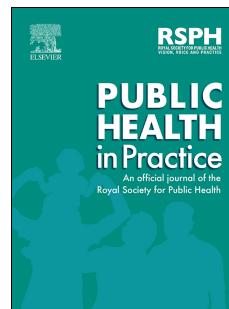


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Enhancing antimicrobial stewardship and health literacy in Europe – moving forward through education and empowerment

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1 **Enhancing antimicrobial stewardship and health literacy in Europe**
2 **– moving forward through education and empowerment**

3

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1 **Abstract**

2 Antimicrobial resistance (AMR) is a silent, growing pandemic of global proportions
3 and impact. This commentary encourages relevant stakeholders to increase their
4 joint commitment to collaboration and systemic action, dedicated antibiotic
5 stewardship and health literacy including a stronger, evidence-based self-care to
6 contribute to solving the AMR challenge. Key factors such as the removal of
7 inadequate access to antibiotics, e.g. over-the-counter (OTC) sale of antibiotics,
8 improving self-care and hygiene can help fight the increasing burden of AMR. Along
9 with the increase in health care literacy, these measures can be implemented swiftly
10 to combat the growing rate of AMR development.

11

12 **Keywords**

13 AMR, health literacy, antibiotic stewardship, health education, empowerment,
14 Europe, self-care, One Health.

15 **The Current Issue of Antimicrobial Resistance**

16 The European Parliament – in the resolution on the Pharmaceutical Strategy for EU
17 – recognised antimicrobial resistance (AMR) as ‘a major global health problem and a
18 serious risk to the well-being of European citizens that will pose a major challenge to
19 European health systems and societies’ and ‘calls on the EU to provide itself with
20 common therapeutic guide for antimicrobials’.¹ In Europe alone, it is estimated that
21 AMR causes more than 670,000 infections and the death of 33,000 people annually
22 and a loss of €1.1 billion yearly in relation to healthcare costs and productivity.² AMR
23 threatens both the patient safety of several medical procedures, the ability to fight
24 outbreaks in either hospital wards or communities, and overall public health. Yet
25 inappropriate use of antibiotics remains high with predominantly viral respiratory
26 infections representing a typical indication for misuse.

27 AMR is a threat to both human health and animal health, and it affects
28 environments and ecosystems, causing societal challenges. Therefore, AMR must
29 be addressed using a One Health approach, highlighting that coordinated action
30 across all sectors is key and our health is interconnected with the health of other
31 organisms, including our microbiome.³ An alteration of the composition of the
32 microbiome due to AMR can have negative effects on the host organism. For
33 example, microbes are causally involved in preventing infections in the whole
34 digestive system including the oral cavity and maintaining a healthy condition.⁴ As a
35 first point of contact with airborne pathogens the oral microbiome serves as a
36 protection shield by providing ‘colonisation resistance’ preventing pathogens from
37 colonizing the mouth and throat mucosa.

38 However, if the microbial inhabitants are disturbed, e.g., by local antibiotics,
39 fungal infections or inflammation of the oral mucosa can occur. If a microbial
40 population is disrupted by antibiotics, pathogens can gain advantage, resulting in
41 systemic infection and inflammation. These infections can be caused by resistant
42 organisms increasing the risk of multidrug-resistant pathogens. Human cohort
43 studies provide persuasive evidence that the amount of antibiotics used by humans
44 – according to recent estimates more than 70 billion antibiotic doses annually – is
45 changing the bacterial diversity in the human microbiome.³ These changes have
46 been associated with asthma, diabetes, autism, irritable bowel syndrome (IBS) which

47 are costly and detrimental side effects due to the loss and disturbance of microbiome
48 in our bodies.^{3,5}

49 **An urgent need for antimicrobial health literacy and stewardship**

50 Health literacy concerns the organisational and individual capacity to share, process,
51 and apply information towards better health for individuals, communities, and the
52 environment. Health literacy is particularly relevant in the context of AMR to
53 understand the use of antibiotics and the impact on the individual and communal
54 microbiome. Increasing health literacy would empower everyone to understand the
55 effects of antibiotics, to use them more appropriately and enable them to take
56 alternative actions in a timely and appropriate manner. One of the key methods to
57 encourage and boost health literacy is the use of antimicrobial stewardship which
58 includes:

- 59 1. Leadership commitment: Demonstrate dedication to and accountability for
60 optimising antibiotic prescribing and patient safety.
- 61 2. Intervention and action: Implement at least one policy or practice to improve
62 antibiotic prescribing, assess whether it is working, for whom - and modify as
63 needed.
- 64 3. Tracking and reporting: Monitor antibiotic prescribing practices and offer
65 regular feedback to clinicians.
- 66 4. Education and expertise: Provide educational resources to clinicians and
67 patients on antibiotic prescribing and ensure access to needed expertise on
68 optimising antibiotic prescribing.
- 69 5. Revisit history: Introduce mechanism to review historical licenses and product
70 to assess risk/benefit ratio in relation to new research including prescription
71 status.

72 Increasing awareness of antimicrobial health literacy and stewardship can help
73 mitigate the harmful effects of AMR in Europe and globally, including the impact on
74 health equity. It is a shared responsibility of decision makers, health professionals,
75 manufacturers, and individuals to decrease the inappropriate use of antibiotics and
76 thereby AMR.

