



How Can Antimicrobial Resistance (AMR) Surveillance Inform Public Health?

James Brooks MD, FRCPC
Centre for Communicable Diseases and Infection Control
Public Health Agency of Canada



Disclosures

- No disclosures or conflicts of interest to declare.

Outline

1. The issue of AMR and the intersection of Public Health.
2. Is AMR lower on the Public Health agenda?
3. National AMR trends potentially driven by community factors.
4. Examples of community health drivers influencing AMR.
5. The way forward...

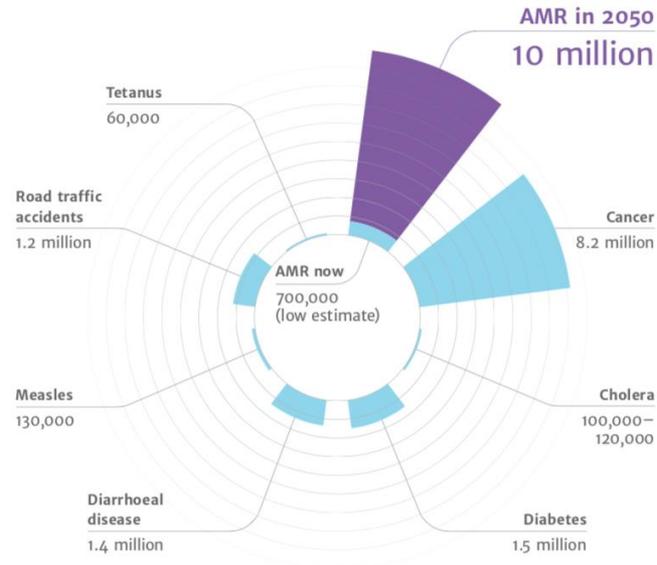
UN General Assembly Political Declaration on Antimicrobial Resistance, September 2016

Antimicrobial resistance poses a fundamental threat to human health, development, and security. The commitments made today must now be translated into swift, effective, lifesaving actions across the human, animal and environmental health sectors. We are running out of time.

Margaret Chan, DG-WHO

How Big a Problem is AMR?

DEATHS ATTRIBUTABLE TO AMR EVERY YEAR



https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf

Public Health Issues and AMR

- Communicable Diseases
 - GC
 - Typhoid
 - Foodborne Outbreaks
- Global Health
 - TB
 - HIV
 - Malaria Outbreaks

All of these are shaped by AMR

Model of **Integrated** One Health Surveillance System

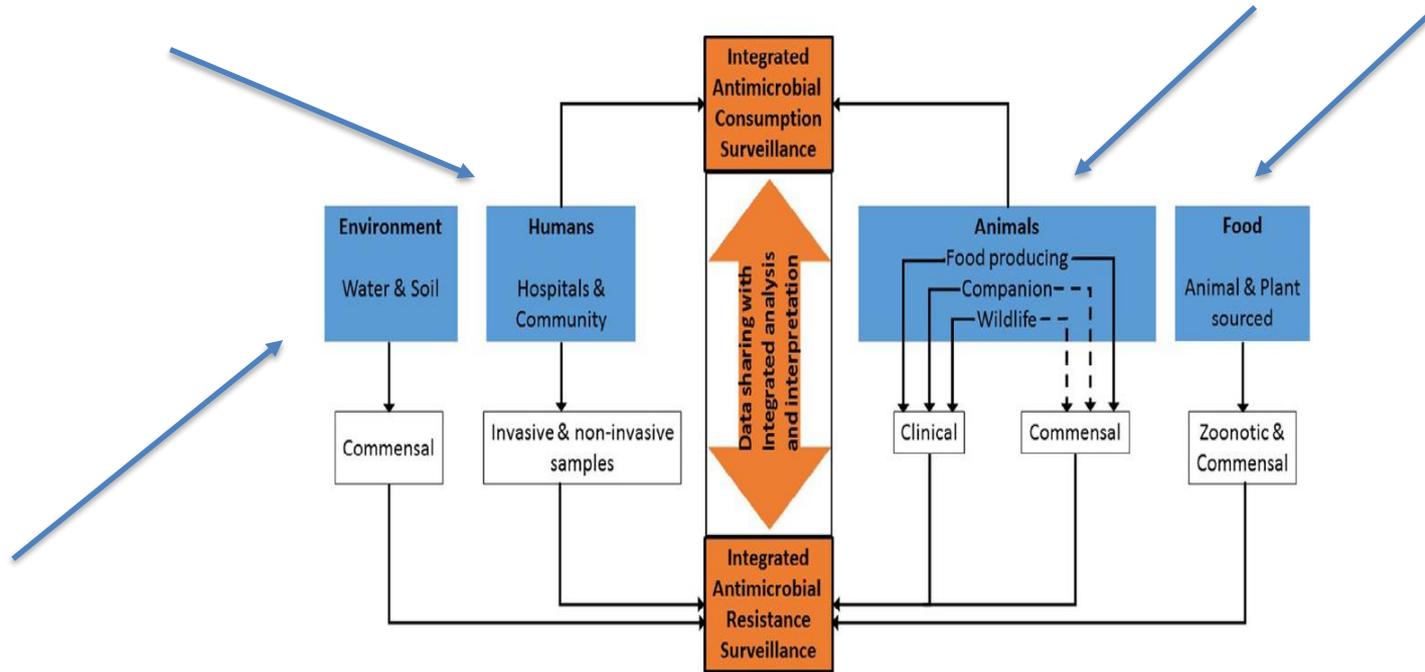
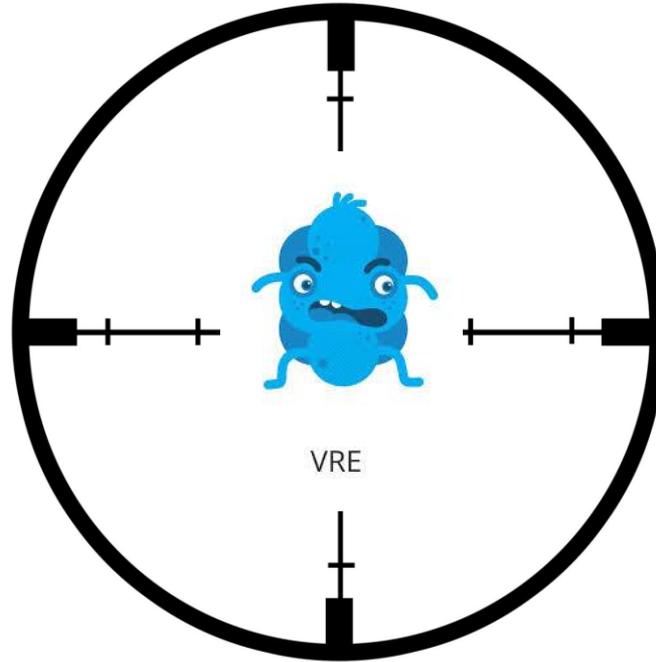


Fig. 1. An interconnected and integrated One Health surveillance framework that puts at its centre antimicrobial resistance and antimicrobial consumption.

