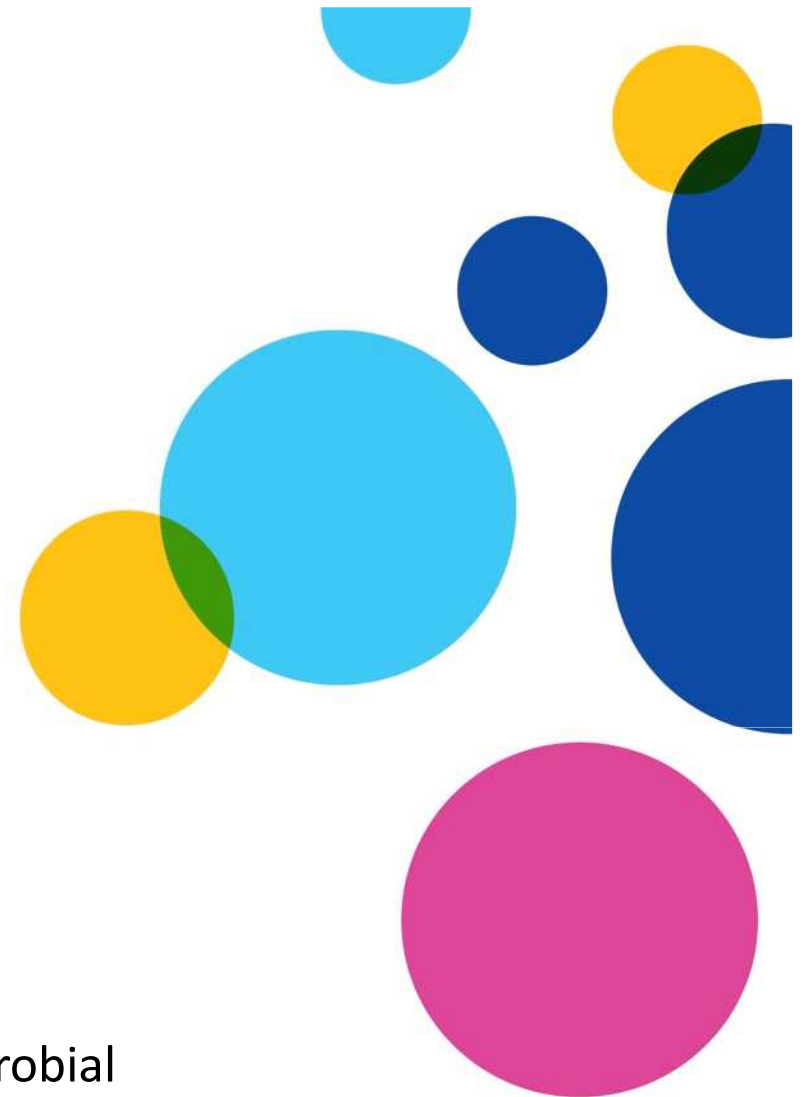


One Health Antimicrobial Stewardship – the challenge of implementation

Professor Karin Thursky

Director, NHMRC National Centre for Antimicrobial
Stewardship

Peter Doherty Institute



stewardship

noun | stew·ard·ship | \ˈstü-ərd-,ship, 'styü-; 'st(y)ürd-\

Popularity: Top 1% of lookups

Examples: STEWARDSHIP in a sentence ▼

Editor's note: Good STEWARDSHIP ▼

Definition of STEWARDSHIP

- 1 : the office, duties, and obligations of a **steward**
- 2 : the conducting, supervising, or managing of something; *especially* : the careful and responsible management of something entrusted to one's care • *stewardship* of natural resources

The scale of the problem



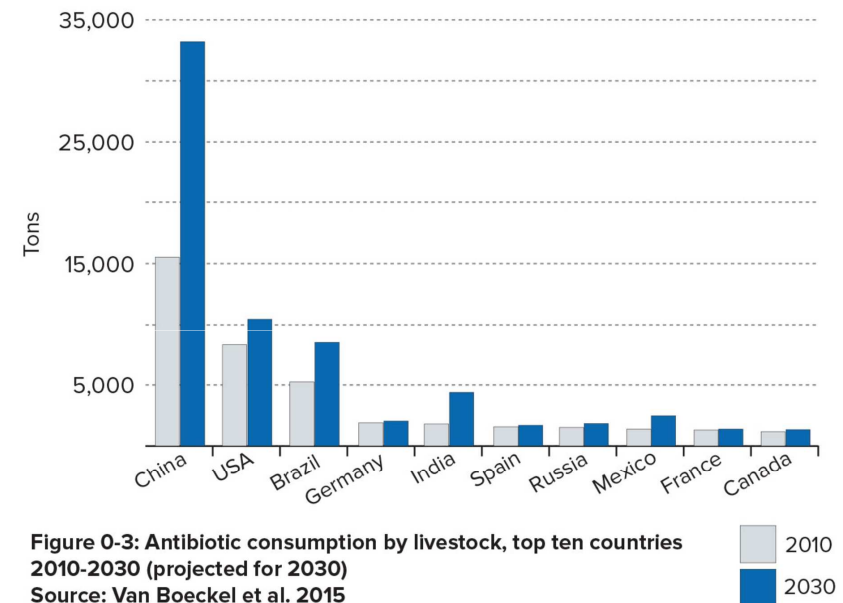
- Animal use:
 - $\frac{3}{4}$ of antimicrobial use is non human
 - Understand gross usage, but not where and how, and why..
- Human use:
 - General practice/ Community - 80% of human use
 - 15% of all GP consultations end in antibiotic prescription
 - Commonest reason is URTI, >80% are viral
 - Aged care - highest intensity of use in community
 - 10% of residents receiving antimicrobial at any time
 - Hospitals - 40% prevalence of antibiotic use
 - 20-50% of use is inappropriate
 - Most common reason is 'prophylaxis'



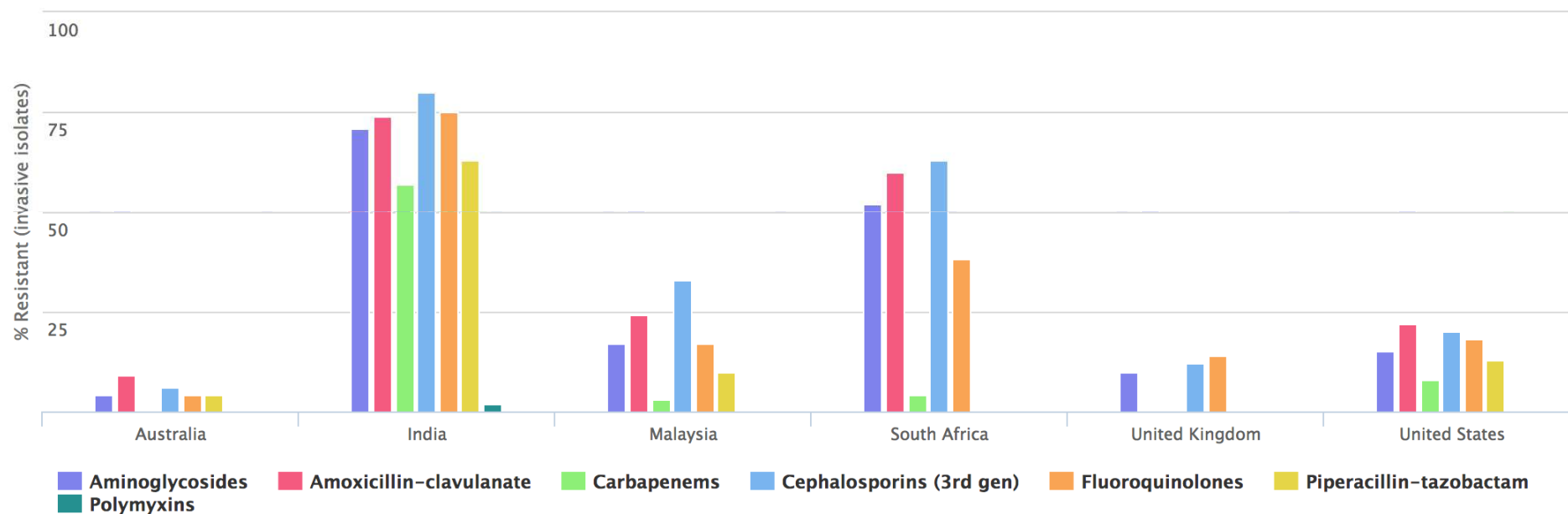
A new sense of urgency



- Identification of the MCR1 gene in pigs in China Jan 2015 (Lancet)
 - Conferred colistin resistance, plasmid
- 19 countries, animal and human isolates
- Calls for bans on colistin use in animals
- Calls for urgent action on AMR
- *A new focus on a One Health approach*



