Antimicrobial consumption and resistance in humans in the EU and conclusions from the ECDC-EFSA-EMA JIACRA report

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Madrid, 5 June 2018

ECDC – European Centre for Disease Prevention and Control

3 April 2018

- An agency of the European Union, located in Stockholm, Sweden
- Founded in 2005; nearly 300 employees
- Mandate to 'identify, assess and communicate current and emerging threats to human health from communicable diseases'
- European Union (EU) (28) and European Economic Area (EEA) (3) = 31 countries with a total of more than 500 million people

Antimicrobial resistance (AMR): what does it mean?

Several, inter-related compartments of healthcare, i.e. patients in primary care, hospitals, nursing homes and long-term care facilities, food animals, food, environment)

Many types of infection, i.e. respiratory tract, urinary tract, skin and soft tissue, bloodstream, surgical site, related to medical devices, etc.)

Many bacteria/microorganisms

Many antimicrobials

Many different genes and mechanisms of resistance

Spread of clones…

… and of resistance genes between bacteria…

Patient stories

Mohammed

Cancer chemotherapy had weakened Mohammed's immune system, allowing an infection with a highly resistant type of *E. coli* to take hold. His doctors were able to successfully treat him with last-line antibiotics.

Read his story >

Daphne

Daphne Deckers, a Dutch author, television host and actor, campaigns to raise awareness about antibiotic resistance following her personal experience with an *E.coli* superbug infection (*Courtesy of WHO/Europe*)

Watch a video by WHO/Europe >

Peggy

Christian Lillis, son of Peggy Lillis, shares his personal story of losing his mother to an *Clostridium difficile infection (C. difficile)* caused by antibiotic use. (*Courtesy of CDC*)

Watch a video by CDC >

Kelly

Antibiotics are being "overprescribed", leading to greater resistance, a former patient says. Kelly Strudwick was diagnosed with a urinary tract infection. (*Courtesy of BBC*)

Watch a video on the BBC website >

Paolo

Paolo fell ill with a serious urinary tract infection with an *E. coli* resistant to many antibiotics. It took two months and three courses of different antibiotics before his infection was successfully treated.

Read his story >

Lill-Karin

Lill-Karin caught a bacterium resistant to multiple antibiotics after a traffic accident followed by hospital stay while on holiday abroad. When transferred to a hospital back home, she had to be placed in a special room, isolated from other patients.

Read her story >

https://antibiotic.ecdc.europa.eu/en/patient-stories

Burden of antimicrobial resistance (AMR) for the EU/EEA

25 000 deaths

each year in the EU/EEA
attributable to
5 multidrug-resistant bacteria
4 main healthcare-associated infections (HAIs)

Update: **November 2018**

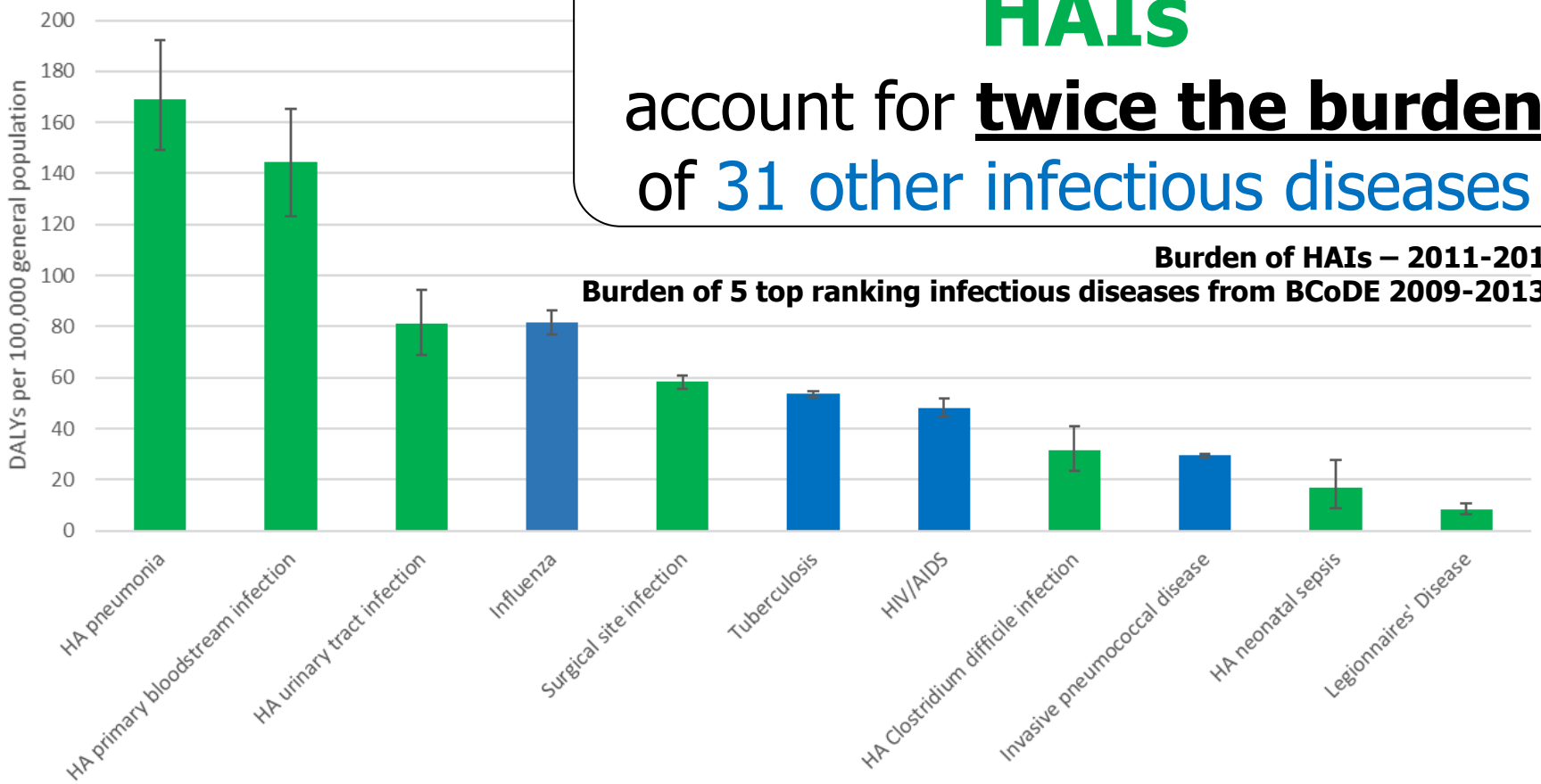
Source: ECDC, 2009.
In: http://ecdc.europa.eu/en/publications/Publications/0909_TER_The_Bacterial_Challenge_Time_to_React.pdf

Comparing the burden of healthcare-associated infections (HAIs) with that of other infectious diseases

HAIs

account for **twice the burden**

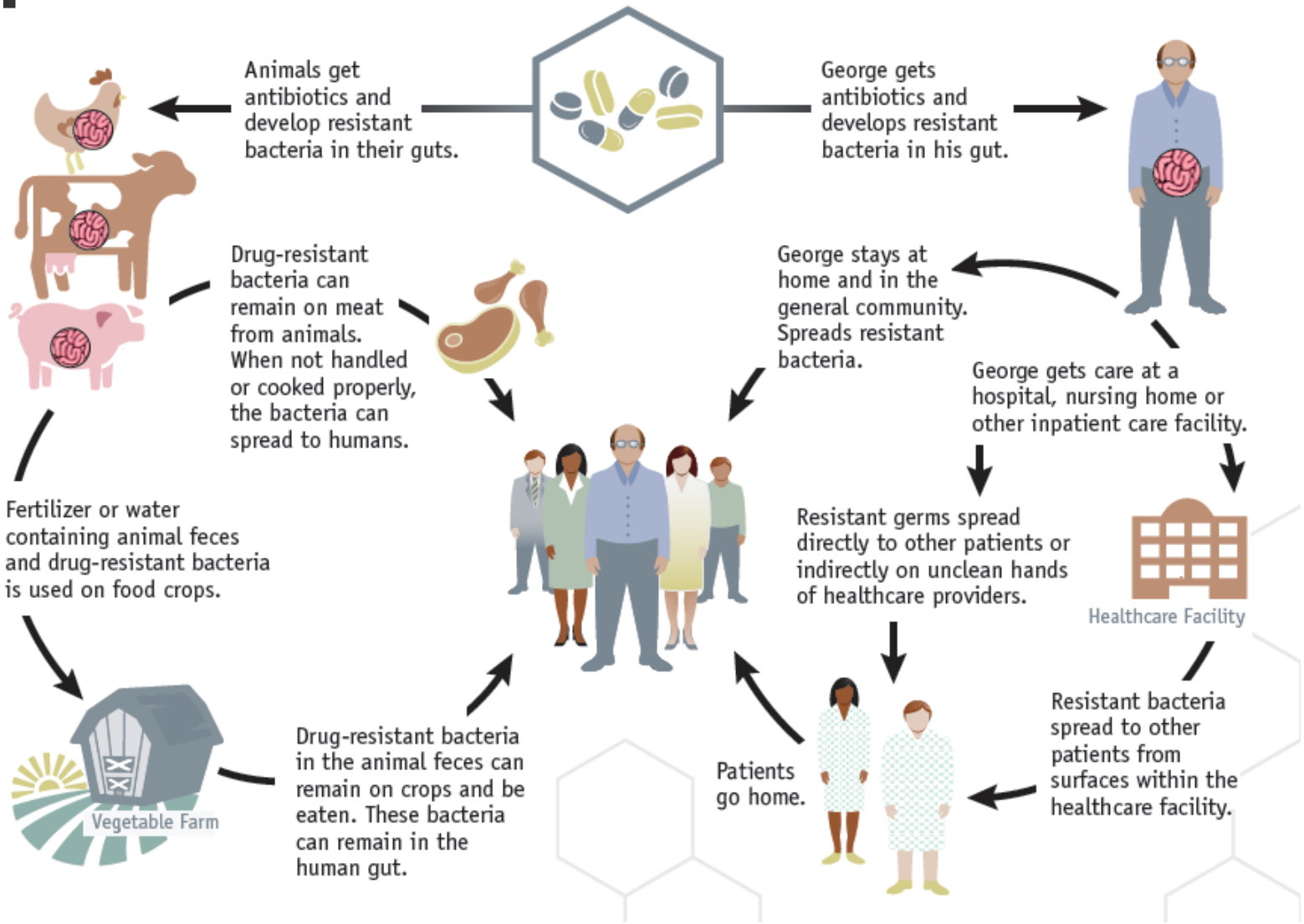
of 31 other infectious diseases



HAI, Healthcare-associated; DALYs: Disability-Adjusted Life Years

Source: *Cassini A, et al. PLoS Med 2016;13(10):e1002150 (18 October 2016)
** Cassini A, et al. Euro Surveill. 2018;23(16):pii=17-00454 (19 April 2018).

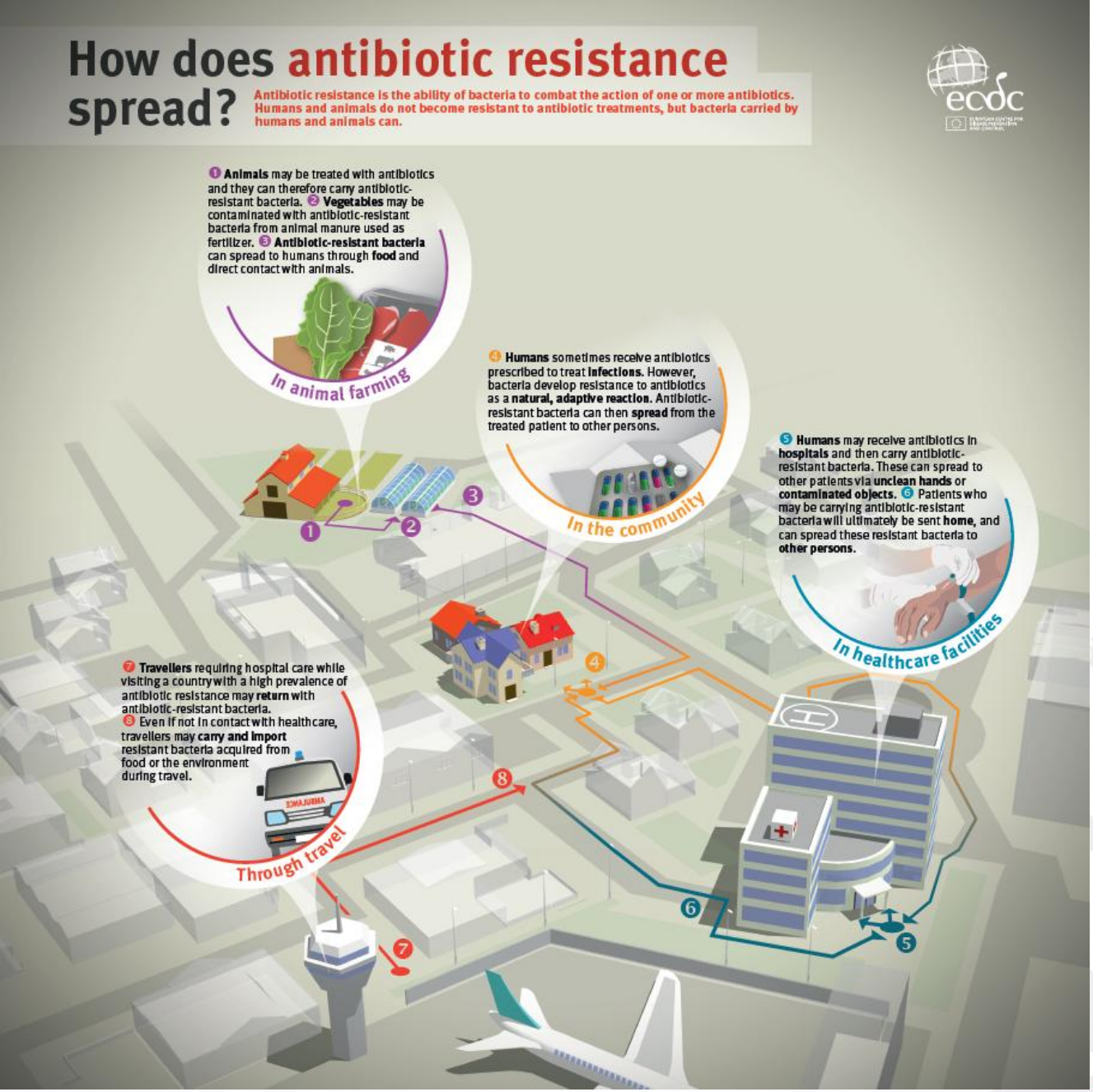
How does antimicrobial resistance spread?



Source: Antibiotic resistance threats in the United States 2013. US CDC,2013.

How does antibiotic resistance spread?

Antibiotic resistance is the ability of bacteria to combat the action of one or more antibiotics. Humans and animals do not become resistant to antibiotic treatments, but bacteria carried by humans and animals can.



Source: ECDC, 2015.

