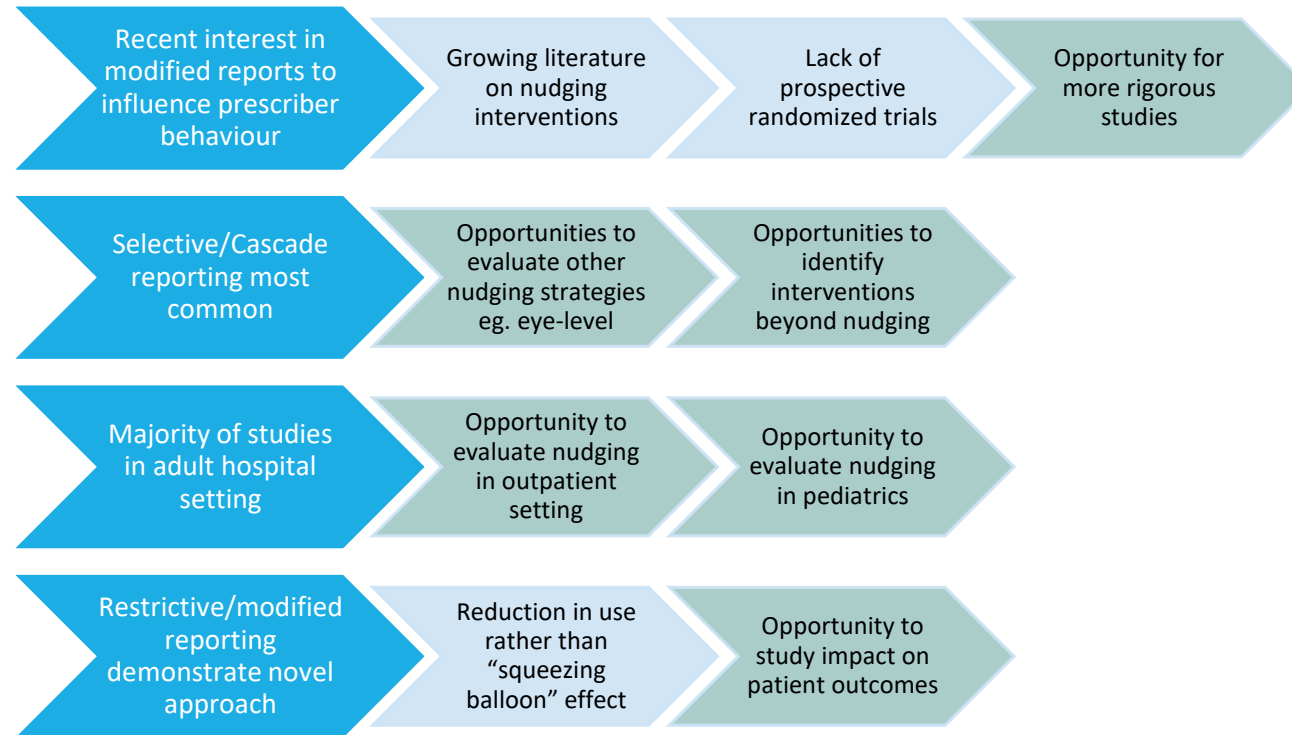
---

Author	without nudging (% appropriate)	with nudging (% appropriate)	Odds Ratio
Brodowy	12.5	24.2	2.2
Daley	53.0	80.0	3.5
Foo	50.0	61.0	1.6
Johnson	48.0	71.0	2.7
Leis	52.0	88.0	6.8
Stefee	78.0	87.0	1.9
<b>Mean</b>	<b>48.9</b>	<b>68.5</b>	<b>2.7</b>

We examined estimated intervention effect sizes drawn from our scoping review (Langford et al 2019) for each study (odds ratios)

# Discussion & Conclusion

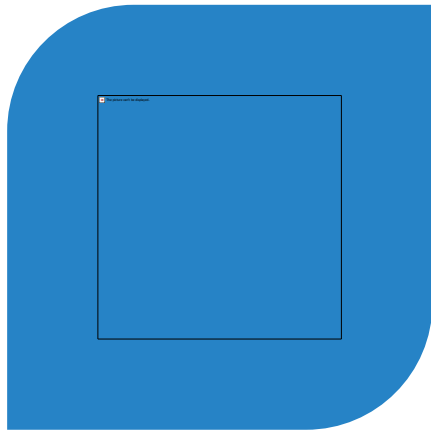
---



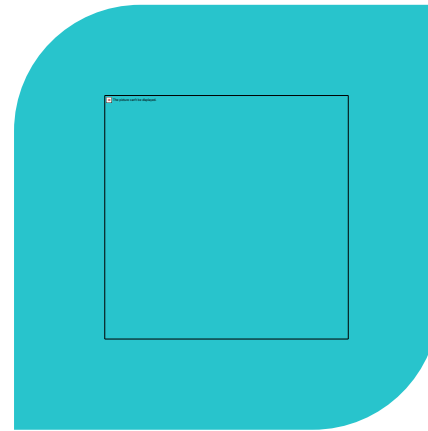
the presentation of antimicrobial options in microbiology reports can influence prescriber behaviour.

