

A large, stylized yellow graphic consisting of several overlapping, wavy bands that sweep across the bottom half of the page. The bands vary in opacity and shade, creating a sense of depth and movement.

National action plan ON ANTIMICROBIAL RESISTANCE 2017–2021

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National action plan on antimicrobial resistance 2017–2021

Antti Hakanen, Jari Jalava ja Liisa Kaartinen



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<p>Abstract</p> <p>Antimicrobials, or antibiotics, are one of the most significant discoveries in the field of modern medicine. The increase of antimicrobial resistance poses a threat to human and animal health globally. For this reason, in autumn 2016, antimicrobial resistance was the fourth health issue ever in the agenda of the UN General Assembly.</p> <p>Preventing antimicrobial resistance is a task that must be tackled with cross-sectional collaboration at all levels of the entire society. Prevention concerns humans, animals, foodstuffs and the environment. Attention is to be paid, both in human and veterinary medicine, to the detection and control of spreading of resistance, prevention of infections and antimicrobial stewardship. In Finland antibiotics are not used in plant production. Globally that is not the case. Therefore antimicrobial usage in plant production is also of concern. Antimicrobial resistance surveillance is an important indicator of effective control measures and detection of new threats.</p> <p>Antimicrobial resistance is a global cross-border health threat that requires continuous preparedness. The global community must promptly react against new threats. This new National Action Plan on Antimicrobial Resistance describes present control measures of antimicrobial resistance in Finland. It proposes new actions to correct observed defects and to strengthen different areas of resistance control in the future.</p>			
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Tiivistelmä	<p>Mikrobilääkkeet eli antibiootit ovat yksi lääketieteen merkittävimmistä keksinnöistä. Mikrobien muuttuminen resistenteiksi eli vastustuskykyisiksi mikrobilääkkeille uhkaa ihmisten ja eläinten terveyttä kaikkialla maailmassa. Tästä syystä resistenssin torjunta nostettiin kautta aikojen neljäntenä terveysaiheena YK:n yleiskokouksen asialistalle syksyllä 2016. Resistenssin torjuntaa on tehtävä poikkihallinnollisessa yhteistyössä kaikilla tasoilla koko yhteiskunnassa. Torjuntatyössä on otettava huomioon ihmiset, eläimet, elintarvikkeet ja ympäristö. Huomiota on kiinnitettävä resistenttien mikrobien tunnistamiseen, leviämisen ehkäisyyn, infektioiden torjuntaan ja lisäksi on varmistettava mikrobilääkkeiden oikea ja vastuullinen käyttö ihmisten ja eläinten hoidossa. Kasvintuotannossa ei Suomessa käytetä mikrobilääkkeitä, mutta maailmalla tilanne on toinen. Siksi myös kasvintuotannon mikrobilääkekäyttö on huomioitava resistenssiä lisäävänä tekijänä. Mikrobilääkeresistenssin seurannalla mitataan torjuntatoimien tehokkuutta ja todetaan uudet uhat.</p> <p>Mikrobilääkeresistenssi on valtioiden rajat ylittävä terveysuhka, joka vaatii jatkuvaa valmiutta ja torjunnan hyvän tason säilyttämistä. Uusiin uhkiin on kyettävä reagoimaan nopeasti. Tässä toimintaohjelmassa kuvataan mikrobilääkeresistenssin torjunnan nykytila Suomessa. Toimenpide-ehdotuksissa keskitytään korjaamaan havaitut puutteet ja esitetään toimenpiteitä, joilla mikrobilääkeresistenssin torjunnan eri osa-alueita voidaan jatkossa vahvistaa.</p>		
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Nyckelord	antibiotika, bakterier, mikrober, smittsamma sjukdomar, WHO	
Referat	<p>Antimikrobiella läkemedel, t.ex. antibiotika, hör till de mest betydelsefulla medicinska uppfinningarna. Att mikrober blir resistenta, det vill säga motståndskraftiga mot antimikrobiella läkemedel, äventyrar människors och djurs hälsa på alla håll i världen. Av denna anledning lyftes resistensbekämpning fram som det genom tiderna fjärde största hälsotemat på agendan för FN:s generalförsamling hösten 2016. Resistensbekämpningen ska genomföras i tväradministrativt samarbete på alla samhällsnivåer. Bekämpningen ska ta hänsyn till såväl människor och djur som livsmedel och miljön. Det gäller att fokusera på att identifiera resistenta mikrober, förhindra spridning, bekämpa infektioner samt säkerställa korrekt och ansvarsfull användning av antimikrobiella läkemedel vid behandling av människor och djur. Inom växtodlingen i Finland används inte antimikrobiella läkemedel, men ute i världen är situationen en annan. Därför bör även användningen av antimikrobiella läkemedel inom odling beaktas som en faktor som ökar resistens. Uppföljningen av antimikrobiell resistens fungerar som indikator för bekämpningsåtgärdernas effekt och för nya hot.</p> <p>Antimikrobiell resistens är ett hälsohot som överskrider staters gränser och som förutsätter konstant beredskap och upprätthållande av en hög bekämpningsnivå. Det är viktigt att kunna reagera snabbt på nya hot. Detta program beskriver nuläget för bekämpningen av antimikrobiell resistens i Finland. De föreslagna åtgärderna fokuserar på att rätta till uppdagade brister och stärka olika delområden inom bekämpningen av antimikrobiell resistens.</p>	
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ABSTRACT