Queenan, et al. *International Journal of Antimicrobial Agents* 48 (2016) 422–427

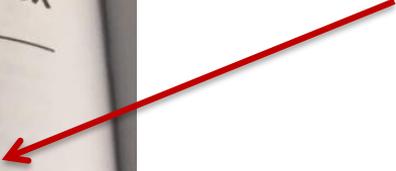
AMR Should be Squarely in the Sights of Public Health



AMR in Public Health Textbooks



resistance, 52, 58, 158
overuse, 141, 257, 474
Antibodies, 155b
Anticipatory counseling, 352
Antigenic drift, 165
Antigens, 155b
95 Ante natal care, 830
On the Antiseptic Principle in the Practice of Surgery (Lister), 20
Antisepsis, 20
Antisera, 155b
ome), Anti-Submarine Detection Committee (ASDIC), 619
Antitoxins, 155b
Anxiety, 383b–384b
y APHA. *See* American Public Health Association
APHA. *See* Agency for Public Health



Index

anti-microbial resistance (AMR), 7, 430
antiretrovirals (ARVs), 461–2; market for, 462–5
avian influenza (AI), 34, 313, 321

Basic Package of Health Services (BPHS), 233–4
bilateral aid, 481
Bill & Melinda Gates Foundation (BMGF), 2, 26, 122, 332, 379, 428, 475, 492, 510; global health commitments and disbursements, 335; grant for Child Vaccine Program, 56
birth attendants, training and support for, 361
blood lead level (BLL), 154–7, 159
Body Mass Index (BMI), 255, 261–2, 304
Brazil Family Health Programme, 113, 114
British American Tobacco (BAT), 32

Campaign for Access to Essential Medicines, 59
carbon monoxide, 164, 166, 167
cardiovascular diseases (CVD), 213, 365–7
cataract, 346–9
Cataract Surgical Rate (CSR), 346–8

Apparent Disconnect of Public Health and AMR in Canada?

“The world is facing an antibiotic apocalypse.”

Dame Sally Davies.

Communicable and Infectious Diseases

Print  Share  A- A A+

Home / Professionals and Partners / Physicians and Health Care Professionals / Communicable and Infectious Diseases

Health care provider information by Disease

- [Blastomycosis, information for health care providers](#)
- [Echinococcus multilocularis - Alveolar Echinococcosis](#)
- [Influenza, information for health care providers](#)
- [Lyme Disease, information for health care providers](#)
- [Measles, laboratory testing information](#)
- [Mumps, laboratory testing information](#)
- [Pertussis, case and contact management guidelines](#)
- [Rabies, Rabies Immune Globulin \(Rablg\) and Rabies vaccine quick reference guide to administration](#)
- [West Nile Virus, information for health care providers](#)

Health care provider information by Topic

- [Management of exposures to blood borne pathogens](#)
- [Reporting a communicable disease](#)
- [Schools and Child Care Centres \(CCC\) guidelines for communicable disease and other childhood health issues](#)

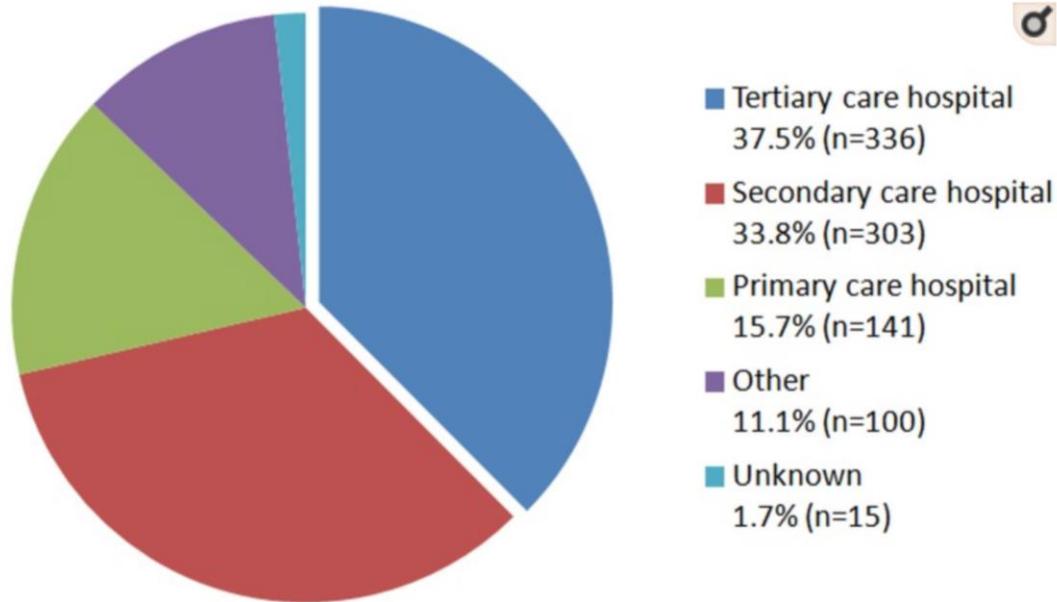


Three Possible Reasons for the Disconnect

- The Boy Who Cried Wolf
- Clinical Disconnect
- A Hidden Epidemic

The Boy Who Cried Wolf

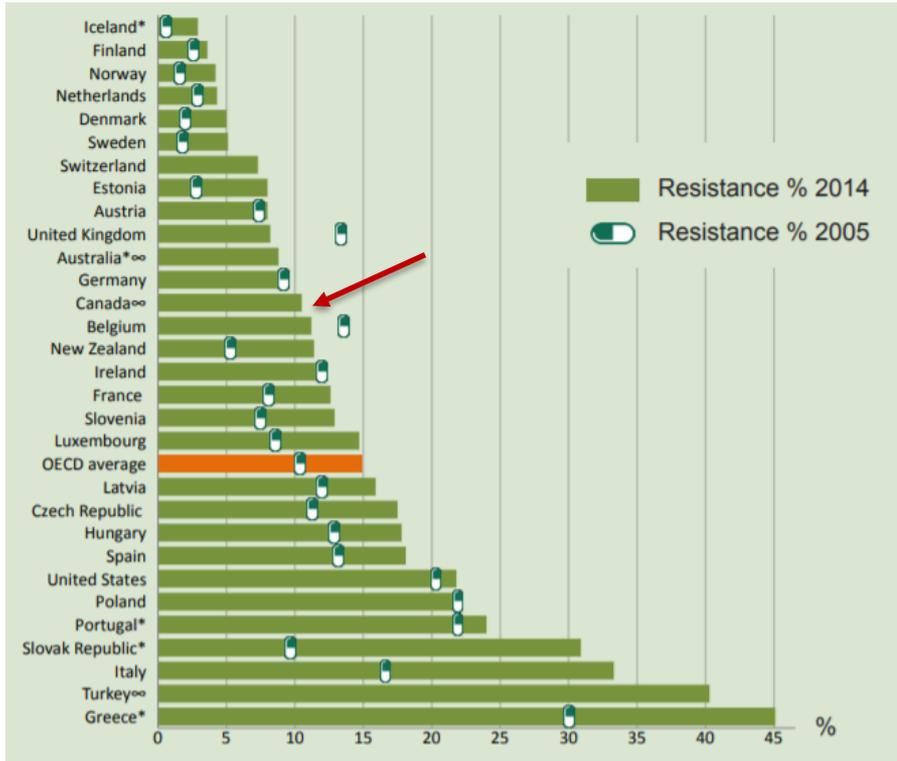
Accurate Projections for AMR Associated Deaths?