Food animals

Photo: US Dept. of Agriculture

2nd Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA) Report, 2017

ECDC/EFSA/EMA second joint report on the integrated analysis of the consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from humans and food-producing animals

Purpose

To provide an integrated analysis of relationships between antimicrobial consumption (AMC) in human and veterinary medicine and the occurrence of antimicrobial reistance (AMR) in bacteria from humans and food-producing animals

ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

efsa
European Food Safety Authority

EUROPEAN MEDICINES AGENCY
SCIENCE MEDICINES HEALTH

3rd report:
December 2020

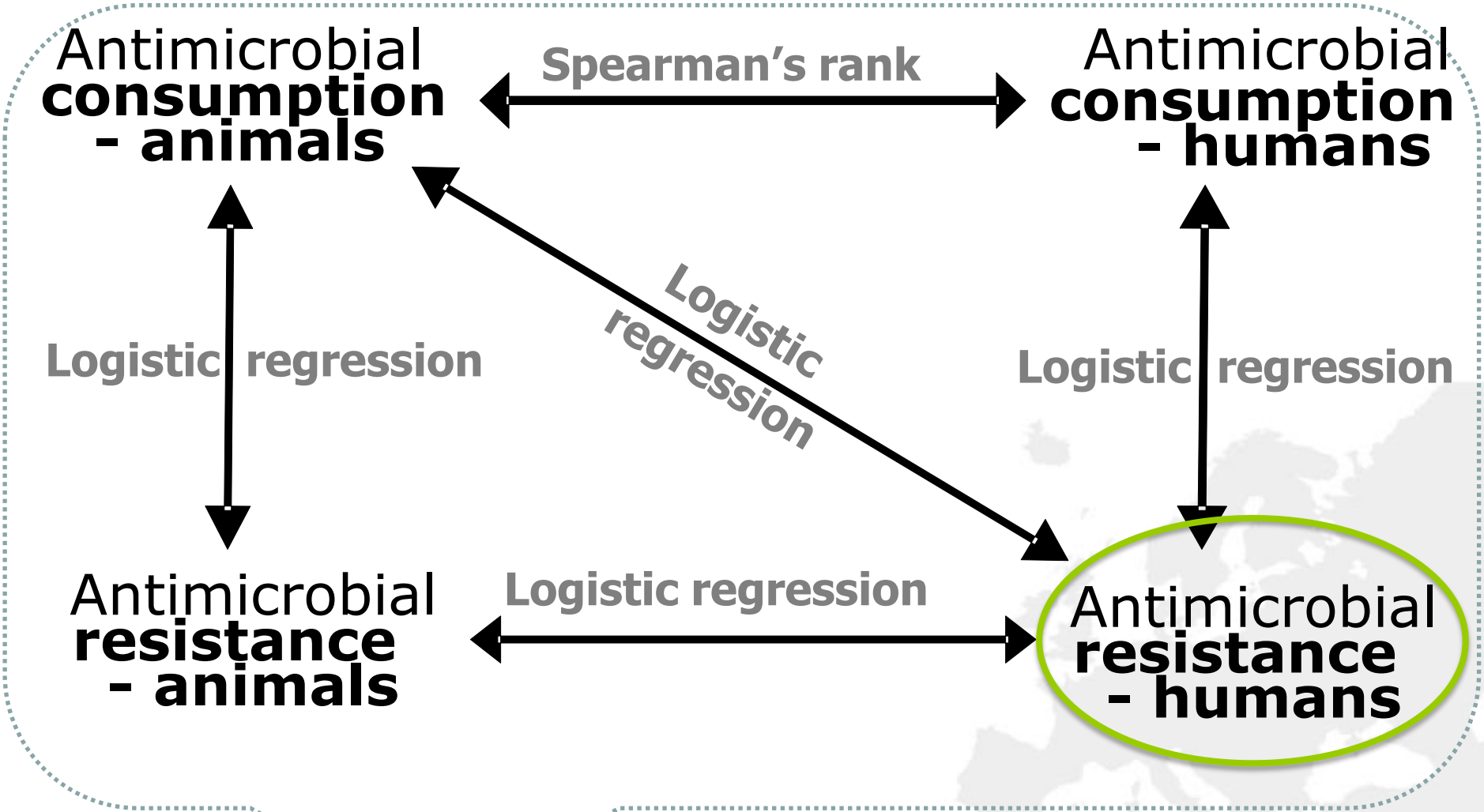
Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

JIACRA reports

- Analysis performed on data from **five EU-wide surveillance networks** managed by the three agencies (ECDC, EFSA, EMA)
- Presents results of analysis to assess the **relationship between AMC and AMR** in food-producing animals and humans
- Conclusions and recommendations in a **one-health perspective** based on results of integrated analysis of data (logistic regression and multivariate analysis)

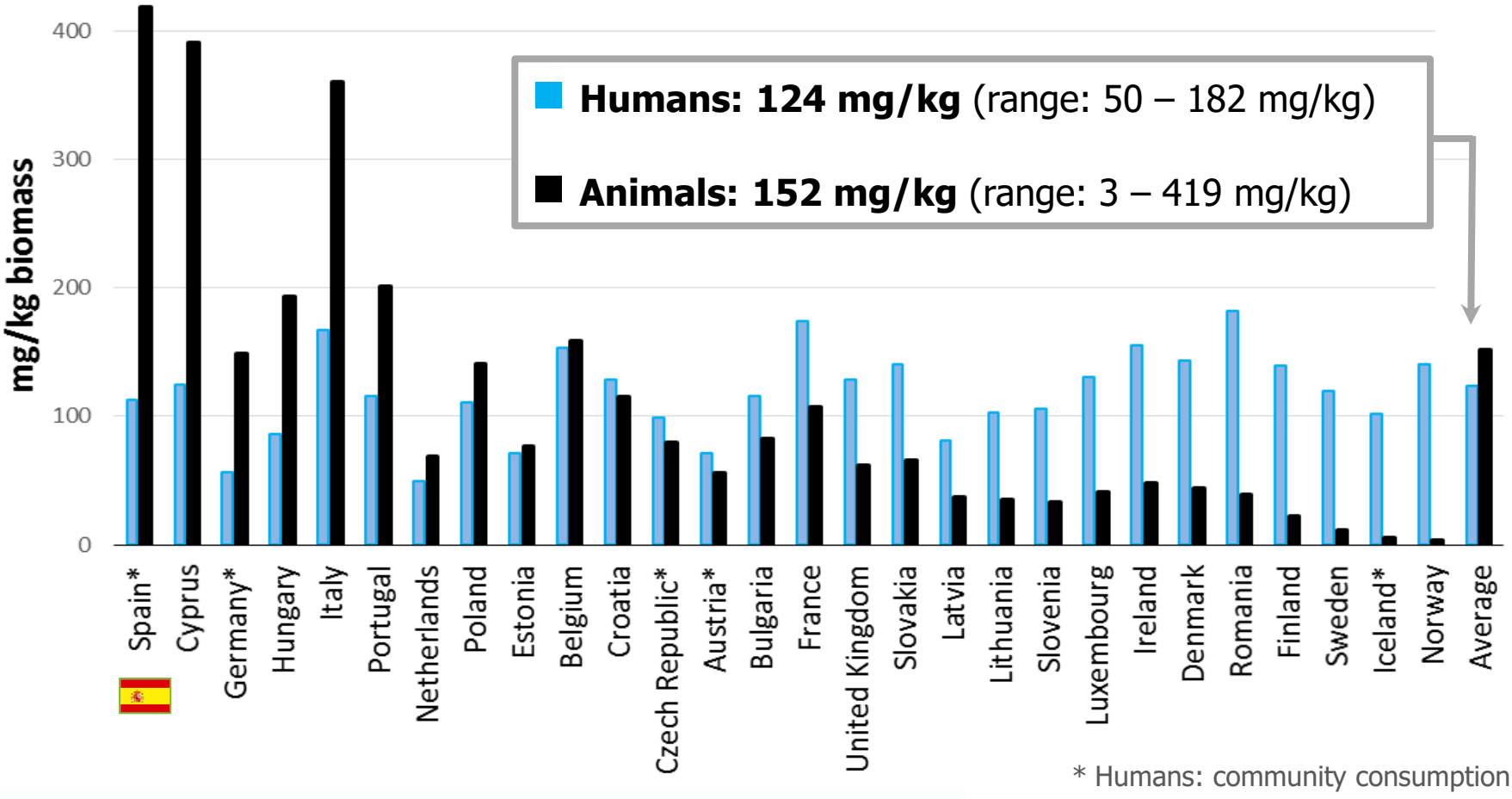
Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

JIACRA analyses performed



Multivariate analysis (2nd JIACRA report)

Biomass-corrected antimicrobial consumption in humans and animals, EU/EEA, 2014

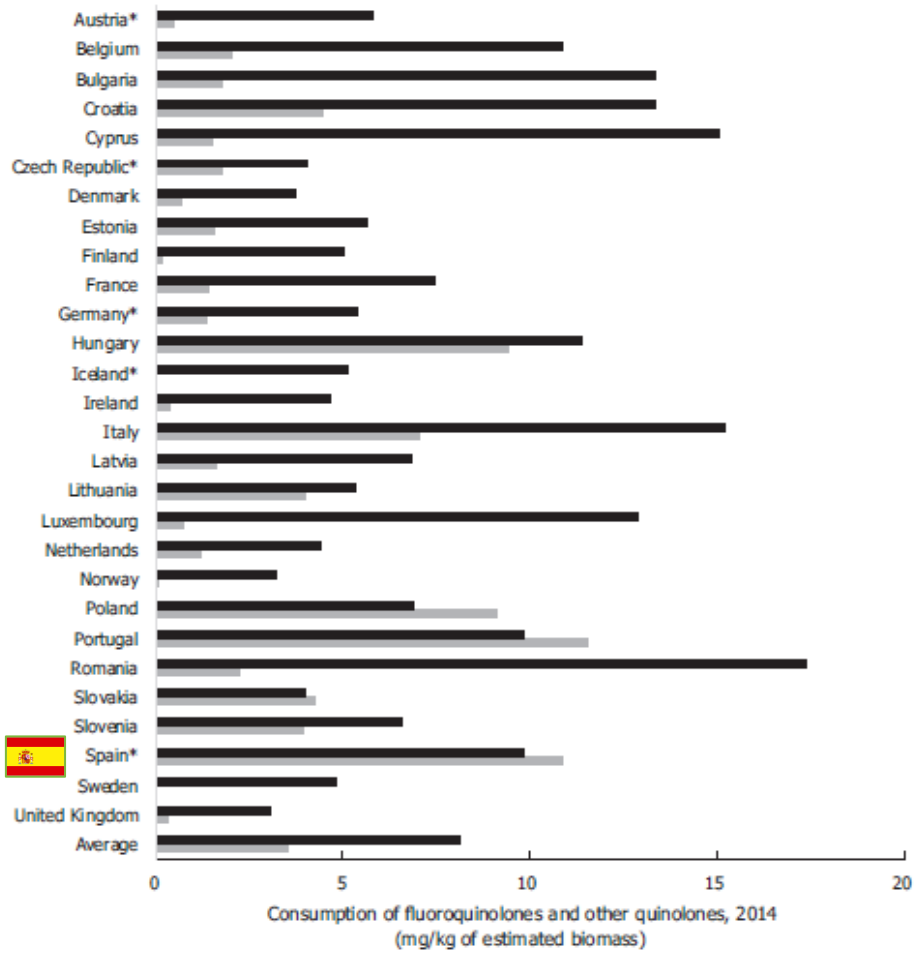


* Humans: community consumption only

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

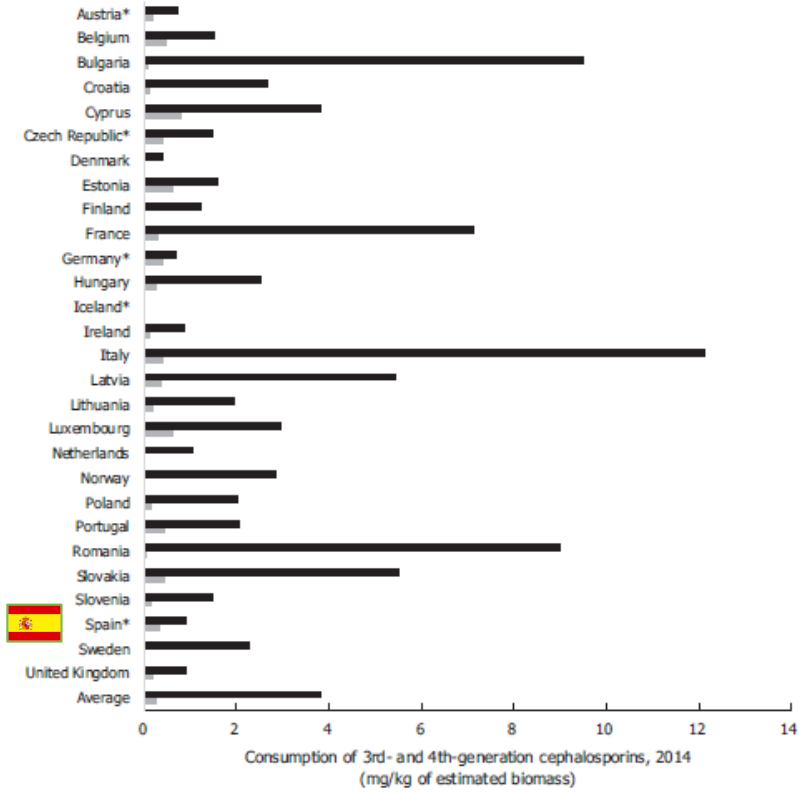
Biomass-corrected antimicrobial consumption in humans and animals, EU/EEA, 2014 (2)

Fluoroquinolones and other quinolones



Humans Animals

3rd- and 4th-generation cephalosporins



* Humans: community consumption only

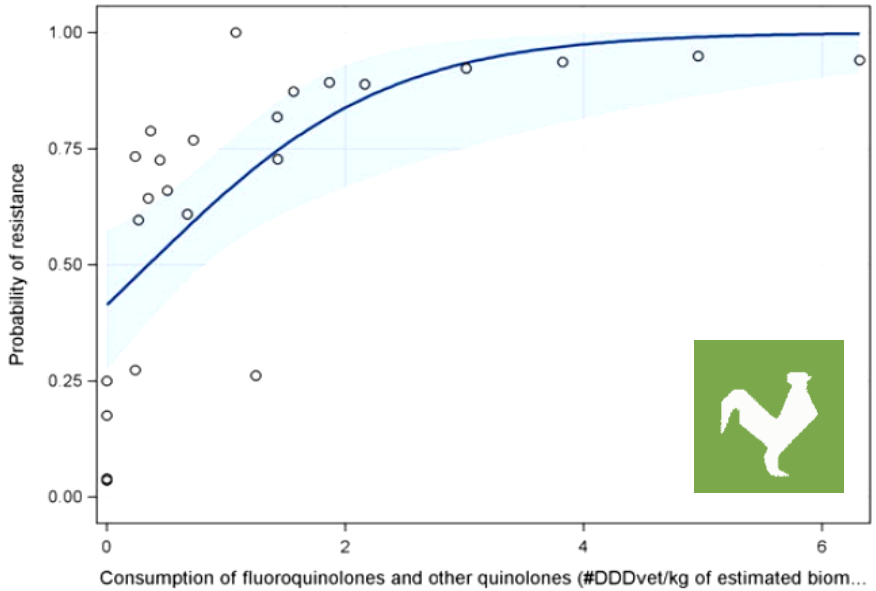
Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA): example