Antimicrobials, in other words antibiotics, are among the most significant inventions in medicine. Antimicrobial resistance, meaning that the microbes become resistant to antimicrobial medicines, is a global health threat to both humans and animals. Therefore, the actions to combat antimicrobial resistance were placed on the agenda of the UN General Assembly agenda held in autumn 2016. This is only the fourth time that a health issue has been addressed by the UN General Assembly. The action to combat antimicrobial resistance must be a joint effort at every level of society. The action must involve both humans, animals, foodstuffs and the environment. Attention must be paid to the identification of resistant microbes, the prevention of their spreading and prevention of infections but we must also ensure that antimicrobials are used correctly and responsibly in the treatment of humans and animals. No antimicrobials are used in Finnish plant agriculture but this is not the case globally. For this reason, the use of antimicrobials in plant production must also be taken into consideration as one further factor of increased resistance. The surveillance of antimicrobial resistance is a way to measure the efficacy of the preventive actions and to detect new threats.

Antimicrobial resistance is a global, cross-border health threat calling for unrelenting preparedness and a maintained good level of control. It is vital that the reaction to new threats is rapid. This National Action Plan describes current situation to combat antimicrobial resistance in Finland. The proposed recommendations for action focus on remedies to the recognised shortcomings, and suggest actions to enhance the various areas of antimicrobial resistance control in the future.

Table 1. Major actions by areas of operation

Area of operation	Major action
Training of professionals and educating the public	<ul style="list-style-type: none"> • Marked increase in communication and education on the significance of tourism for the spreading of antimicrobial resistance. • Support for further training in antimicrobial resistance control provided to social care and healthcare professionals as well as veterinary professionals and animal producers
Nationally coordinated One Health surveillance	<ul style="list-style-type: none"> • Develop real-time notification and reporting system for extremely resistant antimicrobial bacteria to support the exchange of information at the local, regional and national levels with the aim of enhancing appropriate control actions. • Build up an information system to collect animal species-specific usage data on antimicrobials. • Develop statistics and IT systems on antimicrobial use to allow for an itemised analysis of antimicrobial consumption data of hospitals and long-term care facilities.
Prevention of infections and controlling the spread of multi-resistant bacteria	<ul style="list-style-type: none"> • Preparing national recommendations for infection prevention at hospitals and long-term care facilities. • Produce guidelines on the prevention of infections caused by work-related resistant bacteria of animal origin and draft joint operational principles for health and environmental health professionals to investigate and control the incidence of human diseases caused by resistant bacteria of animal origin.
Guidelines for professionals on antimicrobial use	<ul style="list-style-type: none"> • Prepare an antimicrobial manual for outpatient healthcare to cover choices, dosage and course duration of antibiotics used in the treatment of usual infections treated in outpatient care. • Set national objectives for volume of antimicrobial use in animal.
Research	<ul style="list-style-type: none"> • Propose basic and applied research programmes related to antimicrobial resistance and infectious diseases and support domestic and international networking of researchers in the field.
Administrative structures	<ul style="list-style-type: none"> • Enhance administrative cooperation across and between sectors and stakeholders by consolidating the operations of the national expert group (MTKA) through, for example, a legislative decree.

