Reducing antimicrobial use in food animals

Consider user fees and regulatory caps on veterinary use

By Thomas P. Van Boeckel,1 Emma E. Glennon,2,3 Dora Chen,2,4 Marius Gilbert,2,6 Timothy P. Robinson,2,7 Bryan T Grenfell,2,9 Simon A. Levin,4,10 Sebastian Bonhoeffer,1 Ramanan Laxminarayan6,10

The large and expanding use of antimicrobials in livestock, a consequence of growing global demand for animal protein, is of considerable concern in light of the threat of antimicrobial resistance (AMR). Use of antimicrobials in animals has been linked to drug-resistant infections in animals (1) and humans (2). In September 2016, the United Nations (UN) General Assembly recognized the inappropriate use of antimicrobials in animals as a leading cause of rising AMR. In September 2018, the interagency group established by the UN Secretary General will report on progress in the global response to AMR, including antimicrobial consumption in animals. We provide a baseline to monitor efforts to reduce antimicrobial use and assess how three global policies might curb antimicrobial consumption in food animal production: (i) enforcing global regulations to cap antimicrobial use, (ii) adherence to nutritional guidelines leading to reduced meat consumption, and (iii) imposing a global user fee on veterinary antimicrobial use.

The rise of AMR in zoonotic pathogens, including to last-resort drugs such as colistin (3), is an important challenge for human medicine because it can lead to untreatable infections. Evidence linking AMR between animals and humans is particularly strong for common foodborne pathogens resistant to quinolones, such as Campylobacter spp. and Salmonella spp. (4). AMR is also a threat to the livestock sector and thus to the livelihoods of millions who raise animals for subsistence (5).

The primary driver for the accumulation of harmful resistance genes in the animal reservoir is the large quantity of antimicrobials used in animal production (6). Antimicrobial use in livestock, which in many countries outweighs human consumption (7), is primarily associated with the routine use of antimicrobials as growth promoters or their inappropriate use as low-cost substitutes for hygiene measures that could otherwise prevent infections in livestock.

In Europe, regulations have been the principal instrument to limit antimicrobial use in animal production. In the United States, consumer preferences have driven companies to reduce antimicrobial use in animals, although the impact on livestock rearing practices is still nascent (8). Some European countries maintain highly productive livestock sectors while using less than half the current global average amount of antimicrobial per kilogram of animal (50 mg/kg). Therefore, this threshold has been proposed as a potential target for global regulations on veterinary antimicrobial use (9). However, the impact that such policies would have on the global consumption of antimicrobials has yet to be quantified.

A second solution to reduce antimicrobial consumption in animal production may be to promote low-animal-protein diets: China has recently revised downward its nutritional guidelines for meat intake to 40 to 70 g/day (10), which is approximately half the current consumption level in the country. If followed, this measure could have an indirect but substantial impact on the global consumption of veterinary antimicrobials. A third solution to cut antimicrobial use would be to charge a user fee, paid by veterinary drug users, on sales of antimicrobials for nonhuman use (11). This approach has recently received support from the World Bank (12) on the basis that the associated revenues could be injected into a global fund to stimulate discovery of new antimicrobials and support efforts to preserve existing drugs (13). Without further analysis, however, it is unclear whether a user fee policy could achieve a meaningful reduction in the global consumption of veterinary antimicrobials, let alone generate sufficient revenues to support improved livestock rearing practices or the development of new drugs, vaccines, and diagnostics.

GLOBAL TRENDS

Veterinary antimicrobial sales volumes were obtained via public records for 38 countries and self-governing dependencies and estimated for 190 more (supplementary materials). In 2013, the global consumption of all antimicrobials in foods animals was estimated at 131,109 tons [95% confidence interval (CI) (100,812 to 190,492 tons)] and is projected to reach 200,235 tons [95% CI (150,848 to 297,034 tons)] by 2030. Consumption levels varied considerably between countries, ranging from 8 mg/population correction unit (PCU) (a kilogram of animal product) in Norway to 318 mg/PCU in China (see fig. S1). As the largest consumer of veterinary antimicrobials, both in relative (per PCU) and in absolute terms, China has an important leadership role with regard to its response to AMR and has already set precedents in phasing out drugs that are last resorts for human infections but are still in use in Europe in animal husbandry.

In relative terms, humans and animals use comparable amounts of antimicrobials
Limiting meat intake

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[Image 36x471 to 558x759]

SCIENCE

get 1A). If only countries of the Organization

could reduce total consumption by 64% (tar-

target 3) or the number of animals

levels of antimicrobial use (see the graph).