Antibiotic Resistance of *Klebsiella pneumoniae*



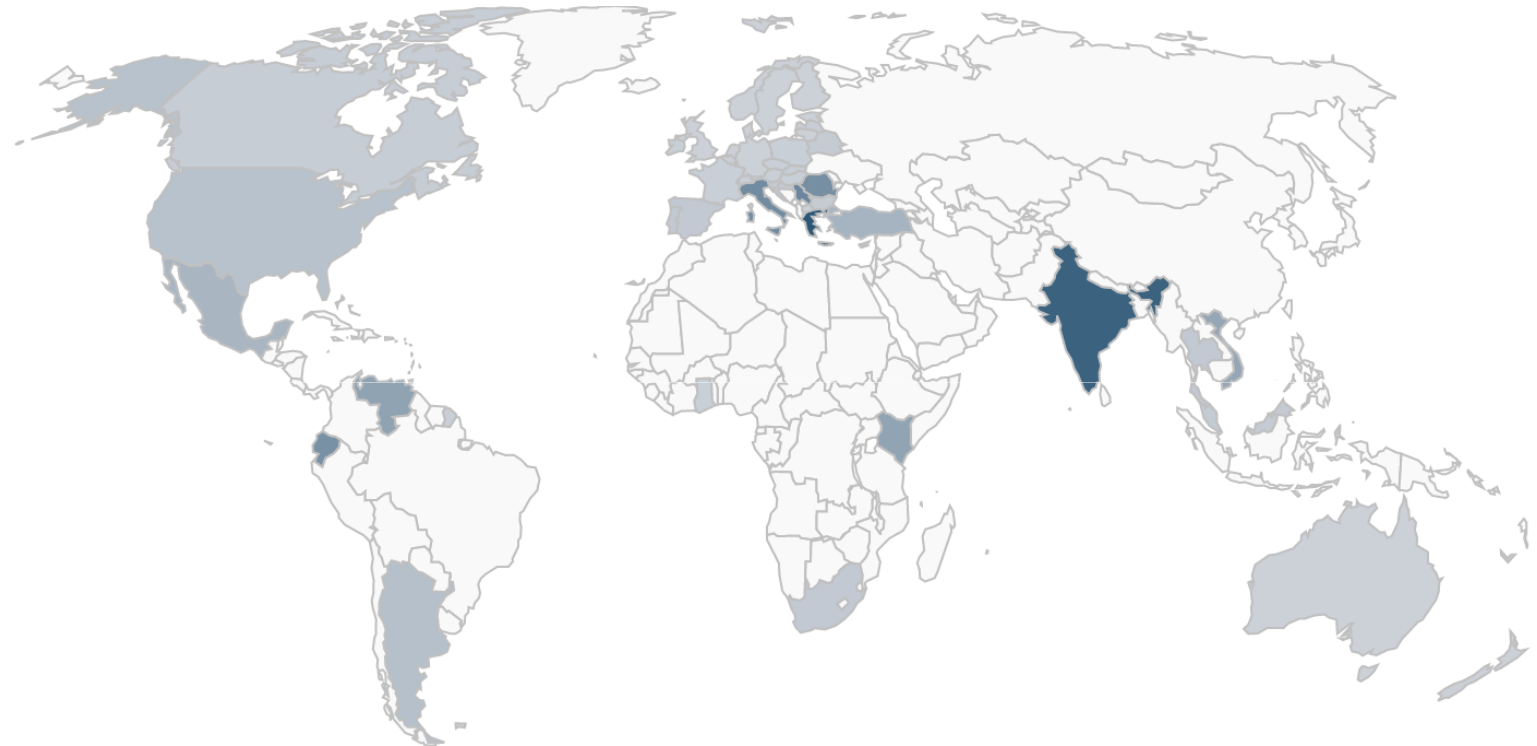
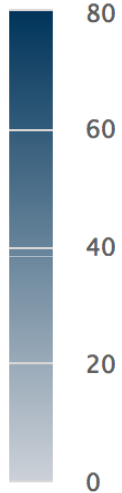
Center for Disease Dynamics, Economics & Policy (cddep.org)

2015 data, CDDEP



Resistance of *Klebsiella pneumoniae* to Carbapenems

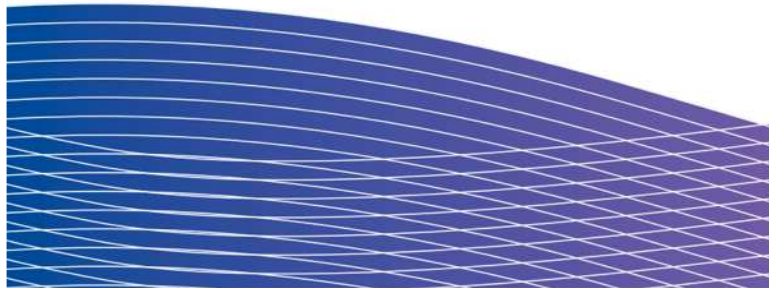
% Resistant
(invasive isolates)



Lots of missing data

Validity of data (e.g only sickest patients get microbiology)

The O'Neill Report May 2016



**TACKLING DRUG-RESISTANT
INFECTIONS GLOBALLY:**
FINAL REPORT AND
RECOMMENDATIONS

THE REVIEW ON
ANTIMICROBIAL RESISTANCE
CHAIRERED BY JIM O'NEILL

MAY 2016

- Commissioned by the UK Government & Wellcome Trust
- Report presented to G20, UN meetings
- 'Implementation ideas'
- A supra-national global organisation to set priorities for new diagnostics, vaccines, new drugs
- Market entry awards to pharma
- Accessibility to all nations

Stewardship –23 mentions.....but undefined



UN Draft Declaration on AMR (Sep 2016)

“**Acknowledge** that the resistance of bacterial, viral, parasitic and fungal microorganisms to antimicrobial medicines that were previously effective for treatment of infections is mainly due to:

1. The **inappropriate use** of antimicrobial medicines in the **public health, animal, food, agriculture and aquaculture sectors**
2. Lack of access to health services, including to diagnostics and laboratory capacity
3. And antimicrobial residues into soil, crops and water

Resistance to antibiotics, *which are not like other medicines*, **is the greatest and most urgent global risk**, requiring increased attention and coherence at the international, national and regional levels”

Plan.....Global Interagency Group: WHO/UN and World Org for Animal Health (OIE)



After the UN declaration on AMR, what comes next?

S

Filed Under: **Antimicrobial Stewardship**

Chris Dall | News Reporter | CIDRAP News | Sep 28, 2016

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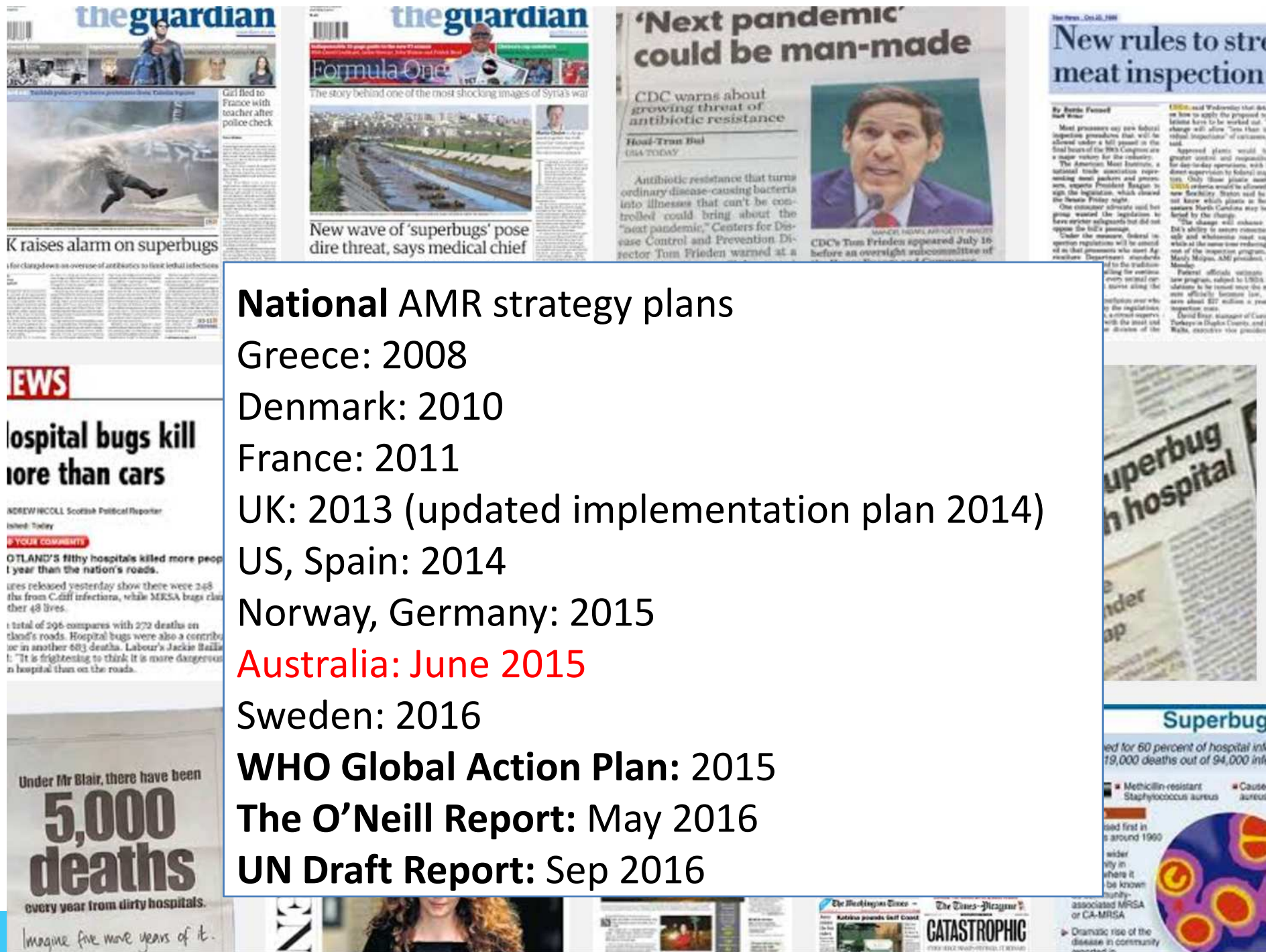
developing nations use antibiotics as a substitute for sanitation, hygiene, and medical care. Asking them to reduce antibiotic use essentially removes a critical tool from their healthcare arsenal.

This is where organizations like the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organization for Animal Health (OIE) will play a significant role. But how these UN bodies will ensure every country is holding up its end of the bargain remains an open question.

The challenge of implementation

"Implementing this will not be easy, at all," said Gian Luca Burci, JD, former legal counsel for the WHO. The UN declaration calls for the creation of a body that will coordinate the efforts of the WHO, FAO, and OIE. But coordination will be a challenge, Burci explained, because those organizations represent different constituencies with different priorities.

