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Recommedations

- Please turn off your microphones
- The presentation will be one hour with additional time for questions
- Please send questions in writing, via Webex chat or email infectioncontrol@paho.org
- The presentation will be available on PAHO website in 48 horas at: http://www.paho.org/hq/index.php?option=com_topics&view=article&id=342&Itemid=40930&lang=en

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Acknowledgement

This webinar is made possible thanks to the auspice and cooperation of the Infection Control Center(CDC), under agreement CDC-RFA-CK13-1302. “BUILDING CAPACITY AND NETWORKS TO ADDRESS EMERGING INFECTIOUS DISEASES IN THE AMERICAS”

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“Antimicrobial Resistance: From Laboratory to Patient Care

Regional Infection Prevention and Control
WebEx Sessions
Washington DC, 10 July 2018

Marcelo Galas
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Communicable Diseases and Health Analysis (CHA). OPS/OMS
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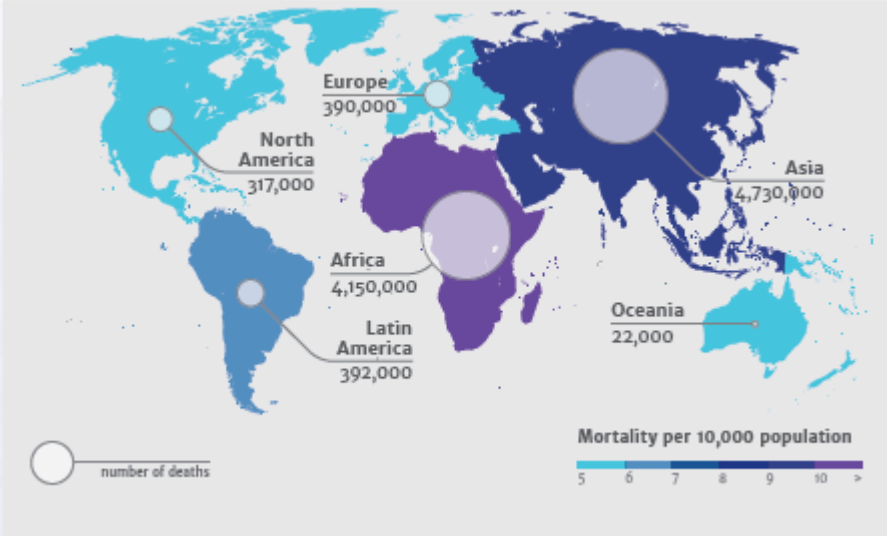
Increasing Awareness and Political Commitment

Mortality and Economic Impact

- In 2050, up to 10 million deaths/year
- 2-3.5 percent reduction of GDP
- Total global cost of up to $USD 100 billion

Deaths Associated to AMR each year until 2050



J. O'Neil, 2014. Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations.

Global Action Plan for Antimicrobial Resistance

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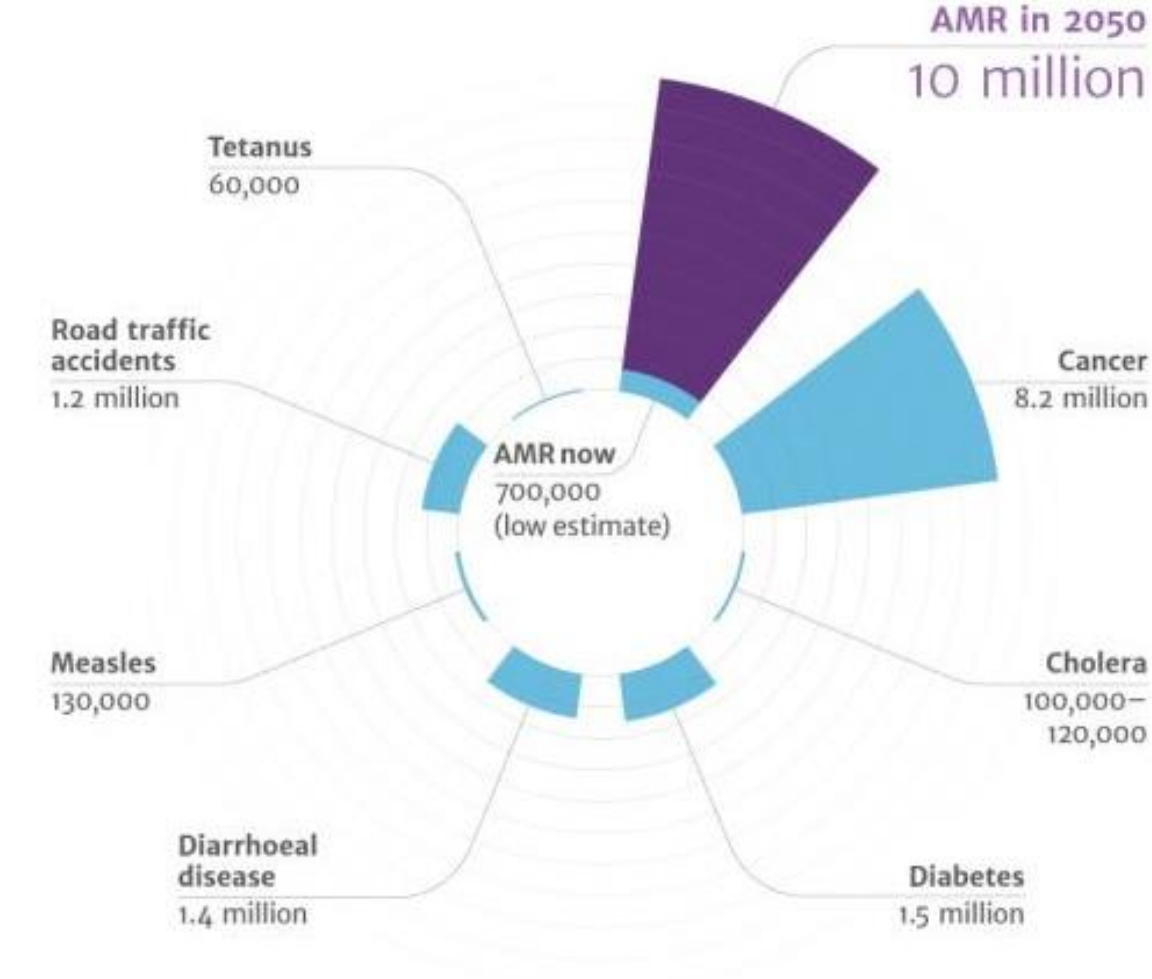
Deaths attributable to AMR by 2050



J. O'Neil, 2014. Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations.

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Final Report

DRUG-RESISTANT INFECTIONS

A Threat to Our Economic Future

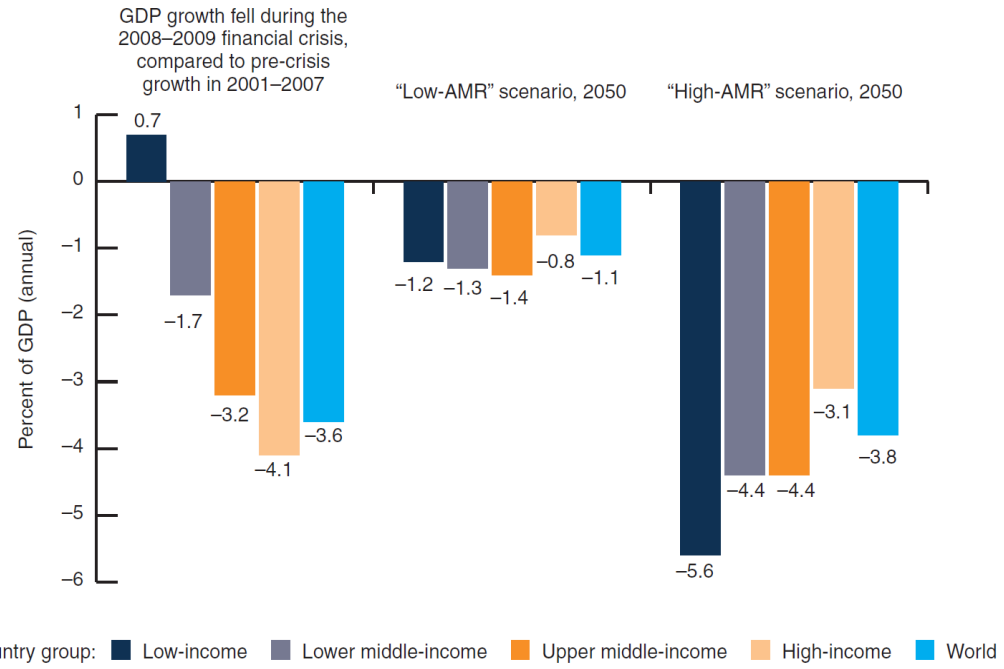
March 2017

WORLD BANK GROUP

WORLD BANK GROUP

Economic Costs of AMR May Be as Severe as During the Financial Crisis

AMR could reduce GDP substantially—but unlike in the recent financial crisis, the damage could last longer and affect low-income countries the most
(annual costs as % of GDP)



The full report is available at worldbank.org/health.

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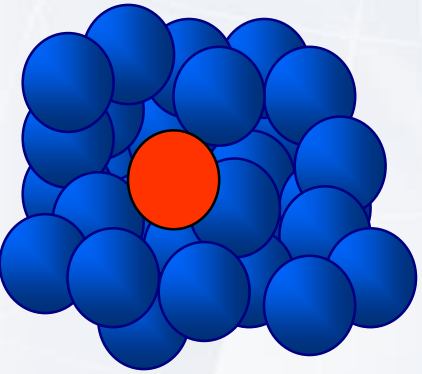
Selection and dissemination of resistance to antibiotics

Emergence and selection of resistance

Dissemination of resistance



Bacterial population with pre-existing resistant mutations

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Genetic mechanisms of emerge and dissemination of resista

Random changes in genes

Specific generation of mutations

Acquisition of new genes

Horizontal Transfer

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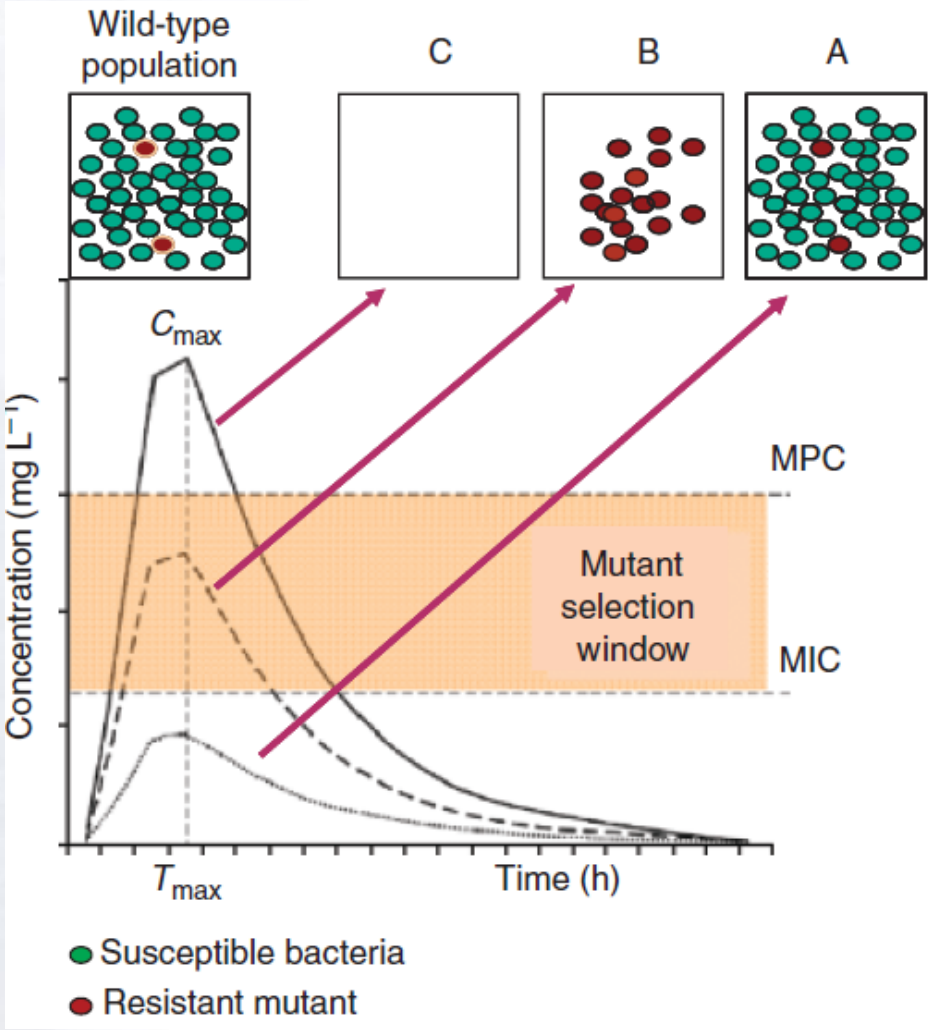
PK/PD – AMR Selection

