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1 Title: AMR and AMU animal monitoring policies in Europe:
2 where are we?

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4 **Short running title:** Animal AMR European policies

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29 **Abstract**

30
31 Antimicrobial resistance has been recognized by the World Health Organization (WHO) as one of the top three
32 threats to human health. Any use of antibiotics in animals will ultimately also affect humans, and vice-versa. The
33 importance of the appropriate monitoring of its usage and resistance has been repeatedly emphasized, as well as
34 the need for global policies in this respect. Under the auspices of the EU research project EFFORT, the mapping of
35 antimicrobial usage and resistance monitoring programs in ten European countries was performed, with a critical
36 comparison with international and European guidelines/policies. Regarding the monitoring of resistance, we did
37 not find important differences between countries. However, the current resistance monitoring systems are
38 focused on food animal species (and fecal samples), ignoring, for example, companion animals. The scenario is
39 different considering the monitoring of antibiotics use. In the recent years, there has been a significant effort to
40 harmonize methodologies. Despite this, the reporting of antimicrobials use is still voluntary. A need for stronger
41 policies was identified.

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44 **Keywords:** Antimicrobial Resistance (AMR); monitoring; policies; animals; Antimicrobial use (AMU)

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54 **Text**

55 **Introduction**

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57 Antimicrobial resistance (AMR) is recognized as one of the major global public health threats, with
58 different reports emphasizing its economic impact (1,2), and the return to a “pre-antibiotics” era (3). It is
59 a perfect example of a “one health” issue, as any use of antibiotics in animals will ultimately affect
60 humans (and vice-versa)(4–6), with an associated environmental component (7–9), that recognizes no
61 national boundaries (10). The development of resistance to antimicrobial drugs is a natural
62 phenomenon, but the overuse and inappropriate use of these drugs, is associated with increased
63 resistance. Therefore, the appropriate monitoring of the use of and development of resistance to these
64 drugs are essential, if one is to achieve control of this problem.

65 The World Health Organization (WHO) has recently recognized that there are significant gaps in
66 (monitoring/surveillance) methods and no global consensus on standards for data collection and
67 reporting of AMR across medical, veterinary and agricultural sectors (WHO, 2014). It is generally
68 accepted that the comparison of results between countries is only possible when the results were
69 obtained using the same (or similar/equivalent) procedures.

70 Under the activities of the “Ecology from Farm to Fork Of microbial drug Resistance and Transmission”
71 (EFFORT) EU-FP7 project, we conducted the mapping of the current monitoring activities related to
72 antimicrobial use and resistance, in the ten European countries participating on the project: Belgium,
73 Bulgaria, Denmark, France, Germany, Italy, Netherlands, Poland, Spain and Switzerland. Here we
74 present the results of this mapping activity, as well as a critical comparison between the mapping results
75 and the current related international guidelines/policies, from a gap analysis perspective.

76 **Materials and methods**

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78 Initially, we took a very practical approach, having in mind the question: If a (European) country wants
79 to set up monitoring systems to control the use and development of resistance to antimicrobials in
80 animals, to which guidelines and policies should the competent authorities be looking at? As a follow-
81 up, we then did a critical comparison with individual countries policies, from a gaps identification
82 perspective. In a second step, we mapped what countries are currently doing to monitor antibiotic use
83 and resistance and finally did a gap analysis.

84 **International policy framework**

85

86 The WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (AGISAR) provided a
87 guidance document with key information for the design of programs of integrated surveillance of
88 antimicrobial (use) and resistance. Despite not being legally binding to countries, it does provide a
89 generic overview of what countries need and show how to achieve the mentioned goals.

90 **European policy framework on monitoring of *resistance* in animals**

91 On a more specific EU level, *Directive 2003/99/EC* set out the goals on the monitoring of zoonoses and
92 zoonotic agents and related antimicrobial resistance. By definition, as a “Directive”, it left up to the
93 countries to decide how to achieve these goals; This was followed in 2007, by the publication of *Decision*
94 *2007/407/EC* (by definition, a “Decision” is a binding legislative act on those to whom it is addressed,
95 being directly applicable) specifically focusing on the harmonized monitoring of AMR in *Salmonella* in
96 poultry and pigs. The most relevant and current related policy is probably *Decision 2013/652/EU*. It has a
97 broader scope, addressing the monitoring and reporting of AMR in zoonotic and commensal bacteria
98 (including *Salmonella* spp., *Campylobacter jejuni* (*C. jejuni*) and *Campylobacter coli* (*C. coli*), indicator

99 commensal *Escherichia coli* (*E. coli*), commensal *Enterococcus faecalis* and *Enterococcus faecium* (*E.*
100 *faecalis* and *E. faecium*) and *Salmonella* spp. and *E. coli* producing Extended-Spectrum β -Lactamases
101 (ESBL), AmpC β -Lactamases (AmpC) and Carbapenemases). Technical specifications on randomized
102 sampling for harmonized monitoring of AMR in these bacteria have been provided by EFSA (12).