The declaration has no set goals and is non-binding



National AMR strategy plans

- Greece: 2008
- Denmark: 2010
- France: 2011
- UK: 2013 (updated implementation plan 2014)
- US, Spain: 2014
- Norway, Germany: 2015
- Australia: June 2015**
- Sweden: 2016
- WHO Global Action Plan: 2015**
- The O'Neill Report: May 2016**
- UN Draft Report: Sep 2016**

Australia's First National Strategy to address Antimicrobial Resistance



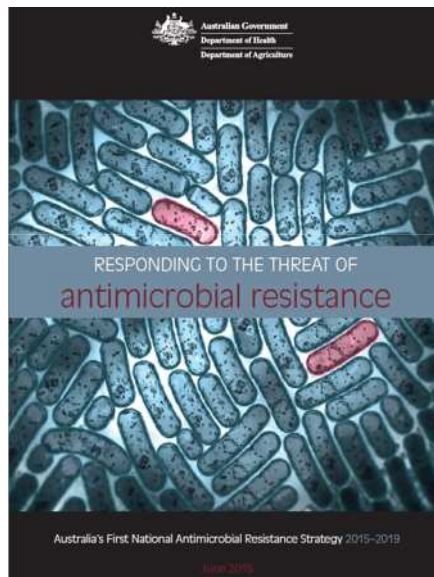
Objective One

Increase awareness and understanding of antimicrobial resistance, its implications and actions to combat it, through effective communication, education, and training

Implement effective antimicrobial stewardship...animal and human

Develop nationally coordinated One Health surveillance of antimicrobial resistance and antimicrobial usage

*settings to
als*



Objective Four

Improve infection prevention and control measures across human health and animal care settings to help prevent infections and the spread of resistance

Objective Five

Agree a national research agenda and promote investment in the discovery and development of new products and approaches to prevent, detect and contain antimicrobial resistance

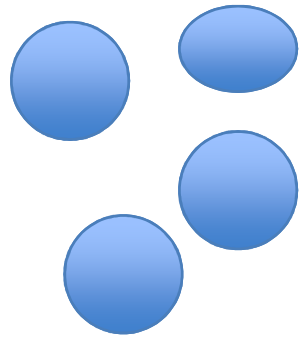
Objective Six

Strengthen international partnerships and collaboration on regional and global efforts to respond to antimicrobial resistance

Objective Seven

Establish and support clear governance arrangements at the local, jurisdictional, national and international levels to ensure leadership, engagement and accountability for actions to combat antimicrobial resistance

A reality check

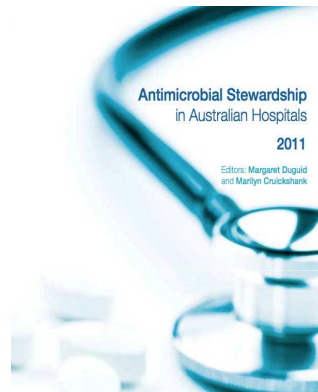


Pre 2008
 Few leaders in
 AMS
 RMH – approval
 system
 implemented
 2005

NAUSP
 Adult DDDs

Triggered
 formation of
 AMS working
 party with
 ACQSHC

2008



**AMS Book
 2011**
**Revised version
 2018 to include
 community,
 indigenous,
 aged care etc.**



Antimicrobial stewardship

Safe and appropriate antimicrobial prescribing is a strategic goal of the clinical governance system.

This criterion will be achieved by:	Actions required:
3.14 Developing, implementing and regularly reviewing the effectiveness of the antimicrobial stewardship system	<p>3.14.1 An antimicrobial stewardship program is in place</p> <p>3.14.2 The clinical workforce prescribing antimicrobials have access to current endorsed therapeutic guidelines on antibiotic usage⁴⁵</p> <p>3.14.3 Monitoring of antimicrobial usage and resistance is undertaken</p> <p>3.14.4 Action is taken to improve the effectiveness of antimicrobial stewardship</p>

**Standalone
 accreditation criteria
 2013**
Update 2018

NAPS introduced 2013
Web portal 2014
*Appropriateness &
 Guidelines concordance*
 Adults and paed
**Key partner for national
 AMR strategy 2015**

Structures and processes to support AMS in Australia (.....in hospitals)



- Australian Commission on Quality and Safety in HealthCare
 - National accreditation program includes AMS as a stand-alone criterion
 - National observation & medication chart (between the flag)
 - Implementation workbooks and toolkits
 - A national clinical care standard for AMS
- National guidelines for AB prescribing – endorsed by accreditation (Therapeutic Guidelines)
- High quality Infection Prevention/Medical care
 - BUT....average hand hygiene compliance, especially doctors
- National Antimicrobial Prescribing Survey
- Tight regulation of drugs/quality
- Well established AMS models (approvals, post prescription review)
 - BUT issues in rural and regional sites
- Already low rates of gram negative resistance, MRSA declining
 - BUT.....high rates of VRE

2015...



Clinical Care
Standards

Clinician Fact Sheet:
Antimicrobial Stewardship

The goal of the Antimicrobial Stewardship Clinical Care Standard is to ensure that a patient with a bacterial infection receives optimal treatment with antibiotics. This means that patients are offered the right antibiotic to treat their condition, the right dose, the right route, at the right time and for the right duration. This should be based on accurate assessment and timely review as to lessen the risk of adverse effects and reduce the emergence of antibiotic resistance.

UNDER THIS CLINICAL CARE STANDARD



A patient with a life-threatening condition due to a suspected bacterial infection receives prompt antibiotic treatment without waiting for the results of investigations.



A patient with a suspected bacterial infection has samples taken for microbiology testing as clinically indicated, preferably before starting antibiotic treatment.



A patient with a suspected infection, and/or their carer, receives information on their health condition and treatment options in a format and language that they can understand.



When a patient is prescribed antibiotics, whether empirical or directed, this is done in accordance with the current version of the *Therapeutic Guidelines* (or local antibiotic formulary). This is also guided by the patient's clinical condition and/or the results of microbiology testing.



When a patient is prescribed antibiotics, information about when, how and for how long to take them, as well as potential side effects and a review plan, is discussed with the patient and/or their carer.



When a patient is prescribed antibiotics, the reason, drug name, dose, route of administration, intended duration and review plan is documented in the patient's health record.



A patient who is treated with broad-spectrum antibiotics has the treatment reviewed and, if indicated, switched to treatment with a narrow-spectrum antibiotic. This is guided by the patient's clinical condition and the results of microbiology tests.

National Centre for Antimicrobial Stewardship (NCAS)

The NCAS is a new NHMRC-funded Centre of Research Excellence that will investigate the evidence gaps in what is known about the relationships between antibiotic use in humans and animals and antibiotic resistance.

The NCAS represents the first One Health collaboration where researchers, scientists and clinicians working on antimicrobial resistance within the human world and the animal world have formally come together to investigate the same key research questions as they apply to livestock, veterinary care, community settings and hospitals. general



○ ○ ○ ● ○ ○

Please select your module below

Hospital

HOSPITAL
NAPS National Antimicrobial Prescribing Survey

SURGICAL
NAPS National Antimicrobial Prescribing Survey

QI Quality Improvement
NAPS National Antimicrobial Prescribing Survey

Residential Aged Care

AGED CARE
NAPS National Antimicrobial Prescribing Survey

Veterinary

VETERINARY
NAPS National Antimicrobial Prescribing Survey

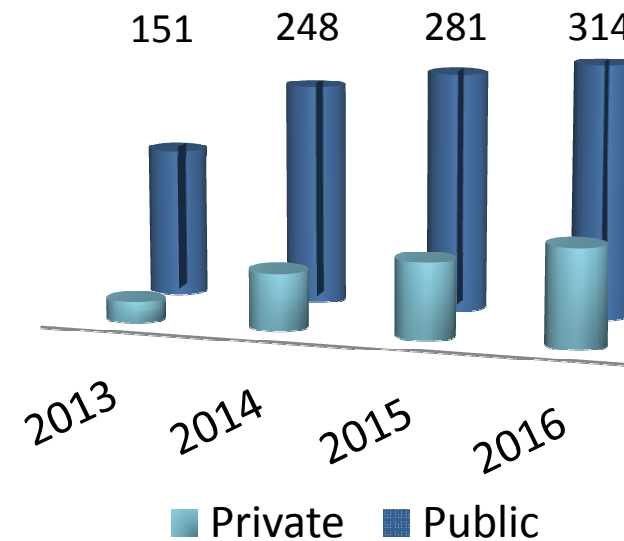
www.naps.org.au

Participation



- Point prevalence survey
- All states and territories
- 33% of all public hospitals in Australia
 - 87% of principle referral hospitals
- 14% of all private hospitals in Australia
 - Annual participation is growing