Table 1. MPC values of different antibiotics against different organisms

Microorganism	Antibiotic	MIC_{50} (mg l^{-1})	MPC_{50} (mg l^{-1})	Reference
Pseudomonas aeruginosa	Ciprofloxacin	0.12	2	Cantón et al. (2003b)
	Levofloxacin	0.25	8	
	Ceftazidime	2	32	
Pseudomonas aeruginosa	Imipenem	2	32	Credito et al. (2010)
	Meropenem	0.5	8	
	Doripenem	0.5	4	
Escherichia coli	Nalidixic acid	1.5	32	Hansen et al. (2008)
	Ciprofloxacin	0.012	0.3	
Escherichia coli	Imipenem	0.25	0.5	Credito et al. (2010)
	Meropenem	0.03	0.06	
	Doripenem	0.03	0.125	
Streptococcus pneumoniae	Levofloxacin	1*	2*	Homma et al. (2007)
	Moxifloxacin	0.125*	0.5*	
Staphylococcus aureus	Ciprofloxacin	0.3†	4†	Zhao et al. (2003)
	Levofloxacin	0.12†	2†	



Cantón R and Morosini MI. FEMS Microbiol Rev 35 (2011) 977–991

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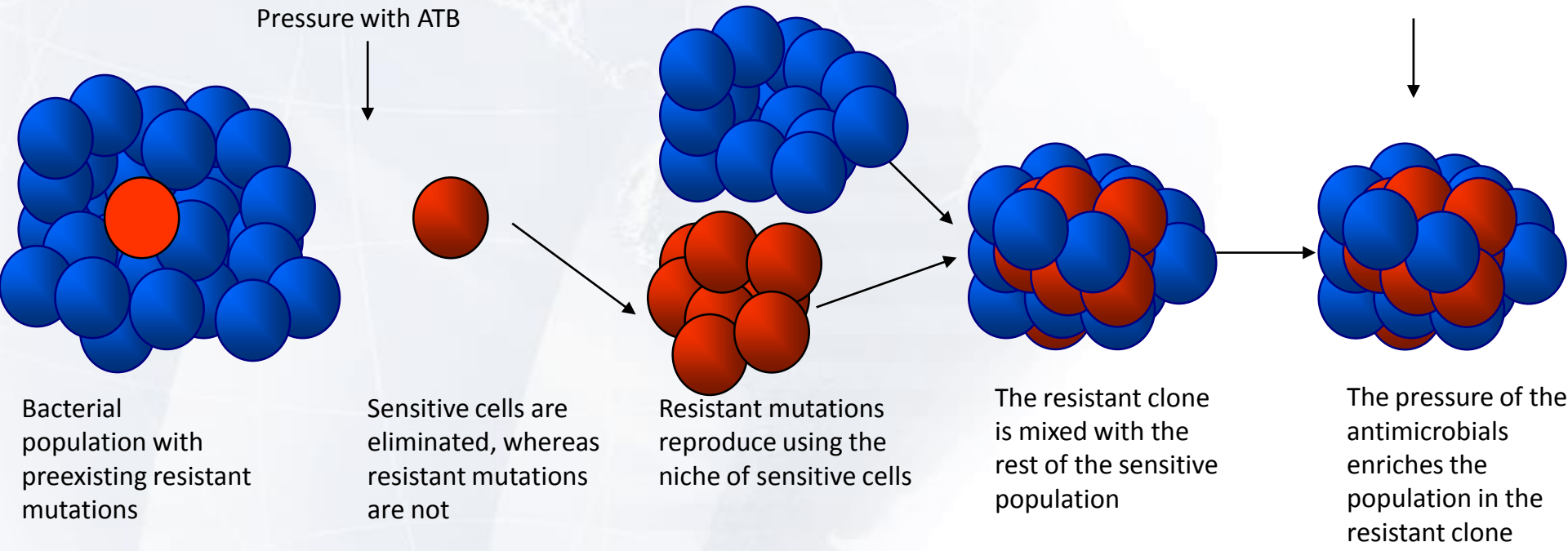
Selection and Dissemination of Antibiotic Resistance

Appearance and Selection of Resistance

Dissemination of Resistance



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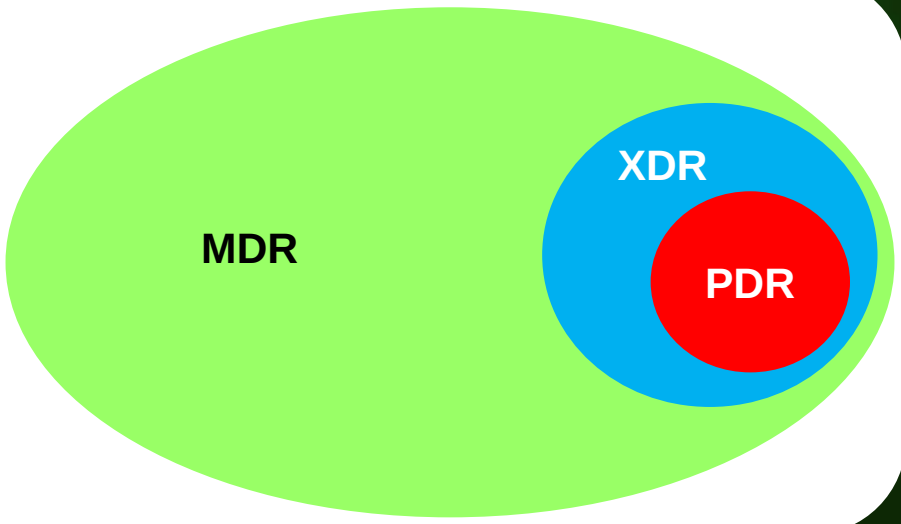
DEFINITIONS

MDR Multi-Resistance: Non sensitive to at least one agent in three or more anti-microbial categories

XDR Extreme Resistance: Non sensitive to at least one agent in all categories except in two or less

PDR Pan-Resistance: Non sensitive to any agents in the antibiotic categories

Non multi-resistant: Includes isolated not sensitive in at least ONE ATB in **≤ 2** antibiotic categories



Human XDR and PDR pathogens in the Americas

Enterobacteria

Acinetobacter spp

P. aeruginosa

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Priority Pathogens for R&D of new antibiotics - WHO

Priority 1: CRITICAL

Acinetobacter baumannii, carbapenem-resistant

Pseudomonas aeruginosa, carbapenem-resistant

Enterobacteriaceae, carbapenem-resistant, 3rd generation cephalosporin-resistant

Priority 2: HIGH

Enterococcus faecium, vancomycin-resistant

Staphylococcus aureus, methicillin-resistant, vancomycin intermediate and resistant

Helicobacter pylori, clarithromycin-resistant

Campylobacter, fluoroquinolone-resistant

Salmonella *spp.*, fluoroquinolone-resistant

Neisseria gonorrhoeae, 3rd generation cephalosporin-resistant, fluoroquinolone-resistant

Priority 3: MEDIUM

Streptococcus pneumoniae, penicillin-non-susceptible

Haemophilus influenzae, ampicillin-resistant

Shigella *spp.*, fluoroquinolone-resistant

27-02-2017

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Human Pathogens Highly R to ATB
Principles for ATB Therapy

1. BGN-XDR (especially *A. baumannii* XDR) ⟶ itte ≠ infection by colonization or contamination.

2. Antimicrobial therapy ⟶ According to ATB

3. In XDR y PDR ⟶ consider most active ATBs, combined therapy and or high doses may be necessary(most common in BGN).

4. Dosage according to PK and PD profile,
   T>CIM (> doses, prolonged infusion) for β-lactam
   AUC/CIM or Cmax/CIM (> doses) for quinolones and aminoglucosides

5. Doses adjusted to weight, liver or renal failure and elderly patients.

6. Eliminate risk factors for infection and control sources for infection

Clin Microbiol Infect 2016; 22: S15–S25

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AMR affects sustainable development

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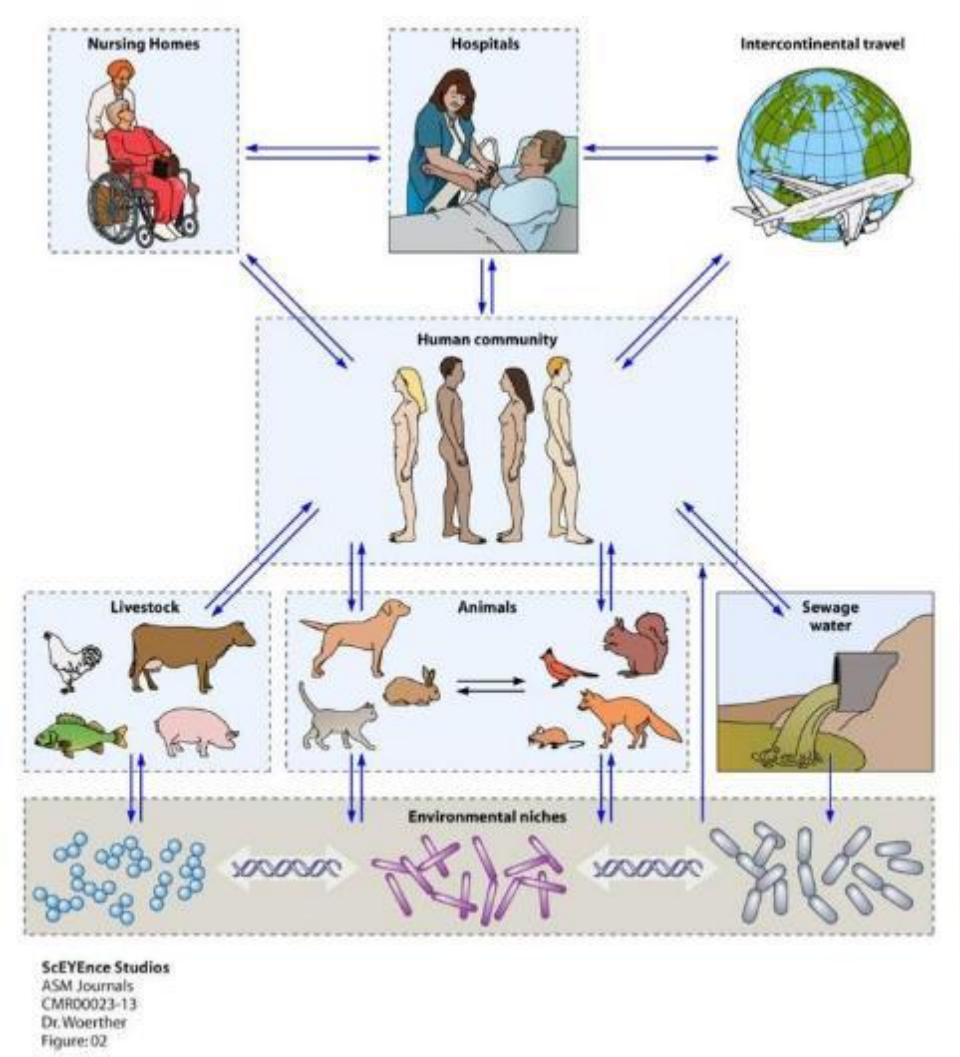

AMR from Medical Standpoint

holistic, integral and multi-sectoral perspective
« One Health"

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Collaboration for *One Health*

Food and Agriculture Organization of the United Nations

Leader in global food and agriculture

WORLD ORGANISATION FOR ANIMAL HEALTH

Leader in health and animal health standards

World Health Organization

Leader in world health

Trilateral Agreement
Collaboration
Unite priorities including Antimicrobial Resistance

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Key Areas– Global Action Plan