# New Systematic Review & Meta-analysis

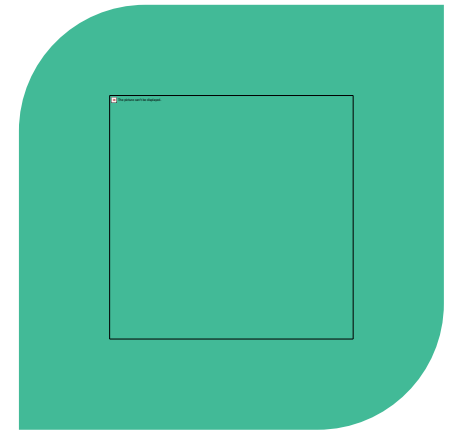
---



FOLLOWING PRISMA REPORTING  
GUIDELINES



REGISTERED PROTOCOL WITH  
PROSPERO



*“WHAT IS THE IMPACT OF  
NUDGING STRATEGIES IN  
MICROBIOLOGY LABORATORY  
REPORTS ON ANTIMICROBIAL  
PRESCRIBING AND ITS  
ASSOCIATED/RELATED  
OUTCOMES?”*

# Nudging in MicroBiology Laboratory Evaluation (NiMBLE): A systematic review and meta-analysis

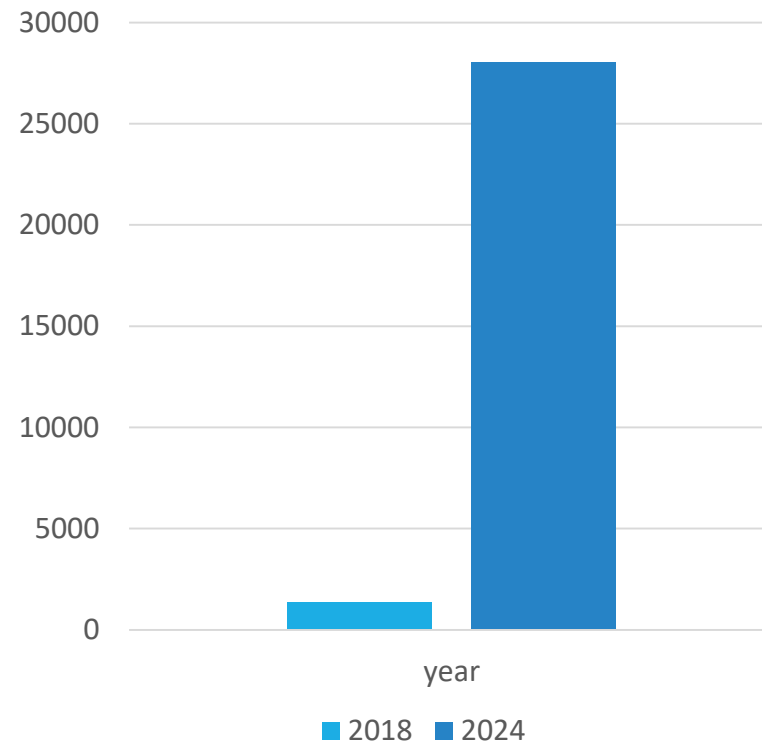
B J Langford et al., Clin Microbiol Infect. 2026 Apr 17:S1198-743X(26)00192-8. doi: 10.1016/j.cmi.2026.04.008. Epub ahead of print. PMID: 42001937.

---

Evaluate impact of microbiology report nudges on  
antimicrobial use and clinical outcomes

# Results

## Literature Search Results



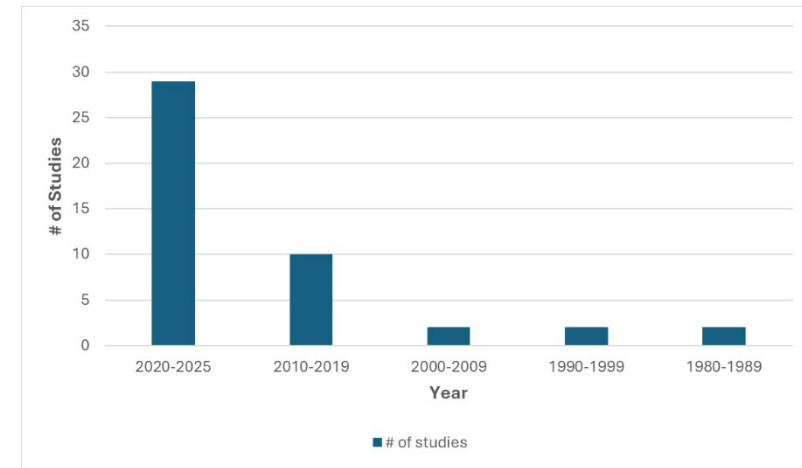
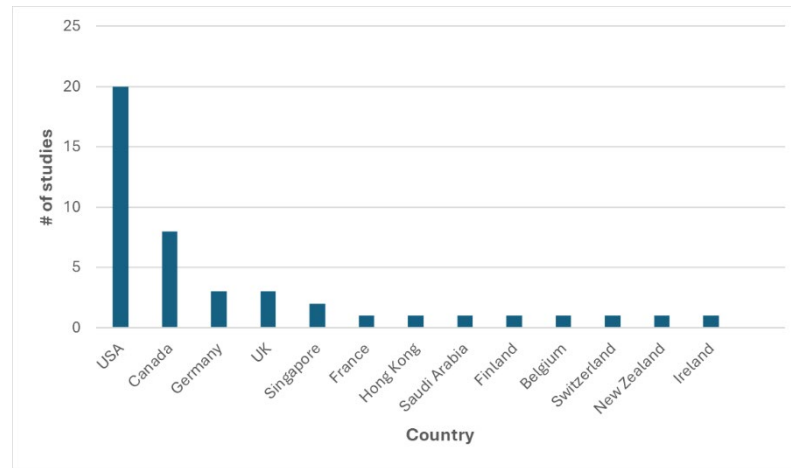
→ 45 studies included