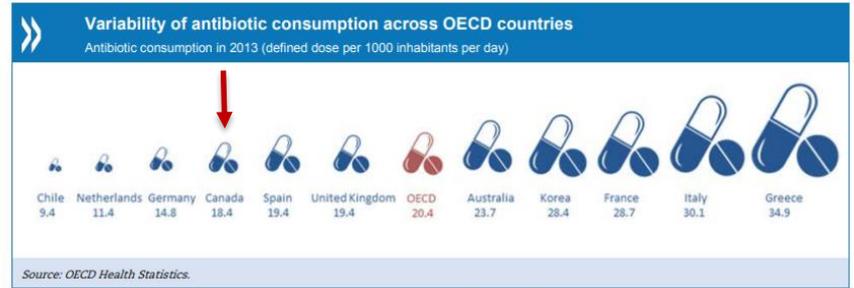
The distribution of hospital care level among hospitals reporting antimicrobial susceptibility and denominator data (subset of all hospitals) to EARS-Net (2013/2014) [6].

de Kraker et al. PLoS Med. 2016

AMR in Canada has not reached critical proportions



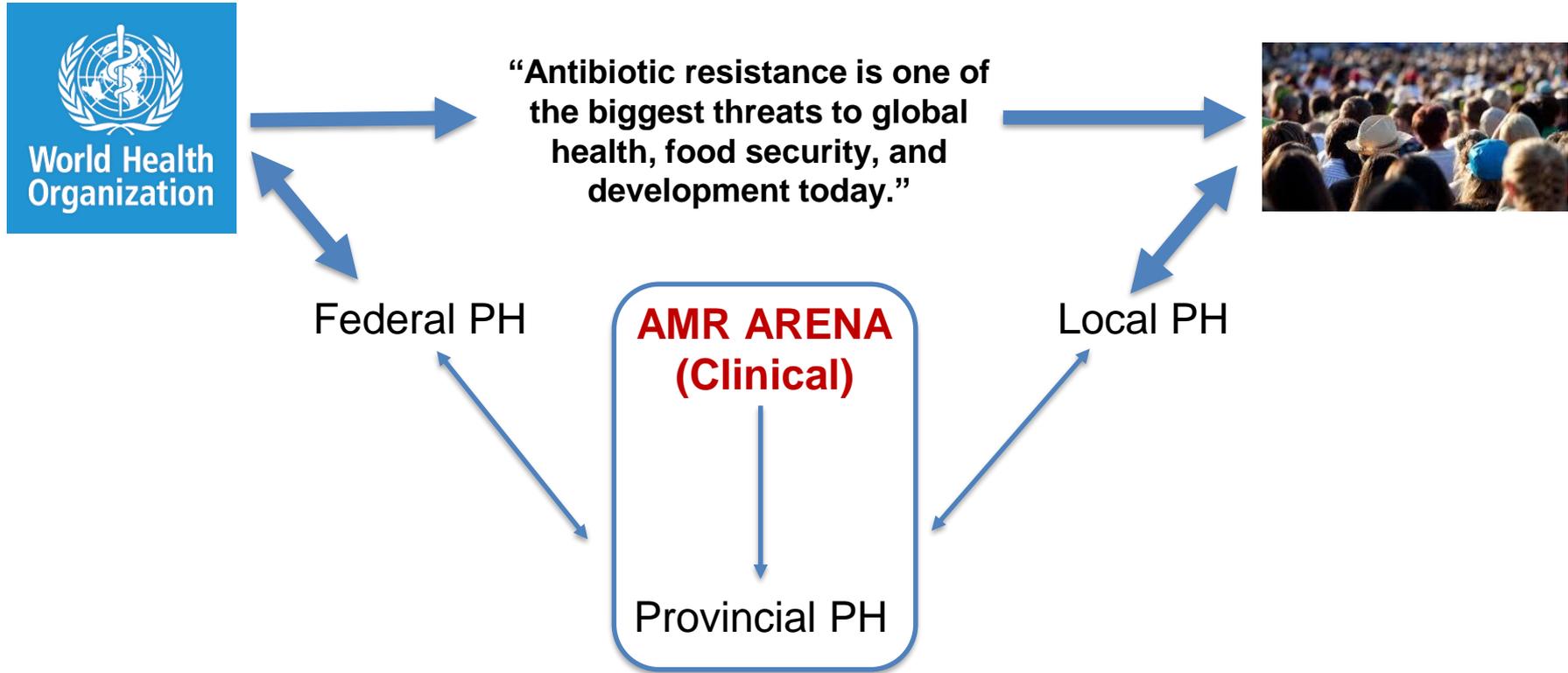
OECD



The status of AMR in Canada is due to foresight and the early efforts of engaged stakeholders.

Clinical Disconnect

Public Health Involvement in Human AMR and Accountability



A Hidden Epidemic

Context for Numbers of AMR Associated Deaths

- 1.6 million people died in 2017 from TB
- 940,000 died in 2017 from HIV
- 430,000 died in 2015 from Malaria

700,000 deaths due to AMR in 2016

<https://www.who.int/features/factfiles/malaria/en/>

https://www.who.int/gho/hiv/epidemic_status/deaths_text/en/

<https://www.tballiance.org/why-new-tb-drugs/global-pandemic>

https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf

Not a Problem Unique to Canada

- Public health organizations tend to be involved in the implementation of AMR policies, **but their involvement is often not coordinated**... across the different services that need to be involved.
- The report on England, for example, describes the **role and action of local public health organizations in implementing AMR activities as being limited and patchy; few have set up local committees mirroring activities at the national level.**

The role of public health organizations in addressing public health problems in Europe: The case of obesity, alcohol and antimicrobial resistance. Health Policy Series, No. 51.

Rechel B, Maresso A, Sagan A, et al., editors.

Copenhagen (Denmark): [European Observatory on Health Systems and Policies](#); 2018.