103 **Global and European policy framework on monitoring of use in animals**

104 At the global level, OIE (Office International des Epizooties) provides guidelines on how to perform the
105 monitoring of the quantities and use patterns of antimicrobial agents in aquatic animals, in its chapter
106 6.3 of the Aquatic Animal Health Code; the equivalent for food-producing animals is provided in chapter
107 6.8 of the Terrestrial Animal Health Code.

108 Coordinated by the European Medicines Agency (EMA), the European Surveillance of Veterinary
109 Antimicrobial Consumption (ESVAC) project was launched in September 2009, following a request to
110 develop an approach for the harmonized collection and reporting of data on the use of antimicrobial
111 agents in animals in the Member States (SANCO/E2/KDS/rzD(2008)520915). ESVAC provides data
112 collection, reporting and analysis protocols, that can be followed by countries (13).

113 **Mapping exercise**

114

115 Initially, we mapped monitoring activities related to antimicrobial *use* and *resistance* including animals
116 and food in countries participating in EFFORT in place in 2014. For this, we used a surveillance mapping
117 methodology developed as part of another FP7 project (RISKSUR www.fp7-risksur.eu). After an initial
118 online training, data collectors received a MS Word template to be completed with information
119 regarding use of antimicrobials in their country, including: method to collect use data, animal
120 populations known (size), indicator of use used, availability (or not) of Defined Daily Dose Animals

121 (DDAs - also known as DDDvet in ESAVC project), the assumed average maintenance dose per day per
122 kg body weight for the main indication in a specified species), classes of antimicrobials for which data
123 was collected, specifications about the inclusion (or not) of premixes data, question about the potential
124 existence of specific policies to discourage or alert about the overconsumption of antimicrobials and if
125 veterinarians were allowed to sell antimicrobials or not. A similar procedure was used to collect the
126 information about the monitoring of resistance, but via an MS Access database template. This database
127 was completed with information about each monitoring activity/component like: the geographical focus
128 of it, legal framework, target species and sectors, sampling points and samples collected,
129 microorganisms tested, means of data acquisition, resistance criteria and whether the monitoring
130 activity was funded and performed by the public or private sector.

131 **Results**

132 **Resistance**

133

134 No major differences were found in the way the monitoring of resistance is being performed in the
135 analysed European countries (Table 1). Testing resistance in microorganisms like *Campylobacter jejuni*,
136 *Campylobacter coli*, *E. coli* and *Salmonella* spp. is being done in all the countries. In addition, few
137 countries (ex. France) have national programmes for veterinary pathogens. The focus of the monitoring
138 programs is in the major food producing species (poultry, cattle and pigs). Slaughterhouses are the most
139 common sample collection points, and the vast majority of the collected samples consist of faecal
140 material. The monitoring activities are mostly active, and under the control of the public sector.

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145 **Table 1:** Summary of the activities to monitor antimicrobial resistance, in animals, as of 2014, in the EFFORT participating countries.