Poultry

Quinolone consumption and probability of resistance to quinolones in *Campylobacter jejuni* from poultry, EU/EEA, 2014

OR = 2.71 [1.57 – 5.63], p < 0.001

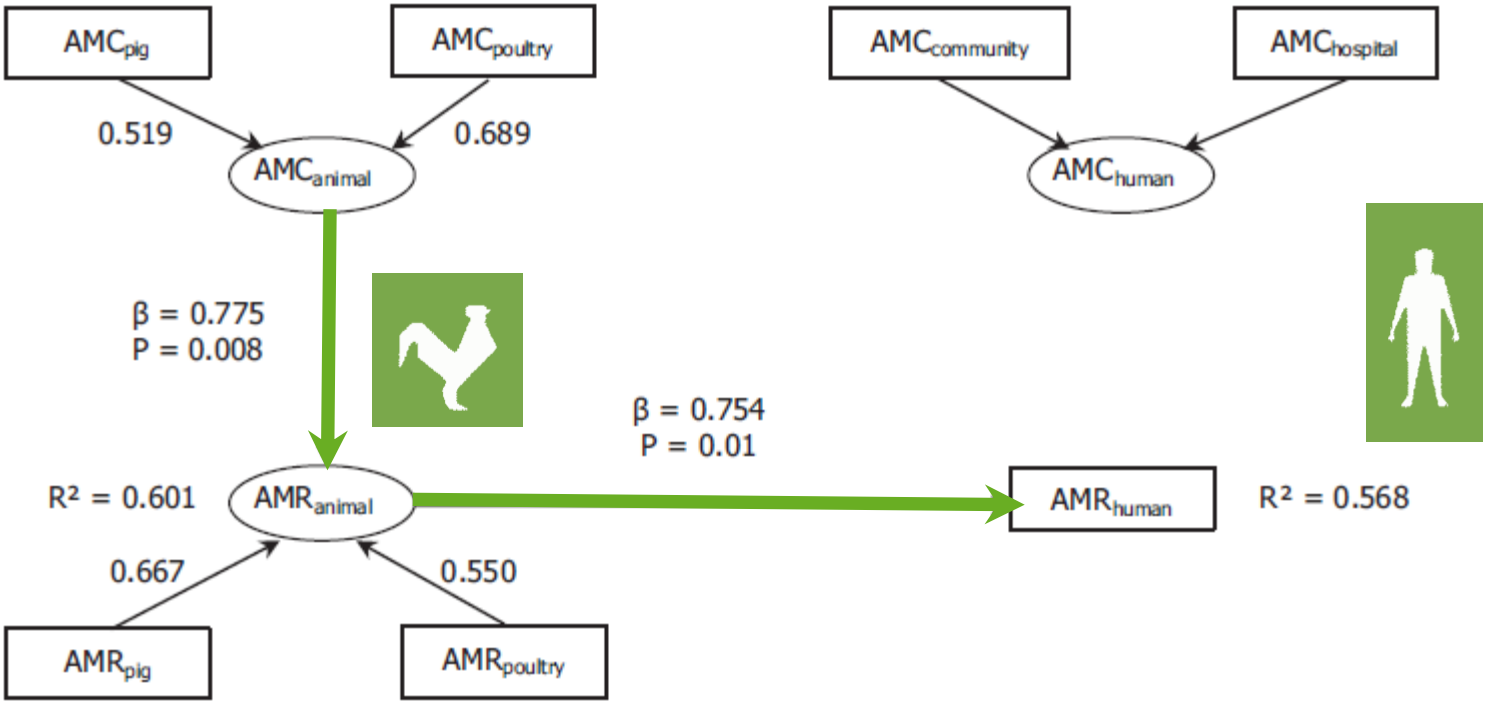


Each dot represent one country.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA):

Results of partial least square path modeling (PLS-PM) of fluoroquinolone consumption and fluoroquinolone-resistant ***Salmonella*** **spp**.

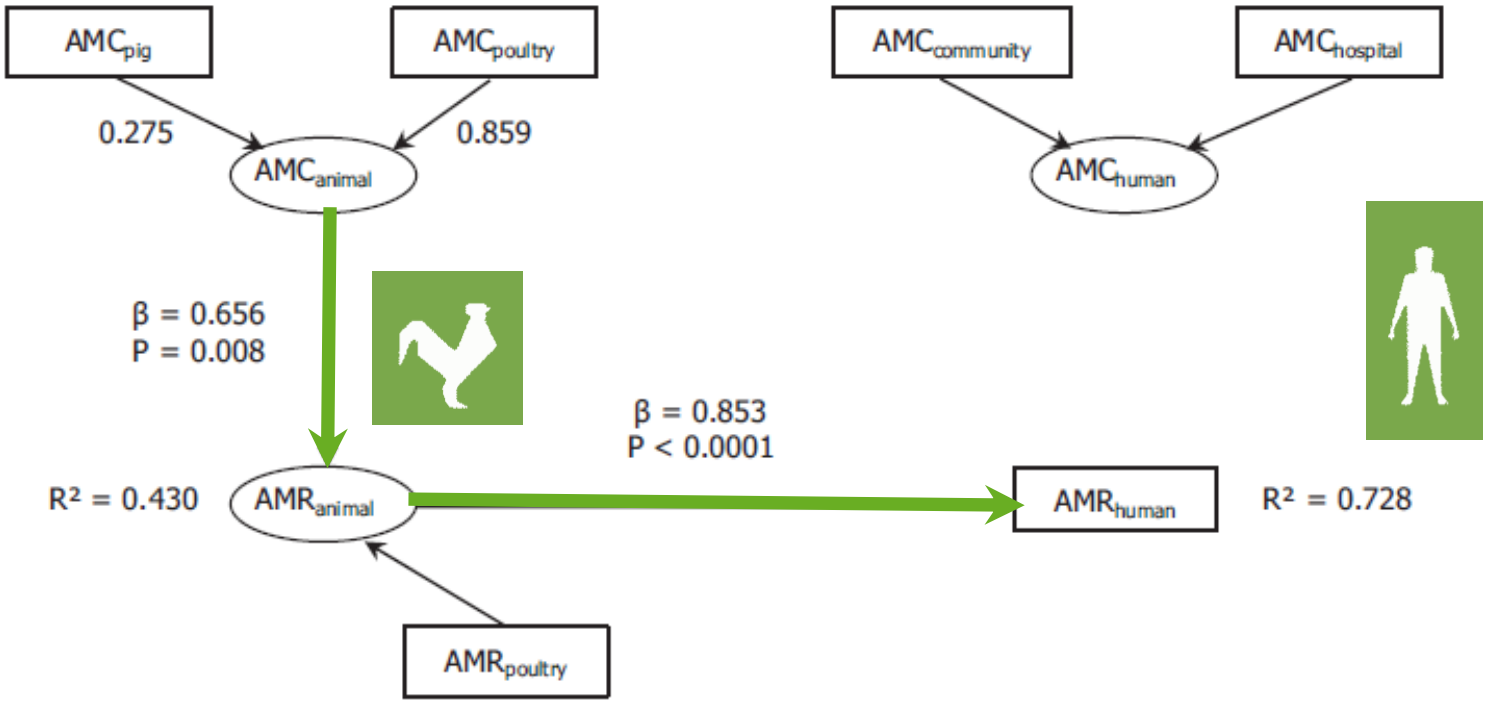


10 countries involved: BE, DE*, DK, ES*†, FR, HU, PT, RO, SK†, UK (Goodness-of-fit = 0.627).
†For these countries, the estimated consumption in pigs in 2014 was used as a proxy for 2015 missing data.
*For these countries, consumption in hospital was estimated.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA):

Results of partial least square path modeling (PLS-PM) of fluoroquinolone consumption and fluoroquinolone-resistant ***Campylobacter jejuni***

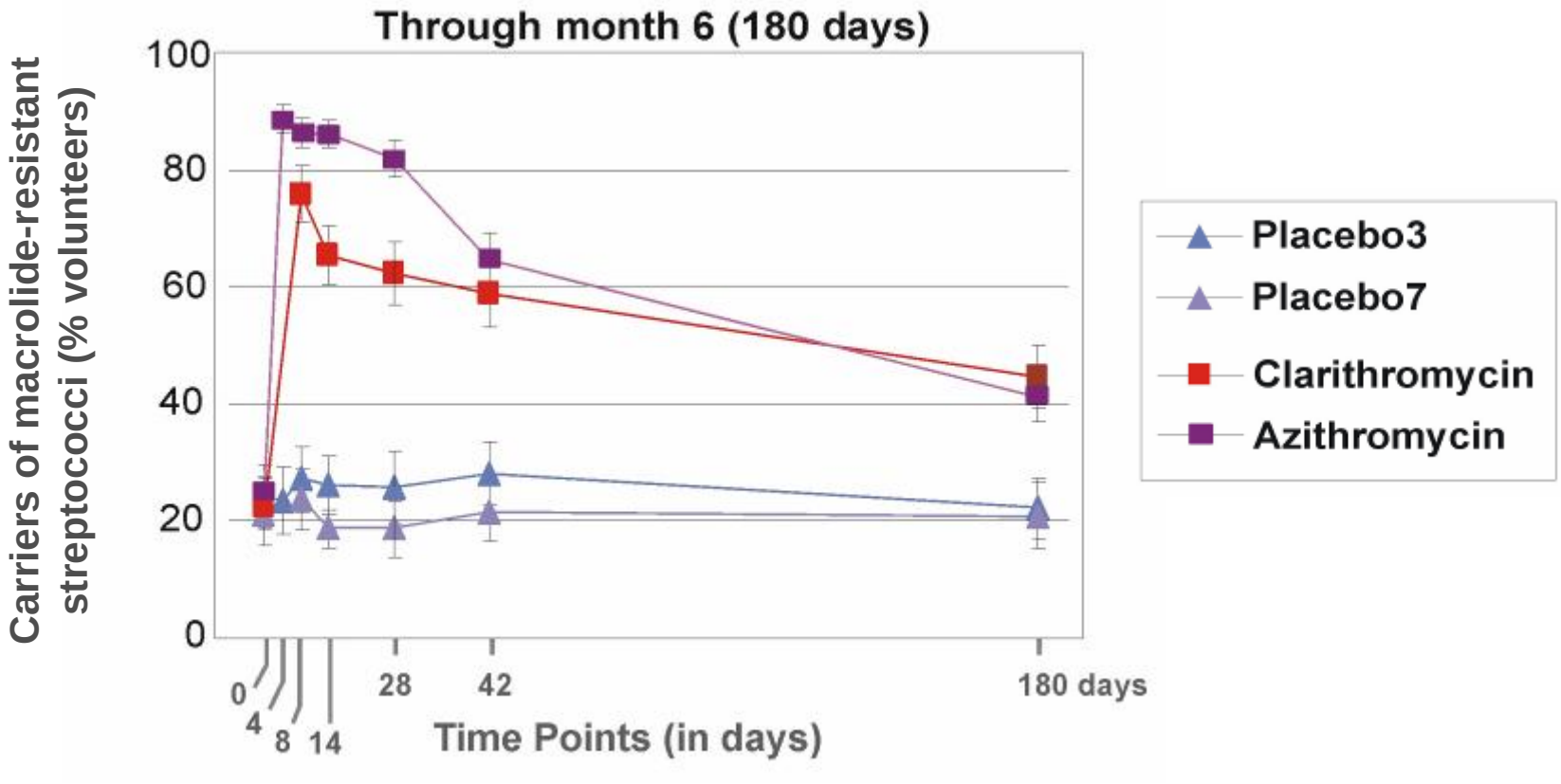


15 countries: AT*, CY, DK, ES*, FI, FR, IS, IT, LT, NL, PT, RO, SI, SK, UK (Goodness-of-fit = 0.617).
*For these countries, consumption in hospital was estimated.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

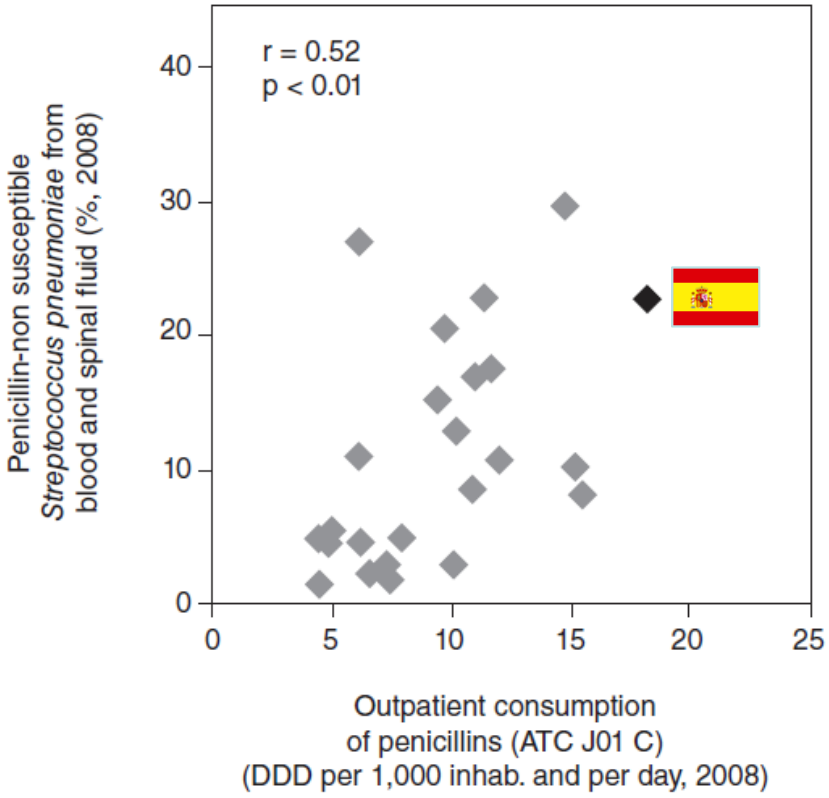
Community

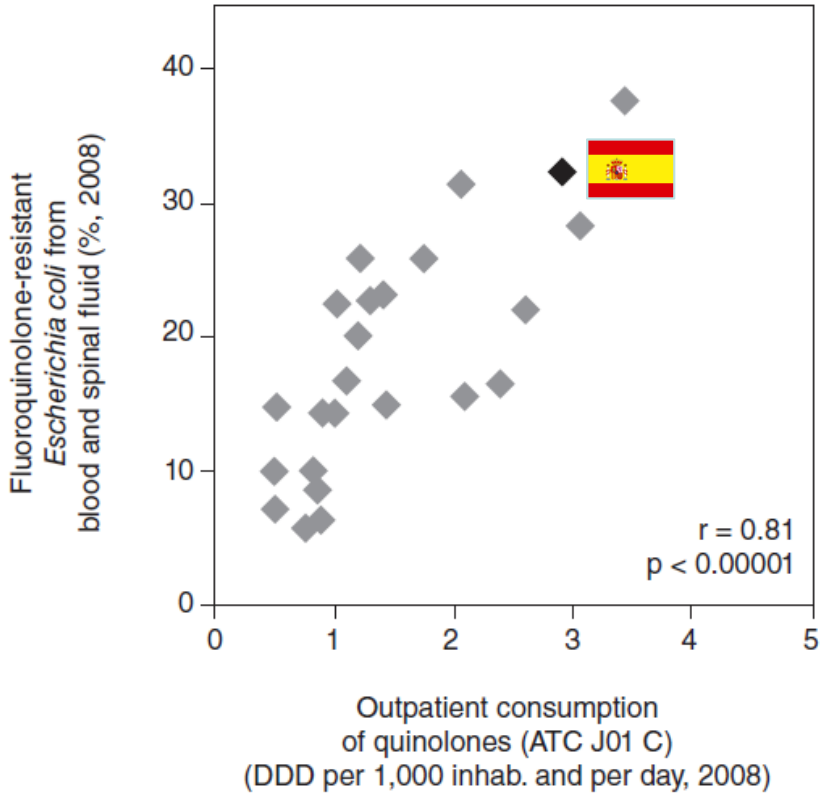
Carriage of resistant bacteria following exposure to antibiotics



Source: Malhotra-Kumar et al. Lancet 2007;369(9560):482-90.