91% (n=41) in adults

84% (n=38) in hospitalised patients

42% (n=19) uncontrolled before-and-after studies

# Results



# Results



56%

25 studies

## Selective/Cascade Reporting

Susceptibility reported only for only preferred agents



18%

8 studies

## Framing/Comments

Provide information to support treatment decisions



27%

12 studies

## Combination Strategies

Both selective reporting and framing are included



0%

0 studies

## Eye-level Reporting

Preferred antimicrobials displayed at top of the list

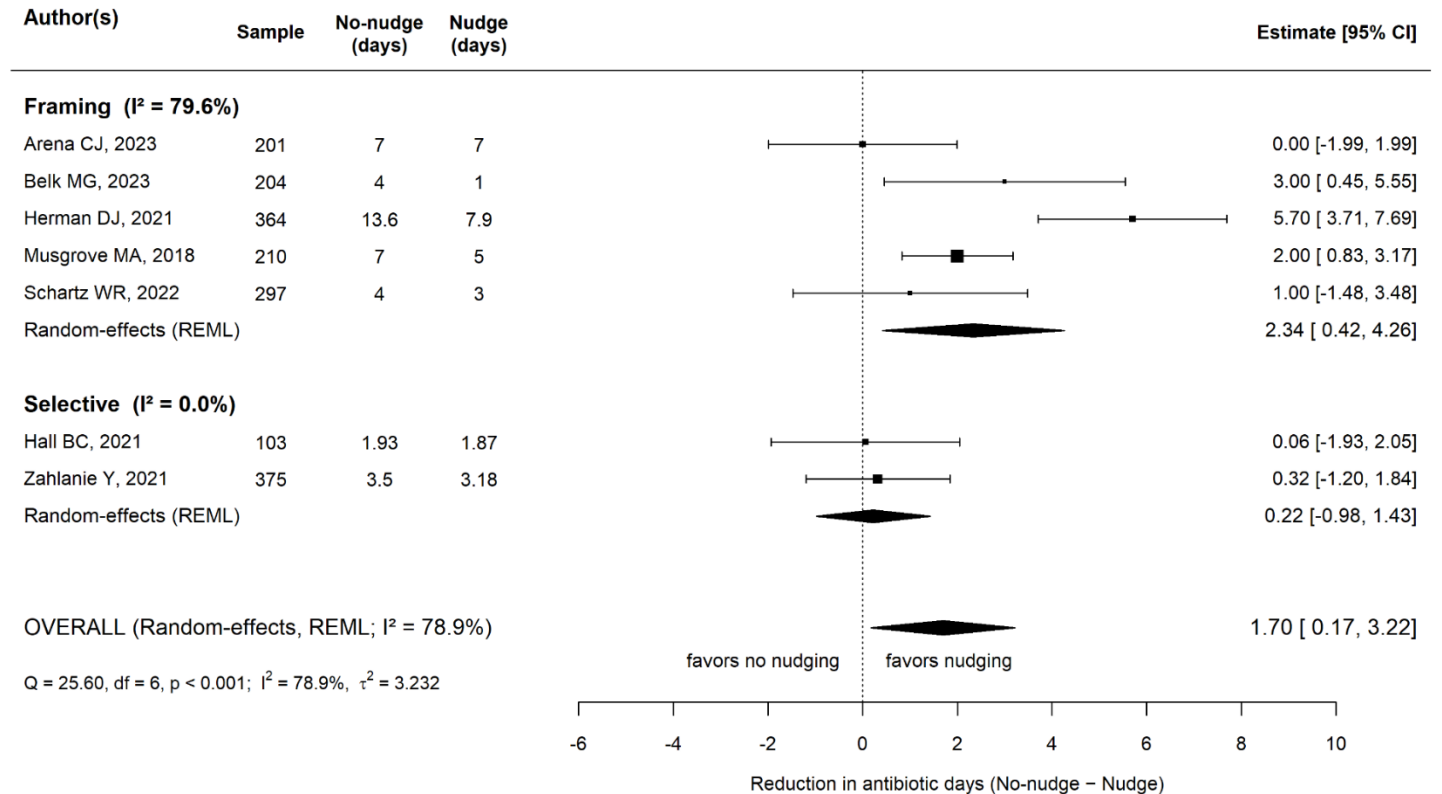
# Nudging associated with reduced duration