National AMR Surveillance and Its Connection to Communities

- National trends in AMR
- Examples of how factors in the community can drive these trends



CARSS – Canadian Antimicrobial Resistance Surveillance System

AMR in human populations

- Carbapenemase-producing *Enterobacteriaceae*
- *Clostridioides difficile*
- Methicillin-resistant *Staphylococcus aureus*
- Vancomycin-resistant *Enterococcus* spp.
- *Streptococcus pyogenes*
- *Streptococcus pneumoniae*
- *Neisseria gonorrhoeae*
- *Mycobacterium tuberculosis*
- Typhoidal *Salmonella enterica*
- Non-typhoidal *Salmonella enterica*

AMR in retail meat

- *Campylobacter* spp.
- *Salmonella* spp.
- *Escherichia coli*

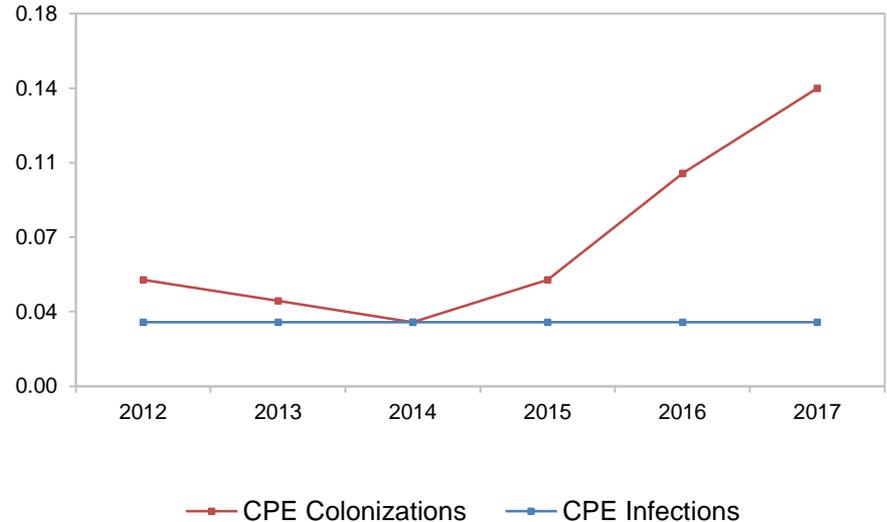
AMU

- Antimicrobials dispensed in the community for use in humans
- Antimicrobials purchased by hospitals for use in humans
- Antimicrobials for use in food-producing and companion animals and crops

Carbapenemase-producing Enterobacteriaceae (CPE)

- CPE infection rates remained low and stable
- CPE colonization rates have increased almost five-fold (people who carry CPEs, but did not have an infection)
- This is a growing public health concern because the colonizing bacteria can be transmitted to others

Rates of CPE, 2012-2017 (per 10,000 patient-days)



Stealth Introduction of CPOs into the Community

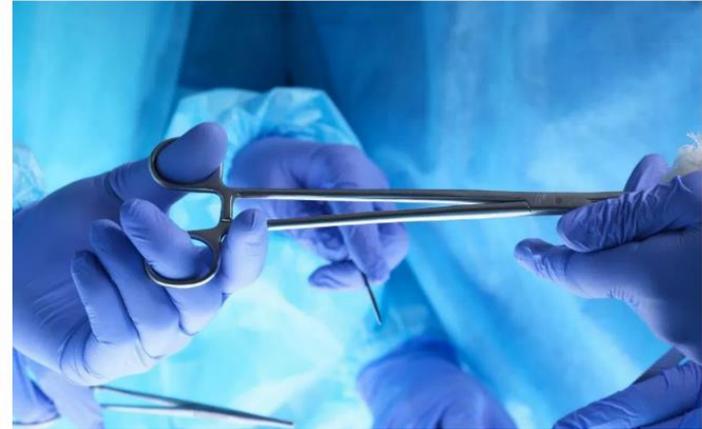
- 80,000 Canadians sought medical care outside of Canada in 2015
- Bariatric surgery among the leading procedures
- Patients had surgery in Tijuana were exposed to XDR *Pseudomonas aeruginosa*
- These people come into your hospitals, work in LTCF, prepare your food
- A role for community IPC?

Conference Board of Canada 2015

NATIONAL POST

At least 30 Canadians at risk of potentially deadly infection after weight loss surgery in Mexico

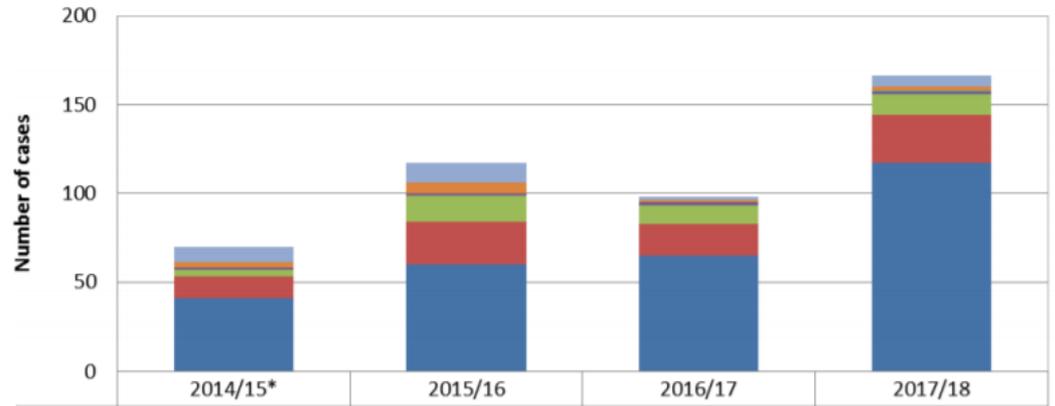
On top of the deadly bacterial infection, the health agency is also warning those patients about HIV, hepatitis B and hepatitis C



CPOs in British Columbia (PICNet data)

- 60% of new cases in 2017/18 reported healthcare exposure outside of Canada
- Yesterday's patient is today's community member

Figure 15. Number of cases of CPO newly identified in BC by carbapenemase resistant gene, 2014/15 – 2017/18

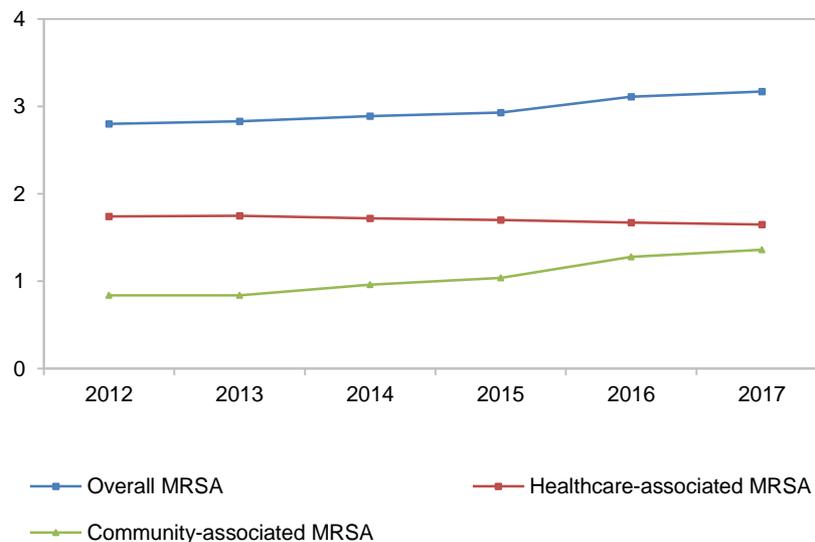


Provincial Infection Control Network of British Columbia (PICNet)
December 2018

Methicillin-resistant *Staphylococcus aureus* (MRSA)

- Overall MRSA infection rates increased by 13% since 2012
 - MRSA infections in hospitals have declined 6%
 - MRSA infections that came from the community have increased 62%
- The rate of more serious and invasive MRSA infections (i.e. blood stream infections) remained high in paediatric hospitals