Relationship between antibiotic use and resistance in the community

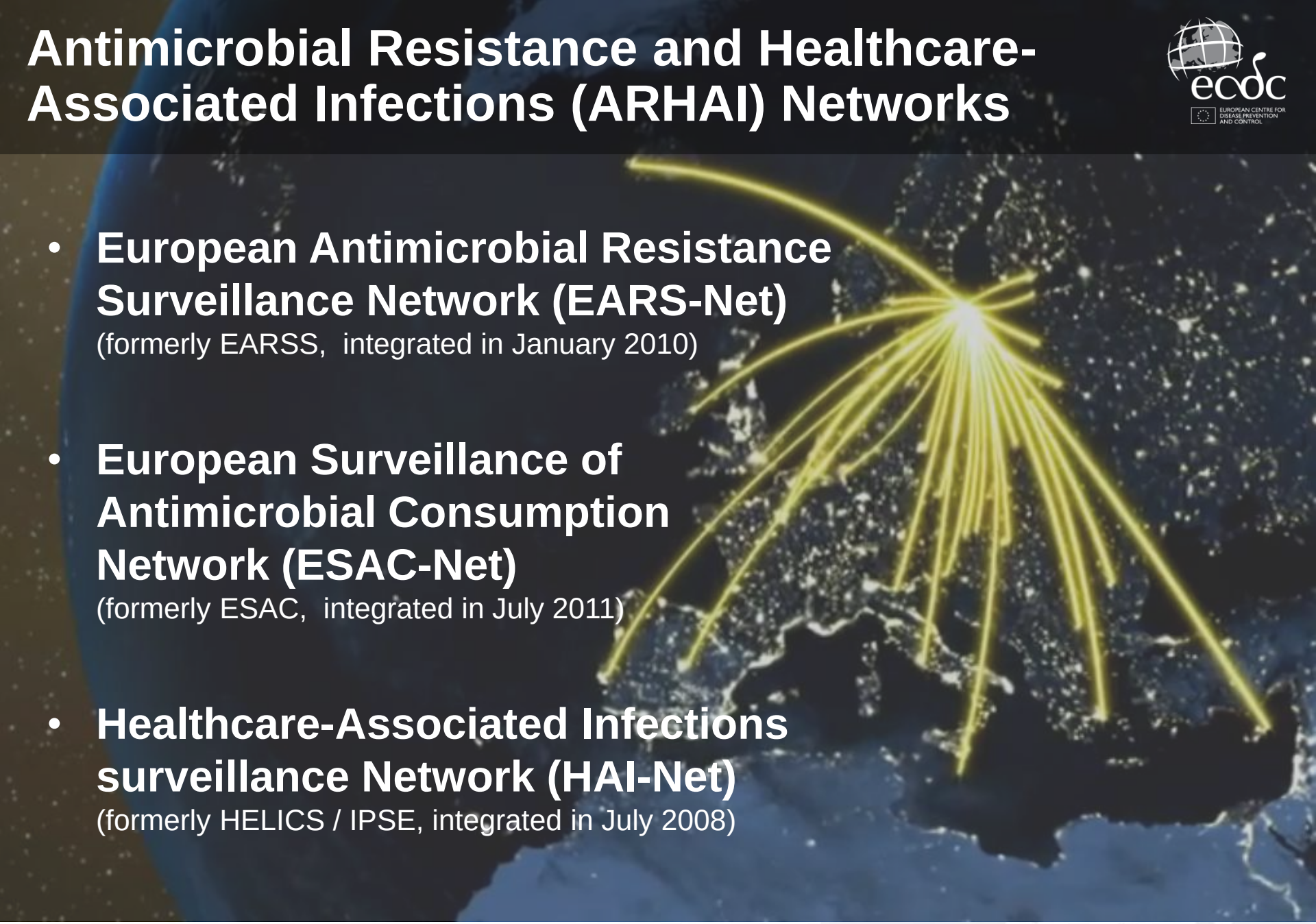




Spain only reports data on reimbursed antibiotic prescription to ESAC. To better represent antibiotic sales and therefore exposure of the Spanish population to antibiotics correction factors were applied to ESAC data based on Campos J, et al. J Antimicrob Chemother. 2007;60:698-701-11.

Source: Monnet DL. Enferm Infecc Microbiol Clin. 2010;28 (Suppl 4):1-3.

Antimicrobial Resistance and Healthcare-Associated Infections (ARHAI) Networks



- **European Antimicrobial Resistance Surveillance Network (EARS-Net)**
  (formerly EARSS, integrated in January 2010)

- **European Surveillance of Antimicrobial Consumption Network (ESAC-Net)**
  (formerly ESAC, integrated in July 2011)

- **Healthcare-Associated Infections surveillance Network (HAI-Net)**
  (formerly HELICS / IPSE, integrated in July 2008)

Defined daily doses
(DDD) per 1000 inh. and per day

Country	2016	Trends in antimicrobial consumption, 2012–2016
Netherlands	10.4	
Estonia	12.0	
Sweden	12.0	↓
Latvia	13.2	
Austria	13.3	
Slovenia	13.9	
Germany	14.1	
Norway	15.2	↓
Hungary	15.4	
Denmark	15.9	
Malta	16.4	
Finland	16.5	↓
Lithuania	16.9	
United Kingdom	19.6	
Bulgaria	19.8	
Croatia	20.7	
Iceland	21.0	
Portugal	21.6†	
EU/EEA	**21.9**	
Spain†	23.0†	↑
Slovakia	23.6	
Poland	24.0	
Ireland	24.2	
Luxembourg	25.5	↓
Italy	26.9	
Belgium	27.5	
Romania	29.5*	
France	30.3	
Cyprus	33.0*	
Greece	36.3	↑
Czech Republic		

Packages
per 1000 inh. and per day

Country	2016	Trends in consumption of antibiotics, 2012–2016
Sweden	0.98	↓
Denmark	1.55	↓
Estonia	1.61	↓
Austria	1.64	
Latvia	1.69	
Finland	1.73	↓
Slovenia	1.85	
Lithuania	1.97	
Spain†	1.99†	
Iceland	2.12	
Portugal	2.16†	
Croatia	2.46	
Ireland	2.52	
Luxembourg	2.53	
Slovakia	2.85	
Bulgaria	2.91	
Belgium		
EU/EEA	**3.14**	
Italy	3.56	
Greece	3.78	
France	4.70	
Czech Republic		

* Total care data, including the hospital sector.

† Reimbursement data (i.e. not including consumption without a prescription and other non-reimbursed courses).

Consumption of antibiotics for systemic use (ATC group J01) in the community, EU/EEA, 2012-2016

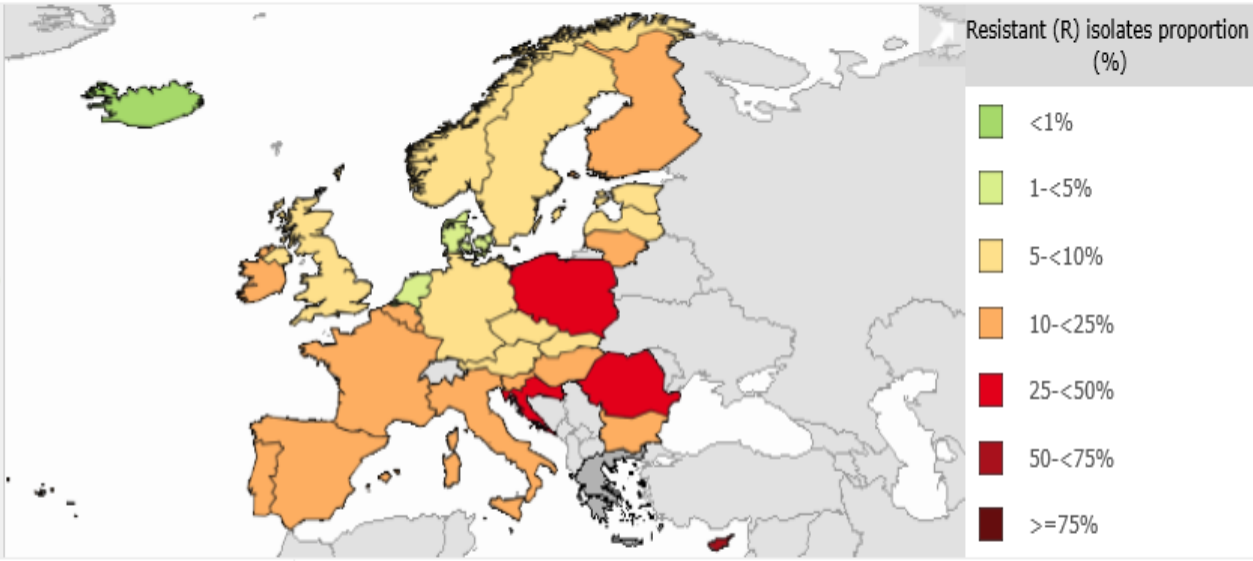
Source: ESAC-Net, 2017. The symbols ↑ and ↓ indicate a significant increasing or decreasing trend for the period 2012-2016, respectively.

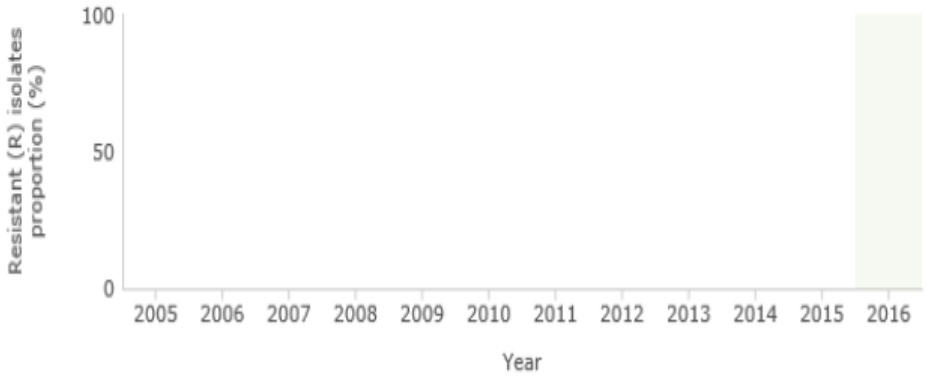
Surveillance Atlas of Infectious Diseases

Antimicrobial resistance | Streptococcus pneumoniae | Macrolides | Resistant (R) isolates proportion

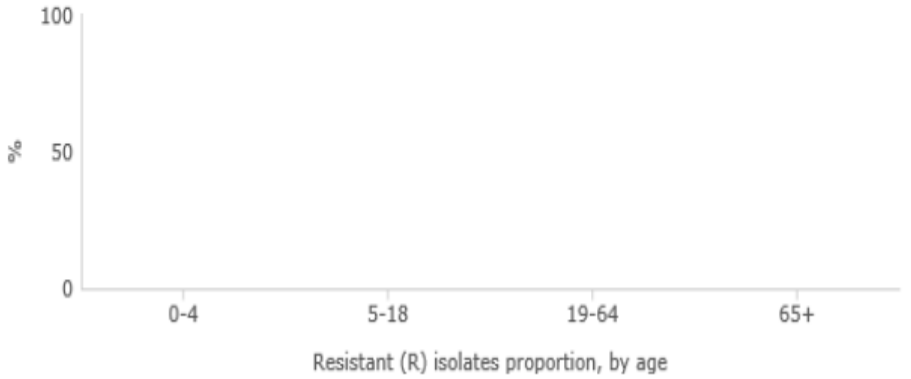
2016

Region	Resistant (R) isolates proportion (%)
Austria	8.6
Belgium	15.7
Bulgaria	21.9
Croatia	33.8
Cyprus	60.0
Czech Republic	7.2
Denmark	4.8
Estonia	7.0
Finland	11.4

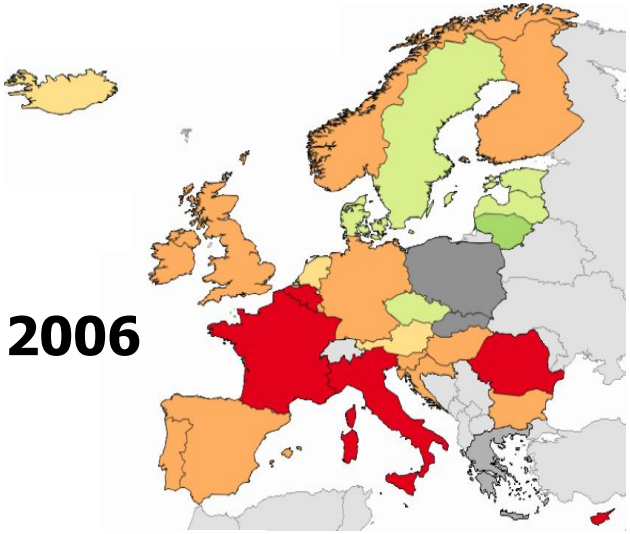




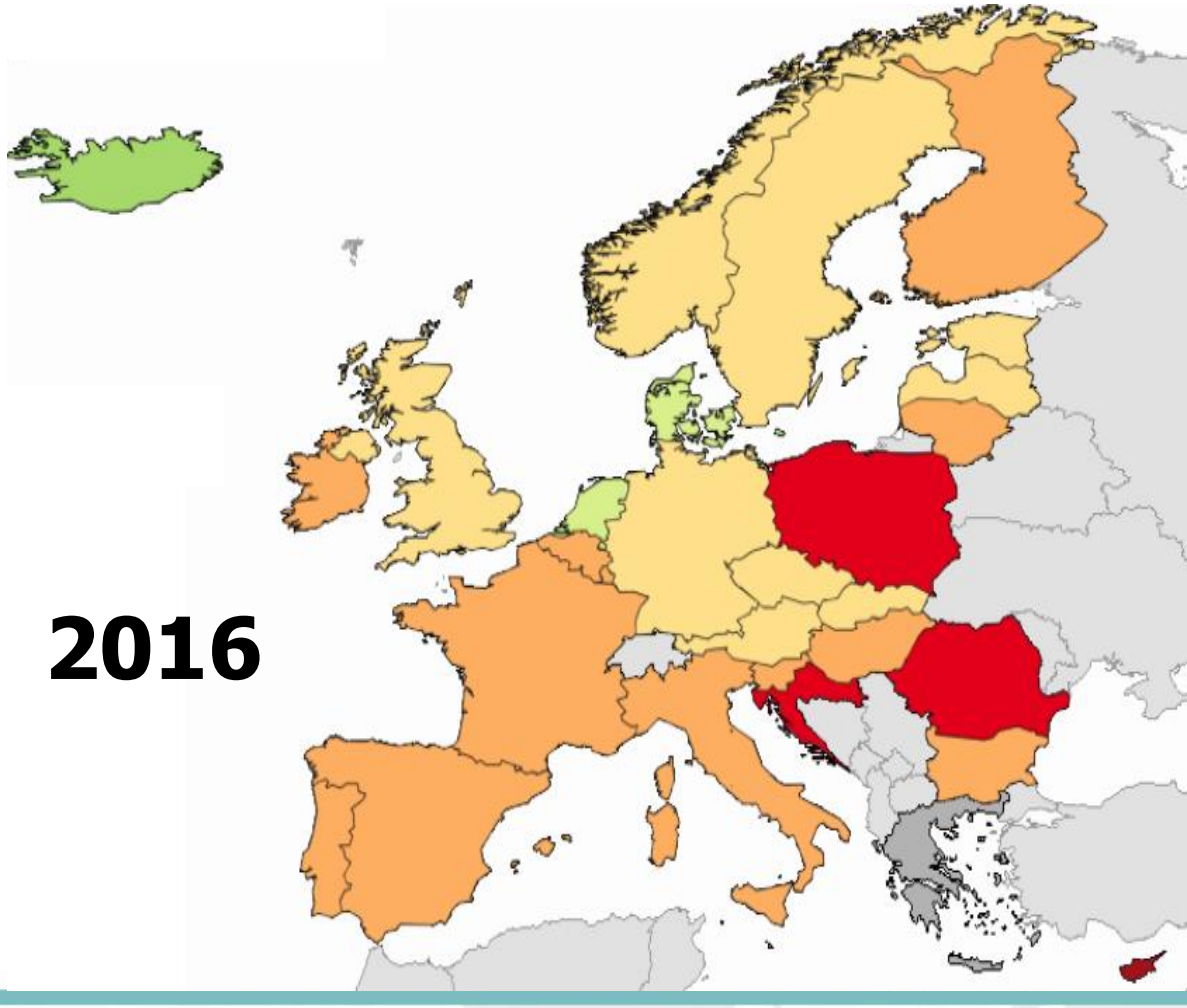
Resistant (R) isolates proportion, by age | Bar