1. Improve knowledge and understanding of AMR

- Risk Communication
- Education

2. Enhance knowledge through surveillance and research

- National AMR Surveillance
- Improve laboratory capacity
- Research and Development

3. Reduce incidence of infections through effective hygiene &IPC measures

- IPC in healthcare facilities
- Prevention at community level
- Animal Health: Prevention and Control

4. Optimize use of antimicrobials in human and animal health

- Access to quality antimicrobials and regulatory systems
- Use in veterinary care and agriculture

5. Assure sustainable investment through research and development

- Measure burden of AMR
- Evaluate investment needs
- Establish procedures for participation

Strategic Plan
Global Action Plan

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54.º CONSEJO DIRECTIVO

67.ª SESIÓN DEL COMITÉ REGIONAL DE LA OMS PARA LAS AMÉRICAS

Washington, D.C., EUA, del 28 de septiembre al 2 de octubre del 2015

Punto 4.9 del orden del día

CD54/12, Rev. 1
2 de octubre del 2015
Original: español

PLAN DE ACCIÓN SOBRE LA RESISTENCIA A LOS ANTIMICROBIANOS

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Key Areas– National Action Plan

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Awareness and Education

Strategic Area I

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Objetive 1: Improve awareness and understanding of AMR through training and education

Microbiologist know:

- Basis of AMR activity (PK-PD)
- Basis of AMR resistance
- Source of AMR mechanisms
- Transmission routes (Disseminations of strains or AMR mechanisms)
- Magnitude of the problem
- Best ways to use laboratory test for patient care

Can collaborate in training of healthcare personnel
Participate in awareness campaigns to promote understanding of problem
Participate in education strategies at undergraduate level

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Surveillance and Research

Strategic Area II

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Objetive 2: Strengthen knowledge and evidence through surveillance and research

Microbiologists are responsable for:

- Quality of diagnosis
- Surveillance: Production of data, collection, analysis and reporting (≠ sources)
- Source of resistant mechanisms
- Detection, confirmation, characterization and communication of AMR emergencies
- Measuring impact of AMR (research)
- Provide microbiological knowledge for the development of guidelines for treatment based on local epidemiology(human)

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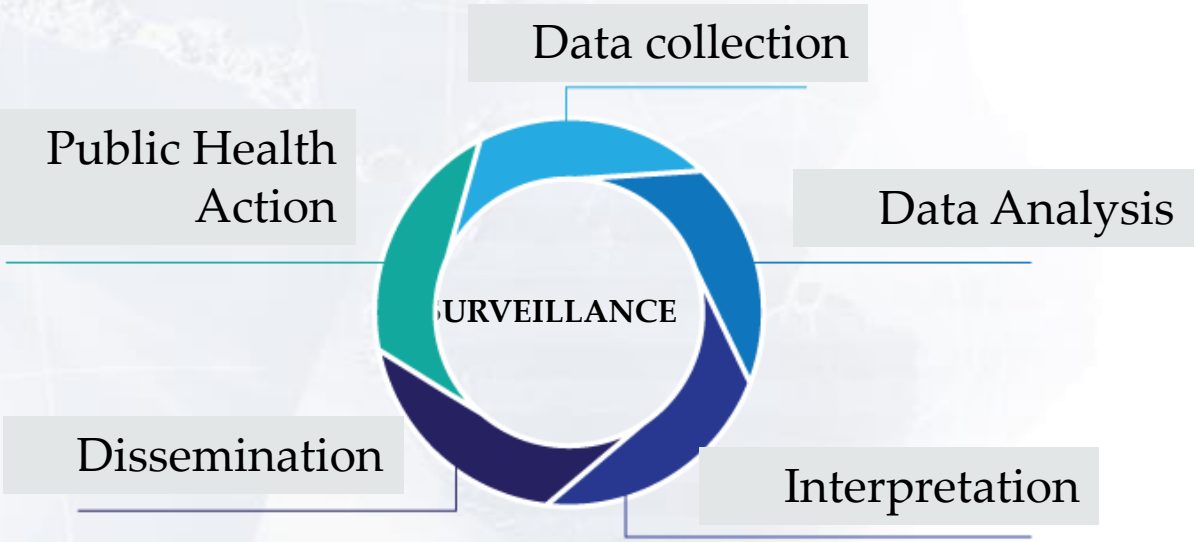
Definition of Surveillance

The collection, analysis, interpretation and systematic dissemination and continuity in data for public health action.



- Understanding of the problem
- Establishment of appropriate intervention measures
- Evaluation of efficacy

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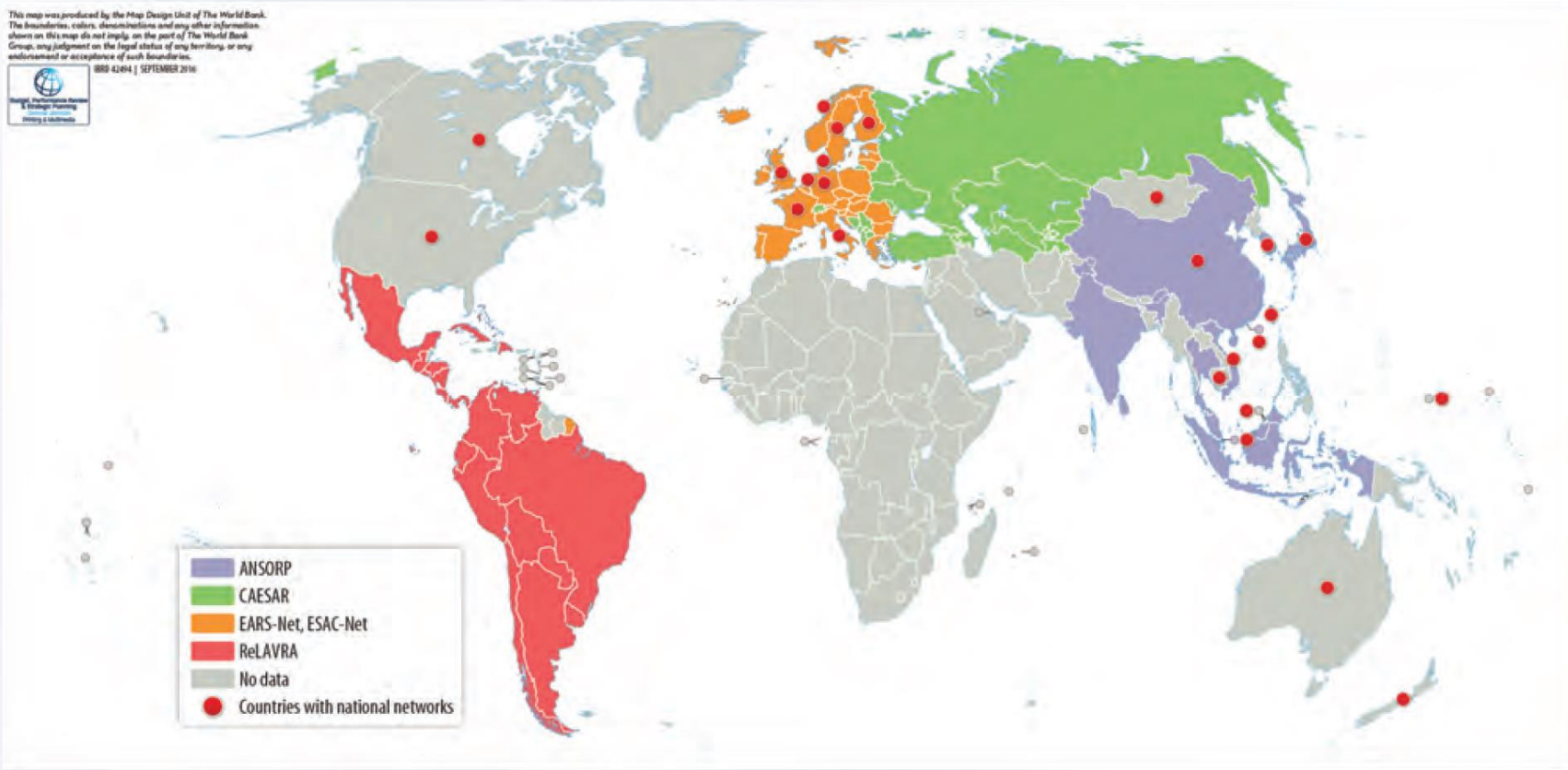
Global AMR Surveillance Networks



Country or Region	Programs
European Union	European Antimicrobial Resistance Surveillance System (EARS-Net) European Antimicrobial Consumption Network (ESAC-Net)
Latin America	Latin American Surveillance Network of Antimicrobial Resistance (ReLAVRA)
Asia	Asian Network for Surveillance of Resistant Pathogens (ANSORP)
Central Asia and Eastern Europe	Central Asian and Eastern European Surveillance of Antimicrobial Resistance (CAESAR)
Global	Global Antimicrobial Resistance Surveillance System (GLASS)

THE KEY

PRODUCE INFORMATION TAILORED TO SYSTEM USERS THAT COVERS ALL PURPOSES

INFORMATION USERS

LOCAL Healthcare Facilities

- Data for individual patient care
- Design empirical treatment plans
- Purchase antimicrobials for faciltiy
- Programs for optimal antimicrobial use
- Infection control programs

NATIONAL Country

- Information for decision-makers – development- implementation- evaluation of PANs
- Data for the development of national treatment guidelines(gono, diarrheas, pneumonias, etc)
- Prevention Strategies(vaccines, education, legislation, etc)
- Production/updating essential medical supply lists

REGIONAL Continent

- Elaboration of regional AMR trends
- Advising Countries
- Prioritization of strategies
- Advocacy

GLOBAL Planet

- Resource Mobilization
- Consensus Building, Global Recommendation and Guidelines

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Components for National Surveillance System

Components of National Surveillance System

Surveillance Protocol

- Definition of samples/pathologies for surveillance
- Definition of pathogens for surveillance
- (ATBs)sensitivity profile for pathogens
- Definition of clinical/epidemiological data to be collected
- Standardization of internal quality control protocol
- Guidelines for clinical reporting(restriction for infection site, pathogen, methodology, etc)
- Definitions related to differentiation of hospital acquired infections in the community, colonization, contaminations, etc.
- Accepted methodologies
- Regulations for interpretation and reporting on current sensitivity tests

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Surveillance Levels

Collaboration
Communication
Exchange of Experiences
Sharing Information
Feedback

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Structure of Global Surveillance System

Collaborating with laboratories

Surveillance data for the development/design of empirical treatment at local level

- > 80% of treatment is empirical

For rational use of antibiotics it is important to know which microorganisms are circulating and their resistance profiles

- Decision-makers need data

To design strategies and measure their impact

Strategy

Use of routineinformation provided by laboratory(requirement: standardization and quality assurance) in sentinel units

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AMR Surveillance

What does AMR surveillance information provide?