Figure 3. Rates of MRSA, 2012-2017
(per 10,000 patient-days)



RESEARCH ARTICLE

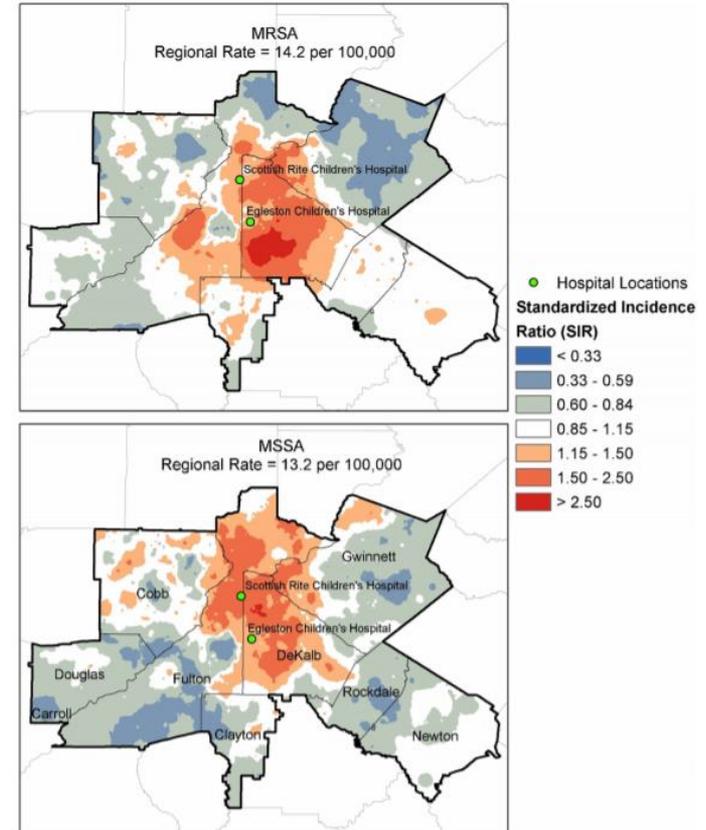
Open Access



Geographic surveillance of community associated MRSA infections in children using electronic health record data

Lilly Cheng Immergluck^{1,2*}, Traci Leong³, Kevin Matthews⁴, Khusdeep Malhotra⁵, Trisha Chan Parker¹, Fatima Ali¹, Robert C. Jerris^{2,6} and George S. Rust⁷

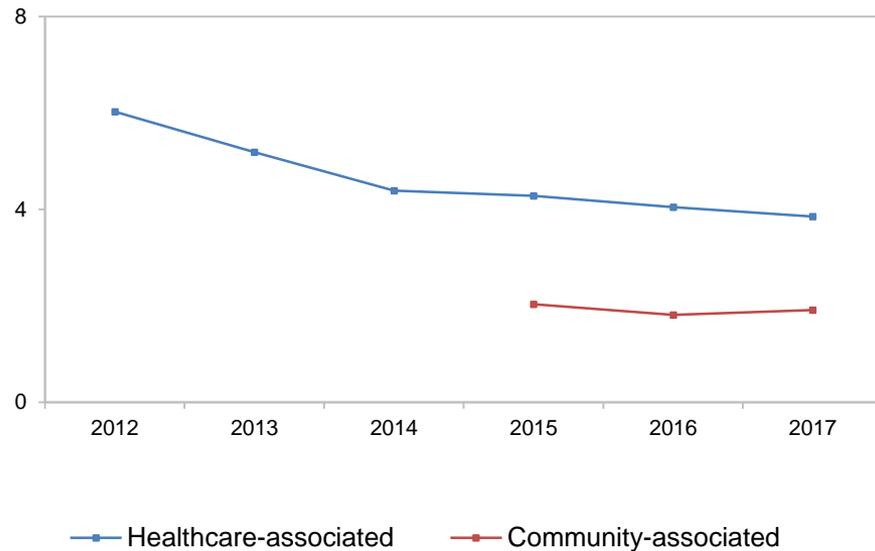
- 10,500 children with *S. aureus* infections at a hospital in Atlanta from 2002-2010.
- Looked at geospatial effects on the MRSA v. MSSA infection
- Risks for MRSA were driven by social determinants of health
 - Black
 - Overcrowding
 - Younger age



Clostridioides difficile infection (CDI)

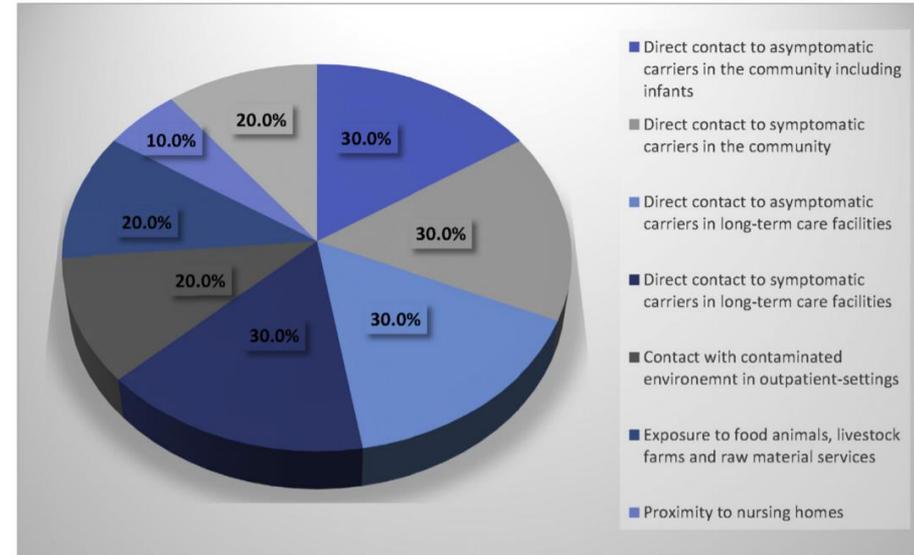
- CDI rates have declined 40% since 2012
- Among people in hospital who had CDI, one-third of these infections came from the community

Figure 2: Rates of CDI, 2012-2017



***C. difficile* transmission in the community**

- Colonization necessary but not sufficient condition for CDI
- Fecal-oral transmission
- 30% CDI community presentation
- Routes of transmission
 - Person to person
 - LTCF
 - Farm exposure



A. Durovic et al. / *Clinical Microbiology and Infection* 24 (2018) 483–492

AMR Gonorrhoea

BBC Sign in News Sport Weather Shop Reel Travel Mo

NEWS

Home Video World US & Canada UK Business Tech Science Stories Entert

Health

Man has 'world's worst' super-gonorrhoea

By James Gallagher
Health and science correspondent, BBC News

28 March 2018

f WhatsApp Twitter Email Share



The image shows a close-up of a person's hand reaching into the pocket of their blue denim jeans. A bright yellow condom is visible, partially tucked into the pocket. The person is wearing a grey t-shirt. The background is blurred, suggesting an indoor setting.

One Model for Public Health and AMR



More Fundamental Community Drivers of AMR

- Effects of Community AMU on AMR
- What could be root cause drivers of AMR in communities?