Streptococcus pneumoniae: % of invasive isolates with resistance to macrolides, EU/EEA, 2006 & 2016



2006

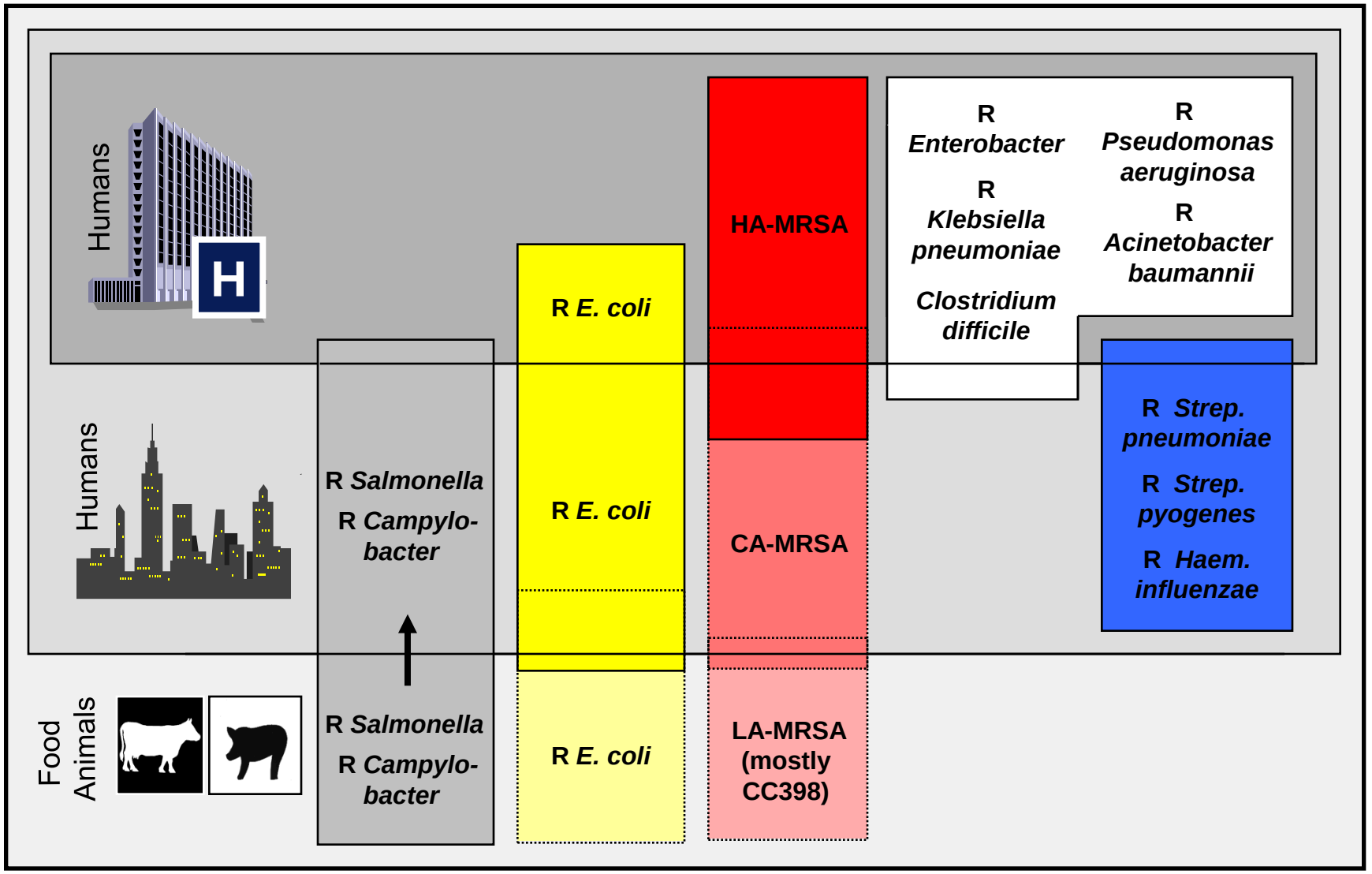


2016

- <1%
- 1-<5%
- 5-<10%
- 10-<25%
- 25-<50%
- 50-<75%
- >=75%
- Not calculated

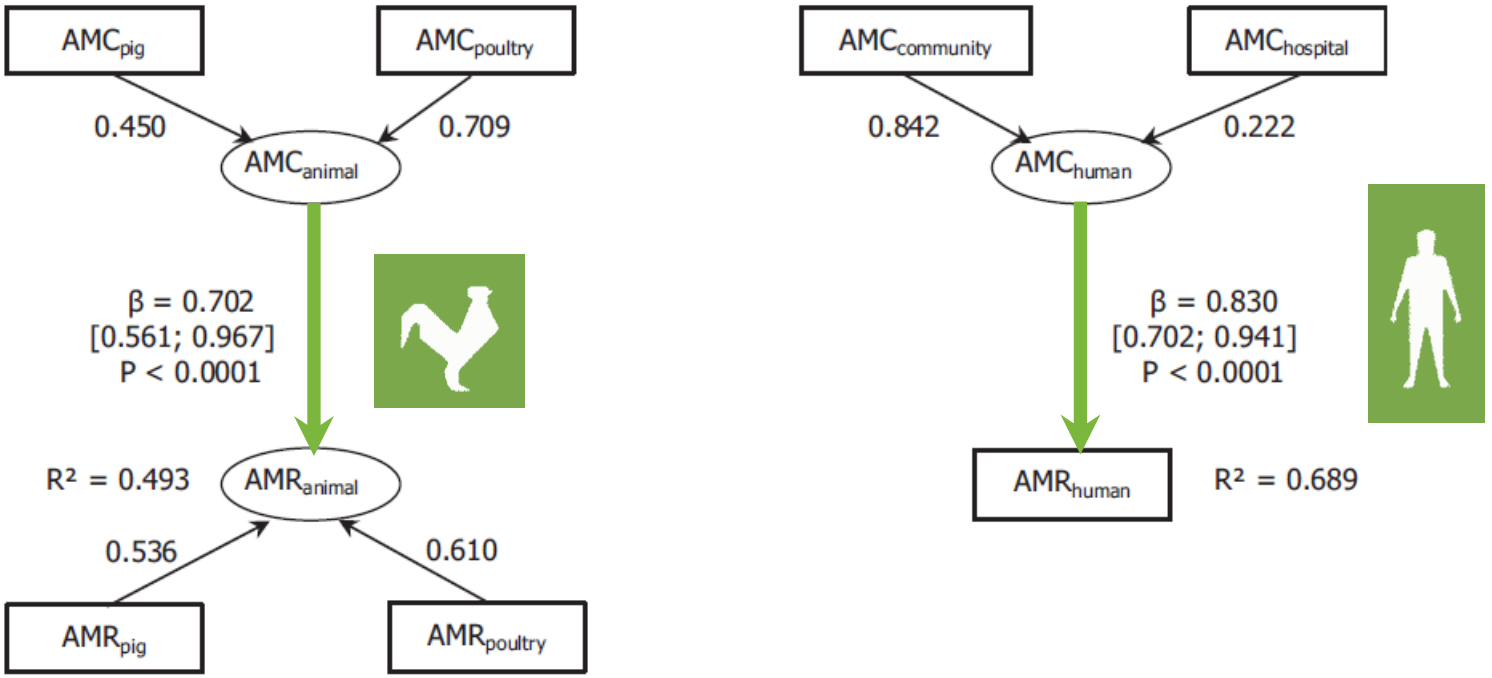
Source: EARS/EARS-Net, 2017 (https://atlas.ecdc.europa.eu).

Compartments of antimicrobial resistance



Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA):

Results of partial least square path modeling (PLS-PM) of fluoroquinolone consumption and fluoroquinolone-resistant ***Escherichia coli***



26 countries: AT*, BE, BG, CY, CZ*†, DE*, DK, EE, ES*†, FI, FR, HR, HU, IE, IT, LT†, LV, NL, NO, PL, PT, RO, SE, SI, SK†, UK (Goodness-of-fit = 0.668).

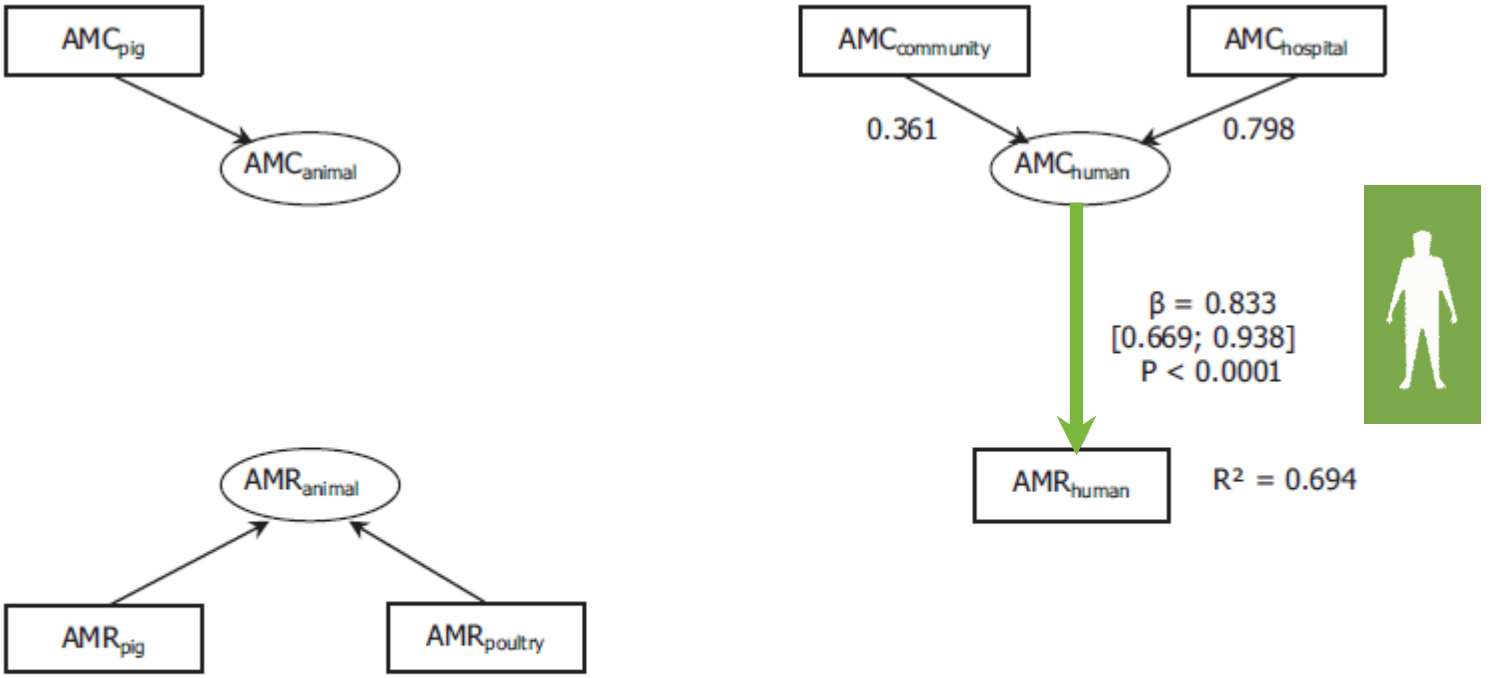
†For these countries, the estimated consumption in pigs in 2014 was used as a proxy for 2015 missing data.

*For these countries, consumption in hospital was estimated.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA):

Results of partial least square path modeling (PLS-PM) of third-generation cephalosporin (3GC) consumption and 3GC-resistant ***Escherichia coli***



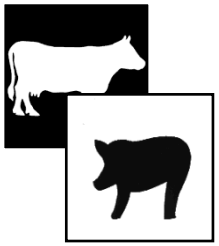
26 countries: AT*, BE, BG, CY, CZ*†, DE*, DK, EE, ES*†, FI, FR, HR, HU, IE, IT, LT†, LV, NL, NO, PL, PT, RO, SE, SI, SK†, UK (goodness-of-fit = 0.686).

†For these countries, the AMC in pigs in 2014 was used as a surrogate of that for 2015 (missing data).

*For these countries, the AMC at the hospital was estimated.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Antimicrobial consumption and AMR: a continuum of risks in our societies



152 mg/kg
(country range:
3 – 419 mg/kg)

ICU & Haem./ bone marrow transplant (BMT)

124 mg/kg (country range: 50 – 182 mg/kg)

~ 90% DDDs

~ 10% DDDs

2% (1-4%) **population on a given day**

35% (21-55%) **patients on a given day**

59% patients

MDR* → MDR → MDR → MDR, XDR, PDR

Imported animals
Imported foods

International travel

Cross-border transfer of patients

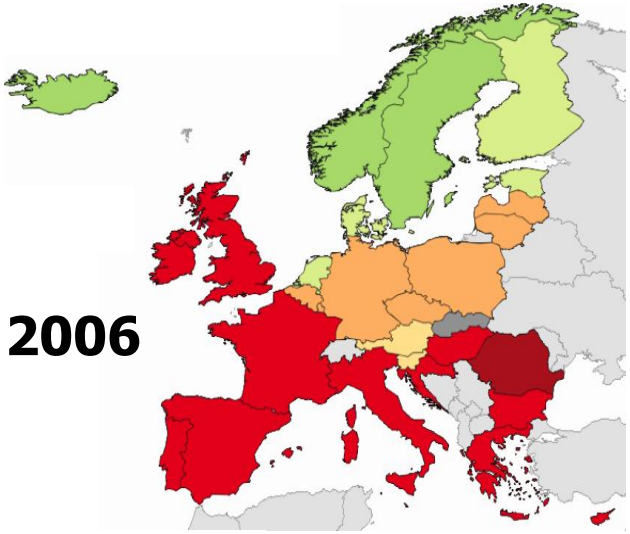
*MDR, multidrug-resistant; XDR, extensively drug-resistant; PDR, pandrug-resistant

Source: ECDC/EFSA/EMA JIACRA report, 2017; ECDC ESAC-Net 2016; ECDC PPS, 2013.