1.7

fewer days of treatment

95% CI: 0.2 to 3.3 days less



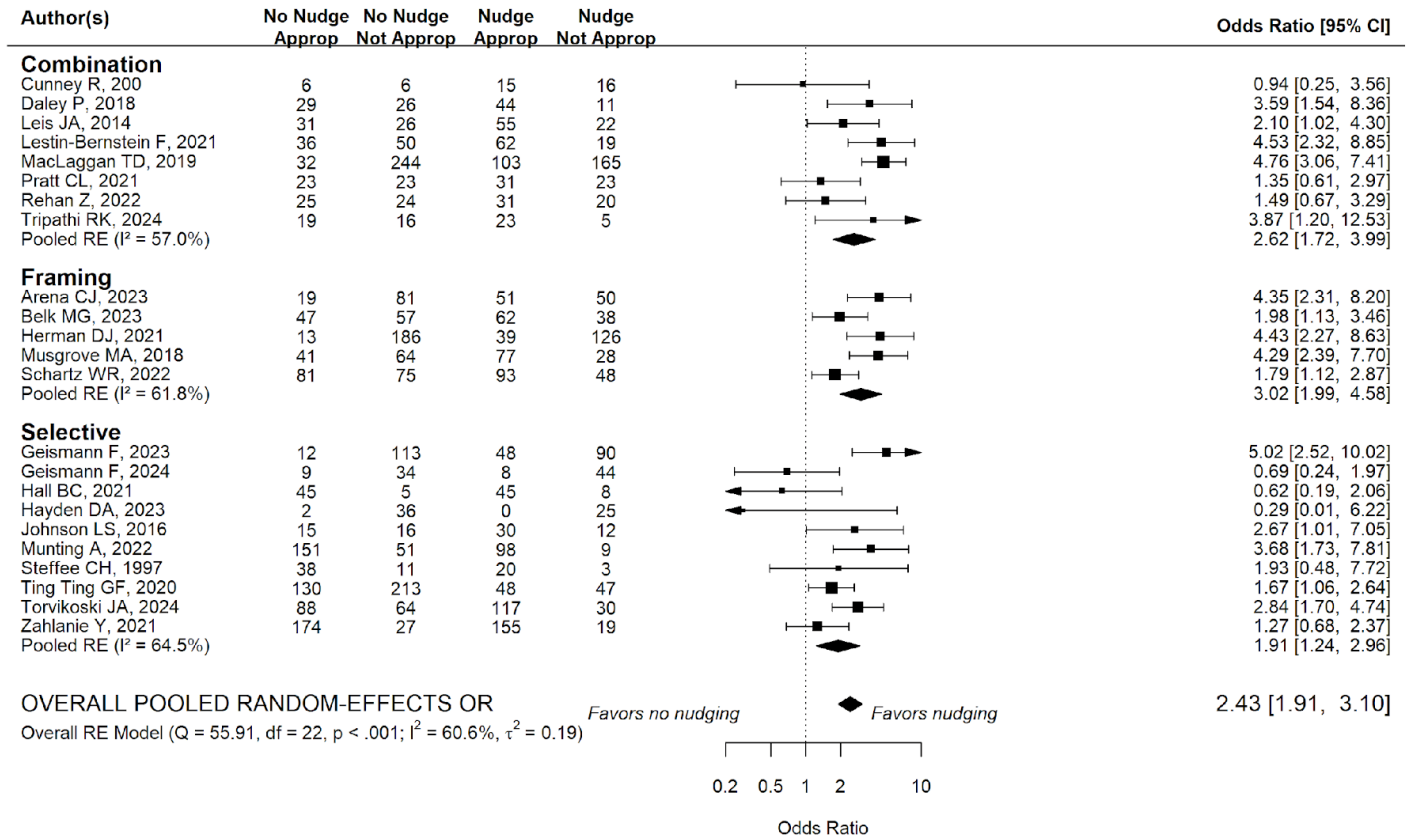
# Nudging associated with improved appropriateness