77 **Over-the-counter antibiotic misuse and the impact on AMR and health**

78 Although, there is much global effort to drive behavior changes on the use of
 79 antibiotics, non-prescription over-the-counter (OTC) sore throat medicine including
 80 lozenges with tyrothricin, gramicidin, bacitracin and neomycin remain available for
 81 self-medication in some countries, including Europe.⁶ However, only a small
 82 proportion of the sore throat conditions are caused by bacteria such as e.g., group A
 83 *Streptococcus*. Sore throats mainly have a viral aetiology (80–95 %)⁷ which makes
 84 antibiotics irrelevant for the treatment while adding to the risk of AMR. Easy access
 85 to OTC antibiotics could contribute to removal of oral colonisation resistance and
 86 creation of ecological niches for resistant organisms caused by overuse of
 87 antibiotics. Consequently, this can on the one hand cause significant damage to the
 88 immune system due to a lack of biodiversity of the microbiome in the mouth or gut. A
 89 microbiome affected by antibiotics increases risks in systemic inflammation and
 90 infection as it has a reduced diversity. On the other hand, it facilitates the spread of
 91 antimicrobial-resistant organisms. Nonetheless, consumers may not be aware of the
 92 impact on AMR for individuals and communities when buying easily available OTC
 93 products containing antibiotics, despite their preference to support sustainable
 94 solutions and products to thus help solve our global crisis to health and economy. It
 95 is therefore important to preserve the efficacy of antibiotics and can be argued that
 96 they should not be made available as OTC.⁸

97 **Reducing inadequate access to antibiotics**

98 While we urgently need to develop new antibiotics to improve the current toolbox, it
 99 is essential at the same time to limit inadequate access to antibiotics. This includes
 100 introducing expanded product labelling to inform about the risk of increasing AMR –
 101 and considering withdrawal of OTC products containing antibiotics. Alternatively,
 102 OTC antibiotic products could become prescription-only (POM), where appropriate
 103 diagnostic procedures can facilitate correct usage.

104 Moreover, traditional, and cultural practices of prescribing antibiotics should
 105 be examined to identify and overcome unsustainable uses of antibiotics and make
 106 them fit-for-purpose. Whilst some countries are reviewing and updating their
 107 antibiotic usages practices, this needs to occur on a global scale with a One Health
 108 approach.

109 **Using a One Health Approach is necessary for combatting AMR**

110 On a systems level, addressing the use of antibiotics and the impact of AMR
 111 in the food and agriculture ecosystems alongside accessibility in pharmacies and
 112 prescription habits – using a One Health-approach – will help mitigate the increase of
 113 AMR within and across countries. This approach should not only consider the impact
 114 on humans and animals, but also the biodegradation of our environment – also on a
 115 microbiological level – that a misuse of antibiotics represents.⁹ The industrial impact
 116 has been identified as a major cause of the spread of AMR e.g., by release of active
 117 antimicrobial compounds into the environment. Monitoring hospital sewage and other
 118 industrial pathways could, therefore, be a specific point of focus.

119 Yet, while AMR is relatively high on the agenda in Europe, less attention is
 120 given to antibiotics in many countries elsewhere. In a globalised world, pathogens
 121 (including resistant strains) can travel and although a local or national top-down
 122 approach will not be sufficient to solve this global problem and eliminate the
 123 development of antibiotic resistance, local actions may help to reduce inappropriate
 124 antibiotic use as seen in low-prescribing countries.

125 Furthermore, prevention of disease transmission is a crucial factor in reducing the
 126 burden of AMR and can be achieved through the means of design, architecture, air
 127 conditioning, and improved self-care and hygiene.

128 **Improving self-care and hygiene**

129 There is a strong need for more action to improve health literacy and the ability to
 130 self-care in addition to system wide, organisational efforts. This is evident as some
 131 patients still believe the misconception that antibiotics can treat viral infections.¹⁰
 132 Recognising the value of an evidence-based, well-educated, informed self-care
 133 strategy, including evidence-based solutions may contribute to quality of care and
 134 reduce the use of antibiotics.

135 Investment in educational efforts concerning hygiene and health literacy in
 136 healthy school and workplace environments can be seen as low hanging fruit with
 137 potential for significant impact.

138 Targeted efforts to support citizens use of appropriate preventive measures
 139 would be both equitable and effective in terms of tackling AMR. Public engagement

140 campaigns such as the global Antibiotic Awareness Day and increased exchange of
141 good practices are needed to develop people's health literacy. New and stronger
142 communication efforts from basic fact sheets to reflections about antibiotics and
143 AMR in media, public events, and online can overhaul mis- and dis-information
144 breaking through dogma and myths and educate about symptomatic treatments.

145 **Conclusions**

146 The AMR challenge is well recognised but addressed with too little action. There is
147 an opportunity to learn from the ambitious political and societal actions during the
148 COVID-19 pandemic and design bold actions to fight AMR. It is important to realise
149 that the impact of AMR is not just a future, potential risk; it is a clear and present
150 danger to health and wellbeing around the world.²

151 AMR is unevenly distributed and as such it places a bigger burden on the
152 poorer or socially deprived communities. Low building standards, poor air quality,
153 confined living conditions, and poor access to adequate hygiene facilities are all
154 drivers for infections and thus potentially antibiotic treatments. Vigor and dedication
155 are needed from national and regional stakeholders to boost the AMR agenda and
156 transform the *status quo* by design, interventions, education, monitoring systems and
157 pharmaceutical innovations.

158 We encourage health care professionals, health communication
159 professionals, decision makers, and civil society to increase their joint commitment to
160 collaboration and action towards system action, dedicated antibiotic stewardship and
161 health literacy including a stronger, evidence-based self-care to contribute to solving
162 the AMR challenge.

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1 **Declarations**

2 a. Ethics approval and consent to participate

3 Not applicable

4

5 b. Consent for publication

6 All co-authors provided consent for publication

7

8 c. Availability of data and materials

9 Not applicable

10

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12 The authors of this paper represent a wide range of organisations, institutions,
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