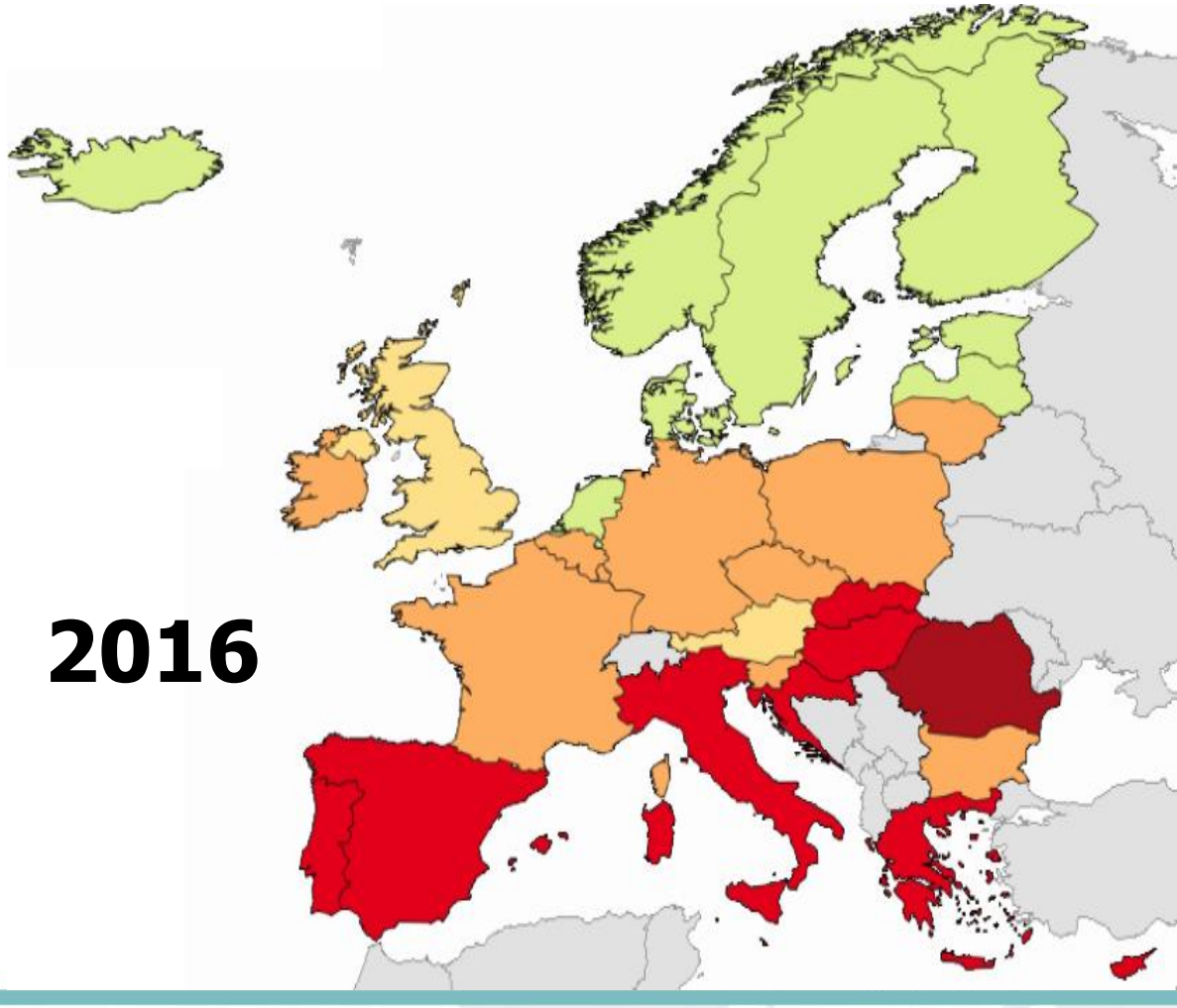
Hospitals

Photo: Luis García

Staphylococcus aureus: % of invasive isolates with resistance to meticillin (MRSA), EU/EEA, 2006 & 2016



2006

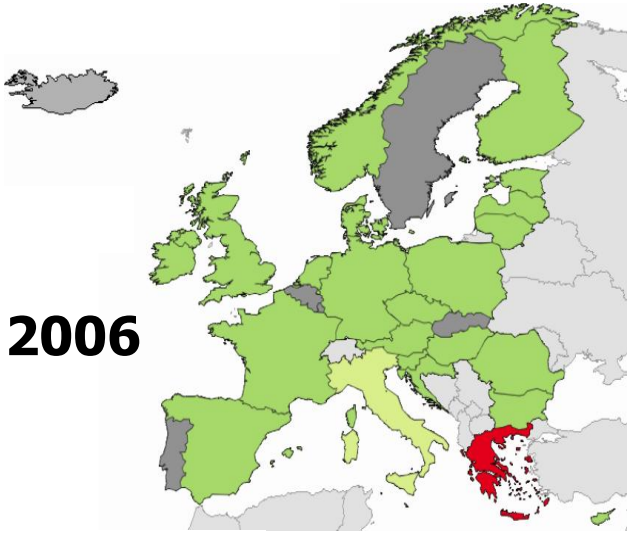


2016

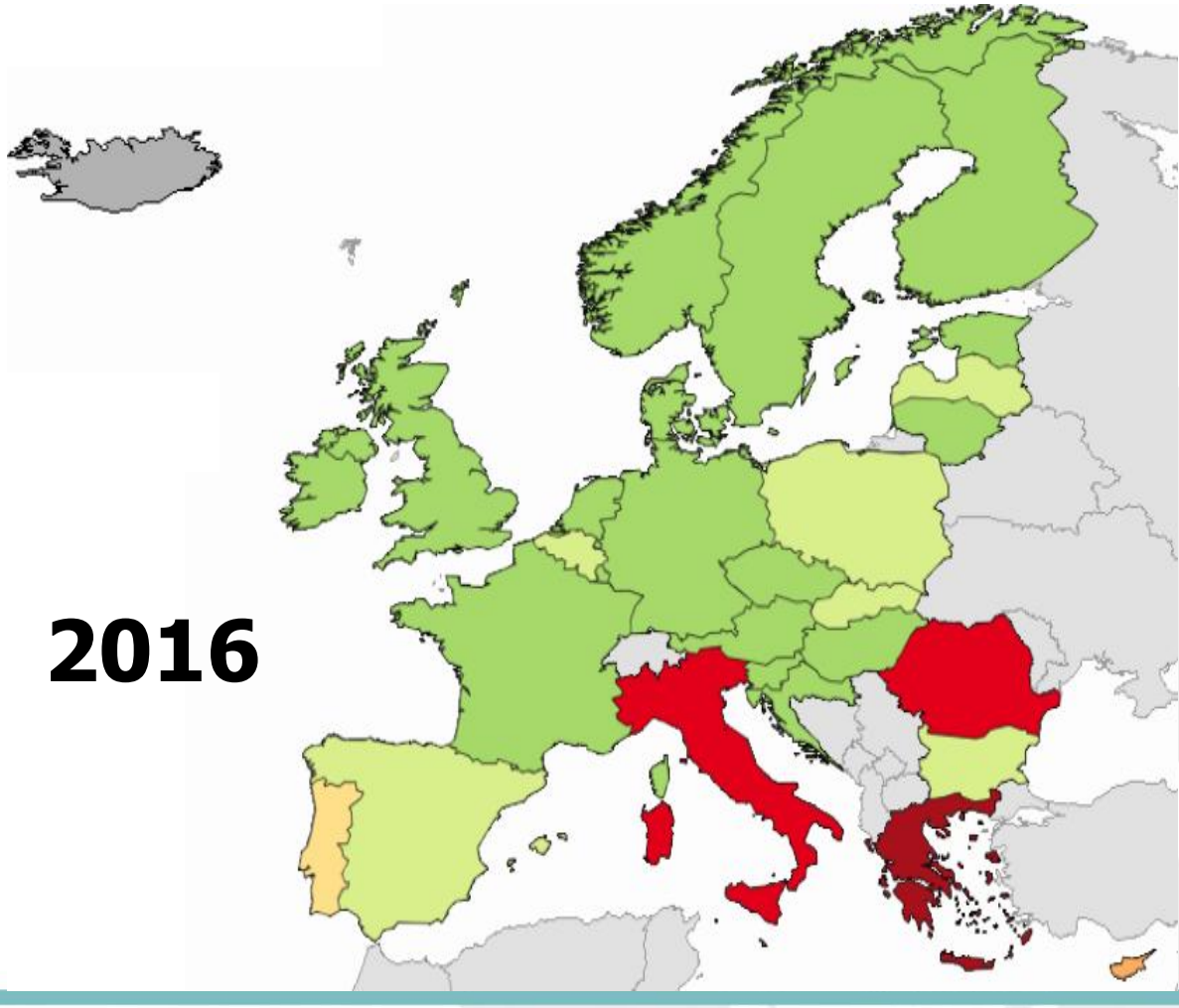
- <1%
- 1-<5%
- 5-<10%
- 10-<25%
- 25-<50%
- 50-<75%
- >=75%
- Not calculated

Source: EARS/EARS-Net, 2017 (https://atlas.ecdc.europa.eu).

Klebsiella pneumoniae: % of invasive isolates with resistance to carbapenems, EU/EEA, 2006 & 2016



2006



2016

- <1%
- 1-<5%
- 5-<10%
- 10-<25%
- 25-<50%
- 50-<75%
- >=75%
- Not calculated

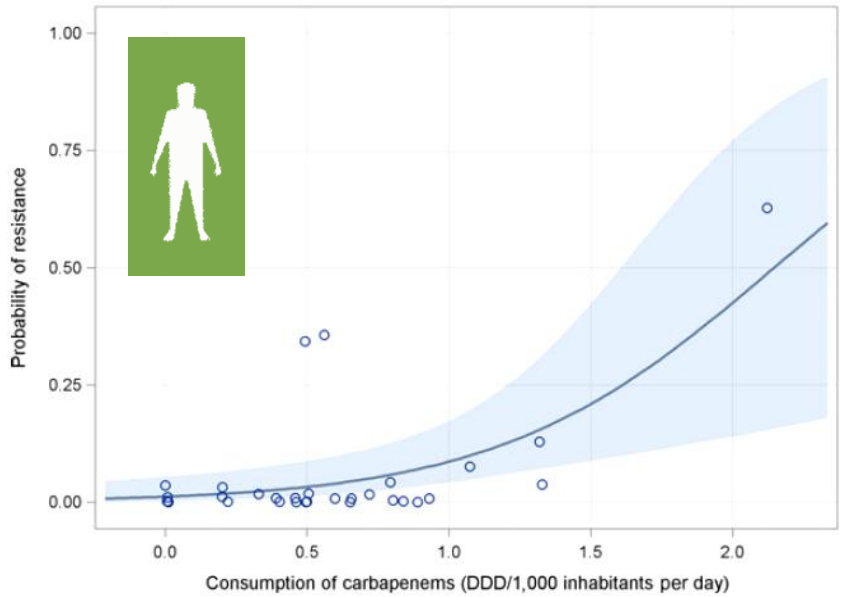
Source: EARS/EARS-Net, 2017 (https://atlas.ecdc.europa.eu).

Joint Interagency Antimicrobial Consumption and Resistance Analysis (JIACRA): example

Humans

Carbapenem consumption and probability of resistance to carbapenems in invasive *Klebsiella pneumoniae* from humans, EU/EEA, 2015

OR = 1.23 [95% CI: 1.08 – 1.42], p = 0.002



Each dot represent one country.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Consumption of last-line antibiotics in the hospital sector, EU/EEA, 2012-2016

Carbapenems
(DDD per 1000 inh. and per day)

Country	2016	Trends in consumption of carbapenems, 2012–2016
Bulgaria	0.028	↑
Poland	0.022	
Netherlands	0.020	
Latvia	0.034	↑
France	0.033	
Norway	0.040	
Hungary	0.048	↑
Lithuania	0.053	↑
Slovakia	0.055	↑
Romania	0.059*	↑
Estonia	0.064	↑
Sweden	0.051	
EU/EEA	**0.052**	
Italy	0.040	
Finland (a)	0.090	
Belgium	0.063	
Slovenia	0.071	
United Kingdom	0.068	
Croatia	0.084	↑
Denmark	0.079	
Luxembourg	0.102	
Ireland	0.081	
Malta	0.113	↑
Cyprus	0.141*	↑
Portugal (b)	0.124	↓
Greece	0.180	

Polymyxins (mainly colistin)
(DDD per 1000 inh. and per day)

Country	2016	Trends in consumption of polymyxins, 2012–2016
Finland (a)	0	
Lithuania	0	
Norway	0.001	
Sweden	0.001	
Latvia	0.002	
Netherlands	0.002	
Bulgaria	0.004	↑
Estonia	0.005	
Luxembourg	0.005	
Denmark	0.006	↑
Ireland	0.006	↓
United Kingdom	0.006	
France	0.007	↓
Belgium	0.008	
Slovenia	0.008	↑
Hungary	0.010	↑
EU/EEA	**0.016**	
Malta	0.016	↑
Croatia	0.017	
Cyprus	0.019*	
Portugal (b)	0.022	
Romania	0.026*	↑
Italy	0.027	↑
Poland	0.034	
Slovakia	0.035	↑
Greece	0.102	↑

* Cyprus and Romania: total care data, including consumption in the community. These data were not used to calculate the EU/EEA population-weighted average.