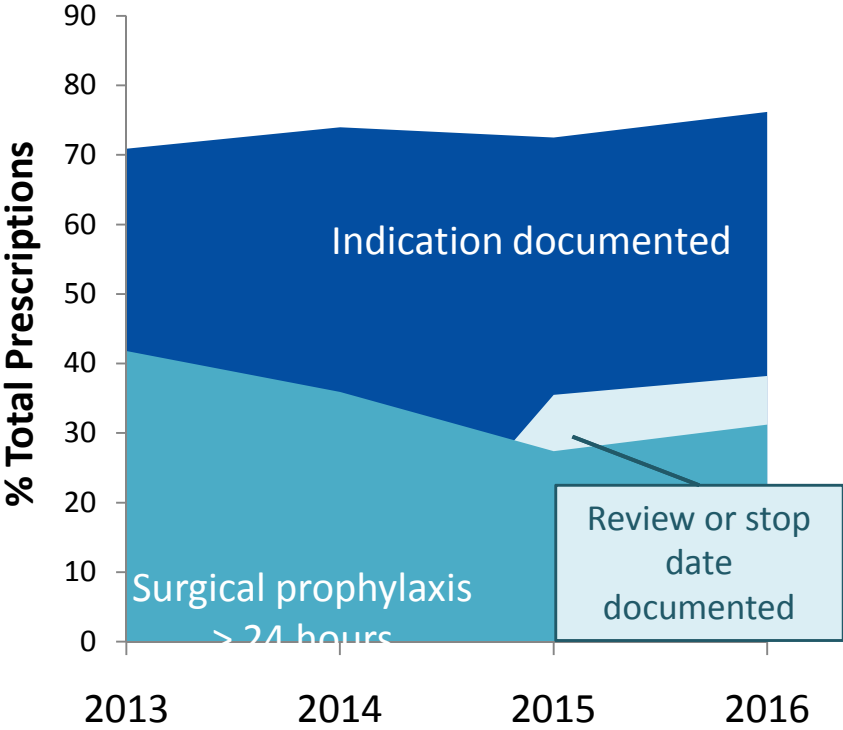
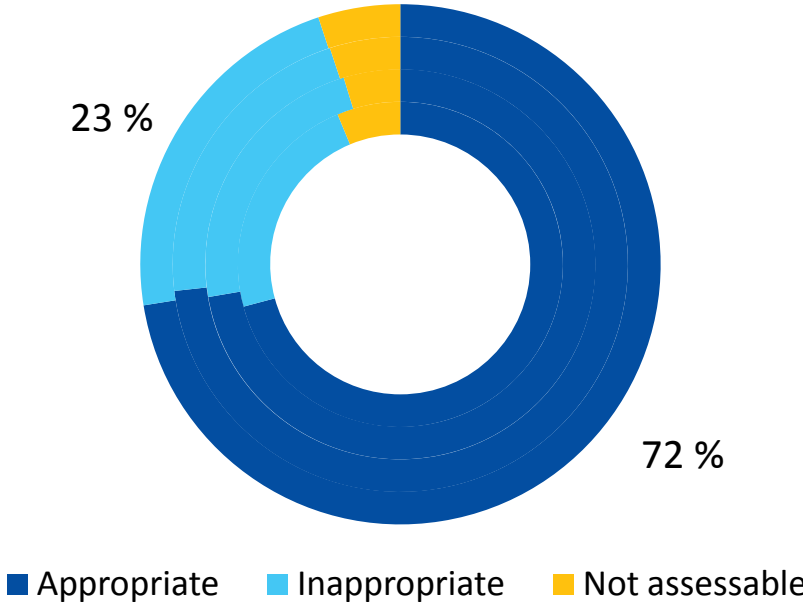
Total Number of Participating Sites



Key indicators



Overall Prescription Appropriateness (%)



Antimicrobial Use in Aged Care Homes in Australia



2016 AC-NAPS report

- 251 residential aged care facilities 1867 prescriptions
 - All states, private and public
- Data on infection prevalence and antimicrobial use
- Poor documentation
 - 22.1% did not have the indication documented
 - 49.9% did not have a review/stop date documented
- Most common indication= UTI: 17.9%
- **23.3% of antibiotics were prescribed for >6 months.**
- For those antimicrobials <6 months (n=1372)
 - **32.4% for residents with no signs/ symptoms of infection**

Require implementation support: Africa, Americas, Eastern Mediterranean, Western Pacific regions

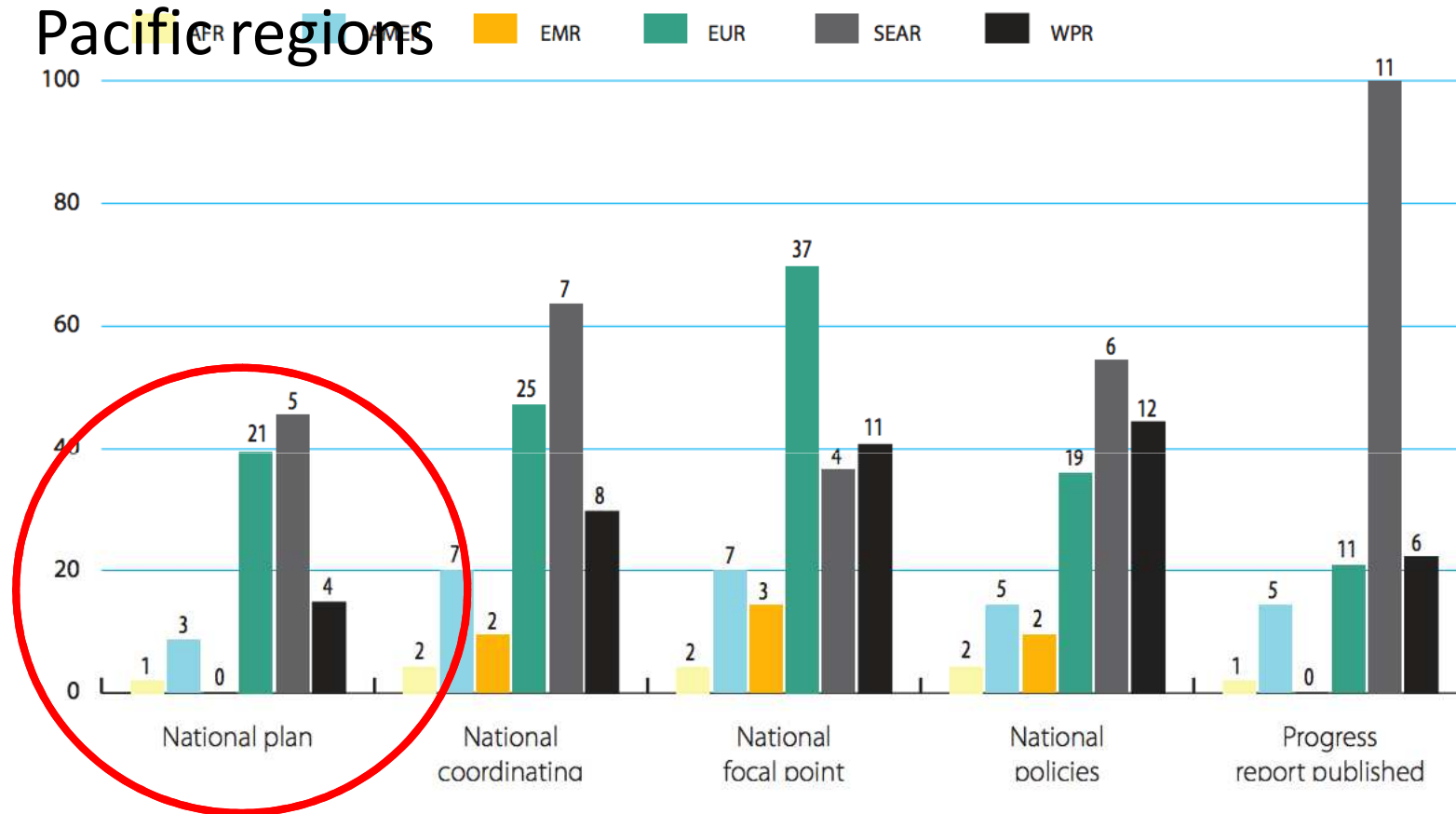


Figure 1.2 – Percentages of Member States that had a national plan for antimicrobial resistance, a coordinating mechanism, a focal point, a policy or a strategy and had prepared a report in the previous 5 years, by region (Note: numbers above the bars represent the numbers of participating Member States that answered “yes”)

AFR, WHO African Region; AMER, WHO Region for the Americas; EMR, WHO Eastern Mediterranean Region; EUR, WHO European Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