- Recognize involved **species**
- Establishes prevalence of pathogens and AMR profile(extension of the problem)
- Suggest alternatives for treatment
- Information for designing control measures
- Determines efficacy of measures

Excellent opportunity to know and improve laboratory quality

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Latin American Network for AMR Surveillance (ReLAVRA)

- Created in 1996 by PAHO/WHO
  - 8 countries
  - Pathogens transmitted by food: *Salmonella*, *Shigella* and *V. cholerae*
- Incorporation of countries and expansion
  - 2000: Nosocomial pathogens, 14 countries
  - 2008: 19 countries

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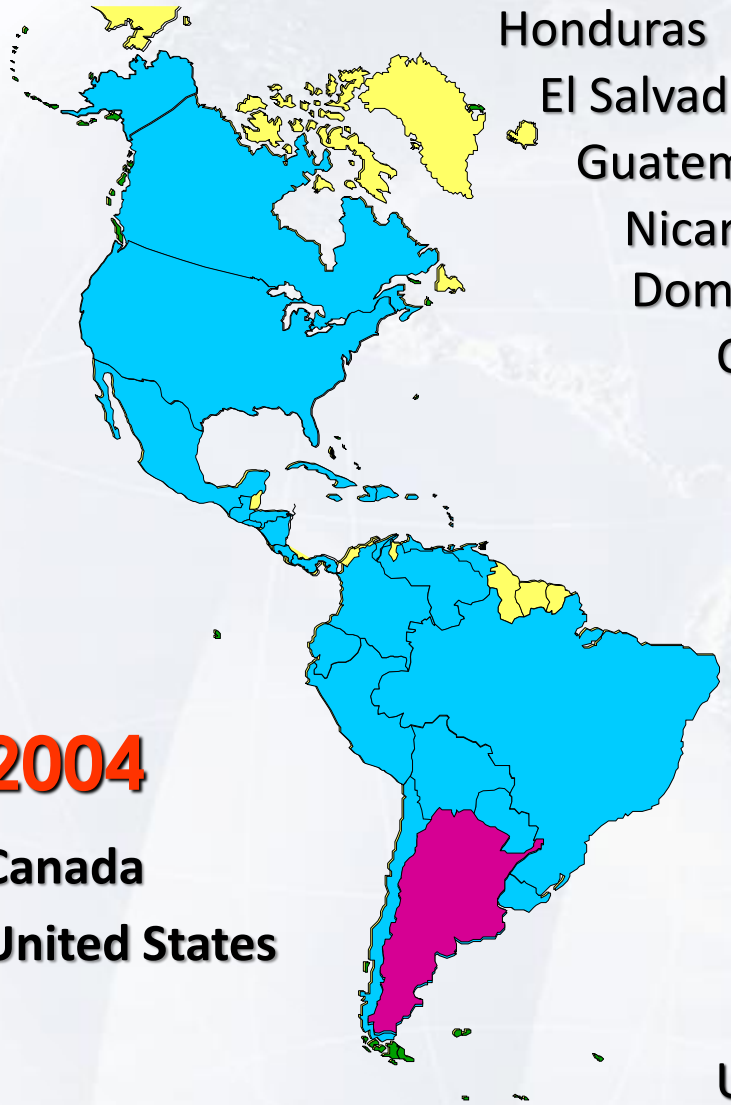

Mexico
Honduras
El Salvador
Guatemala
Nicaragua
Dominican Republic
Costa Rica
Panama
Cuba
Colombia
Venezuela
Ecuador
Perú
Bolivia
Chile
Paraguay
Brasil
Uruguay
Argentina

2004

Canada

United States

ReLAVRA

Coordination

PAHO

Quality Control Referral Center

Argentina

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Latin American Network for AMR Surveillance **(ReLAVRA)**

"Obtain reliable, timely and reproducible data to be used to improve patient care and strengthen surveillance programs through the establishment of sustainable quality control programs"

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2012

Latin American Network for AMR Surveillance – **ReLAVRA**

20

National reference laboratories

Capacity

750 Sentinel Laboratories

Surveillance

Instituto Nacional de Enfermedades Infecciosas, C. Malbrán, ANLIS, Argentina

Regional Reference Laboratory

Quality

325,000 isolations

Report to the referral laboratory

WHONET

Software

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Network Growth

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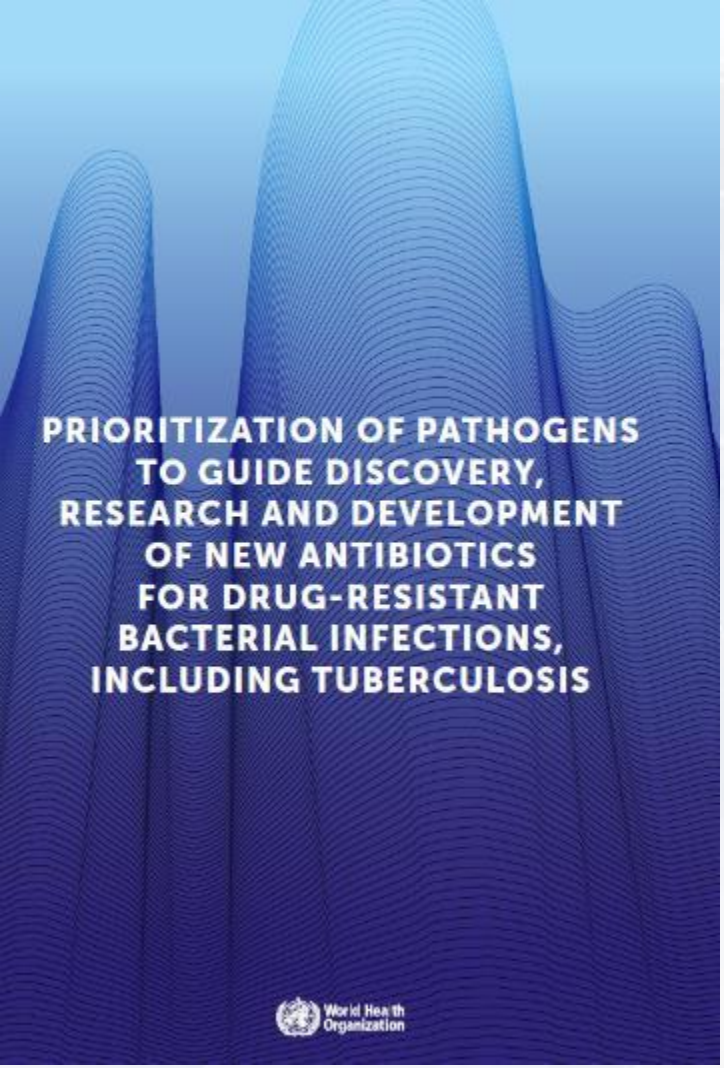
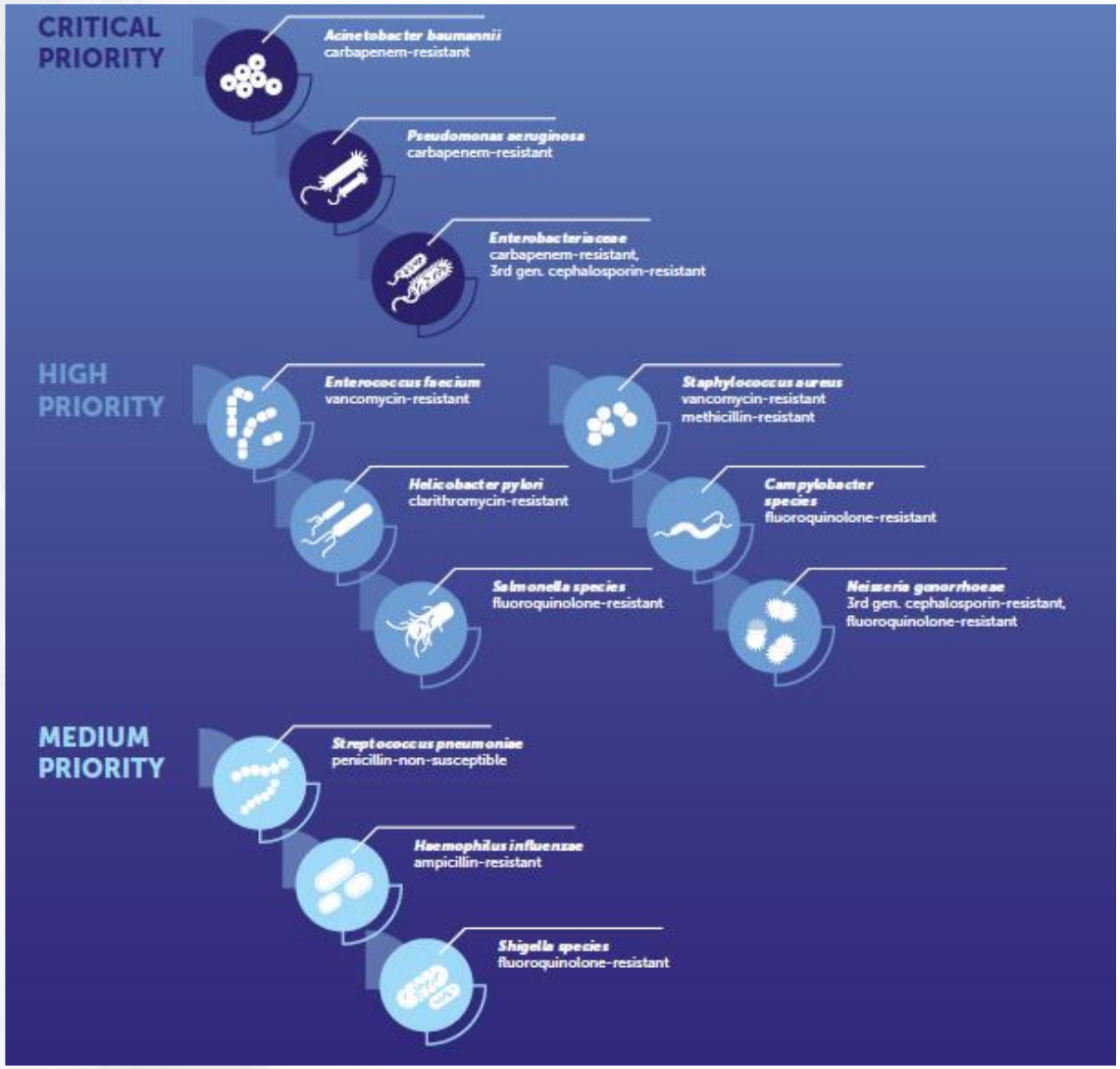
http://www.who.int/medicines/areas/rational_use/PPLreport_2017_09_19.pdf?ua=1





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Pathogens under surveillance
1996-2017

Nosocomial pathogens

- *Enterococcus* spp.
- *Klebsiella pneumoniae*
- *Acinetobacter* spp.
- *Pseudomonas aeruginosa*
- *Staphylococcus aureus*
- *Escherichia coli*
- *Enterobacter* spp.

Community pathogens

- *Salmonella* spp.
- *Shigella* spp.
- *Vibrio cholerae*
- *Escherichia coli*
- *Neisseria meningitidis*
- *Neisseria gonorrhoeae*
- *Streptococcus pneumoniae*
- *H. influenzae*
- Campylobacter
- *S. β hemolítico*
- *S. aureus*

Pathogens under surveillance
RELAVRA 1996-2017

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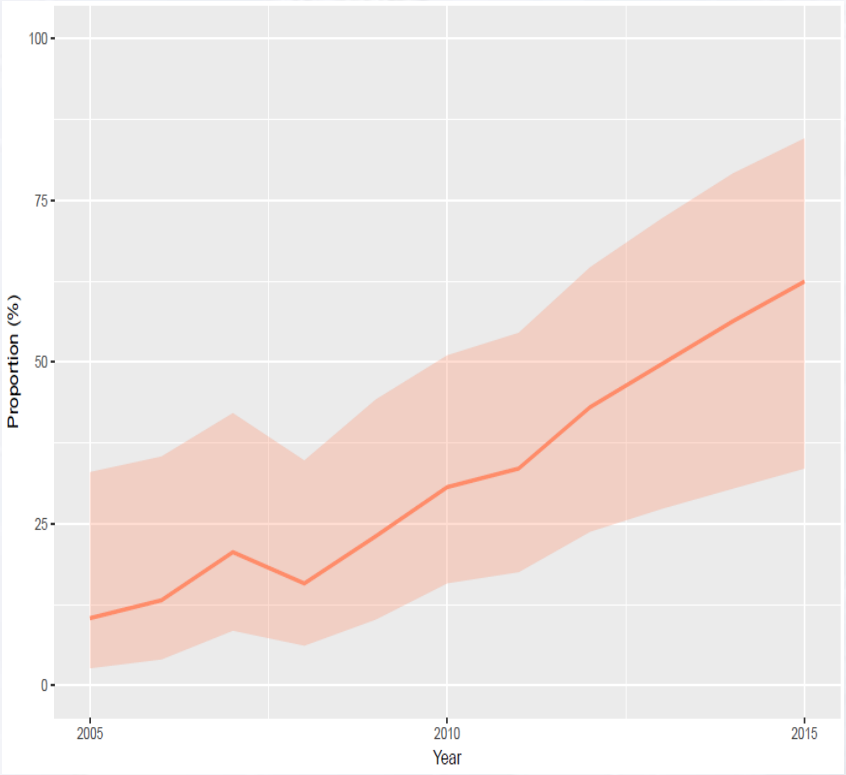
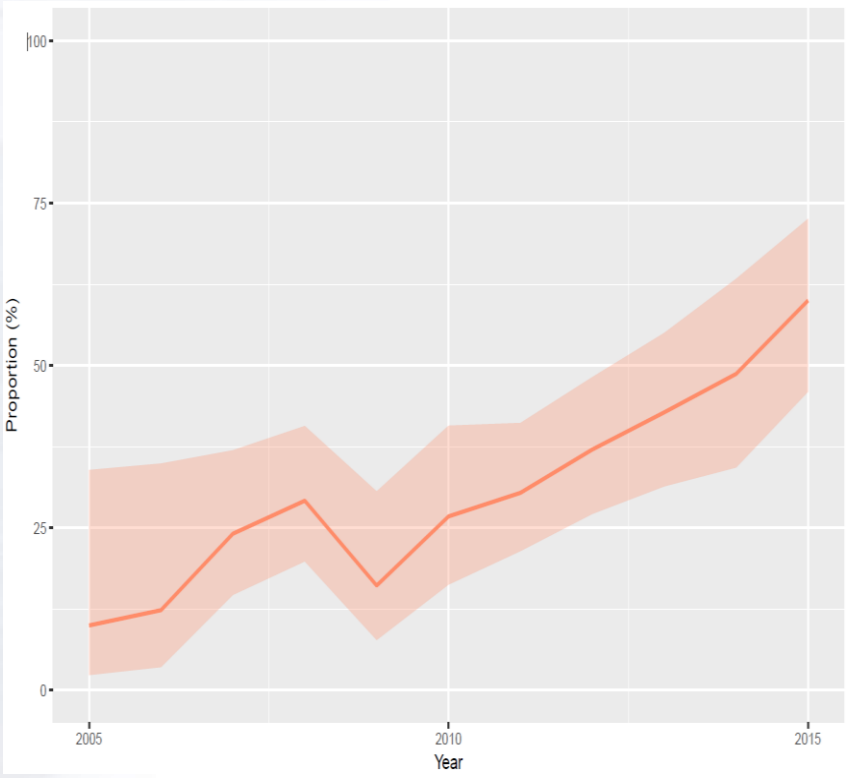
- *S. aureus*