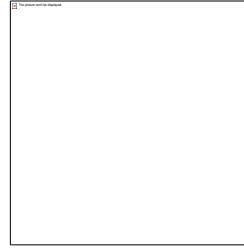
2.4X

↑ odds of antibiotic appropriateness

OR 2.4; 95% CI: 1.9 to 3.1

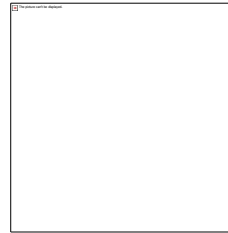


No evidence of harm



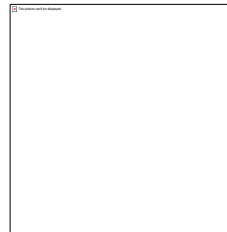
**No difference in *C. difficile***

OR 1.1; 95% CI: 0.9 to 1.3



**No difference in length of stay**

1.1 days 95% CI: -0.4 to 2.5



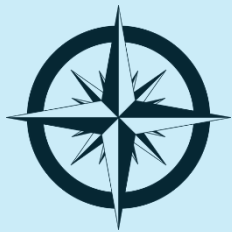
**No difference in mortality**

OR 1.1 95% CI: 0.6 to 1.7

# Conclusions

---

Increasing body of evidence suggests microbiology nudges are an effective and scalable approach to support antibiotic stewardship



### BASELINE/DEFAULT

All tested reported antimicrobials in alphabetical order

VS

**Framework of nudging strategies** to apply to antimicrobial susceptibility reports in various clinical scenarios, to further study methods of optimizing prescribing



### SELECTIVE

Restricted list of preferred antimicrobial option(s)



### FRAMING

Addition of written comments to guide prescription choice to baseline report



### EYE-LEVEL

Preferred antimicrobial(s) displayed at the top of list

# Background/Rationale

---

- St. Joseph's Health Centre – 400 Bed Community Teaching Hospital in Toronto
- Target fluoroquinolones
  - High usage
  - *C. difficile* Infections/Outbreaks
  - High rates of resistance
- In February 2011, we initiated a selective reporting policy aimed at reducing use of fluoroquinolones

Langford BJ, Seah J, Chan A, Downing M, Johnstone J, Matukas LM. Antimicrobial Stewardship in the Microbiology Laboratory: Impact of Selective Susceptibility Reporting on Ciprofloxacin Utilization and Susceptibility of Gram-Negative Isolates to Ciprofloxacin in a Hospital Setting. *Journal of Clinical Microbiology*. 2016;54(9):2343-7.

# Selective Reporting of Ciprofloxacin

- Can you spot the difference?

Before



After

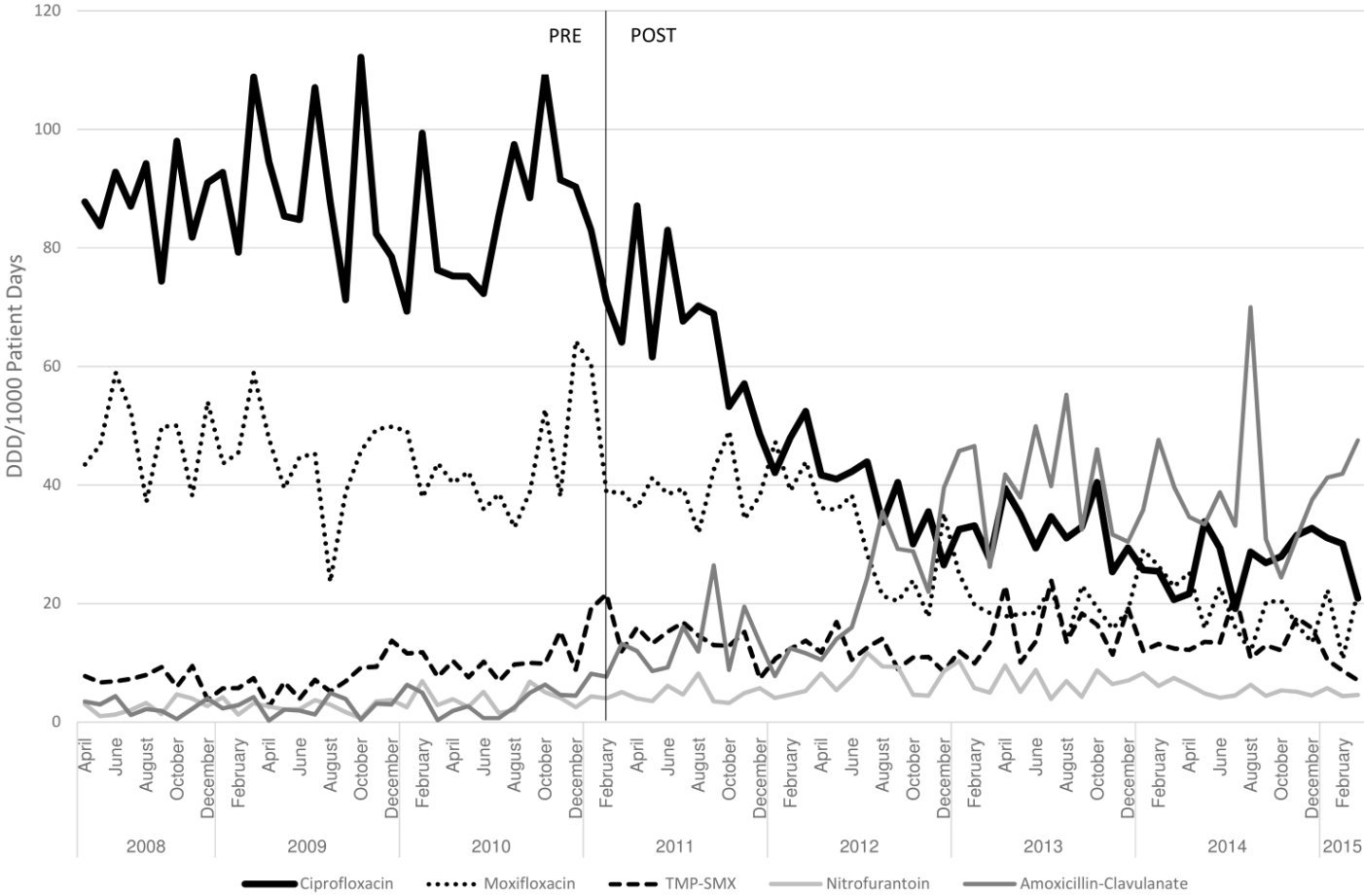
Culture Urine	Escherichia coli >100 x E6 CFU/L.	Culture Urine	Escherichia coli >100 x E6 CFU/L.
Ampicillin:	S	Ampicillin:	S
Cefazolin:	S	Cefazolin:	S
Ciprofloxacin:	S	Gentamicin:	S
Gentamicin:	S	Nitrofurantoin :	S
Nitrofurantoin :	S	Tobramycin :	S
Tobramycin :	S	Trimethoprim/Sulfa:	S
Trimethoprim/Sulfa:	S		