The Role of the WHO

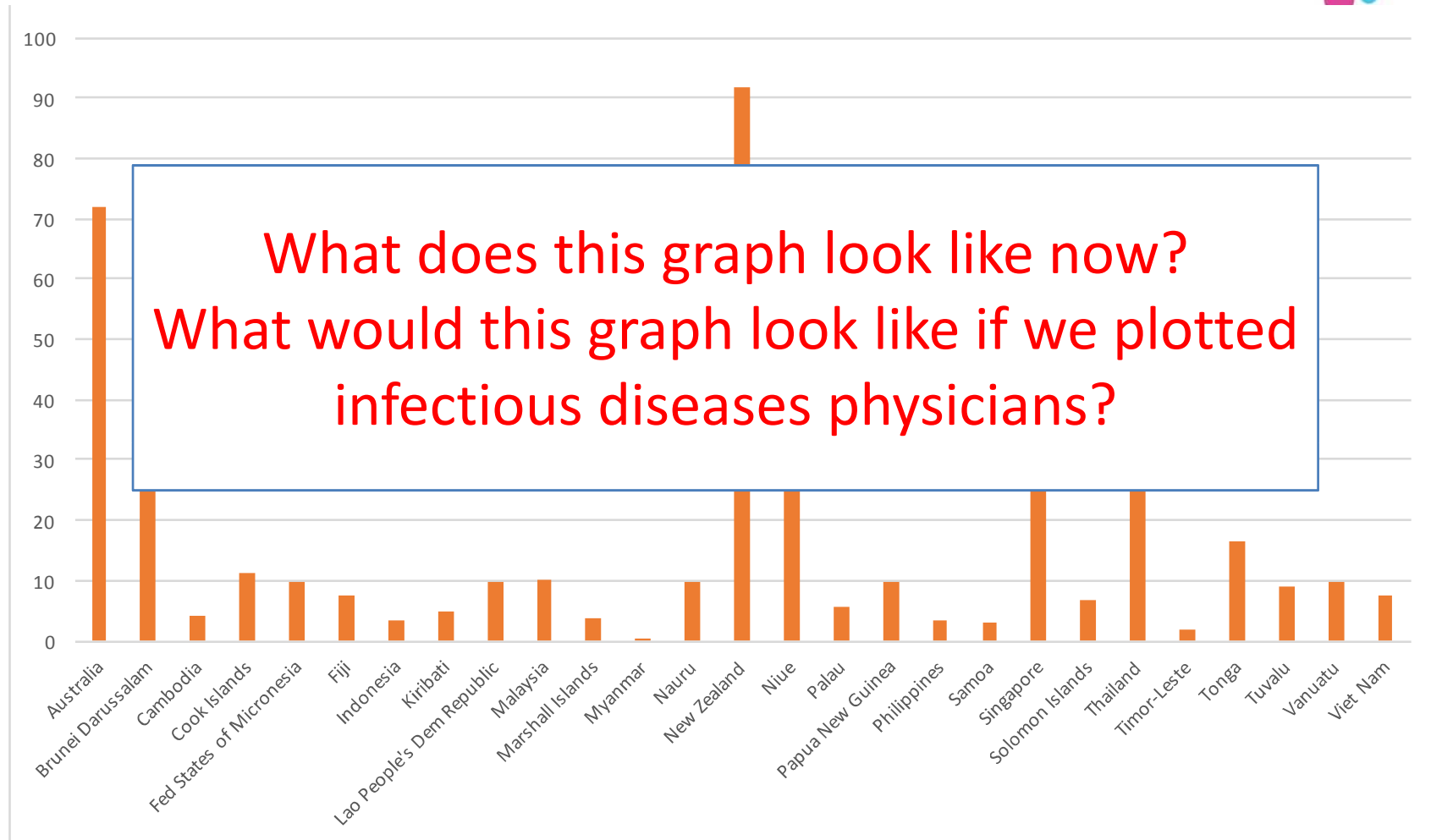


- AMS sits in Essential Medicines
- Lacks an implementation strategy (cannot be a one size fits all)

BUT

- AMS straddles Public Health, Quality and Safety, *and* Essential Medicines
- 3 separate governance arms
- **Focus has been on usage surveillance & AMR surveillance**
- Many national AMR strategies set targets for MRO rates. Is this the best outcome?
- *Patient safety should be the priority* (meaningful)

Workforce capacity for AMS in South East Asia



Pharmacists working per 100,000 population (as at 2004)

Worldmapper.org

Source data from 1998-2004

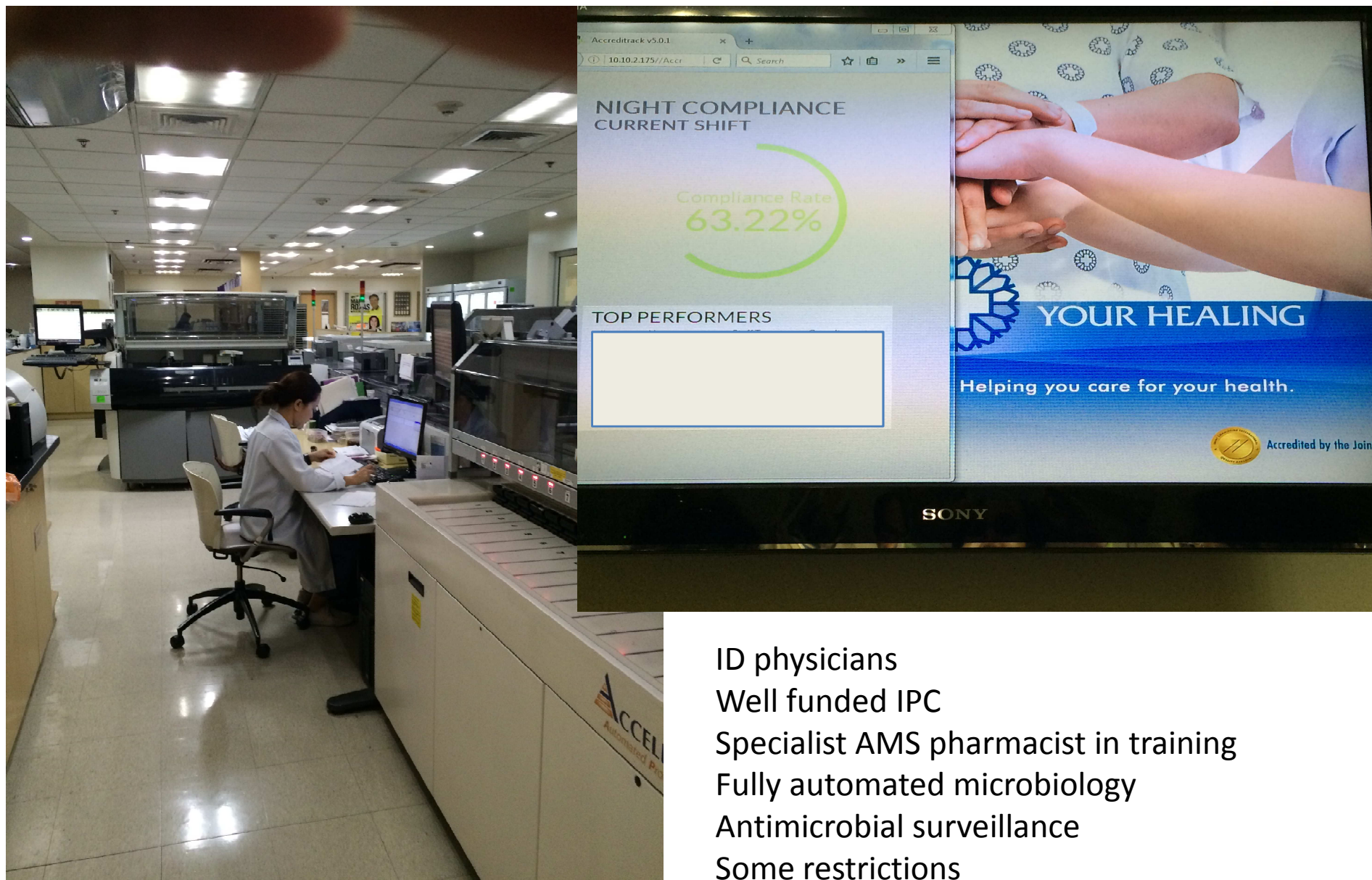
The Philippines as a case study



NCAS visit to WPRO May 2016
Site visits in Manila
Purpose: Assess organisation
readiness, identify gaps, and provide
recommendations

The health care system

- Large private sector provides 30% pop and 70% of HCW
- Good links between private and public (supportive
- 4 levels of hospitals (only 20% level 3 or 4 with micro)
- Licensed hospitals *automatically* granted accreditation (being driven by universal health insurance)
- Inequity of access to health services/large out of pocket expenses
- National AMR policy 2015
- Administrative order for Includes AMS but funding only for IPC practioners 1: 100 beds
- Several AMS champions
- No dedicated funding for AMS
- No AMS training programs
- National guidelines being developed but no implementation plans
- AMR surveillance 24/1800 sites (undertakes credentialing activities) (ARSP)- WHONET
- National drug formulary- 6 antibiotics – tied to reimbursement but only for ARSP accredited hosp
- 3rd generation cephalosporins and FQ unrestricted
- No antimicrobial usage surveillance



- ID physicians
- Well funded IPC
- Specialist AMS pharmacist in training
- Fully automated microbiology
- Antimicrobial surveillance
- Some restrictions
- BUT No drug charts

PHYSICIAN'S ORDERS
Pls. indicate Lic. No. w/ Printed Name & Signature

1. p wound puncture ✓
 2. Secure consent for procedure ✓
 3. Clean prep of the site ✓
 4. spinal needle 922 # 2 ✓
 5. gloves 1/2 # 2 ✓
 6. mask # 1 ✓
 7. specimen container # B ✓
 8. vaccine 22 # 1 ✓
 9. Start Amphotericin B ✓
 10. 50g + at W 100 cc ✓
 11. to run over 4hrs @ 24H ✓
 12. pre- & post hydration ✓
 13. pass 100 cc ✓

DIAGNOSIS: HIV/Hospital Acquired Pneumonia

DRUGS AND MEDICINES DISPENSED

DATE DISPENSED	4/18	4/19	4/20	21	22	23	24	25	26	27	28	29	30	5/1	5/2
Salacet	1														
Dexam	1		1						1	1					
Dist. Hw							2(-1)	2							
Safety kit	1	1													
ASSPL	1														
Kee	1	2	2	1	2	2	2	2	2				2	2	3
PIPHAZ 4.5g W 100cc NIC 40mg	3	4	4	4	3-9										
	6	6	2	6	6	6	6	6	6	6	6	6	6	6	6
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

RESEARCH INSTITUTE FOR TROPICAL MEDICINE
Filinvest Corporate City Compound
Alabang, Muntinlupa City

INFECTION CONTROL
ANTIBIOTIC MONITORING FORM

For AMPHO B

Revision No.: 1

DATE: 5/1/16
ROOM: _____

CLINICAL DIAGNOSIS: Cryptococcal meningitis

DRUGS	DOSE/FREQUENCY	DURATION
Amphotericin B	50mg IV q 24h	14

INDICATION FOR ANTIMICROBIAL USE:
 Prophylactic
 Therapeutic
 Empiric
 Definitive

CULTURE AND SENSITIVITY RESULT (if applicable):
 (+) Brain CSF: Cryptococcus
 CF: a: Cryptococcus

Requesting Resident/Fellow:
 Anna Del Joy Yap, M.D.
 License No. 118073
 Signature over Printed Name

Action taken: Approved Disapproved

MISHELLE GONZALES, D.O., M.D.
 Infectious Disease Consultant of the Month

Need basic building blocks in place

Medication charts:
Drug orders and administration



1500 bed university hospital
AMS program in place (HEALS)

- ID expert
- Pharmacist

Nurse to patient ratio 1:20

Poor IT infrastructure

Only basic patient record systems

A few clinical pharmacists

Some clinical guidelines/
pathways (e.g Dengue, CAP)

Microbiology reports hand
delivered to wards once per day

No real-time notification of +BC

Their national AMR strategy - goals



- Reduce by 30% CRE infections acquired during hospitalization
- Maintain the prevalence of ceftriaxone-resistant *Neisseria gonorrhoeae* to 0%
- Reduce by at least 30% overall MRSA bloodstream infections compared to rates in 2014
- Reduce by 30% MDR *Pseudomonas* spp infections acquired during hospitalization compared to estimates in 2014
- Reduce by 25% ciprofloxacin-resistant non-typhoidal salmonella infections compared to 2014

Is this the right focus? What about patient safety?