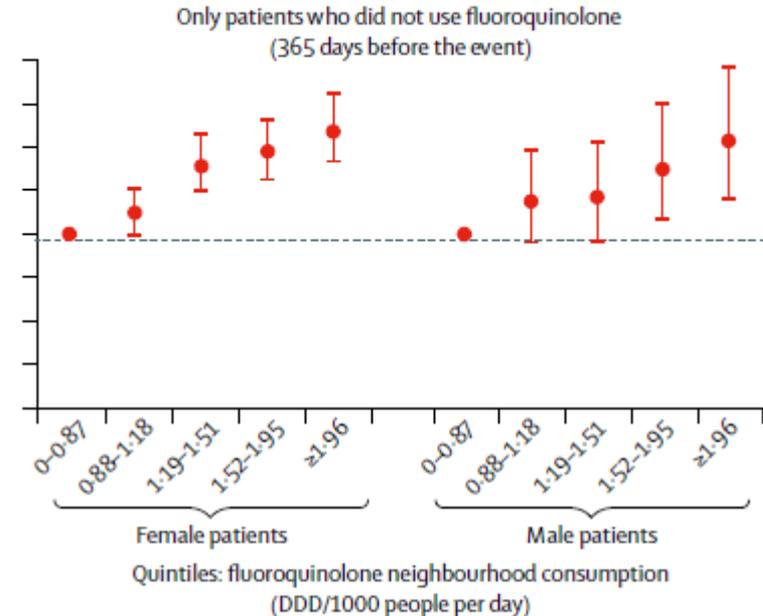


Association between urinary community-acquired fluoroquinolone-resistant *Escherichia coli* and neighbourhood antibiotic consumption: a population-based case-control study

Marcelo Low, Ami Neuberger, Thomas M Hooton, Manfred S Green, Raul Raz, Ran D Balicer, Ronit Almog

- Tested the association between neighbourhood fluoroquinolone consumption and the probability of having FQ-R *E coli* in urine cultures.
- More than 2.5 million urine culture results.
- Increased risk of acquiring fluoroquinolone-resistant *E. coli* in neighbourhoods with higher fluoroquinolone consumption, independent of previous personal use of antibiotics.

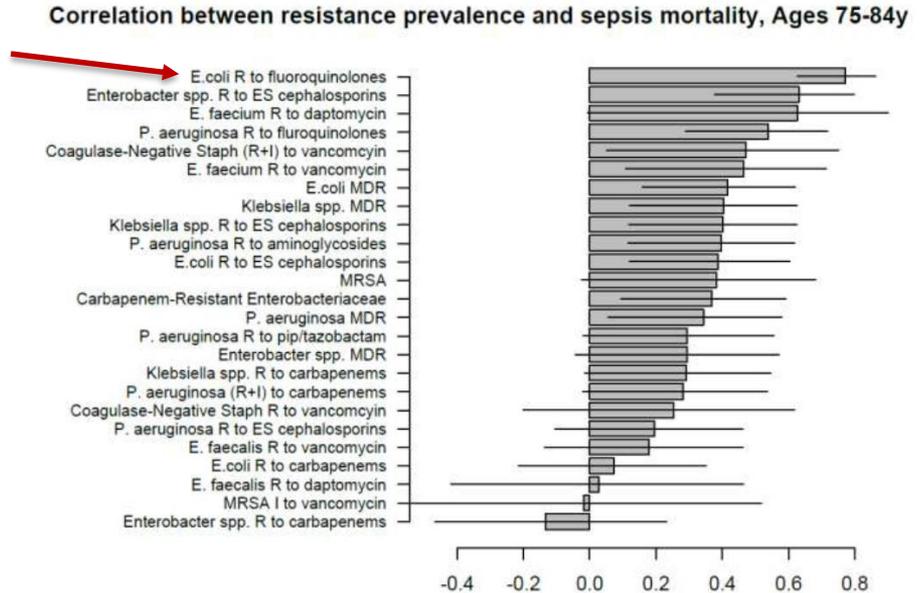
B Adjusted odds ratio (95% CI) associated with FQ-RE *coli*



Lancet Infect Dis 2019

Significance of FQ-R *E.coli* in a community

- Looked at the rates of mortality and septicemia in 50 states in the US, 2013-2014
- Compared with a database containing CA-UTI culture results from approximately the same period of time.
- Among all age groups <85yo, FQ-R *E. coli* strongly associated with sepsis and mortality from sepsis



Goldstein. *International Journal of Antimicrobial Agents* 2019

AMR is Driven by Core Public Health Metrics

- Metagenomic analysis of untreated sewage to characterize the bacterial resistome from 79 sites in 60 countries.
- Metagenomics=sequencing DNA of all organisms in the sample
- Resistome=the AMR genes identified from all organisms



ARTICLE

<https://doi.org/10.1038/s41467-019-08853-3>

OPEN

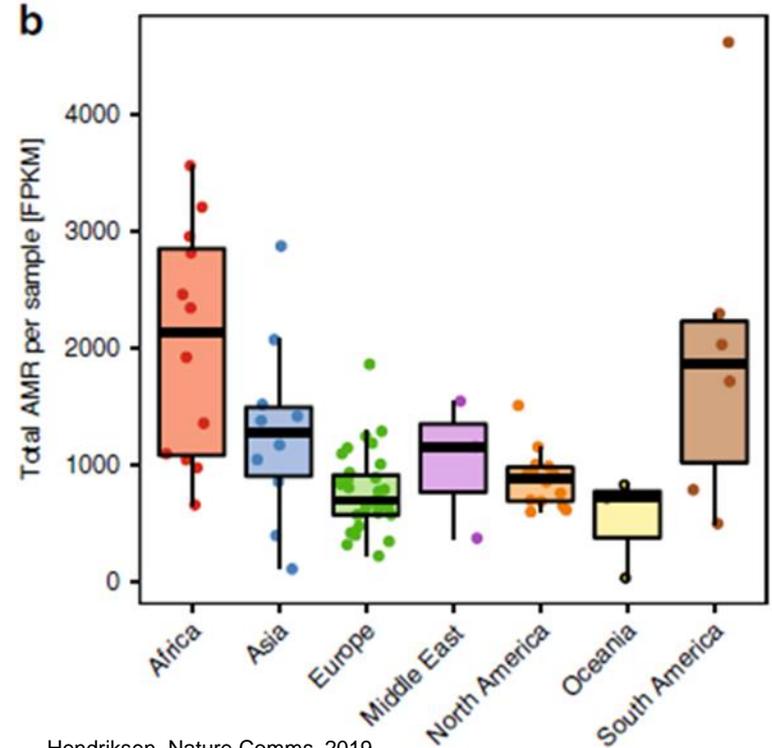
Global monitoring of antimicrobial resistance based on metagenomics analyses of urban sewage