# Methods

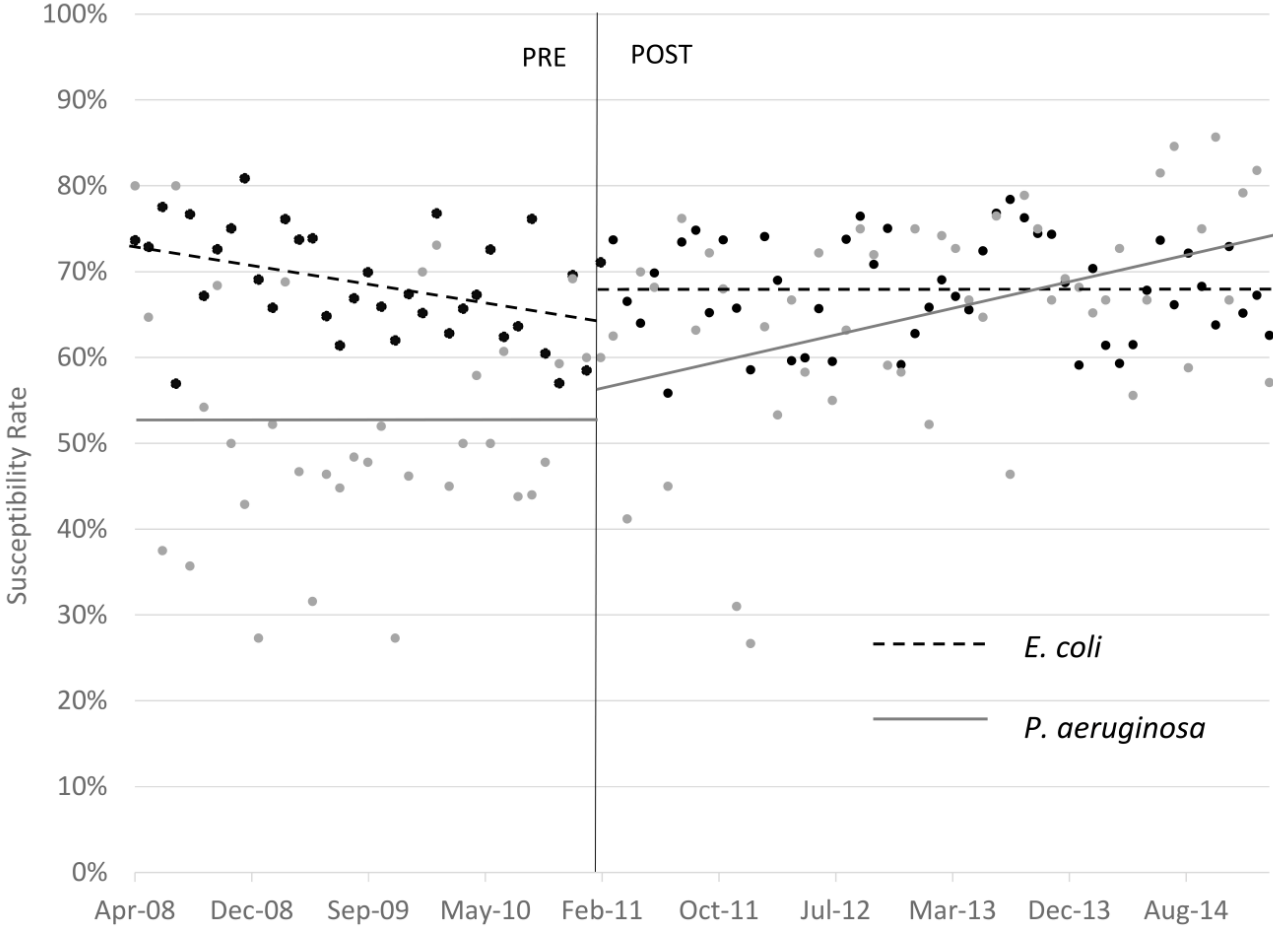
---

- **Primary Outcome:** Antibiotic Use Per 1000 Patient Days (measured in Defined Daily Doses)
  - Ciprofloxacin
  - Moxifloxacin
  - TMP-SMX
  - Nitrofurantoin
  - Amoxicillin-Clavulanate
- **Secondary Outcome:** % Susceptibility to Ciprofloxacin
  - *E. coli*
  - *P. aeruginosa*

# Results - Antibiotic Utilization



# Results – Antibiotic Susceptibility



# Discussion

---

## Strengths

- Rigorous assessment of selective reporting as part of an ASP
  - Reduced fluoroquinolone use
  - Reduced resistance
- Address class of antimicrobial with significant risk of harm (fluoroquinolones)

## Limitations

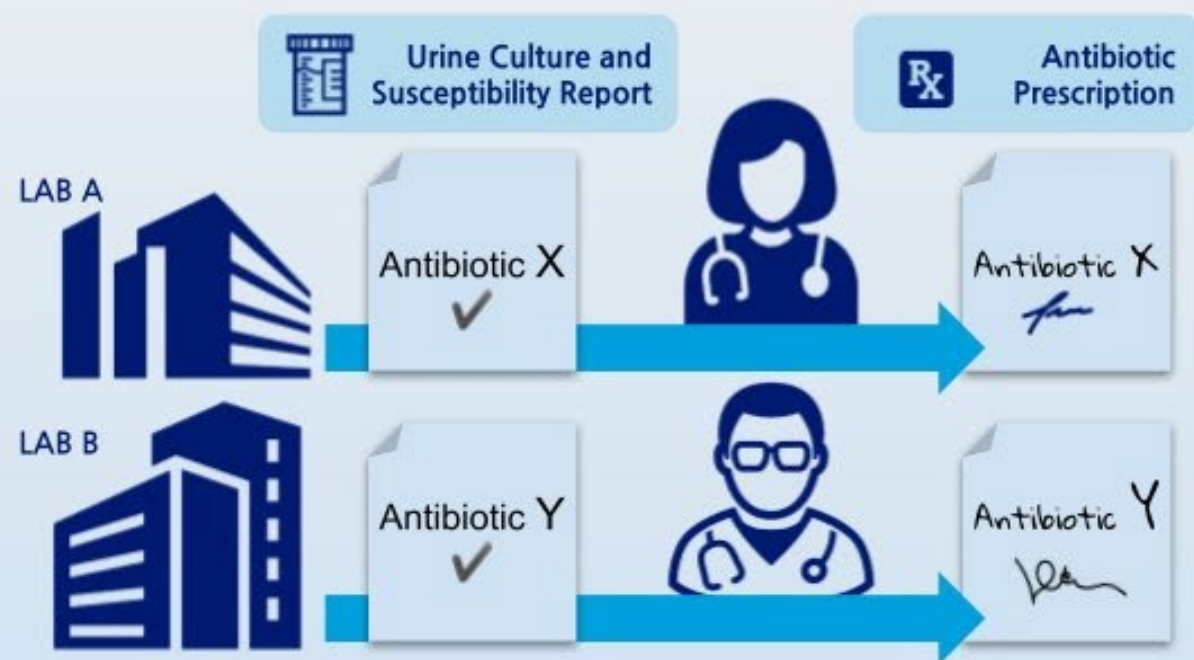
- Numerous confounders
- Non-automated process
- Generalizable to urinary cultures
- “Squeezing the balloon”: shift of antibiotic use from one class to another

# Laboratory reporting practices influence antibiotic prescribing

## Out of Sight, Out of Mind?

Of over 100,000 positive urine cultures from 48 outpatient laboratories in Ontario, there was wide variability in the reporting of antibiotic susceptibility results. Laboratories reported different numbers and types of antibiotics. When an antibiotic was shown on a laboratory report, the physician was **three-fold** more likely to prescribe that antibiotic.

These research findings support opportunities for laboratories to help improve antibiotic stewardship in outpatients.