Our recommendations (short term)



Theme	Action item	Leading groups
Workforce	Appoint and provide dedicated funding to AMS champions and explore public-private collaboration for education and mentoring	DOH and WHO
Workforce	Clinical pharmacists should be recognised as an essential part of the AMS workforce, with dedicated government level funding provided	DOH
Guidelines	National guideline implementation should be discussed as a matter of urgency and an implementation plan developed	Guidelines Committee and AMS champions
Guidelines	Local hospital guidelines and clinical pathways should be reviewed and brought into line with national recommendations where possible	Hospital AMS/ID clinicians
Education	Develop specific AMS training package for clinical pharmacists, ICPs and clinicians that local hospitals can utilise (and modify as required depending on their local hospital context)	DOH, WHO and AMS champions
Documentation	Introduction of a standardised national medication chart whereby the medication order and administration are directly written onto the same document	DOH
Documentation	Improvements are made to ensure greater transparency and communication of patient alert information	DOH, Hospital executives
Documentation	Adaptation and implementation of clinical practice guidelines for the early recognition and management of sepsis should be a priority for all hospitals	Hospital AMS/ID clinicians
Restriction	Consider the addition of <u>fluoroquinolones</u> and 3 rd and 4 th generation <u>cephalosporins</u> to hospital restriction lists	Hospital AMS/ID clinicians
Audit and review	Use of community dispensed antimicrobials should also be monitored, including an approval form if it is for a restricted antimicrobial	Hospital AMS/ID clinicians
Audit and review	Audit and feedback of antimicrobial prescribing quality should be undertaken, particularly for non-restricted antimicrobials	Hospital AMS/ID clinicians

Understanding AMS: Requires a mixed methods approach



- How are antibiotics being used?
 - Volume, indication, appropriate AND inappropriate use
- What are the drivers? Prescriber knowledge and attitudes
- What interventions fit workflow and are acceptable?
- What interventions are effective?
- What interventions are sustainable to change prescribing behaviour?

Can we ultimately change practice and policy?

The National Centre for AMS



Royal Melbourne Hospital
University of Melbourne
Doherty Institute
Monash University
Other research groups

A health services research centre

A One Health Approach

Cross stream collaboration and
facilitation

Multi-institutional

Human: Hospitals, Aged Care, General
practice

Animal: Companion, Livestock

Policy role

National AMR Strategy

AURA Program Partner (NAPS)

Commission AMS Advisory

Inter-jurisdictional networking

Activities

NAPS, ACNAPs, SNAPS, Vet NAPS

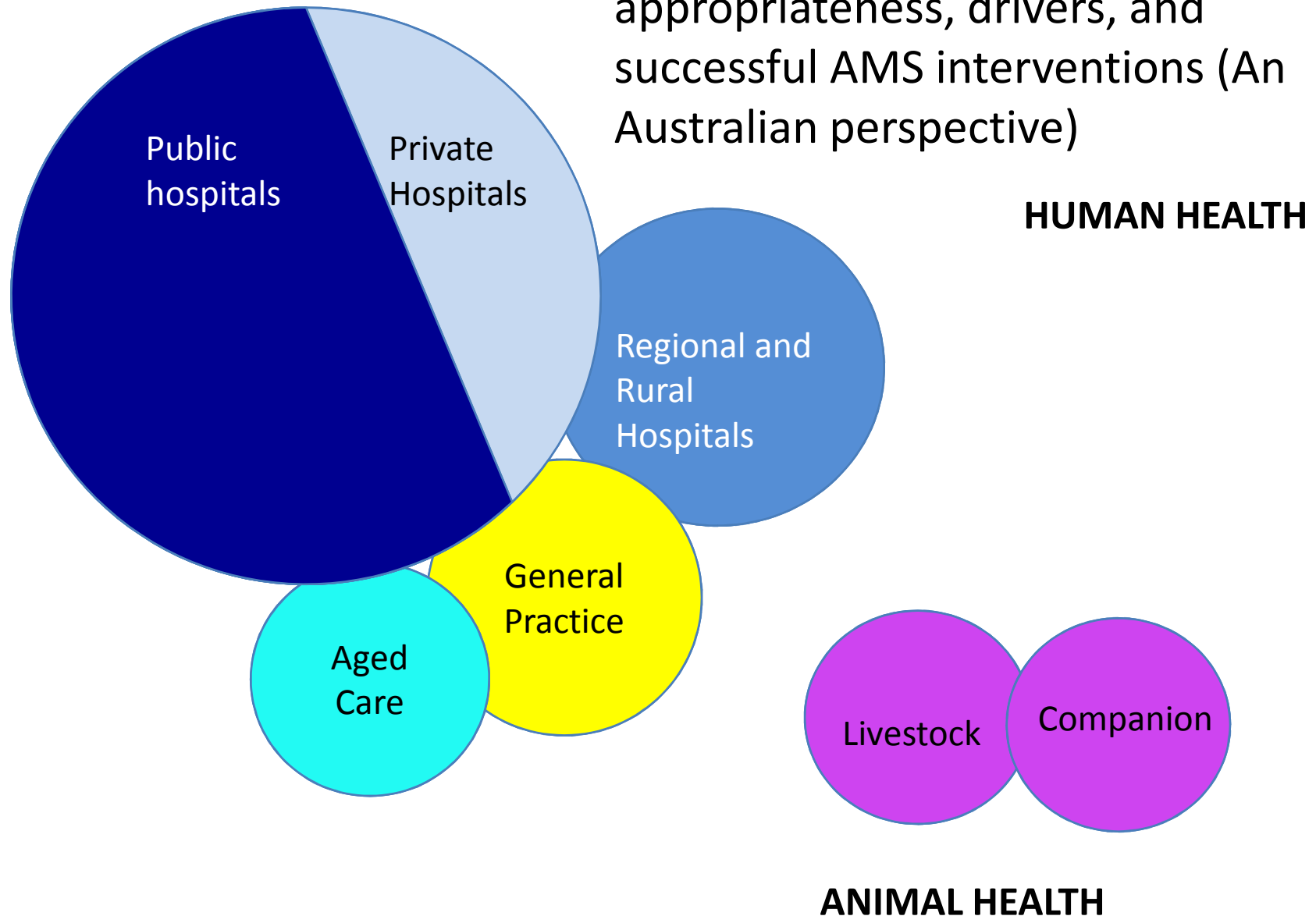
Guidance (68 hospitals)

Educational Workshops

Mentorships

Emerging regional role/ WHO

Current state of knowledge about antimicrobial use appropriateness, drivers, and successful AMS interventions (An Australian perspective)



AMS implementation challenges in regional, rural and remote hospitals

Evaluation of NAPS data looking at patterns of prescribing and appropriateness in regional/rural/remote hospitals

- Inappropriate prescribing of antimicrobials for CAP, COPD and surgical prophylaxis higher
- >25% all orders for prosthetic joint infections, sepsis and endocarditis occurred in **non-major city hospitals**

Qualitative study (focus groups, purposive interviews)

- Current models for AMS programs (barriers and facilitators)

Develop models for delivery of AMS

- E.g Telehealth, supportive prescribing roles nurses, pharmacists

The Role of the Nurse in AMS



1. Perceptions of the nursing role:

How do nurses perceive their role and influence in AMS ?
How do members of the multidisciplinary team perceive the nurse role ?
What are the barriers, enablers to support nursing involvement, participation?
What could nursing participation look like?

2. Knowledge and understanding:

What do nurses know and understand about AMR and AMS ?

3. Current situation:

Explore current models of AMS inclusive of nurses – what's in place, what's worked well, what's worked less well ?

4. Evaluation of models, intervention

What works where, for who, what circumstances



Antimicrobial Use

Differs dramatically:

1. B/w food animals and companion animals
2. Intensity of production
3. Vets versus farmers
4. B/w species



Investigating prescribing practices in animals



- Survey of surgical prophylaxis: Dogs and cats, horses, cattle
 - Low use of antimicrobials with high importance rating
 - Dogs and cats: Drugs and doses appropriate but administered after surgery in many instances & for prolonged durations
 - Horses & cattle: Drugs appropriate but doses variable and administered after surgery in many instances & for prolonged durations