Experts contributing to the Plan of Action

Antti Hakanen, Chief Physician, Hospital District of Southwest Finland
Jari Jalava, Senior expert, National Institute for Health and Welfare
Liisa Kaartinen, Senior inspector, Finnish Food Safety Authority Evira
Anni Virolainen-Julkunen, Ministerial Counsellor for Health and Medical Affairs,
Ministry of Social Affairs and Health
Sari Ekholm, Senior Medical Officer, Ministry of Social Affairs and Health
Nina Kaario, Senior Veterinary Officer, Ministry of Agriculture and Forestry
Eeva Nurmi, Ministerial Adviser, Ministry of the Environment
Outi Lyytikäinen, Research Professor, National Institute for Health and Welfare THL
Pekka Eränkö, Senior Medical Officer, Finnish Medicines Agency Fimea
Terhi Laaksonen, Head of Unit, Finnish Food Safety Authority Evira
Anna-Liisa Myllyniemi, Head of Research Unit, Evira
Asko Järvinen, Senior Medical Officer, Helsinki and Uusimaa Hospital District HUS
Mari Kanerva, Ward Chief, HUS
Tea Nieminen, Specialist, HUS
Jaana Syrjänen, Ward Chief, Tampere University Hospital TAYS
Reetta Huttunen, Assistant Chief, TAYS
Risto Vuento, Senior Medical Officer, Fimlab
Maija Rummukainen, Senior Medical Officer, Kuopio Region Central Hospital KSKS
Maarit Wuorela, Ward Chief, City of Turku
Jane Marttila, Senior Medical Officer, City of Turku
Tiina Kurvinen, Infection Control Nurse, Hospital District of Southwest Finland
Anu Kantele, Professor, University of Helsinki
Jaana Vuopio, Professor, University of Turku

Abbreviations, definitions and translations of the special vocabulary

AmpC	Class C beta lactamase
AMR	Antimicrobial resistance, antibiotic resistance
Avohilmo	System of treatment notifications in primary healthcare, outpatient care
Biosecurity, farms	Modes of operation to reduce the spreading of infectious animal diseases in animal production
Codex Alimentarius	International food standards, recommendations and guidelines adopted by the Codex Alimentarius Commission founded by FAO and WHO in 1963.
Colonisation	The microbe settles and grows in the normal microbial flora (e.g., of humans) without causing any signs and symptoms.
CPE	Carbapenemase-producing Enterobacteriaceae
EAAD	European Antibiotic Awareness Day
EARS-Net	European Antimicrobial Resistance Surveillance Network
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
ELTDK	Faculty of Veterinary Medicine
EMA	European Medicines Agency
ESAC-Net	European Surveillance of Antimicrobial Consumption Network
ESBL	Broad-spectrum beta lactamase
ESVAC	European Surveillance of Veterinary Antimicrobial Consumption
ETT	Eläinten terveys ry (Animal Health Association), with the mission including the promotion of production animal health and wellbeing by coordinating the national animal healthcare and by steering the importation of animal materials and feeds in a way to control risks of disease.
ETU	National animal healthcare operations, managed by ETT and the Finnish Food Safety Authority Evira
EU	European Union
EUCAST	European Committee on Antimicrobial Susceptibility Testing
Evira	Finnish Food Safety Authority
FAO	Food and Agriculture Organization
FiRe	Finnish Study Group for Antimicrobial Resistance
Finres	National surveillance report on antimicrobial resistance (humans)
FINRES-Vet	Finnish Veterinary Antimicrobial Resistance Surveillance and Consumption of Antimicrobial Resistance
GLASS	Global Antimicrobial Resistance Surveillance System
JPIAMR	Joint Programming Initiative on Antimicrobial Resistance
MDR-Aci	Multidrug-resistant Acinetobacter
MDR-Pseud	Multidrug-resistant Pseudomonas
MDR-TB	Multidrug-resistant Mycobacterium tuberculosis

MMM	Ministry of Agriculture and Forestry
MRSA	Methicillin resistant <i>Staphylococcus aureus</i>
MTKA	National expert group of antimicrobial resistance control
One Health	Joint health; notion combining human, animal and environmental health
OIE	World Organisation for Animal Health
OKM	Ministry of Education and Culture
OPH	Finnish National Agency for Education
Prudent use of antimicrobials	Antimicrobials are used for the treatment of infections on medical and veterinary grounds, in order to minimise their adverse effects. (See Area of operation 4).
SEP ry	Suomen Eläinlääkäripraktikot ry, Association of Finnish Practicing Veterinarians
SIRO	Hospital infection programme
STM	Ministry of Social Affairs and Health
TEKES	Finnish Funding Agency for Innovation
TEM	Ministry of Employment and the Economy
TEY ry	Association of Production Animal Veterinarians
THL	Institute for Health and Welfare
TTL	Finnish Institute of Occupational Health
TTR	Register of communicable diseases
UN	United Nations, UN
VRE	Vancomycin-resistant <i>Enterococcus</i>
WHO	World Health Organization
VNK	Prime Minister's Office
YM	Ministry of the Environment
Zoonosis	Name for infectious diseases common to humans and animals

Aim

Antimicrobials, in other words antibiotics, are among the most significant inventions in medicine. They save human lives and have made modern medicine and veterinary medicine possible. Antimicrobial resistance, meaning that the microbes become resistant to antimicrobial medicines, is a global health threat to both humans and animals. The aim of this Plan of Action is to maintain antimicrobial medicines efficacious in Finland.