These factors suggest that the food animal

reservoir is a greater source of resistance
genes than humans. However, the subse-
quent spread of those genes to humans fol-

furthermore, a central distinction between animals and hu-

mans is the purpose of antimicrobial use. Un-

like in humans, antimicrobial use in animals

is primarily intended for growth promotion

and mass prophylaxis. These uses are often

administered both through feed, directly

targeting the gut, and in low-dose patterns

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reservoir is a greater source of resistance
genes than humans. However, the subse-
quent spread of those genes to humans fol-

ows complex pathways, and recent work has

highlighted that curtailing antimicrobial use

in animals alone will not suffice to contain

AMR in humans (16).

GLOBAL SOLUTIONS

The use of antimicrobials in food animals

could be reduced by 2030 between 9 and

80% with effective policies compared with a

business-as-usual target (BAU) of continued

growth of the livestock sector with current

levels of antimicrobial use (see the graph).

This could be achieved either by reducing the

quantity of antimicrobial used per animal

(targets 1 and 3) or the number of animals

that we raise for food (target 2).

Meat consumption. Limiting meat intake

worldwide to 40 g/day—the equivalent

of one standard fast-food burger per per-

son—could reduce global consumption of

antimicrobials in food animals by 66% (tar-

target 2A). This reduction is comparable with

what could be achieved through regulations

targeting antimicrobial use (targets 1A and

1B). In comparison, meat consumption in the

United States currently averages 260 g/

day (OECD 2015). In this context, and given

increasing appetites for meat in emerging
economies, it seems unlikely that antimicro-
bial use in food animals could be reduced

substantially through voluntary adherence to

such drastic changes in dietary habits.

Under a more realistic global cap of 165 g

meat/day (projected EU average in 2030),
global consumption of antimicrobials could

be reduced by 22% (target 2B). Reduced

meat consumption could thus have substan-
tial benefits on AMR as well as other envi-

ronmental and human health issues.

User fees. Imposing a user fee of 50% of the

current price on veterinary antimicrobials

could reduce global consumption by 31%

(target 3C). More important, such a policy

would also generate yearly revenues between

US$ 1.7 billion and 4.6 billion (Protocol

S4). In comparison, the level of investment

necessary for the development of one new

antimicrobial compound is typically US$ 1

billion (18). Alternative rates of 10 or 100%

for the user fee would reduce the global

consumption by 9 and 46%, generating rev-

enues of US$ 0.4 billion to 1.2 billion and

US$ 2.8 billion to 7.5 billion, respectively.

Concretely, the fee could be applied at the

point of manufacture or wholesale purchase

for imported products. The advantages of

this implementation are twofold. First, given

the limited number of drug manufacturers,

enforcement would require only limited re-

sources. Second, manufacturers are more

likely than veterinarians to keep records

of volumes traded, especially in countries

where drugs are used without prescription.

However, because user fees could be passed

on to individual farmers, these could also

have adverse effects if not accompanied by

other measures to reduce the need for an-

timicrobials in food production. Here, we

identify that demand for veterinary antimi-

crobials is on average more elastic in LMICs

(Protocol S4), with the notable exception of

China, where demand was inelastic because

of increased reliance on antimicrobials for

food production. LMICs could therefore be

disproportionally affected by a user fee.

[118 mg/PCU and 133 mg/kg, respectively

(J4)], but given that the biomass of animals

raised for food exceeds by far the biomass of

humans, new resistant mutations are more

likely to arise in animals. Furthermore, a

central distinction between animals and hu-

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Regulations. A global regulation putting a

cap of 50 mg of antimicrobials per PCU per

year, the current global average amount,
could reduce total consumption by 64% (tar-

target 1A). If only countries of the Organization

for Economic Cooperation and Development

(OECD) and China were to adopt this regula-
tion, the global consumption in 2030 would

already be reduced by 60% (target 1B). In

the short term, target 1B may be preferred

because it would have substantial impact on

global consumption without targeting vul-
nerable farmers in low- and middle-income

countries (LMICs) who rely on the abil-
it to treat livestock for subsistence (17). In

some high-income countries, regulatory ap-

proaches have achieved substantial reduc-
tion in antimicrobial use within a few years

and at moderate costs. However, in LMICs,

the cost of setting up surveillance systems is a

barrier to enforcement, and our findings are

contingent on enforceability.

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Pigs in cages, Quanzhou, China. As the largest consumer of veterinary antimicrobials, China is critical for combating antimicrobial resistance (AMR).
Antimicrobial consumption in food animals by 2030

Business as usual and intervention policies are shown. Revenue ranges are estimated for different fee rates (TR) and price elasticities of demand (PED). For 3C, 3D, and 3E, PEDs are derived from time series of imports of veterinary antimicrobials in each country (Protocol S4); the global average PED was -0.95. See supplementary materials for discussions of uncertainty in all estimates shown in figures. PUC, population correction unit.

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SUPPLEMENTARY MATERIALS

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