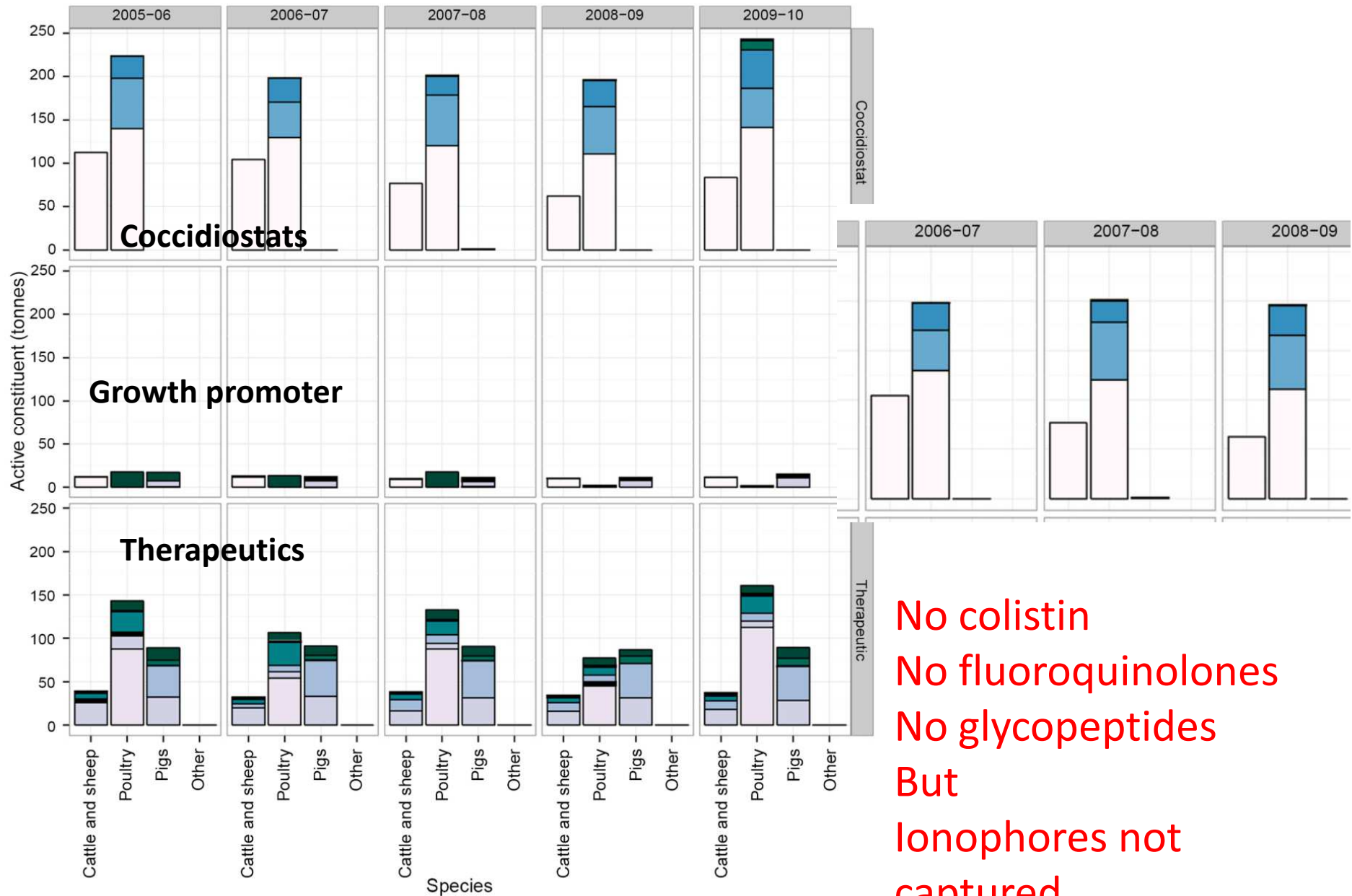
Hardefeldt, LY, Browning, GF, Thursky, K, Gilkerson, JR, Billman-Jacobe, H, Stevenson, MA, Bailey, KE. Antimicrobials used for surgical prophylaxis by companion animal veterinarians in Australia. *Veterinary Microbiology* 2017

AMS in Veterinary Medicine



- VET-NAPS: Species/Drug/Dose/Indication
- Mixed methods study
 - Online questionnaire, Focus group discussions
- Study population to cover diversity of veterinary practices
- Development of evidence based guidelines for surgical prophylaxis
- Trial of stewardship options
- External funding (Vic, Fed): training and educational materials

Australian Livestock Use Over Time



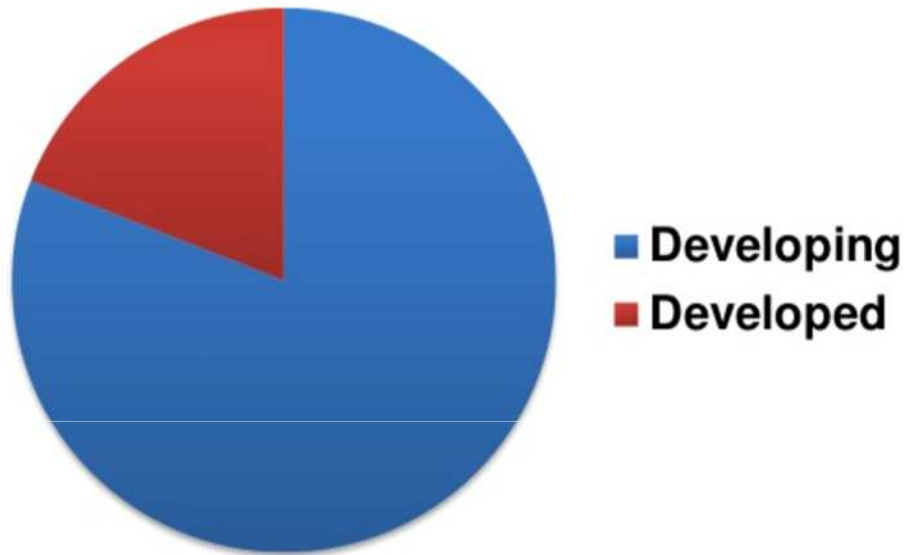
No colistin
 No fluoroquinolones
 No glycopeptides
 But
 Ionophores not captured

Livestock Stream



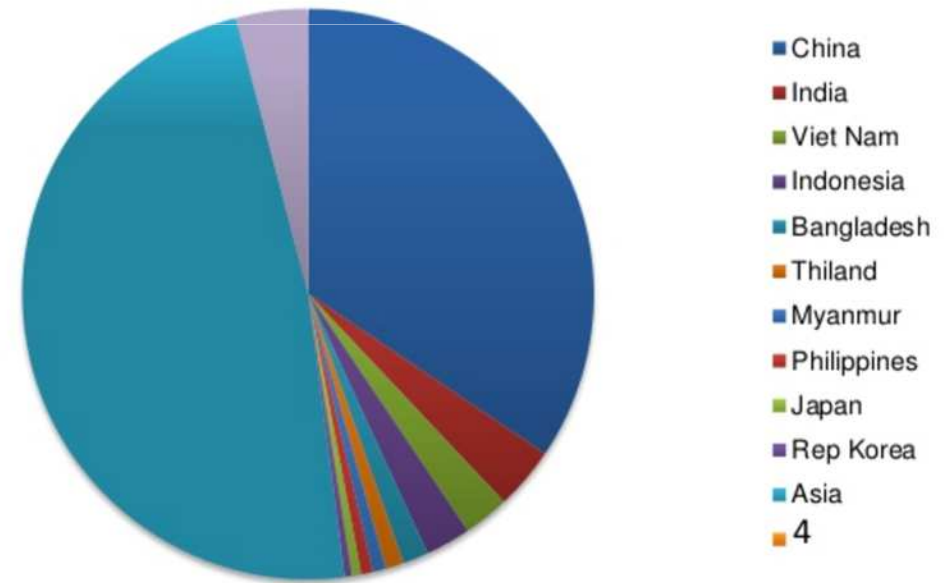
- Industry becoming engaged in this space
- Developing their own AMS programs (commercially sensitive)
- NCAS opportunity to develop audits and surveys, VETNAPS
- Pig industry and largest cattle/dairy group engaged
- *Other key areas for AMS: Label recommendations and dosage/withdrawal time*
- **Poor knowledge about use over lifecycle & impact on AMR**

Livestock numbers (37 billion)



Antimicrobial use in developing countries unknown
Unregulated

% world aquaculture



“If we treat ducks for two days and they aren’t cured we change to human drugs. We cocktail 10 tablets of this, 10 tablets of that and 20 tablets of this one. Altogether 200 tablets are mixed in 100 or 200 L of water for the ducks to drink. No one taught me, just my experiences.”

Antibiotics: practice and opinions of Cambodian commercial farmers, animal feed retailers and veterinarians

[Chhorvoin Om](#) and [Mary-Louise McLaws](#) 

Antimicrobial Resistance & Infection Control 2016 5:42 | DOI: 10.1186/s13756-016-0147-y | © The Author(s). 2016

Received: 7 August 2016 | Accepted: 3 November 2016 | Published: 11 November 2016

AGRICULTURE

HUMANS



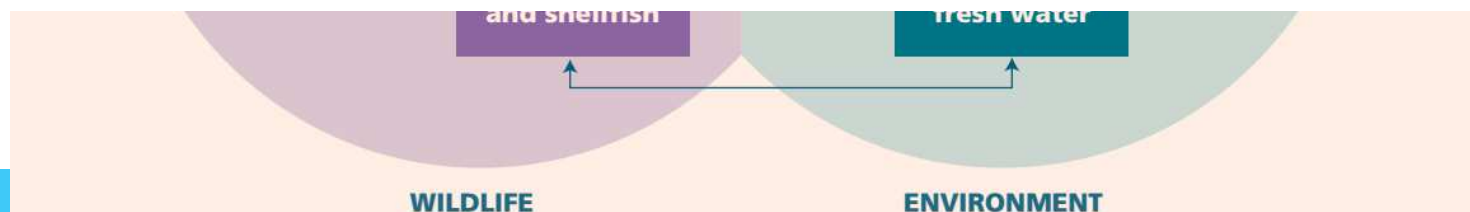
We do not understand

1. Dynamics and interactions of genes and microbes within microbiota, and microbiomes, scales of microbial ecosystems
2. The impact of antimicrobial use on bacterial populations and the extent of resistance gene transfers between animal and human gut environments
3. The relationship of AMR in livestock, and incidence of resistant infections in humans