Neisseria gonorrhoeae

Resistant to penicillin (2005-2015)



Resistant to ciprofloxacin (2005-2015)



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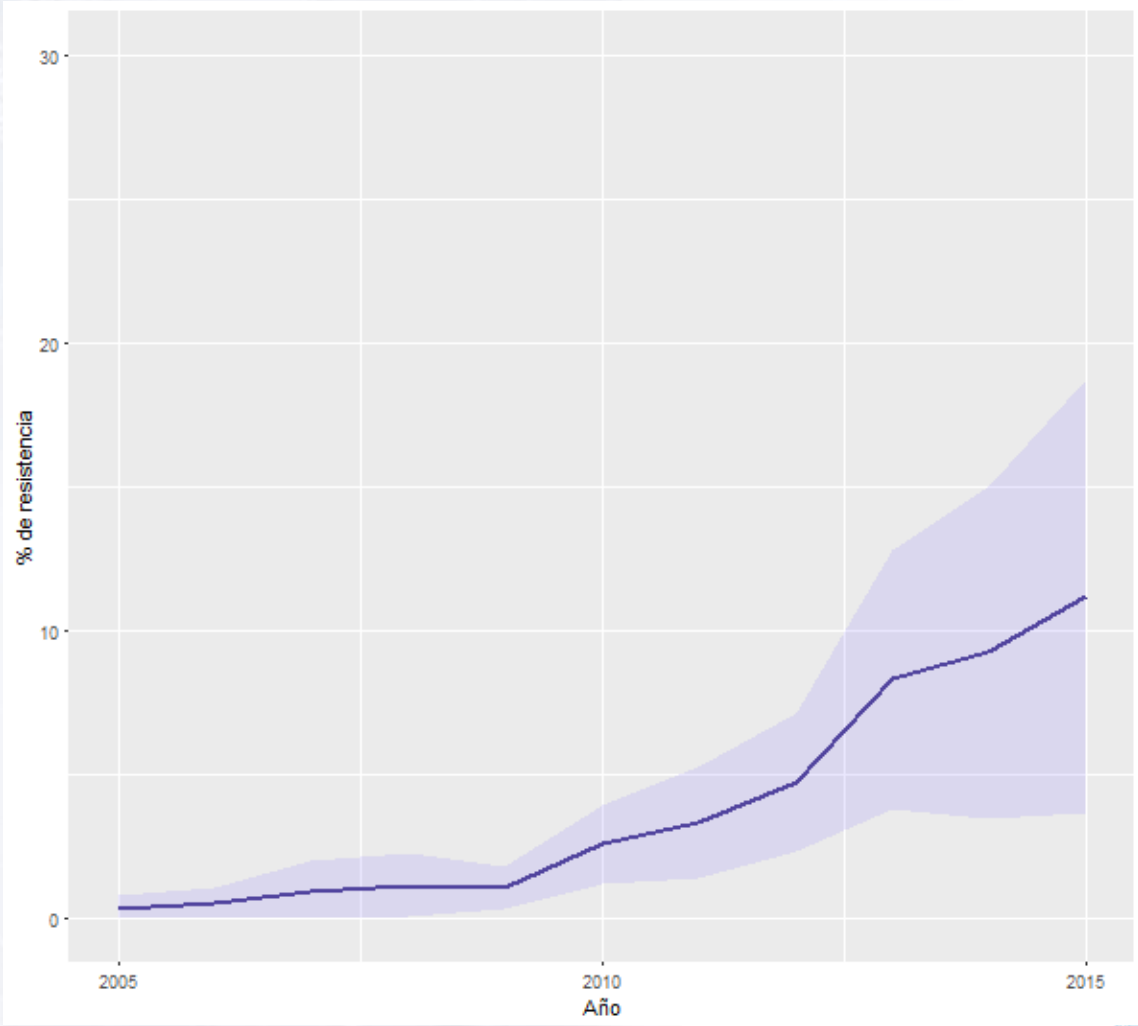
Klebsiella pneumoniae

Resistant to carbapenemes (2005-2015)



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Américas

Infection Prevention and Control

Strategic Area 3

Objective 3: Reduce incidence of infection through effective hygiene and infection prevention and control measures

- IPC
  - Effective hand hygiene
  - Cleaning/Sterilization procedures
  - Reduce healthcare associated infections(HAIs)
- Prevention at community level:
  - Vaccination
  - Hand Hygiene
  - Environmental Sanitation
- Animal health: prevention and control
  - Vaccination
  - Biosecurity and hygiene
  - Sustainable animal production

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Objetive 3: Reduce incidence of infection through effective hygiene and infection prevention and control measures

Microbiologist may collaborate with:

- Adequate management of clinical samples
- Precise and timely identification and sensitivity tests
- Patient and environmental surveillance cultures
- Using microbiological data for early detection of events that can be outbreaks in hospital and communities
- Study and characterize outbreaks
- Evaluation of dissemination of nosocomial and community pathogens
- Collaborate with impact evaluation of prevention strategies(ex: vaccines)
- Notify healthcare personnel on appearance of AMR mechanisms under surveillance at hospital or emergence of new pathogens/AMR mechanisms

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Main Nosocomial Infection Pathogens

Emerging resistant pathogens (MDR, XDR y PDR)

- *S. aureus* meticillin-resistant (MRSA)
- Enterococos resistant to vancomycin (VRE)
- Negative Bacilios gram MDR-GN
  - ETBs resistant to carbapenems (CRE)
  - BLEE Productors
  - *Acinetobacter baumannii*
  - *Pseudomonas aeruginosa*
- *C. difficile*

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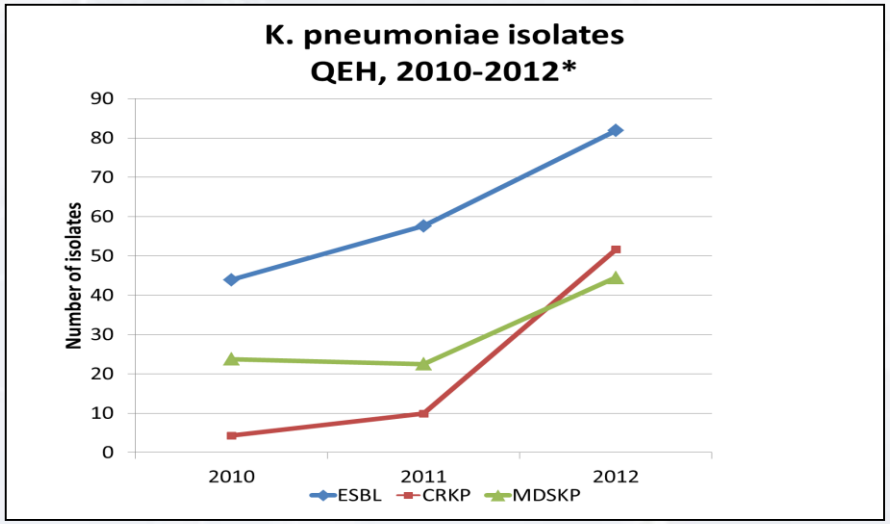
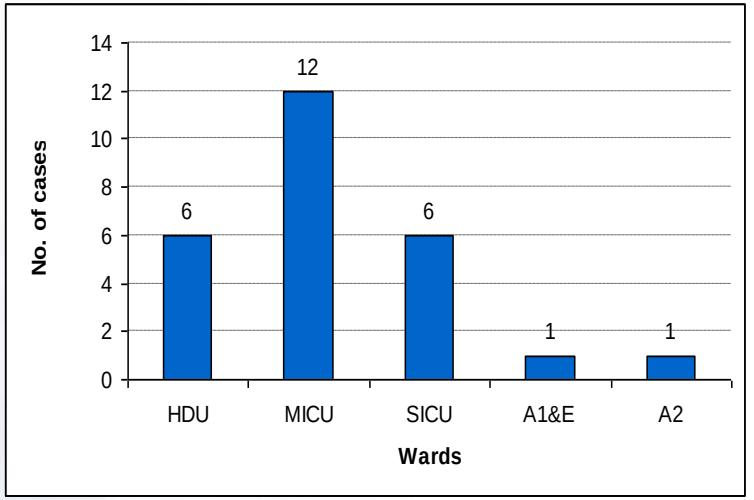
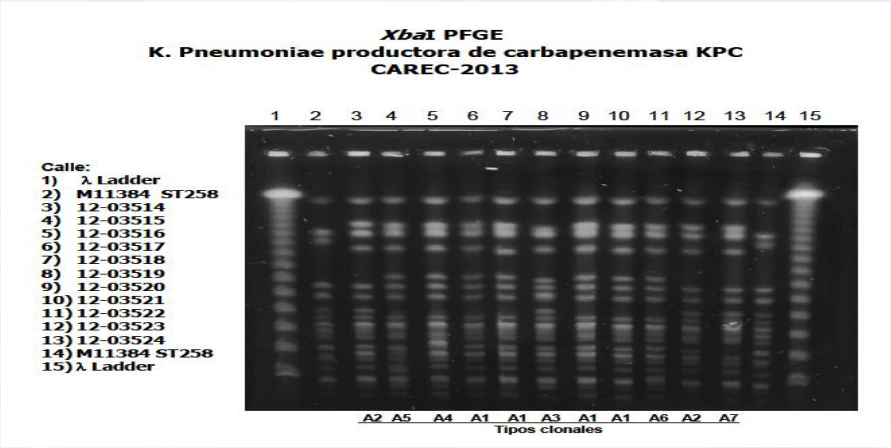
KPC Outbreak……..





Number of KPC outbreaks per ward, January- September 2012



PFGE of selected samples. Take into consideration similarity in band patterns in each sample.