Rene S. Hendriksen¹, Patrick Munk ¹, Patrick Njage¹, Bram van Bunnik ², Luke McNally³, Oksana Lukjancenko¹, Timo Röder¹, David Nieuwenhuijse⁴, Susanne Karlsmose Pedersen¹, Jette Kjeldgaard¹, Rolf S. Kaas¹, Philip Thomas Lanken Conradsen Clausen¹, Josef Korbinian Vogt¹, Pimlapas Leekitcharoenphon¹, Milou G.M. van de Schans⁵, Tina Zuidema⁵, Ana Maria de Roda Husman⁶, Simon Rasmussen ⁷, Bent Petersen⁷, The Global Sewage Surveillance project consortium[#], Clara Amid⁸, Guy Cochrane⁸, Thomas Sicheritz-Ponten⁹, Heike Schmitt⁶, Jorge Raul Matheu Alvarez¹⁰, Awa Aidara-Kane¹⁰, Sünje J. Pamp¹, Ole Lund⁷, Tine Hald¹, Mark Woolhouse², Marion P. Koopmans⁴, Håkan Vigre¹, Thomas Nordahl Petersen¹ & Frank M. Aarestrup ¹

Hendriksen, Nature Comms. 2019

Antibiotic Resistance Varied Across the Globe

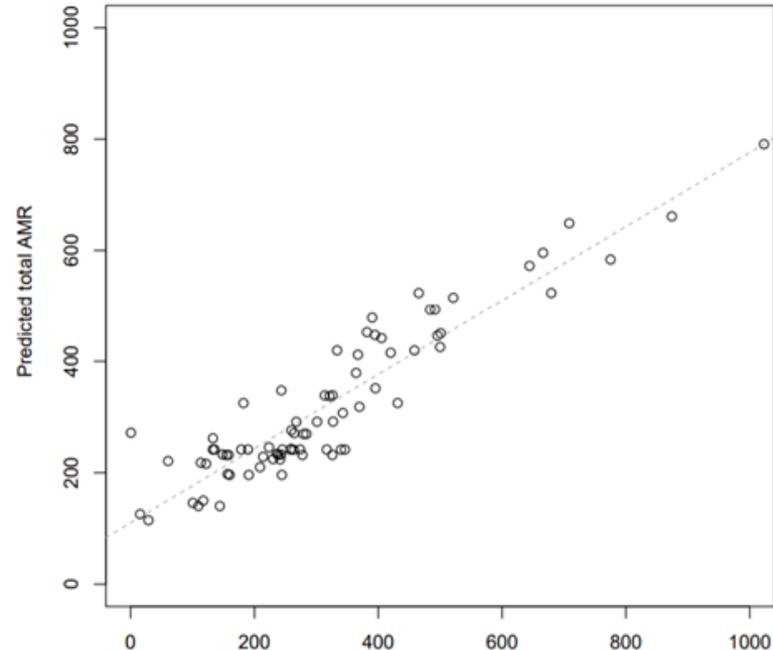
- Africa, Asia and South America had the highest rates of AMR.
- *Not* correlated with AMU.
- This suggests that the total AMR abundance is mainly influenced by local/national parameters



Hendriksen, Nature Comms. 2019

Population Factors Explained most of Global AMR Variation

- World Bank - Health, Population and Development Indicators, eg.
 - Mortality rate
 - Death due to communicable disease
 - Infant mortality
 - Sanitation
- “Improving sanitation, health, and perhaps education as part of the sustainable development could be effective strategies for limiting the global burden of AMR.”