Need molecular sequencing, epigenetics, integrated surveillance between animals and humans

www.fao.org/antimicrobial-resistance

2016. Drivers, dynamics and epidemiology of AMR in animal production.



WILDLIFE

ENVIRONMENT

stewardship

Appearance of β -lactam Resistance Genes in Agricultural Soils and Clinical Isolates over the 20th Century

David W. Graham¹, Charles W. Knapp², Bent T. Christensen³, Seánín McCluskey² & Jan Dolfing¹

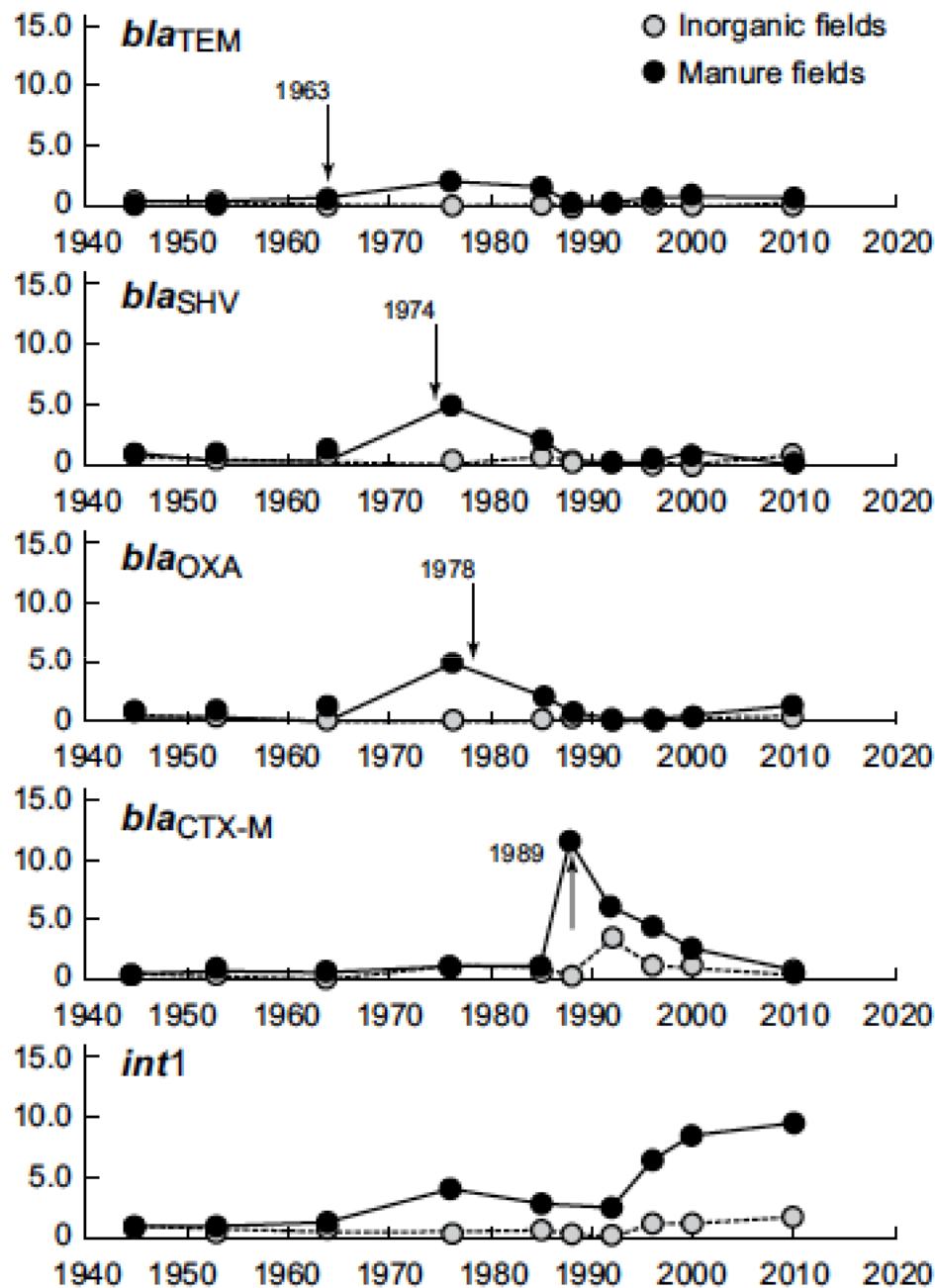


Sci Rep. 2016 Feb 16;6:21550

- ? Agricultural vs. medical use driving AMR
- VanX proto-resistance and multi-resistance genes detected in ~30,000-year old DNA from permafrost. (D'Costa, Nature 2011)
- Incr. AB use has *mobilised AMR genes*, accelerated bacterial AMR evolution in strains not previously intrinsically resistant
- **Phenotypic detection of AMR** is only observed when a strain is exposed to an antibiotic.
 - Often false presumption that AR acquisition is primarily driven by factors at the point of detection (e.g., a hospital)
 - Original acquisition of ARGs or mutations might occur elsewhere, including the natural environment.

Unique Study Opportunity

- Systematic soil archiving since 1923 in a facility in Denmark established to study the role of **manure** versus **inorganic fertilisers**
- V. Detailed soil and field management records.
- DNA harvested from 1923-2010
 - Broad spectrum β -lactamases (blaTEM and blaSHV)
 - Extended-spectrum (blaOXA and blaCTX-M) (ESBL), were chosen as “biomarkers” for the appearance of β -lactam resistance over time
 - *Int1* (integrons) also analysed (represent mobile genetic elements and horizontal transfer of AR)



AR genes emerged in manure fertilised fields only

Rise correlated with introduction of antibiotics into agriculture in the 50's

Fall associated with banning of antibiotics for non-therapeutic use in the 90's

Dates correlate with the first published reports of BLAC resistance in humans

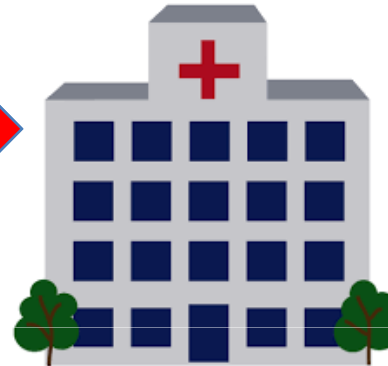
Lack of data linkages



Imported AMR

Antimicrobial Use in the Community
PBS, NPS Medicines Insight

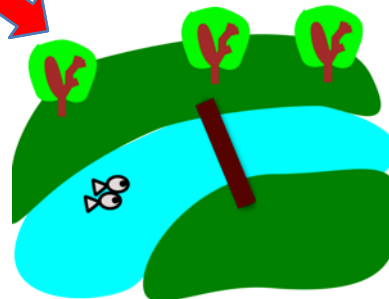
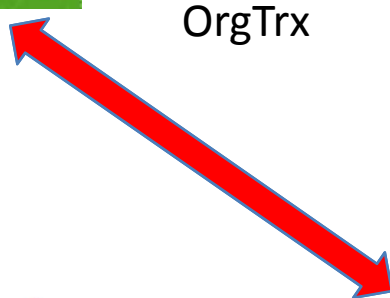
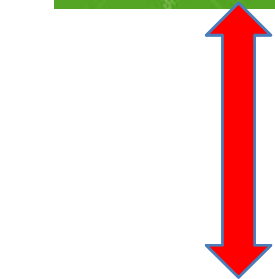
Antimicrobial Use in Hospitals
NAPS, SNAPS, NAUSP



HAI Surveillance
Hand Hygiene
Patient outcomes
from hospital
admissions
databases

AMR Surveillance
AGAR
OrgTrx

Bureau of Statistics
Medicare data



Antimicrobial use in companion
Antimicrobial use in livestock
AMR Surveillance in animals

Antimicrobial/AMR
residues in crops, water

Complex
relationships
How to measure
impact?

Thank you



Twitter: [NCAS_Aus](https://twitter.com/NCAS_Aus)

Website: <https://ncas-australia.org>

A screenshot of the Twitter profile for NCAS Australia. The profile name is "NCAS_Australia" with the handle "@NCAS_Aus". The bio states: "National Centre for Antimicrobial Stewardship - a One Health approach. Animal and human AMS. Innovation and implementation. Tweets by Prof Karin Thursky + team." The location is "RMH at the Doherty Institute" and the website is "ncas-australia.org". The profile was joined in April 2015. The profile statistics show 1,890 tweets, 770 following, 1,051 followers, 907 likes, 4 lists, and 0 moments. A recent tweet from "NCAS_Australia @NCAS_Aus · 9h" is visible, with the text: "Awareness of resistance does not translate into a suitable level of concern on the ward AProf Sasheela". Below the tweet is a photo of a presentation slide titled "However....." with bullet points: "Awareness of resistance does not translate into suitable level of concern on the ward", "Localised interest of antibiotic usage continue", "Specific antibiotics harbour long-established inappropriate prescribers habits that are difficult to change- senior vs junior", "Not aware or not using hospital/national abx guidelines", "External guidelines are mostly for the better but can be problematic if intersect with local initiatives - UTI, pneumonia", and "Attendance by 'non converters' is usually poor for abx AMR/AMS/IC related talks CME".

A banner for the NCAS Journal Club. It features a photograph of a smiling woman on the left and a presentation slide on the right. The slide has the text "NCAS Journal Club" at the top and "How much is your AMS program..." below it.

The NCAS logo is displayed on the left. To its right, the text reads: "The monthly NCAS Journal Club presents and discusses all aspects of One Health antimicrobial stewardship and includes (but not limited to):" followed by a bulleted list: "article reviews", "updates from conferences", "new innovations in technology", and "general items of interest". Below this, it says: "We invite you to join us for these meetings, either by logging onto the Webinar, or joining us in person at Seminar Room 2, Mezzanine Level, The Doherty Institute, 792 Elizabeth Street, Melbourne, commencing at 08:30 a.m." and "Register now for this year's webinars:" followed by a "Register Here" button.