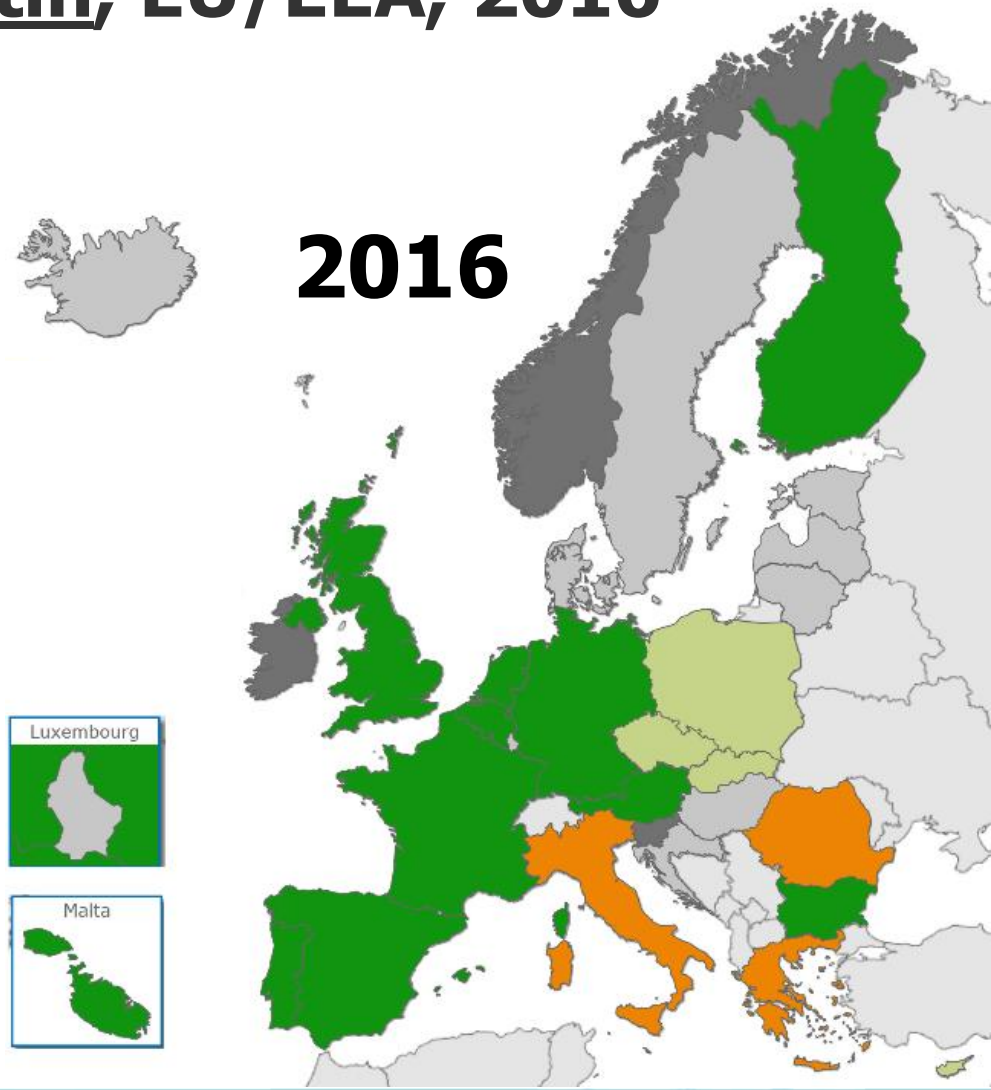
(a) Finland: data include consumption in remote primary healthcare centres and nursing homes.

(b) Portugal: data relate to public hospitals only.

Source: ESAC-Net, 2017. The symbols ↑ and ↓ indicate a significant increasing or decreasing trend for the period 2012-2016, respectively.

Klebsiella pneumoniae: % of invasive isolates with combined resistance to carbapenems and colistin, EU/EEA, 2016

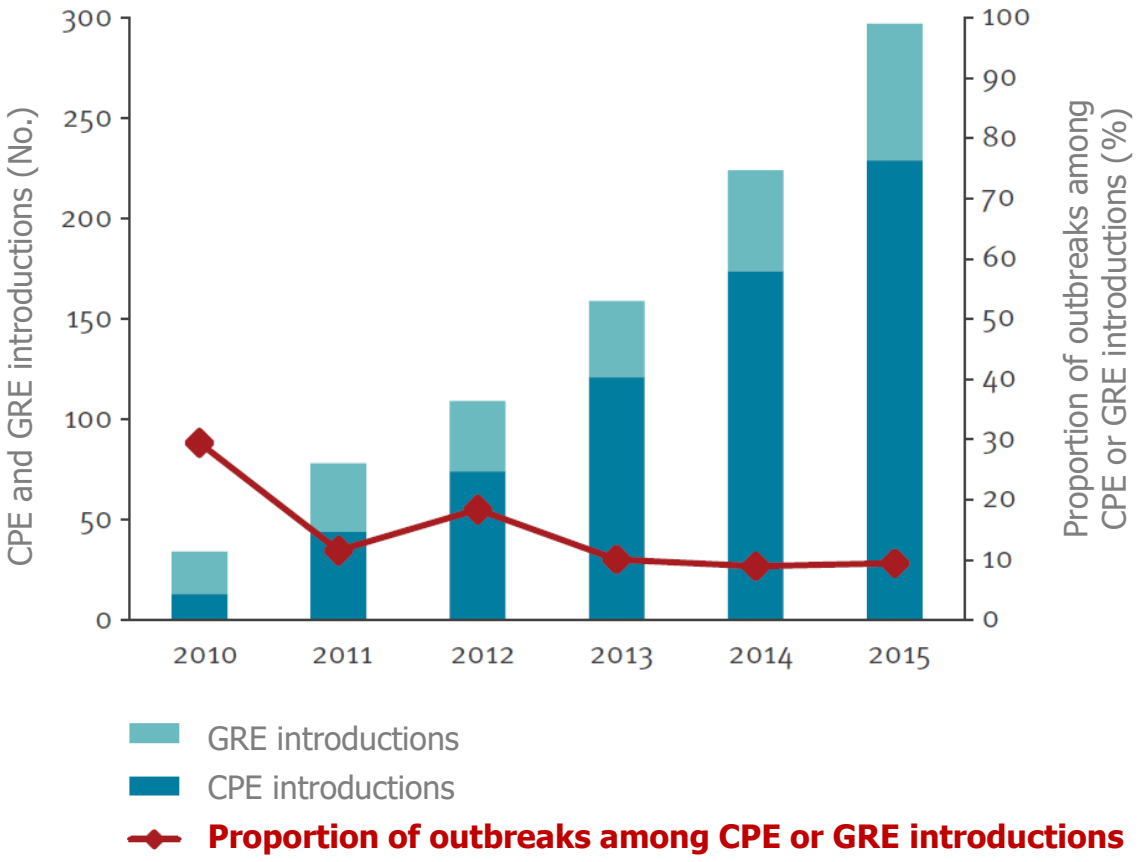
- < 1%
- 1% to <5%
- 5% to <10%
- 10% to <25%
- 25% to <50%
- ≥ 50 %
- Less than 10 isolates reported
- No data



Source: EARS-Net, 2017

All isolates tested for carbapenem susceptibility were included in the denominator to limit the effect of sequential testing.

No. of carbapenemase-producing *Enterobacteriaceae* (CPE) and glycopeptide-resistant *Enterococcus faecium* (GRE) introductions and proportions of outbreaks in Paris, France, 2010-2015

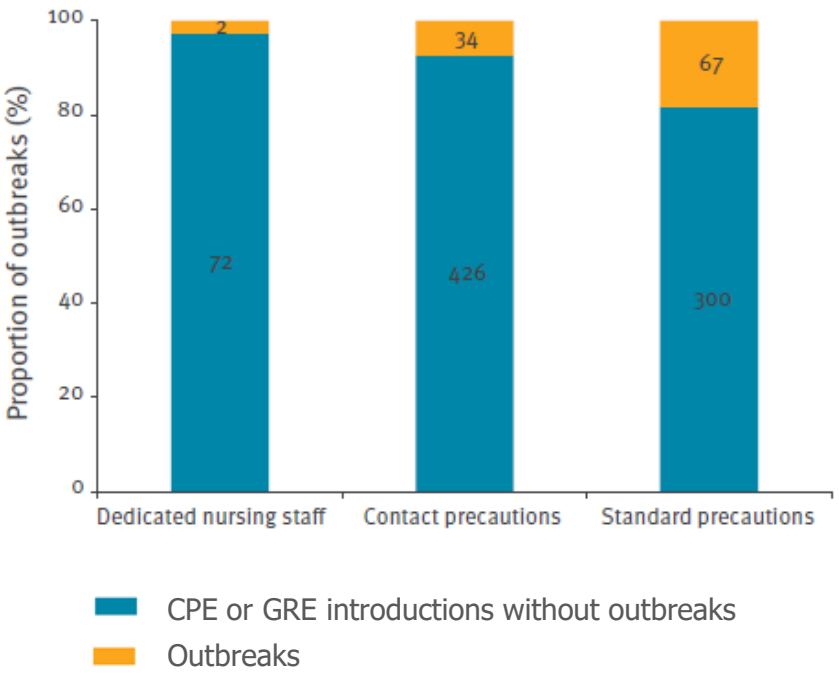


CPE, carbapenemase-producing *Enterobacteriaceae*; GRE, glycopeptide-resistant *Enterococcus faecium*.

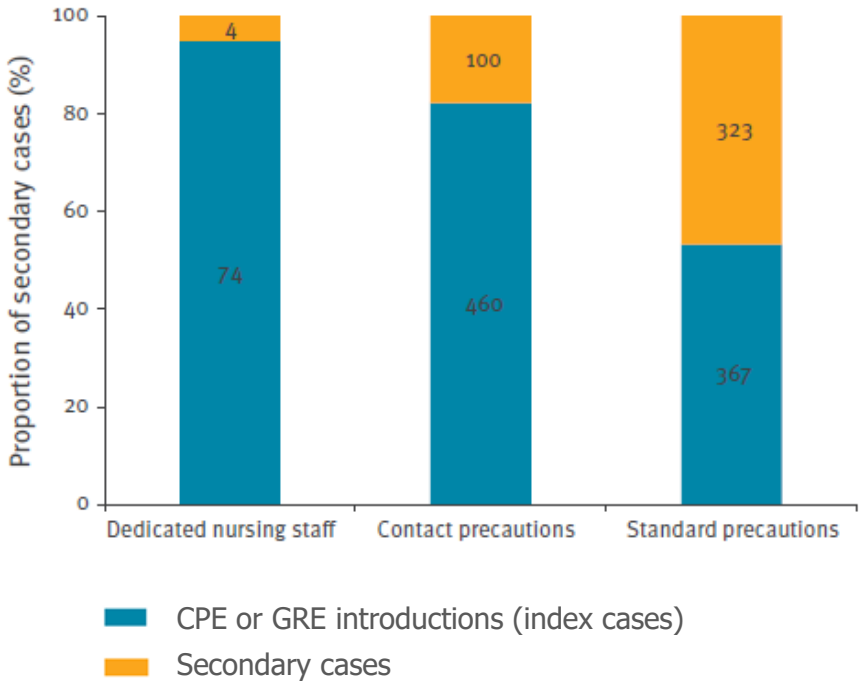
Adapted from: Fournier S, et al. Eurosurveillance (22 February 2018).

Proportion of outbreaks and secondary cases of carbapenemase-producing *Enterobacteriaceae* (CPE) and glycopeptide-resistant *Enterococcus faecium* (GRE) according to measures implemented within the first two days around an index case, Paris, France, 2010-2015

Proportion of <u>outbreaks</u> (n=103) among CPE or GRE introductions (n=901)



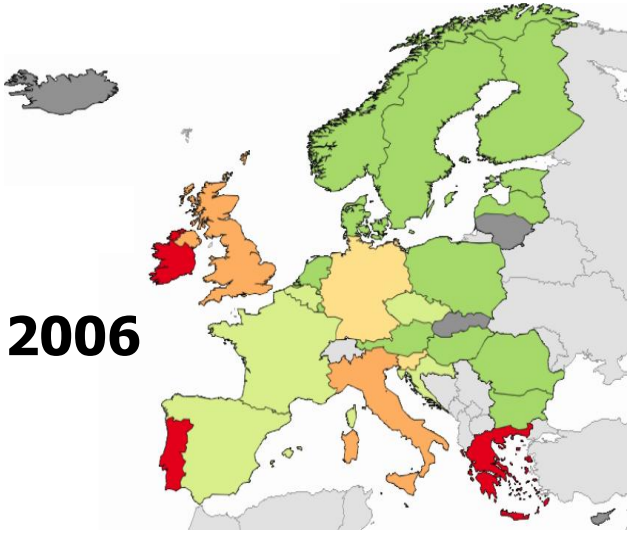
Proportion of <u>secondary cases</u> (n=427) among CPE or GRE cases (n=1,328)



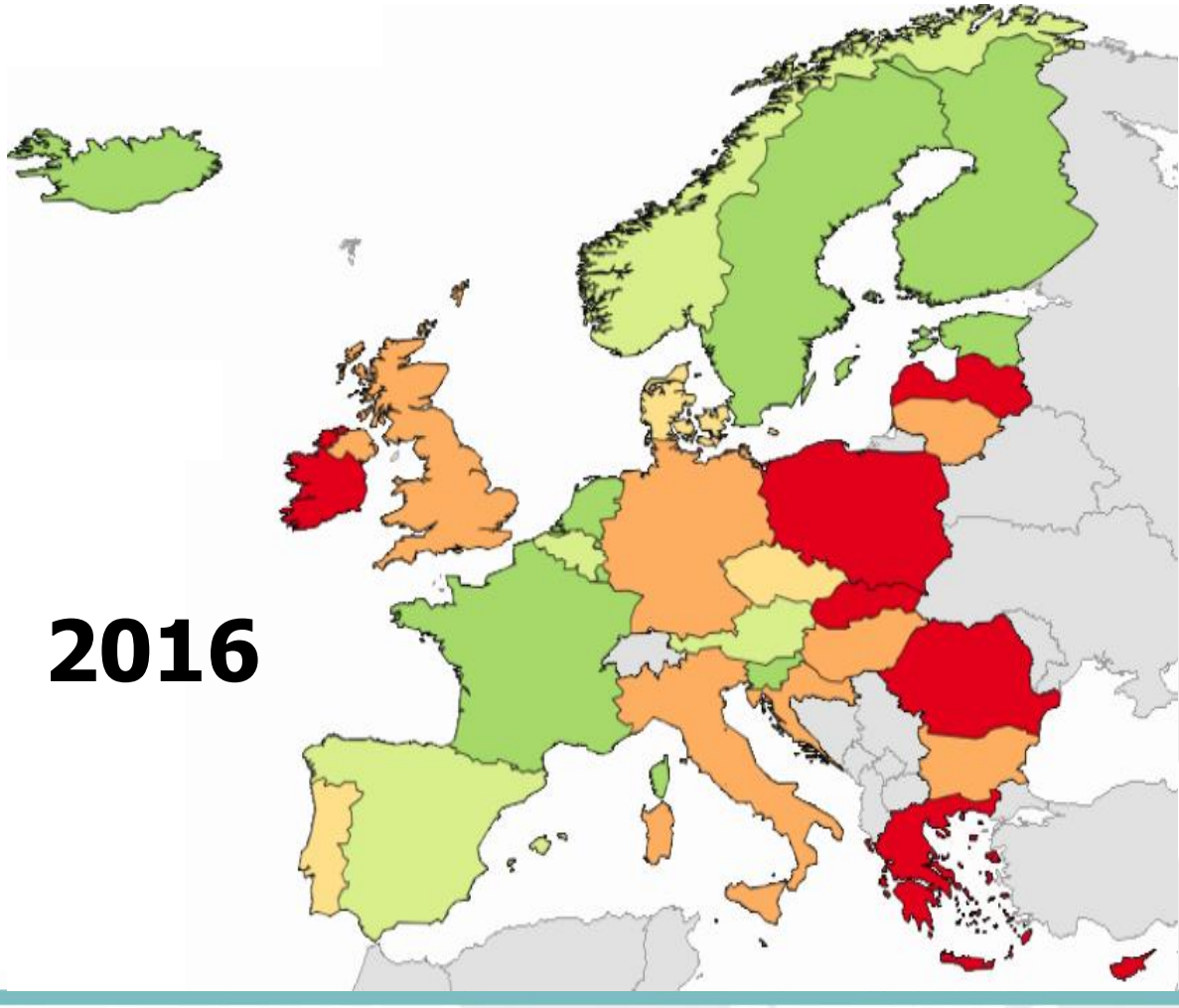
CPE, carbapenemase-producing *Enterobacteriaceae*; GRE, glycopeptide-resistant *Enterococcus faecium*.