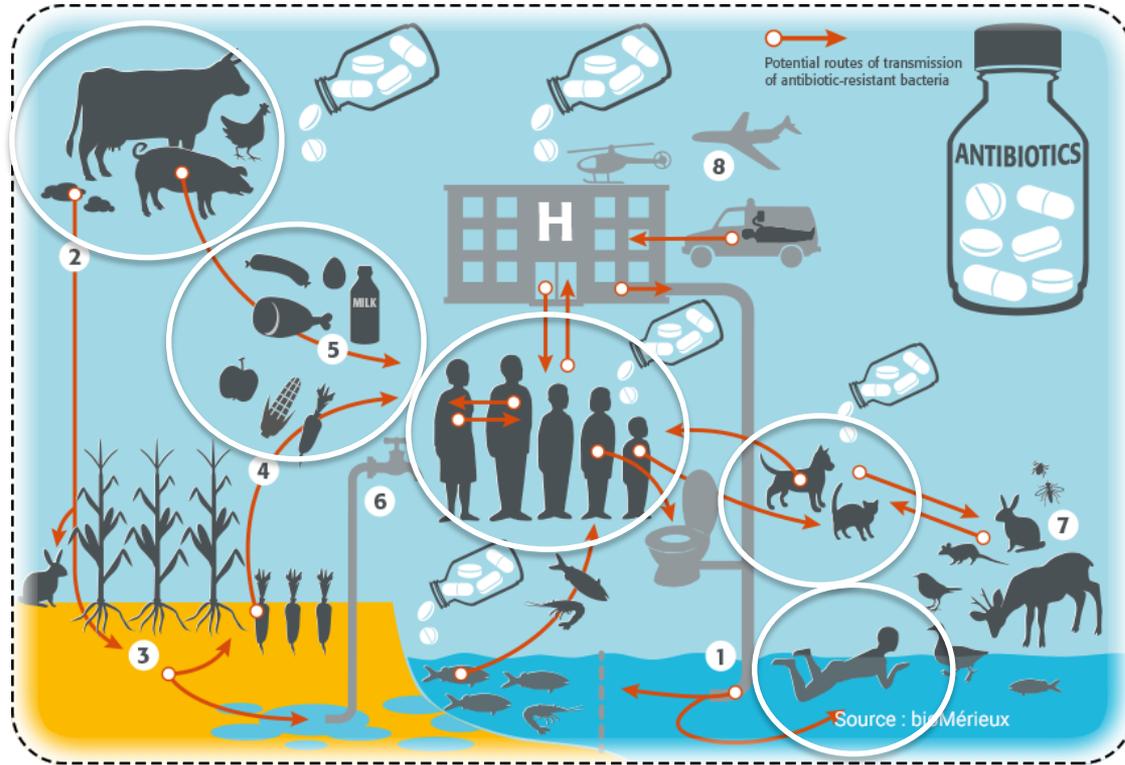


Hendriksen, Nature Comms. 2019

Summary

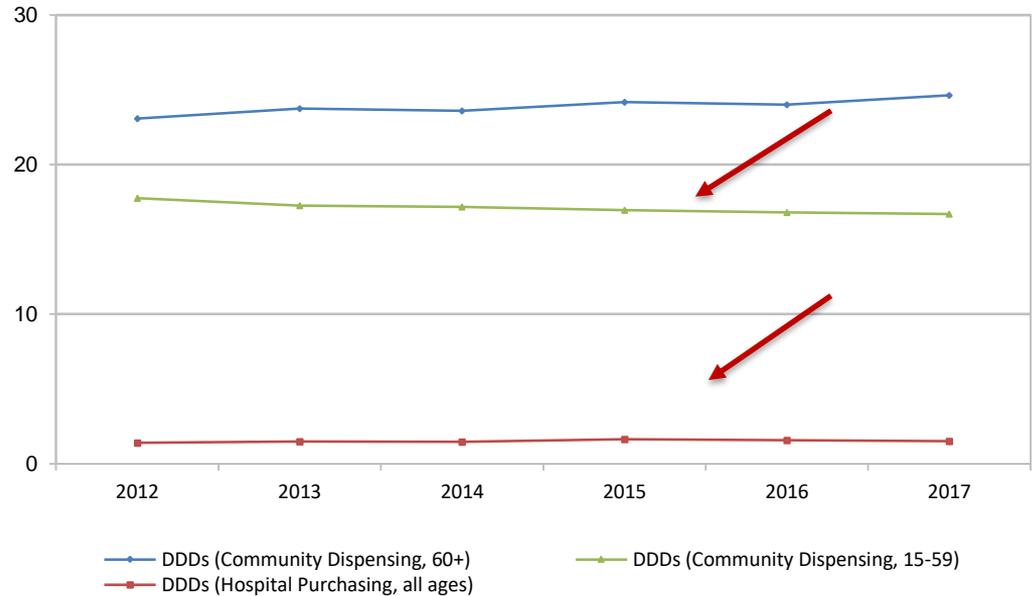
- Described the issue of AMR
- Discussed the disconnect with local public health
- Made the case for PH and AMR
 - issues that clearly overlap with current PH activities
 - indirect of drivers of AMR in the community
- What are some of the engagement points for “on the ground” public health?

AMR Surveillance in Area of Overlap With Existing PH Monitoring



Community Antimicrobial Consumption is Dominant

- Majority of antimicrobials are dispensed through community pharmacies – 92%
 - Community AMU among adults far greater than total hospital antimicrobial purchasing
- However, people who are in hospital are much more likely to be receiving antibiotics than people in the community



Public Health Levers - Antimicrobial Stewardship

- Partner with leads in pharmacy, medical services, and public health offices to initiate or grow AMS programs
- Advocate for AMR surveillance and programs in community settings:
 - Long-term care
 - Prisons
 - Community health clinics
- Use surveillance data for local priority planning (including any data on medical tourism)

Engage in Advocating for Reducing of Antimicrobial Use

Alternate Prescribing Techniques

USE ANTIBIOTICS WISELY
Not All Bugs Need Drugs

Antibiotics don't treat a cold or the flu

Antibiotics should be taken only as directed

Lower your risk of illness by keeping your hands clean and vaccinations up to date.
Talk to your healthcare provider for more information.

CANADA.CA/ANTIBIOTICS

UTILISEZ LES ANTIBIOTIQUES JUDICIEUSEMENT
On n'a pas besoin de pilules pour tous les microbes

Les antibiotiques ne traitent pas le rhume, ni la grippe

Les antibiotiques doivent être pris selon les indications

Réduisez le risque de maladie en gardant vos mains propres et en veillant à ce que vos vaccins soient à jour.
Pour en savoir plus, consultez un professionnel de la santé.

CANADA.CA/ANTIBIOTIQUES

DELAYED PRESCRIPTION

Working Diagnoses:
 Viral upper respiratory tract infection (e.g., common cold)
 Viral bronchitis (cough)
 Viral pharyngitis (sore throat)

Delayed Prescription
 About Your Delayed Prescription
 WAIT. Don't fill your prescription just yet. Your health care provider believes your illness may resolve on its own. Follow the steps below to get better.

First, continue to monitor your symptoms over the next few days and try the following remedies to help you feel better:

- Gargle with salt water.
- Drink plenty of water.
- For a sore throat, use lozenges, throat lozenges or spray, or gargle with salt water.
- For a stuffy nose, use saline nasal spray or drops.
- For fever and pain relief, acetaminophen or ibuprofen.
- Other _____

Wash your hands often to avoid spreading infections.

If you don't feel better in _____ days, go ahead and fill your prescription at the pharmacy.

If you feel better, you do not need the antibiotic and the prescription can be thrown out.

If things get worse, please contact your health care provider.

Antibiotics should only be taken when medically necessary. Unwanted side effects like diarrhea and vomiting can occur, along with destruction of your body's good bacteria that can leave you more susceptible to infections.

To learn more, visit www.chicagoinjurycenter.org/antibiotics

www.antibioticawareness.ca

Antibiotic Awareness Week

The Challenge For The Public For Providers About

Think you need antibiotics?
Think Twice. Seek Advice.

LEARN MORE

THE CHALLENGE

Unnecessary antibiotic use and misuse directly contribute to the rise in resistant bacteria. Antibiotic Awareness Week promotes cautious and correct use of antibiotics to help prevent and control the spread of bacteria that develop resistance to the medications.

Antimicrobial Stewardship Curriculum for Health Professionals

MODULE 1: Consequences of Use of Antimicrobial Agents

Learning Outcomes

By the end of this module, you should be able to

- define, in plain language, the term antimicrobial resistance (AMR).
- explain how the use of antimicrobial agents contribute to the development of AMR.
- identify antimicrobial-resistant organisms (AROs) common to Canadian primary care settings, and
- differentiate between short and long-term harms of antimicrobial use on individual patients and broader community health.

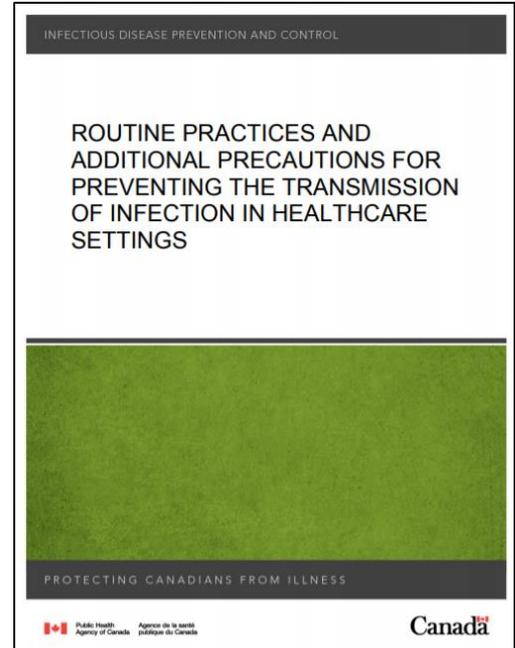
Infection Prevention and Control in Community Settings

Infection prevention and control in home health care: The nurse's bag

Irena Bakunas-Kenneley, PhD, APRN-BC, CIC, and Elizabeth A. Madigan, PhD, RN, FAAN
Cleveland, Ohio

This study evaluates bacterial contamination rates of home health care nurses' bags and the patient care equipment found inside. Nurses' bags—a ubiquitous fomite in the home health care environment—may serve as a potential reservoir for multidrug-resistant organisms.

Copyright © 2009 by the Association for Professionals in Infection Control and Epidemiology, Inc.
(*Am J Infect Control* 2009;37:687-8.)



Alexander Fleming predicts the Public Health responsibilities in AMR

Mr. X. has a sore throat. He buys some penicillin and gives himself, not enough to kill the streptococci but enough to educate them to resist penicillin. He then infects his wife. Mrs. X gets pneumonia and is treated with penicillin. As the streptococci are now resistant to penicillin the treatment fails. Mrs. X dies. Who is primarily responsible for Mrs. X's death?

Alexander Fleming, Nobel Lecture, December 11, 1945