Langford BJ, Daneman N, Diong, C, Marchand-Austin A, Adomako K, Saedi A, Schwartz KL, Johnstone J, MacFadden DR, Matukas, LM, Patel SN, Garber G, Brown KA. Clinical Microbiology and Infection. 2020. <https://doi.org/10.1016/j.cmi.2020.10.001>



### BASELINE/DEFAULT

All tested reported antimicrobials in alphabetical order

VS

**Framework of nudging strategies** to apply to antimicrobial susceptibility reports in various clinical scenarios, to further study methods of optimizing prescribing



### SELECTIVE

Restricted list of preferred antimicrobial option(s)



### FRAMING

Addition of written comments to guide prescription choice to baseline report



### EYE-LEVEL

Preferred antimicrobial(s) displayed at the top of list

# Microbiology Comment Nudge Improves Pneumonia Prescribing

–Musgrove et al; OFID 2018

---

- to assess the impact of a microbiology comment highlighting the absence of *Staphylococcus aureus*/MRSA and *P. aeruginosa* in respiratory culture
- implementing the microbiology comment would reduce antimicrobial therapy targeting MRSA and *P. aeruginosa*
  - “commensal respiratory flora”  
vs
  - “commensal respiratory flora only: No *S. aureus*/MRSA or *P. aeruginosa*.”

# Results

---

	Pre	Post	P value
De-escalation	41 (39%)	77 (73%)	<0.001
MRSA Tx de-escalation	39 (37%)	75 (71%)	<0.001

**A simple, behavioral nudge in microbiology reporting increased de-escalation**

Duration of therapy	7 days	5 days	<0.001
Acute kidney injury	33 (31%)	15 (14%)	0.003

# Examples of Framing

Aim	Examples from Micro Reports
Appropriate antimicrobial choice for targeted therapy usually leading to de-escalation	<ul style="list-style-type: none"><li>- Give information on PK/PD</li><li>- Poor penetration of aminoglycosides in resp tract</li><li>- Suggest restricted choice and higher dose for CNS infection</li><li>- Use symbols for broad (← →) and narrow spectrum (→←) abx</li><li>- Suggest cefazolin dosing for gnb infections</li></ul>
Avoiding treatment of colonizing microorganisms	<ul style="list-style-type: none"><li>- Report <i>Candida</i> spp. in resp as colonization</li><li>- Present <i>S. aureus</i> in upper resp tract as potential colonizer</li><li>- Present bacteria isolated in catheter urines as probable colonizers</li><li>- Present typical skin flora in single BC sets as potential contaminants</li></ul>

# Examples of Framing

Aim	Examples from Micro Reports
Appropriate duration	<ul style="list-style-type: none"><li>- Add duration of therapy for:<ul style="list-style-type: none"><li>- <i>S. aureus</i> (at least 14 days for uncomplicated infection)</li><li>- Candidemia (at least 14 days from first neg BC)</li><li>- M. Tb (link to treatment guidelines)</li></ul></li></ul>
Additional diagnostic measures	<ul style="list-style-type: none"><li>- Suggest follow BC and echo for <i>S. aureus</i> bacteremia</li><li>- Suggest colonoscopy in patients with <i>Streptococcus gallolyticus</i> subsp <i>gallolyticus</i> bacteremia</li><li>- Suggest possible prosthesis infection when repeatedly isolating CNST in BC</li></ul>

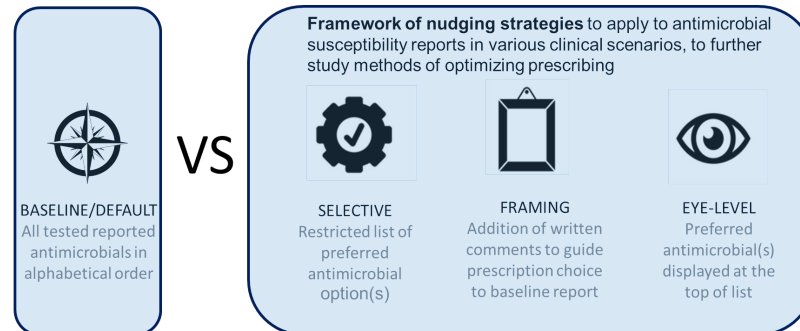
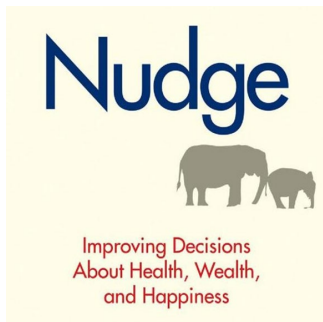


Antimicrobial resistance threatens the very core of modern medicine and the sustainability of an effective, global public health response to the enduring threat from infectious diseases.



The Core Elements of  
**Hospital Antibiotic Stewardship  
Programs: 2019**

- **Action: Microbiology-based Interventions**





# Thank you to our team:

---

## AHSC AFP Innovation Fund: joint MOH + OMA

Dr. Larissa Matukas

Dr. Linda Taggart

Dr. Bradley Langford

Dr. Reem Haj

Dr. Elizabeth Leung

Dr. Mark McIntyre

Dr. Mark Downing

Dr. Kevin Brown

Dr. Aaron Scherer

Duncan Westwood

Jenna Wong

Daniella Castellan

Keerthika Selvakumar

Esther Jeong

Vaishnav Sivakumar