	Microorganisms tested	Animals species tested	Collection of samples	Samples collected	Means of data acquisition	Antimicrobial susceptibility test	Resistance criteria	Public vs Private
Belgium	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>Salmonella</i> ; <i>E. coli</i> ; <i>Enterococci</i>	Poultry (broilers, laying hens and turkey) ; Pigs (finishers) ; Cattle (beef, dairy, veals)	Abattoir	Caecal; Faecal; Carcasses, meat and meat products (for poultry)	Active and passive	Dilution method and Diffusion method	Clinical break-point and Epidemiological cut-off value	All public
Bulgaria	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>Carbapenemase</i> ; <i>E. coli</i> ; <i>ESBL producers</i> ; <i>Salmonella</i> , <i>Staphylococcus spp.</i>	Poultry (broilers, laying hens); Pigs (finishers) ; Cattle (beef, dairy, veals); Sheep	Abattoir	Feces	Active	Diffusion method	Clinical break-point	Public
Denmark	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>E. coli</i> ; <i>Enterococci</i> ; <i>Salmonella spp.</i> ; <i>Staphylococcus spp.</i>	Poultry (broilers); Pigs (sows/boars, finishers); Cattle (beef); other	Abattoirs; Farms; Retailers; breeding herds	Caecal; Blood; Cloacal; Rectum; Meat (pork, beef and broiler)	Active	Dilution method	Epidemiological cut-off value	Public
France	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>E. coli</i> ; <i>Enterococci</i> ; <i>Pasteurella spp.</i> ; <i>Salmonella spp.</i> ; <i>Staphylococcus spp.</i> ; <i>Streptococcus spp.</i>	Birds (non-poultry); Cats; Cattle (beef, dairy, veals), Dogs, Donkeys, Ducks, Fish, Goats, Horses, Pigs (suckling piglets, weaners, sows/boars, finishers); Poultry (broilers, laying hens); Rabbits; Sheep; Turkey	Abattoir, Veterinary clinics and farms	Caecal; Environmental; Different samples sent to the laboratory for diagnosis	Active and Enhanced passive	Dilution method and Diffusion method	Epidemiological cut-off value; Veterinary breakpoint established by CA-SFM vet	Public and Private
Germany	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>E. coli</i> ; <i>Salmonella spp.</i> ; <i>Methicillin-resistant Staphylococcus spp. (MRSA)</i> ; <i>In addition several animal pathogens (passive system)</i>	Poultry (broilers, laying hens and turkey) ; Pigs (sows/boars, finishers) ; Cattle (beef, dairy, veals)	Abattoirs; Farms; Retailers;	Caecal; Environmental; Meat (pork, beef, broiler and turkey meat); isolates from clinical samples sent for testing	Active and Passive	Dilution method	Epidemiological cut-off value;	Public
Italy	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>Carbapenemase</i> ; <i>E. coli</i> ; <i>ESBL producers</i> ; <i>Salmonella spp.</i> ; <i>AmpC producers</i>	Poultry (broilers, laying hens and turkeys); Cattle (beef); Pigs (finishers)	Farms; Abattoirs; Various points of the food chain	Faeces; Environmental; Dairy products; Meat; Swabs from carcasses	Active and Passive	Dilution method	Epidemiological cut-off value	Public
Netherlands	<i>Campylobacter jejuni</i> ; <i>Salmonella spp.</i> ; <i>Enterococci</i> ; <i>AmpC producers</i> ; <i>Carbapenemase producers</i> ; <i>E. coli</i> ; <i>ESBL producers</i> ; <i>MRSA</i> ; <i>Pasteurella spp.</i> ; <i>Staphylococcus spp.</i> ; <i>Streptococcus spp.</i> ; <i>Listeria spp.</i> ; <i>Mannheimia haemolytica</i> ; <i>Histophilus somni</i> ; <i>Klebsiella</i> ; <i>Enterobacter</i> ; <i>Actinobacillus pleuropneumoniae</i> ; <i>Bordetella bronchiseptica</i> ; <i>Haemophilus parasuis</i>	Poultry (broilers, laying hens, turkeys); Cattle (dairy, veals); Pigs (suckling piglets, weaners, sows/boars, finishers); Horses; Sheep; Goat	Farms; Abattoirs; Veterinary clinics.	Faeces; Clinical samples	Active and Passive	Dilution method and Diffusion method; Other	Epidemiological cut-off value; Clinical break-point; Other	Public and Private
Poland	<i>E. coli</i> ; <i>Salmonella spp.</i> ; <i>Staphylococcus spp.</i> ; <i>Streptococcus spp.</i> ; <i>MRSA</i> ; <i>Pasteurella</i> ; <i>mastitis agents</i>	Poultry (broilers, laying hens and turkeys) ; Cattle (beef and dairy) ; Pigs (suckling piglets, weaners, sows/boars, finishers)	Farms; Abattoirs	Rectal swabs; Cloacal swabs; Environment (boot swabs, dust, faeces); Diagnostic specimens (milk, faeces, organs, lesions)	Active, Enhanced passive and Passive	Dilution method and Diffusion method	Epidemiological cut-off value; Clinical break points	Public
Spain	<i>Campylobacter spp.</i> ; <i>Enterococcus spp.</i> ; <i>E. coli</i> ; <i>Salmonella</i>	Cattle ; <i>Gallus gallus</i> (fowls) ; Broilers ; Laying hens ; Pigs (fattening) ;	All food chain; slaughterhouses.	Faeces; Lymph nodes	Active	Dilution method	EUCAST CLSI	Public
Switzerland	<i>Campylobacter coli</i> ; <i>Campylobacter jejuni</i> ; <i>Enterococci</i> ; <i>Carbapenemase</i> ; <i>E. coli</i> ; <i>ESBL producers</i> ; <i>Salmonella spp.</i> ; <i>AmpC producers</i> ; <i>MRSA</i>	Poultry (broilers); Cattle (veal); Pigs (finishers)	Abattoirs	Rectal swabs; Cloacal swabs; Nasal swabs; Diverse (evaluation of resistance in <i>Salmonella</i>)	Active and Passive	Dilution method	Epidemiological cut-off value	Public