Adapted from: Fournier S, et al. Eurosurveillance (22 February 2018).

Enterococcus faecium: % of invasive isolates with resistance to vancomycin, EU/EEA, 2006 & 2016



2006



2016

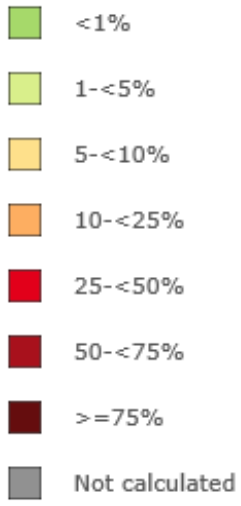
- <1%
- 1-<5%
- 5-<10%
- 10-<25%
- 25-<50%
- 50-<75%
- >=75%
- Not calculated

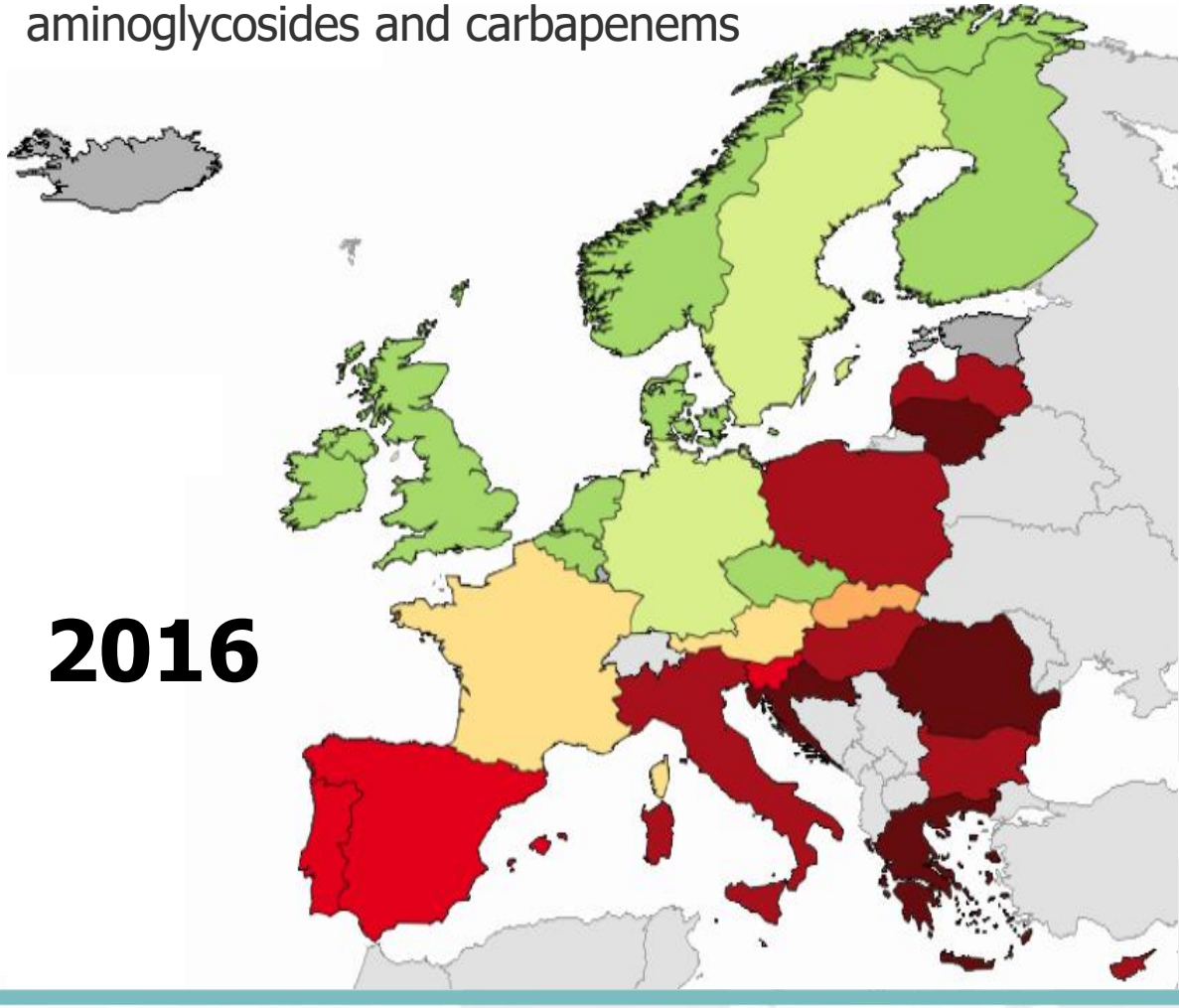
Source: EARS/EARS-Net, 2017 (https://atlas.ecdc.europa.eu).

Acinetobacter spp.: % of invasive isolates with combined resistance*, EU/EEA, 2012 & 2016

*Fluoroquinolones, aminoglycosides and carbapenems

2012





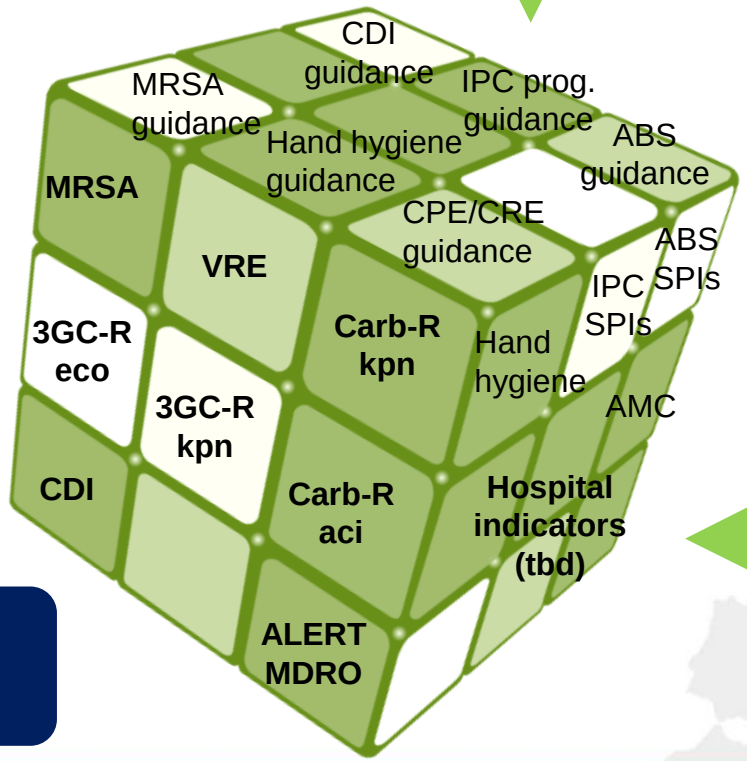
2016

Source: EARS/EARS-Net, 2017 (https://atlas.ecdc.europa.eu).

2nd ECDC point prevalence survey (PPS) of healthcare-associated infections and antimicrobial use in European acute care hospitals, 2016-2017

Guidance (directory of online resources)

Outcome indicators (HAI, selected MDROs)



Structure and process indicators (incl. antimicrobial consumption)

ECDC report: **November 2018**

Source: ECDC, 2015.

Publications & data

Examples

- *Mycobacterium chimaera* cardiovascular infections linked to heater-cooler devices
- *Candida auris* infection
- *optrA* (transferable oxazolidinone and chloramphenicol resistance)

Epidemic Intelligence Information System (EPIS)

tool

The Epidemic Intelligence Information System (EPIS) is a web-based communication platform that allows nominated public health experts to exchange technical information to assess whether current and emerging public health threats have a potential impact in the European Union (EU).

Download

EPIS - specific privacy statement - 2016 - EN - [PDF-106.53 KB]

Access Epis

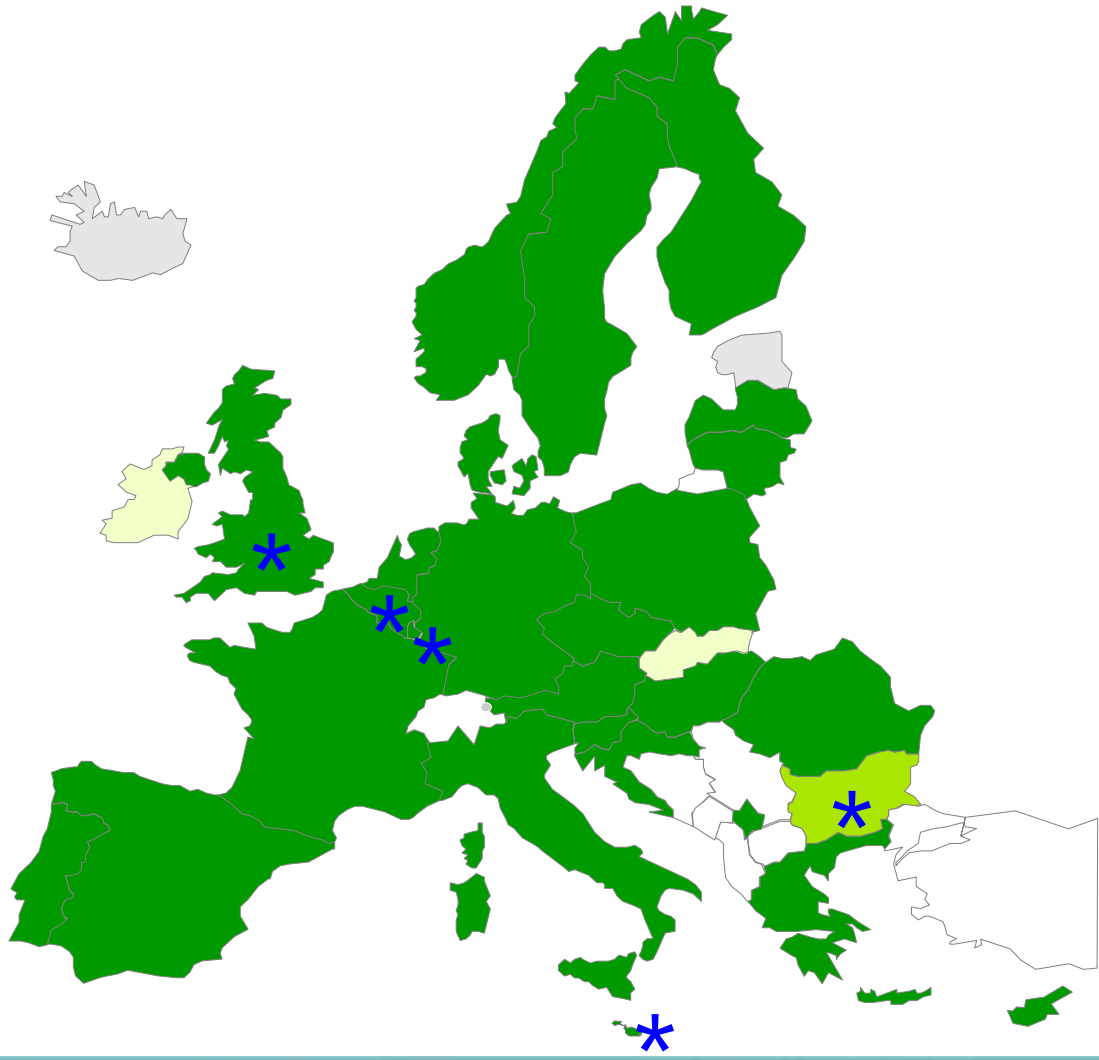
Country visits to discuss antimicrobial resistance (AMR) issues, 2006-2018

As of 4 June 2018

- Done
- Planned (invitation received)
- Discussed
- * Jointly with DG SANTE/F

- Based on Council Recommendation of 15 November 2001 on the prudent use of antimicrobial agents in human medicine (2002/77/EC)
- Reports (observations, conclusions, suggestions, examples of best practice)
- **24 EU Member States, 1 EEA country** and 1 EU enlargement country (see map)
- 5 follow-up visits (Greece × 2 and Hungary × 2, Malta)

- **2018:** 4 additional visits* jointly with DG SANTE/F5, in a One Health perspective



Source: ECDC, 2018. Country visit reports: https://ecdc.europa.eu/en/infectious-diseases-public-health/antimicrobial-resistance/preparedness/country-visits-reports

European Centre for Disease Prevention and Control

An agency of the European Union

Antimicrobial resistance

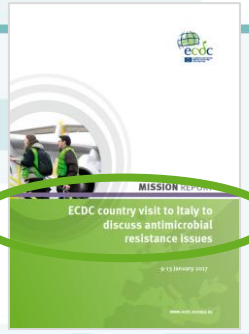
Annual surveillance report | Data from the Atlas | Directory: Guidance on prevention and control | European Antibiotic Awareness Day

All updates | Publications | News | Events | Data

Publication

Rapid Risk Assessment: Extensively drug-resistant (XDR) Neisseria gonorrhoeae in the United Kingdom and Australia

risk assessment - 7 May 2018



https://ecdc.europa.eu/en/antimicrobial-resistance

JIACRA main conclusions and recommendations (1)

- The total and average population-weighted antimicrobial consumption (AMC) was higher in animals than in humans, although in 2/3 of the countries, AMC was lower in animals than in humans. This indicates that a low number of countries accounts for a large proportion of AMC in animals.

- The results for both humans and animals indicate that there is a strong impact of AMC on the occurrence of AMR in both sectors. Measures to reduce AMC would therefore most likely help to prevent and control the spread of AMR in a one-health-perspective.

- Substantial variation in AMC across countries and in both humans and animals was observed. This indicates that in some countries, there is a large potential for improving prudent use in order to reduce the occurrence of AMR in a one-health-perspective.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017.
http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

JIACRA main conclusions and recommendations (2)

- Multivariate analysis proved a useful approach to assess the effect on AMR in bacteria in humans from AMR in bacteria from animals and AMC in both animals and humans.
- For AMR in *Salmonella* and *Campylobacter,* strong associations between the animal and human sector were observed. This indicates that AMR in zoonotic bacteria in animals is of significance to AMR in humans in a one-health-perspective.
- Inherent sector specific characteristics of the systems for collection and reporting data on AMC and AMR in bacteria from humans and animals hampers direct comparisons.
- Dedicated studies to collect data specifically for integrated analysis could allow for more precise assessments of the association between the two sectors and could address specific one-health related questions of interest.

Source: ECDC, EFSA & EMA, 2017. EFSA Journal, 27 July 2017. http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4872/epdf

Humans + Animals = One Health

Prudent use of antibiotics. Everyone is responsible!

2008 – 2018

EUROPEAN ANTIBIOTIC AWARENESS DAY

A EUROPEAN HEALTH INITIATIVE

18 November 2018

antibiotic.ecdc.europa.eu

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WORLD ANTIBIOTIC AWARENESS WEEK

NOVEMBER 2018

ANTIBIOTICS HANDLE WITH CARE