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Nosocomial Outbreak Investigation: Laboratory Role

Investigation Step	Role of clinical microbiology laboratory
Acknowledgement of Problem	Surveillance and early alert system, ideally part of laboratory information system; notify IPC staff of outbreak of possibility, unsual resistance patterns, possible patient to patient transmission
Establish case definition	Helps and advises on inclusion of laboratory diagnosis in case definition
Confirm cases	Perform laboratory confirmation
Complete case search	Characterize bacterial cultures with precision, store cultures of sterile sites and of epidemiological importance, laboratory data base of new cases
Establish base line and compare with attack rate during outbreak	Provide continous data monitoring for baseline for selected units and infection sites, find previous cases in laboratory data base
Characterize outbreak	Perform genotyping of involved strains, compare with isolated endemic strains to determine if the outbreak involves a clone (only if the type of pathogen involved is routinely stored)
Generate hypothesis about causality: reservoir, propagation mode, vector	Carry out complementary studies if there are grounds for epidemiological link : personnel, patients, environment
Case-control or cohort study	Adjusts laboratory procedures if needed
Continual surveillance to document efficacy of control measures	Maintain laboratory surveillance and alert functions

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Clinical Microbiology and Infection Prevention. D. Diekema and M. Saubolle. J Clin Microb. 2011, S57–S60

Appropriate Use of Antibiotics

Strategic Area 4

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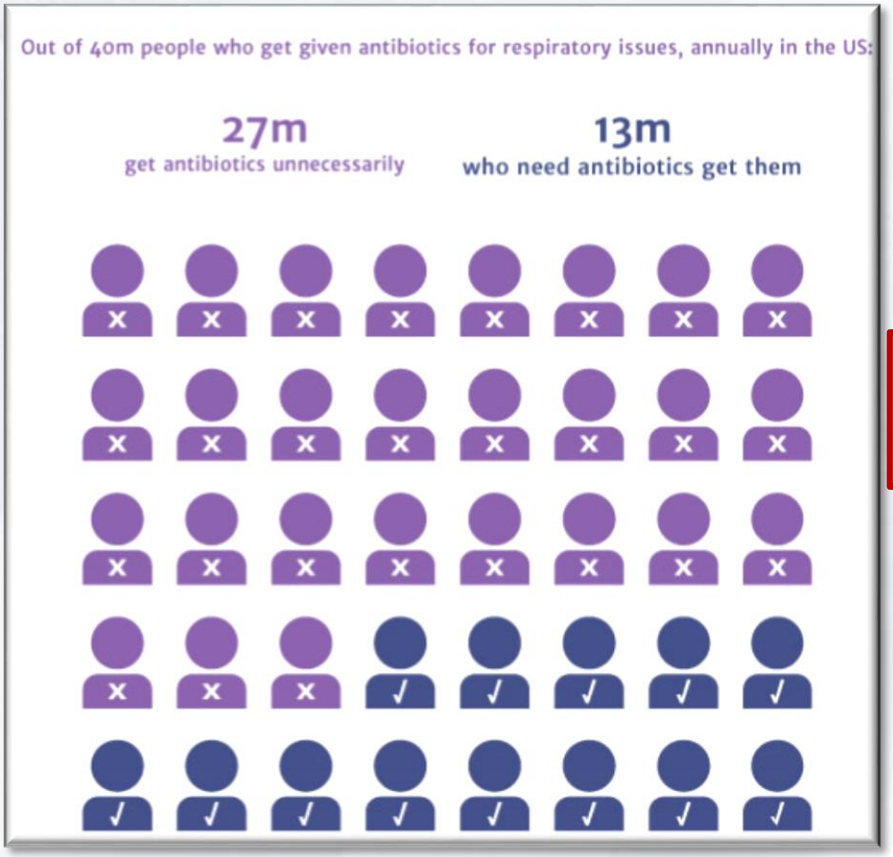
Unnecessary use of antibiotics at a global level



Shapiro, JAC. 2013

Phenotype and molecular methods

- Infection Prevention
- Rapid Methods
- Surveillance

Policies and regulations

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Optimize the use of antimicrobials: Benefits

- **Improve clinical outcomes of patients with infections**;
- **Minimize adverse effects associated with the use of antimicrobials (including onset and dissemination of resistances);**
- Guarantees use of cost-efficient treatments

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Objective 4: Optimize use of antimicrobials in human and animal health

Microbiologists can participate in better use of antimicrobials(Stewardship/PROA):

- Timely, appropriate and quality diagnosis results
- Selective report on sensitivity according to pathogen, site of infection, AMR profile, etc.
- Report based on pharmacokinetic and pharmaco-dynamic parameters
- Special tests when necessary:
  - Rapid testing
  - Quantitative testing
  - Bactericide tests
  - Evaluation of synergic activities
  - Alternative treatment
  - Drug Assessment
- AMR Surveillance

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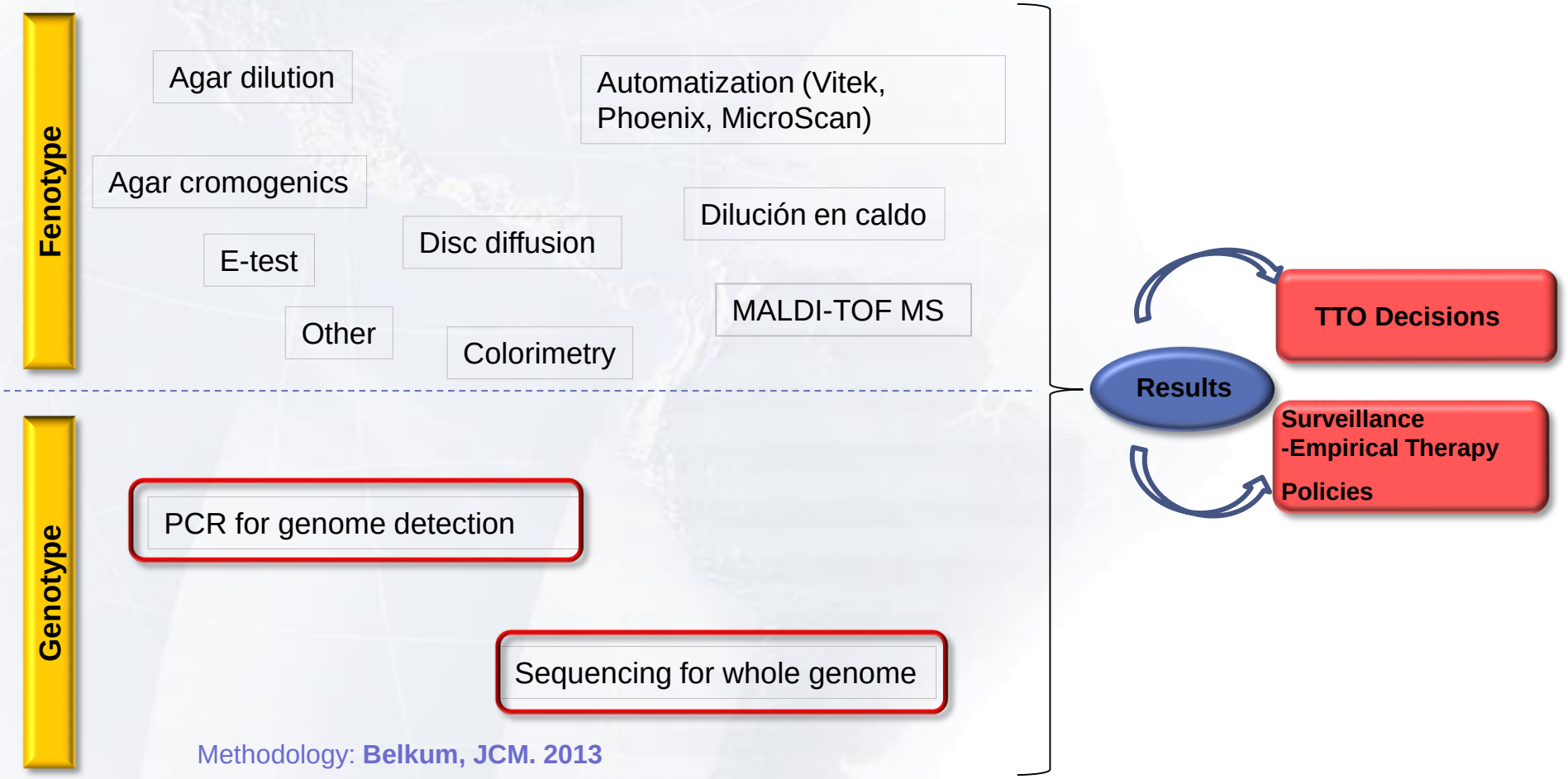
Methodologies for sensitivity tests



Methodology: **Belkum, JCM. 2013**

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¿WHY IS IT IMPORTANT TO DETECT CARBAPENEMASE?

Various methodologies to study sensibility to carbapenemase (Discos, BMD, automatized systems, E-test) each one determines carbapenemasas with different sensibility.