147 Use

148

149 Table 2 summarizes the monitoring activities regarding the use of antimicrobials in the ten countries.

150 Sales data (from pharmacies, feed companies, wholesalers and/or pharmaceutical companies) is the
151 main source to derive/extrapolate use/consumption when such data is not available at national level.

152 Besides this, automated data collection is in place in Denmark and The Netherlands, in combination with
153 veterinary prescriptions data. In France, information is also collected via a retrospective longitudinal
154 study.

155 The antimicrobial use data is not divided by species in Belgium, Bulgaria and Italy. In the other countries
156 included in this study, it is not always possible to disaggregate the consumption in the individual species
157 (eg. dogs and cats are reported together in Denmark and France) and there is no common way of
158 grouping the different animal species (eg. "cattle" is reported in a single category (dairy+beef) in
159 Denmark, France and Poland while in the Netherlands usage data for rosé and white veal calves are
160 reported separately from other cattle (dairy+beef)).

161 In none of the countries are the size of all the animal population species (live and slaughtered, when
162 applicable), known.

163 "Total weight of Active Substance" is the indicator of usage reported in seven countries: Belgium,
164 Bulgaria, Denmark, France, Germany, and The Netherlands. In Belgium and France, "Weight of Active
165 Substance per biomass at risk to be treated" (units: mg AS/PCU) is also used, and this is the only
166 indicator used in Italy, Poland, Spain and Switzerland. Additionally, France uses the Animal Level of
167 Exposure to Antimicrobials (ALEA, the DCDA divided by the biomass) and the Netherlands the "Number
168 of days treated per individual" (Total amount of Kg, irrespective of active ingredient, by Kg of active
169 substance/year, by pharmaco-therapeutic group (DDDA nat and DDDAfarm/year)).

170 A list of DDDA`s is not available in Bulgaria, Germany, Italy, Poland, Spain and Switzerland. Belgium has
171 established it (for pigs and poultry) by product, active substance, administration route and age group;
172 Denmark by product, administration route and age group, France by product and The Netherlands by
173 active substance and ATCvet category.

174 All the countries have data collected and available for all the antimicrobial classes (according with the
175 ATCvet index list). Premixes data are included in the usage data in all the countries, except in Germany
176 and The Netherlands.

177 Denmark, Germany and The Netherlands have in place specific policies to discourage, or alert to the
178 “overconsumption” of antimicrobials, in opposition to the other seven countries.

179 Veterinarians are allowed to sell antimicrobials in Belgium, France, Germany, Poland, The Netherlands
180 and Switzerland.

182 **Table 2:** Summary of the activities to monitor antimicrobial use, in animals, as of 2014, in the EFFORT participating countries.