D. Barbarini

An undetected carbapenemase increases patient mortality in

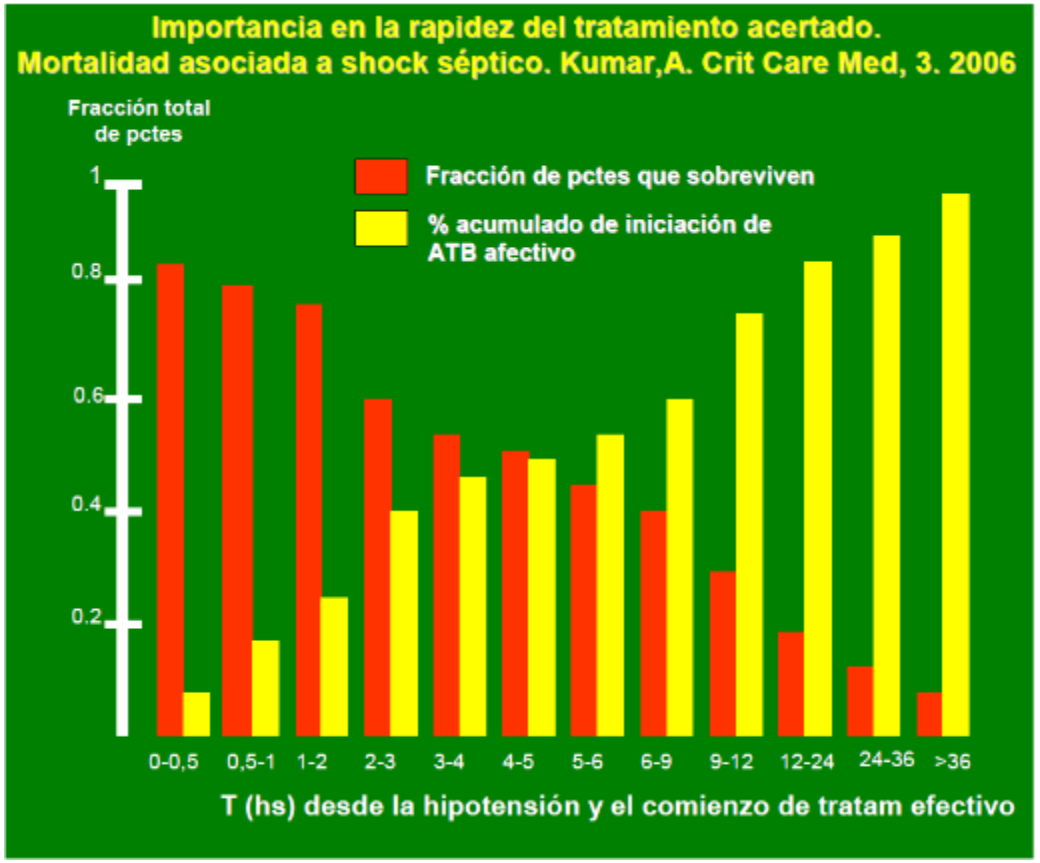
20-40%

due to sub-optimal treatment

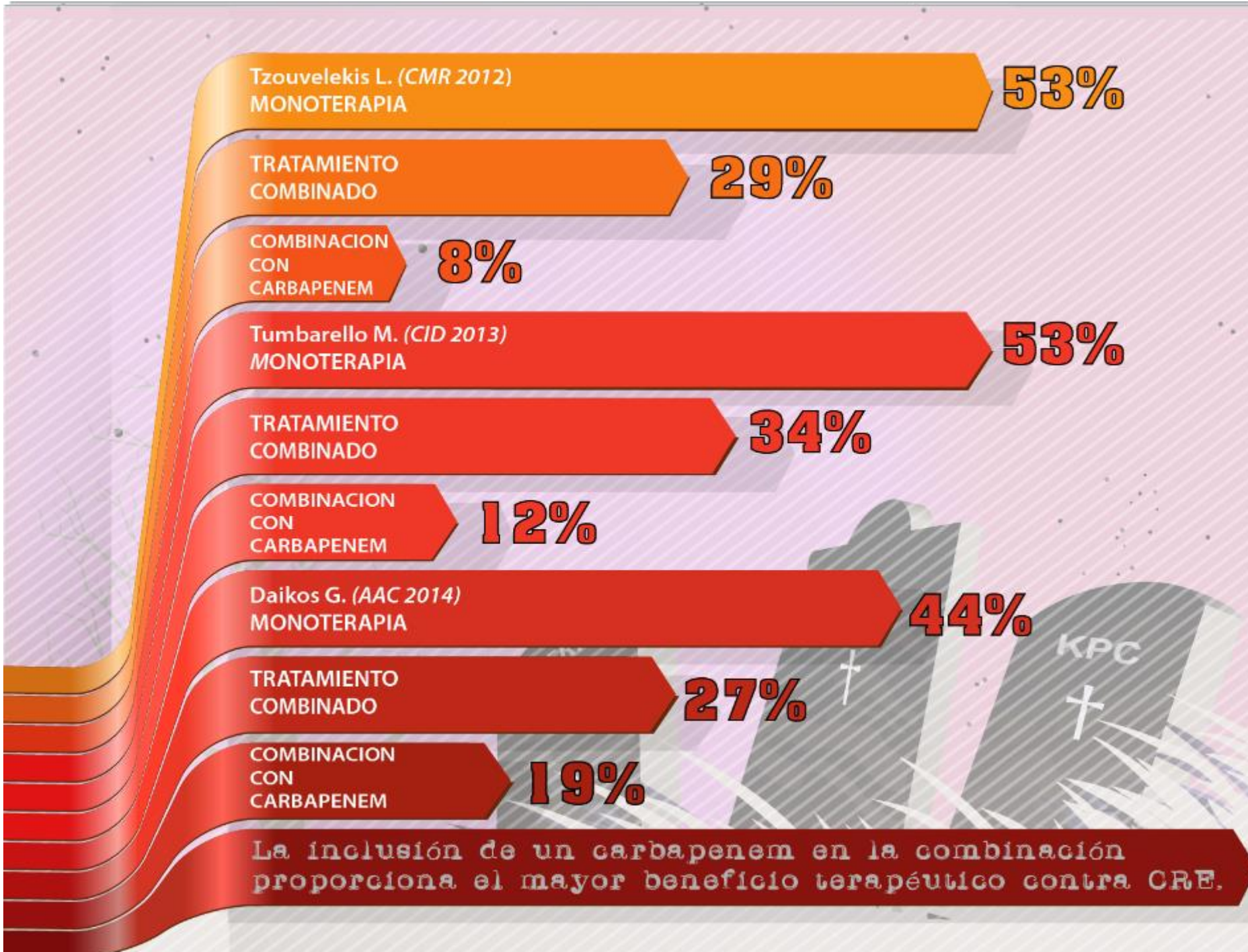
Qureshi Z. 2012; Tzouvelekis, L. 2012; Tumbarello M. 2013; Petrosillo N. 2013; Daikos G. 2014

In carbapenemase endemic zones, labs must conduct rapid detection of resistant mechanisms to assure adequate patient treatment and take appropriate infection control measures

DELAY IN ESTABLISHMENT OF ADEQUATE TREATMENT



Beginning correct therapy within 1 hour of initial hypotension is related with 80% of survival; for each hour in delayed treatment survival rate declines by 7.6%

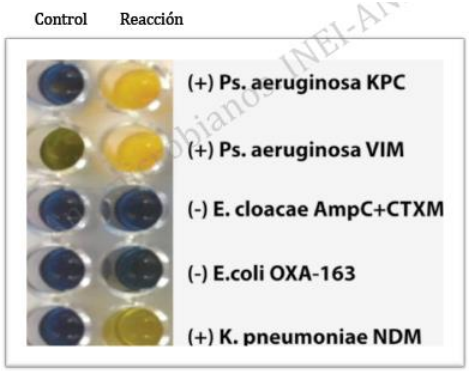

Tzouvelekis L. (CMR 2012)
MONOTERAPIA
53%
TRATAMIENTO COMBINADO
29%
COMBINACION CON CARBAPENEM
8%
Tumbarello M. (CID 2013)
MONOTERAPIA
53%
TRATAMIENTO COMBINADO
34%
COMBINACION CON CARBAPENEM
12%
Daikos G. (AAC 2014)
MONOTERAPIA
44%
TRATAMIENTO COMBINADO
27%
COMBINACION CON CARBAPENEM
19%
KPC
La inclusión de un carbapenem en la combinación proporciona el mayor beneficio terapéutico contra CRE.

- An undetected carbapeneme increases mortality and is an independent factor with poor prognosis….
- Timeliness in detection…

Rapid Method

rdmann P, EID 18(9):1503, 2012. Nordmann P, JCM 50(11):3773, 2012. Nordmann P, AAC 56(12):6437, 2012

Blue carba Test

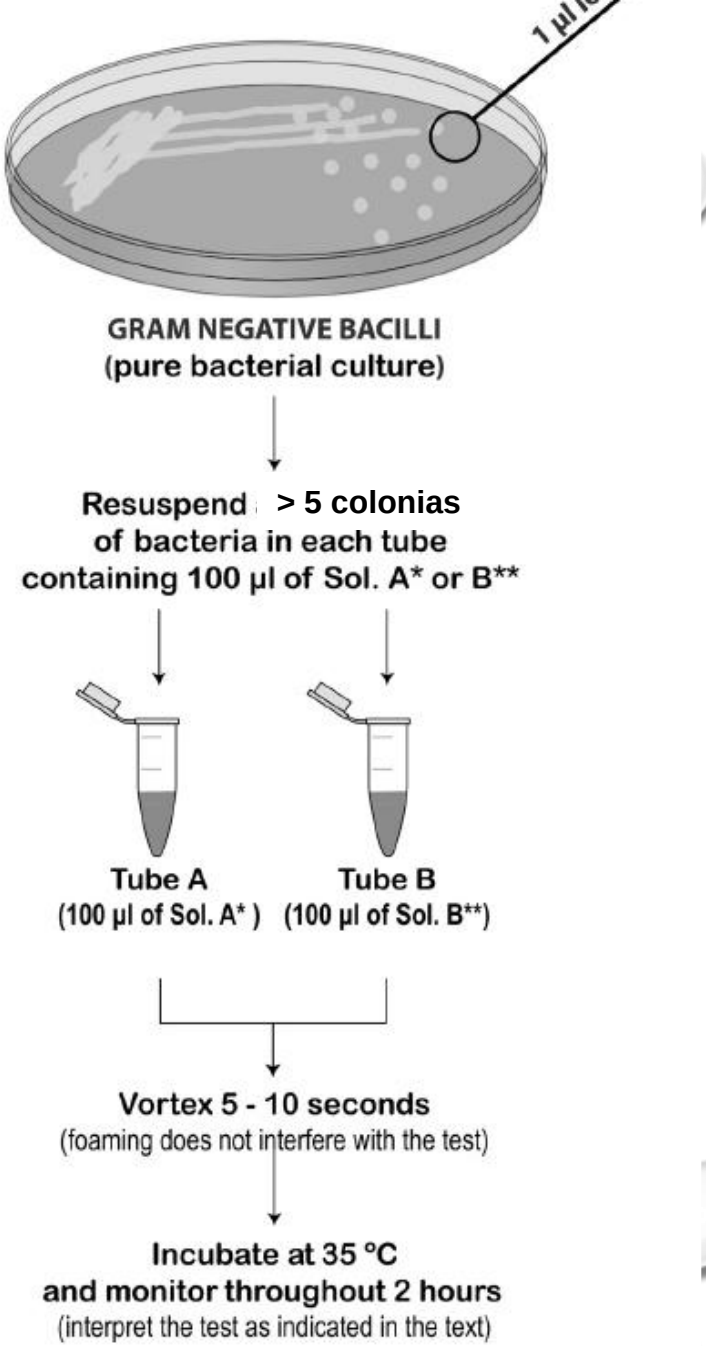


***Sol. A:** Azul de Bromotimol 0,04% + SO_4Zn 10mM*

Adjust to pH 7. CRITICAL!!!

****Sol. B:** Sol A **3 mg/ml of imipenem***

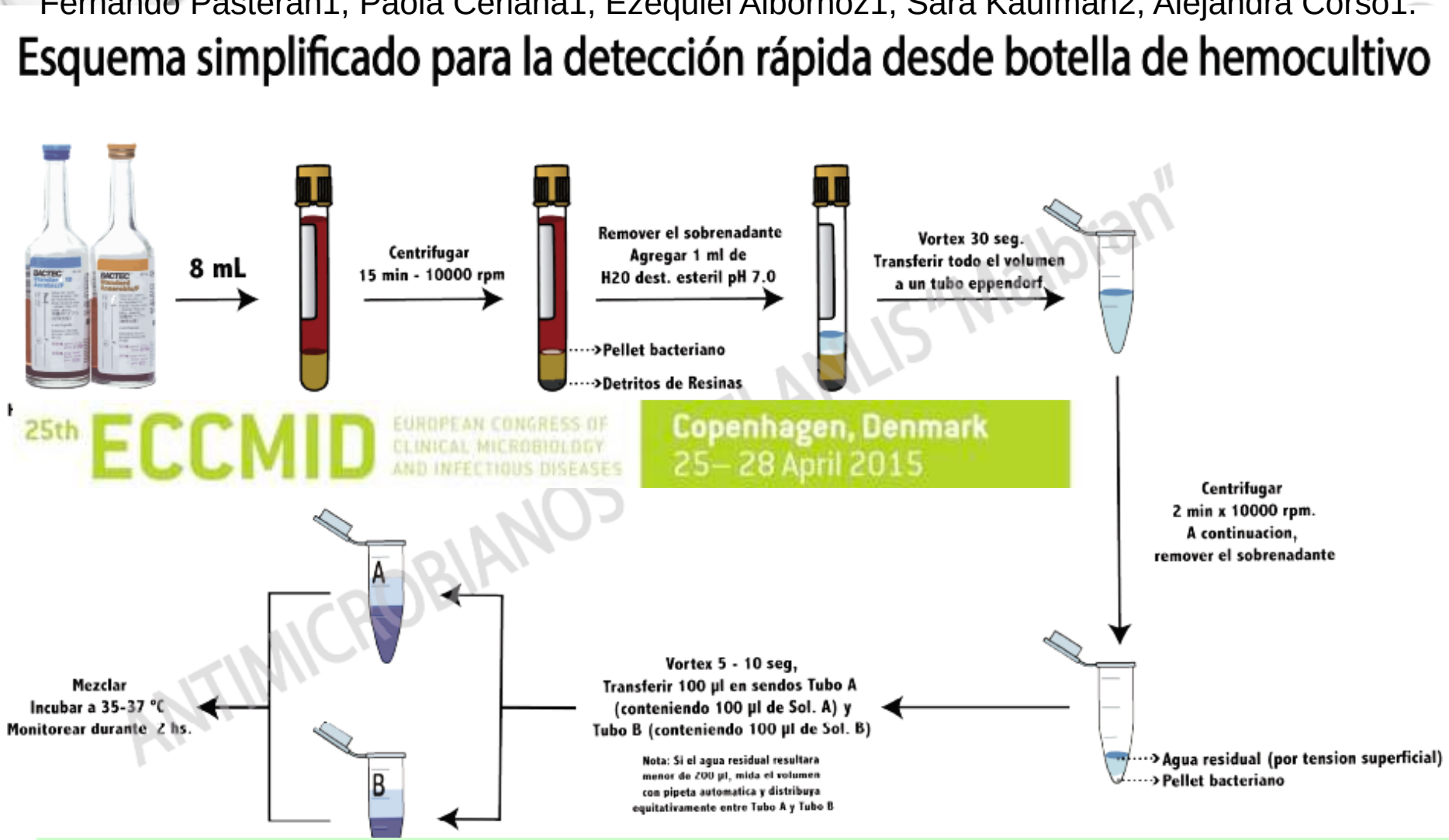
or 6 mg/ml imipenem-cilastatina (injectable formulation)



www.antimicrobianos.com.ar/protocolos/bluecarba

Rapid Detection of Carbapenemase-Producing Gram Negative Bacilli from Blood Cultures Using the Blue-Carba Test (BCT)

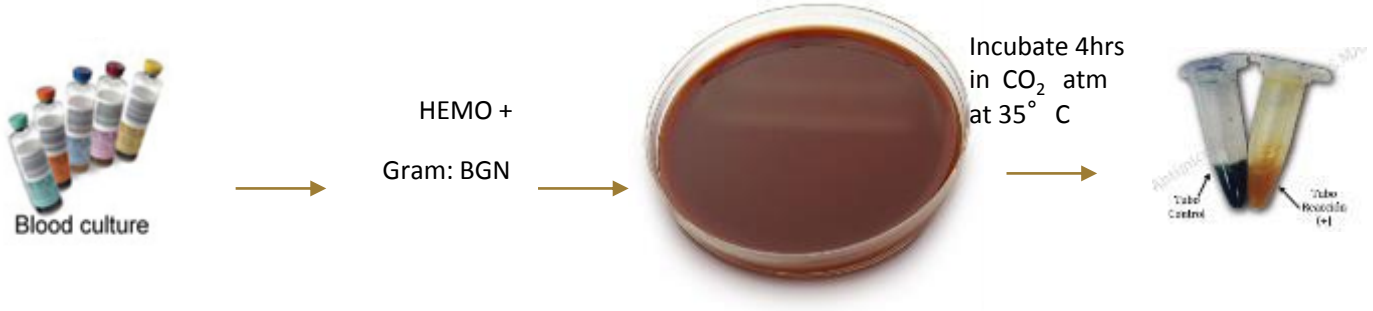
Fernando Pasteran1, Paola Ceriana1, Ezequiel Albornoz1, Sara Kaufman2, Alejandra Corso1.



- Detected carbapenemase directly from blood culture with a similar sensitivity (95% vs 97.5%) to Bctest directly of colony with specifity of 100%
- Reduced detection time from 24-48hours to 30-150 min.

Rapid Blue-Carba test: reduction in the detection time of carbapenemases performed from a 4-hour bacterial lawn

Marcela Nastro, Melisa Ayora, Susana García, Carlos Vay, Ángela Famiglietti & Carlos Hernán Rodriguez



Correlation between Blue-Carba from colony and RBCT (rapid blue carba test) was 98.3% (OXA163 kpn).

The rapid identification of CPO CR using RBCT allows clinicians to take appropriate therapeutic measures in shorter time frames because incubation time was reduced from 24 to 4 hours.

Journal of Chemotherapy 2016

Lateral Flow Immunochromatographic (IC) Assay
OXA-48 K-SeT® and KPC-K-SeT ®
(Coris BioConcept, Gembloux, Belgium)

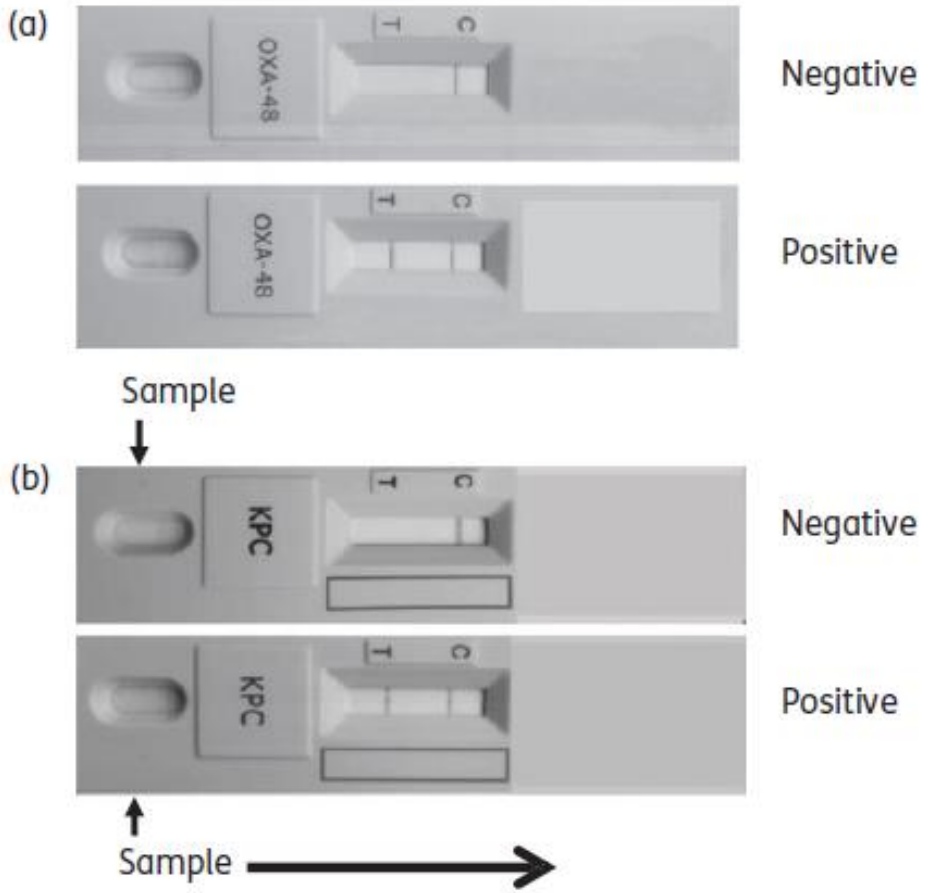
OXA-48, OXA-162, OXA-181, OXA-204, OXA-232 y OXA-244

Positives between 15 and 360 seconds

Negatives after 15 minutes

Directly from colony but can also be via urine or blood sample.

100% of S and E



Glupczynski et al. JAC 2016 (Jan). Dortet et al. JAC 2016 (Mar).


MER <=2
100%
sobrevida
MER 4
†
20%
MER 8
†
25%
MERO
16
†
35%
MERO
>32
†
43%
MEROPENEM
TIGECICLINA
COLISTIN
Clinical evidence: SUITABLE FOR COMBINED TREATMENT ("TREATABLE" RANGE)
NON SUITABLE
CLSI S
CLSI I
CLSI R
Mortality associated with combination therapy according to MER MIC Tumbarello M., 2012. Petrosillo N., 2013

Carbapenemase-producing Enterobacteriaceae in México Latin America (2015)

KPC

NDM

OXA

Not recorded | Recorded | Sporadic spread | Endemic spread

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Highly Resistant Human Pathogens

LABORATORY METHODS

1. **Extended Antibiogram**
2. **Confirmation of resistance mechanism**
3. **Quantitative Methods**
4. **Death Curves(or speed of IV bactericide)**
5. **Synergy Methods**
6. **Dosing of serum concentrations of antimicrobials**

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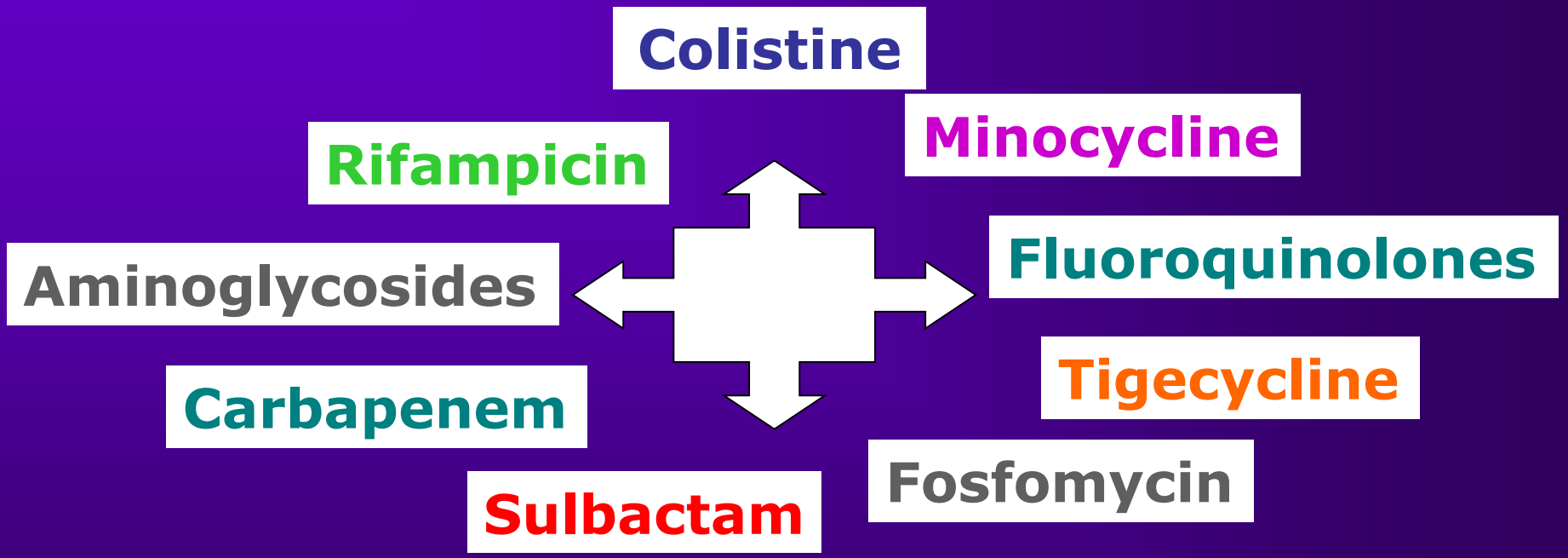
Synergetic Relationships

Alternative treatment for severe infections due to XDR or PDR BGN. Each strain is different!



<u>Synergy in subpopulation</u>: One drug kills the subpopulation that is resistant to the other drug and viceversalación que es R a la otra droga y viceversa.

<u>Mechanistic Synergy</u> : How each drug acts in a different celular site, one drug increases the mortality rate of another.

J Y Song y col. 2007, JAC 60:317 - T Y Tan y col. 2007, JAC 60:421 – Motaouakkil S y col. 2006, JI 53:274 – Timurkaynak F y col. 2006, IJAA 27:224 - Landman D. y col 2008, CMR 21:449-465 – Yahav D. y col. CMI 2012

Highly Resistant Human Pathogens

Infection	Two-drug combination	Three-drug combination
XDR *Enterobacteriaceae* [19,33,40,59,60]	Tigecycline-based combinations: • Tigecycline + aminoglycosides[a] • Tigecycline + carbapenems[b] • Tigecycline + fosfomycin • Tigecycline + polymyxin Polymyxin-based combinations: • Polymyxin + carbapenems • Polymyxin + tigecycline • Polymyxin + fosfomycin Other combinations: • Fosfomycin + aminoglycosides[a] • (ceftazidime or cefepime) + amoxicillin–clavulanic acid • Aztreonam + aminoglycosides[a]	• Tigecycline + polymyxin + carbapenems[b]
XDR *Acinetobacter baumannii* [42,49,54,55,64]	Combinations based on sulbactam or its fixed-dose combination: • (cefoperazone–sulbactam or ampicillin–sulbactam) + tigecycline • (cefoperazone–sulbactam or ampicillin–sulbactam) + doxycycline • Sulbactam + carbapenems[b] • Tigecycline-based combinations: • Tigecycline + (cefoperazone–sulbactam or ampicillin–sulbactam) • Tigecycline + carbapenems[b] • Tigecycline + polymyxin Polymyxin-based combinations: • Polymyxin + carbapenems[b] • Polymyxin + tigecycline	• Cefoperazone–sulbactam + tigecycline + carbapenems[b] • Cefoperazone–sulbactam + doxycycline + carbapenems[b] • Imipenem + rifampicin + (polymyxin or tobramycin)
XDR *Pseudomonas aeruginosa*[c] [29,30,40,43]	Polymyxin-based combinations: • Polymyxin + antipseudomonal β-lactams[d] • Polymyxin + ciprofloxacin • Polymyxin + fosfomycin • Polymyxin + rifampicin Antipseudomonal β-lactams-based combinations: • Antipseudomonal β-lactams[d] + aminoglycosides[a] • Antipseudomonal β-lactams[d] + ciprofloxacin • Antipseudomonal β-lactams[d] + fosfomycin Ciprofloxacin-based combinations: • Ciprofloxacin + antipseudomonal β-lactams[d] • Ciprofloxacin + aminoglycosides[a] Combination of two β-lactams: • (ceftazidime or aztreonam) + piperacillin–tazobactam • Ceftazidime + cefoperazone–sulbactam • Aztreonam + ceftazidime	• Polymyxin + antipseudomonal β-lactams[d] + ciprofloxacin • Polymyxin + antipseudomonal β-lactams[d] + fosfomycin • Polymyxin IV infusion + carbapenems + polymyxin aerosol inhalation • Aztreonam + ceftazidime + amikacin

Clin Microbiol Infect 2016; 22: S15–S25

Conclusion

The microbiology lab has to do more than provide microbiological diagnosis of patients to prevent and control AMR.

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WORLD ANTIBIOTIC AWARENESS WEEK

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Thank you!

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