	Data collection	Consumption separated by species	An. pop. unknown (l=live; s=slaughtered)	Indicator of usage	DDAs available?	AM classes collected	Premises included	“Yellow card”?	Vets sell?
Belgium	Sales (feed companies and wholesalers)	No	Cats (l); Dogs (l); Ducks (s); Fish (l&s); Goats (s); Horses (s); Pigs: suckling piglets (l&s), weaners (s), sows/boars (s); Poultry: laying hens (s); Rabbits (s); Sheep (s); Turkey (s)	Total weight of AS; Weight of AS per biomass at risk to be treated	Yes (by product, AS, administration route, age group, for pigs and poultry)	all	Yes	No	Yes
Bulgaria	Sales (wholesalers and pharmaceutical companies)	No	Cats (l); Dogs (l); Birds (non-poultry) (l&s); Ducks (l&s); Fish (l&s); Rabbits (l&s); Turkey (l&s)	Total weight of AS	No	all	Yes	No	No
Denmark	Automated data collection; Sales (pharmacies and feed companies); veterinary prescriptions	Yes: dogs+cats (pharmacy data); cattle (dairy+beef); fish; goats; pigs (weaners, sows/boars, finishers); poultry (broilers, laying hens), sheep, turkey; horses (pharmacy data)	Birds (non-poultry) (l&s); Cats (l); Dogs (l); Donkeys (l); Fish (l); Horses (l&s); Pigs: suckling piglets (s), weaners (s), sows/boars (s); Poultry: laying hens (s); Rabbits (l&s); Sheep (l&s); Turkey (l&s)	Total weight of AS	Yes (by product, administration route, age group)	all	Yes	Yes	No
France	Retrospective longitudinal study; Sales (pharmaceutical companies)	Yes: Dogs+cats; Cattle; fish; horses; Pigs; poultry (including turkeys and ducks); rabbits; sheep+goats	Birds (non-poultry) (l); Cattle: beef (s), dairy (s), veals (l); Ducks (l); Fish (l); Horses (s); Pigs: suckling piglets (l&s), weaners (l); finishers (l); Poultry: broilers(l), laying hens (l); Rabbits (l); Turkey (l)	Total weight of AS; Weight of AS per biomass at risk to be treated ; ALEA	Yes (by product)	all, except QJ01R	Yes	No	Yes
Germany	Sales (pharmaceutical companies)	Yes: Pigs (weaners, finishers); poultry (broilers); turkey	Birds (non-poultry) (l&s); Donkeys (l); Fish (l&s); Goats (l&s); Pigs: suckling piglets (l&s); Rabbits (l&s); Sheep (l&s)	Total weight of AS	No	all	No	No	Yes
Italy	Sales (pharmaceutical companies)	No	Cats (l)	Weight of AS per biomass at risk to be treated	No	all	Yes	No	No
Netherlands	Automated data collection; Sales (pharmaceutical companies); Veterinary prescriptions	Yes: cattle; pigs; poultry (broilers); turkey	Birds (non-poultry) (l&s); Ducks (l&s); Fish (l&s); Rabbits (s)	Total weight of AS; Number of days treated per individual (DDA _{Anat} and DDA _{farm})	Yes (by AS, ATC vet category)	all	No	Yes	Yes
Poland	Sales (wholesalers)	Yes: cattle; goats; pigs; poultry; sheep	Cats (l); Dogs (l); Birds (non-poultry) (l&s); Ducks (l&s); Fish (l&s); Rabbits (l&s); Turkey (l&s)	Weight of AS per biomass at risk to be treated	No	all, except QJ01R	Yes	No	Yes
Spain	Sales (pharmaceutical companies)	Yes: birds (non-poultry); cats; dogs; fish; goats; horses; fish, salmon, trout; cattle; poultry; pigs	Cats (l); Dogs (l); Birds (non-poultry) (l&s); Ducks (l&s); Fish (l&s); Rabbits (l&s); Turkey (l&s)	Weight of AS per biomass at risk to be treated	No	all, except QJ01R and QJ01X	Yes	No	No
Switzerland	Sales (pharmaceutical companies)	No.	Birds (non-poultry) (l&s); Cats (l); Cattle: beef (l), veals (l); Dogs (l); Donkeys (l); Ducks (l&s); Fish (l&s); Goats (l); Pigs: suckling piglets (l&s), weaners (l&s), sows/boars (s), finishers (l); Poultry: broilers (l), laying hens (l); Rabbits (l); Turkey (l&s)	Weight of AS per biomass at risk to be treated	No	all	Yes	No	Yes

184 Discussion

185

186 The EC Decision 652/2013 on the monitoring and reporting of antimicrobial resistance in
187 zoonotic and commensal bacteria, is binding on all the EU countries (14). Considering this, it
188 was not surprising that few differences were found on the way countries are monitoring the
189 level of resistance. However, there are several aspects that this policy does not cover, that
190 should be addressed in upcoming policies. The current monitoring activities are mostly
191 focused on food producing animals. But, for example, fish (aquaculture) are not considered
192 (being aware that this is not a developed sector in all the EU countries). Considering some
193 recent reports (15), particular attention should be given to this section, in the near future.

194 The mandatory monitoring is mostly performed via faecal material. While most of the
195 prudent use guidelines in veterinary medicine recommend a good diagnosis, antibiogramme
196 use and epidemiological knowledge of animal disease, no strong regulations have been
197 established to support the best practice in veterinary laboratories. This way, resistance
198 developing microorganisms that live in different body organs (lungs, mammary gland,
199 uterus, etc.) might be missed. The direct sampling and analysis of food samples is also not
200 mandatory. Including these analyses in the routine European mandatory activities would be
201 labour and financially demanding, and cross-contamination issues would have to be carefully
202 taken into account. In any case, it would certainly help to clarify, and above all to quantify,
203 the different transmission AMR pathways between humans and animals, areas that despite
204 progress in the past few years, still have significant knowledge gaps. Metals exposure (like
205 silver and zinc oxide) has been recognized as a factor contributing to AMR selection (16,17),
206 but the current policies do not mandate the monitoring of resistance to these agents.

207 Antimicrobial resistant bacteria have been repeatedly identified in “environmental” samples

208 (7–9), but despite this, the monitoring of resistance via “environmental” samples is currently
209 not mandatory. Having this information would be quite useful to better understand the
210 spread of resistance between humans, animals and the environment.

211 The vast majority of the current monitoring activities are “active” (vs passive collection of
212 information) and managed and funded by the public authorities of each country. Considering
213 that antimicrobials are a public good, these approaches make sense, and facilitate both the
214 harmonization and transparency of methods. On the other hand, it is the private
215 industry/owners that mostly make the use of antimicrobials, thereby benefiting from them.
216 It is also true that they are the ones directly affected with all the adverse consequences
217 (both in humans and animals) of the existence of resistance. Therefore, an increased
218 involvement of the private industry would be desirable.

219 The scenario is significantly different regarding the monitoring of the use of antimicrobials.
220 This can perhaps be mostly explained by the fact that there is currently not any binding
221 European policy that mandates countries to report their use of antimicrobials in the animal
222 sector, with specific guidelines. The legal framework for veterinary medicinal products
223 currently under revision can be an opportunity to change this policy reality, and it does seem
224 that at least report sales quantities will become mandatory, with mandatory monitoring to
225 be implemented in two to three years.

226 The ESVAC project has been certainly contributing for the collection of harmonized data.
227 However, most of the data collected still refers to sales data, and not use data. This scenario
228 is planned to change in a relatively near future(18). Collecting the actual use data at the
229 farm level, is certainly a demanding task for different agents involved in this sector, but it is,
230 at the same time, the most accurate way. An antibiotic sold, is not an antibiotic used, and

231 only the recording of the actual use will avoid the need for approximations, corrections and
232 use of other indicators of use.

233 Knowing the animal population at risk, i.e., the denominator regarding the use of the
234 antimicrobials, is critical. In the analyzed countries, the major food producing animal
235 populations are known (poultry, cattle and pigs), but this is not always true for other “minor”
236 species. The use/sales of antimicrobials is reported in such a way that does not always allow
237 the differentiation between the different species, types and stages of production, and this is
238 critical when it comes to identifying the species and stages of the food chain where
239 prevention and control measures should focus on. Currently, the same antibiotic commercial
240 product can be commercialized/is indicated for different animal species, creating an
241 additional hurdle when it comes to the quantification of its use in a specific species.

242 The usefulness of having a “yellow card” policy has been recognized in Denmark (19). Under
243 this policy, a farmer receives a yellow card if he/she uses antimicrobials in a quantity two
244 times higher than the national average. However, such policies only exist in Denmark and
245 The Netherlands. The same way, the implementation of policies that restrict the sales of
246 antimicrobials by veterinarians have had positive impact (20), but at the moment such
247 policies only exist in half of the analyzed countries.

248 **Conclusion**

249

250 The current European policies regarding the monitoring of resistance in animals, provide
251 specific guidelines when it comes to food producing animals. However, most of the analyses
252 to be performed are based on faecal samples, and, for example, companion animals, food

253 and the environment are not even considered. Important gaps that we here suggest to be
254 addressed in upcoming policies.

255 At the moment, there is not an European policy that mandates countries to report their use
256 of antimicrobials in animals, and most of the data available is based on sales, and not use
257 data.

258 Considering the unanimously recognized significant dimension of the AMR problem, these
259 scenarios should be urgently changed. The EU ban on the usage of growth promoters in
260 2006 provided a strong global message, and the EU is recognized as an AMR best practices
261 region (Plantady, 2016, personal communication). Developing and implementing the policies
262 suggested in this paper, should inform policy development in other regions where similar
263 activities may still be lacking.

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