Structure of the Action Plan

The control of antimicrobial resistance calls for extensive operations comprising society as a whole, taking both humans, animals, plants, foodstuffs, and the environment into consideration in line with the One Health approach. In the Plan of Action, the control of antimicrobial resistance is discussed both separately from and together with human healthcare, animals and foodstuff safety and the environment. The Action Plan comprises six operative areas that are vital to the control of antimicrobial resistance: 1. Training of professionals and education of the general public; 2. nationally coordinated One Health surveillance, including the surveillance of antimicrobial resistance and use of antimicrobials; 3. prevention of infections and control of spreading of multi-resistant bacteria; 4. guidance for the use of antimicrobials; 5. research; and 6. administrative structures. The Plan of Action describes the current situation in all areas of operation, sets objectives and records actions to achieve the objectives. The responsible parties for each action are presented. In addition, the Plan of Action will include a model for the follow-up of the implementation of the actions. Some of the proposed actions cover several areas of operations.

Background

In autumn 2016, the actions to combat antimicrobial resistance were placed on the agenda of the UN General Assembly. This is only the fourth time that a health issue has been addressed by the UN General Assembly. Antimicrobial resistance has reached such global dimensions that immediate action is required if we want to retain the efficacy of antimicrobials. When bacteria, viruses or fungi become resistant to antimicrobials, it becomes increasingly difficult to treat the infections they cause, the courses of therapy become longer and, in the worst-case scenario, infection-related mortality increases. According to estimates, about 10 million people will die in 2050 due to infections caused by antimicrobial resistant microbes unless we are able to curb the growth of antimicrobial resistance (1).

The increase in antimicrobial resistance also has remarkable financial consequences. Productivity will decrease with rising morbidity. Costs will grow due to expensive therapies and, for example, increasing needs to isolate patients. Antimicrobial resistance will also worsen animal health, lowering productivity and raising costs, and will increase the number of resistant bacteria transferring from animals and foodstuffs to humans. Antimicrobial resistance has also been included in the list of the top 20 major future risks of the World Economic Forum (2). By 2050, the cumulative costs caused by antimicrobial resistance will, according to certain estimates, amount to USD 108 billion.

Antimicrobial resistance develops when the microbes adapt and start to grow despite the presence of antimicrobials. The resistance is in direct connection to the quantity and frequency of antimicrobial use. When they end up in the environment, the antimicrobials cause the same selection of resistant microbes as takes place in humans and in animals. Therefore, the development of resistance and the spreading of resistant microbes is a concern for our entire living environment. Resistant microbes circulate in the human and animal populations through physical contact, foodstuffs, water and the environment. They do not respect any boundaries and move easily from one country to another carried by humans, animals and foodstuffs. Antimicrobial resistance is a significant cross-border health threat.

Comprehensive action is needed to control antimicrobial resistance. These actions can be classified in two categories: preventing the selection of resistant microbes on the one hand and preventing their spread on the other hand. The selection of resistant microbes is influenced by the use of antimicrobials. Reducing the overall consumption of antimicrobials and using them in a prudent manner will decrease the selection pressure and thereby the risk for the inducing resistance in microbes. The means to promote prudent use of antimicrobials include, above all, guidance and the utilisation of microbiological diagnostics. The prevention of infections, in turn, decreases the need for the use of antimicrobials. One good example is provided by the vaccination programmes which can reduce the incidence of infections of the respiratory tract, in turn resulting in a diminished need to use antimicrobials. Prudent use of antimicrobials, microbiological diagnostics and the prevention of infections through biosecurity measures, vaccinations and other measures are also key issues in veterinary medicine and animal production.

The prevention of the spreading of resistant microbes is the other cornerstone in the combat of antimicrobial resistance. This applies primarily to various healthcare facilities but it also includes the prevention of population-level colonisation. On the population level, tourism has become a significant factor in the spreading of resistant microbes. Here, the control measures are not only targeted at the prevention of infections but also and specifically at the prevention of the population-level colonisation. Public instruction and advice measures play a key role. Controlling the spread of resistant microbes also involves animals and food production.

Novel antimicrobials provide one means to solve the resistance problem. Development of medicines is vital but also extremely expensive and slow. It is of primary importance for the steering of antimicrobial use to develop real-time, easy-to-use and reliable microbiological tests that would allow for faster and improved diagnostics of infectious diseases. Finland has both traditional know-how and industry in this sector.

The surveillance of antimicrobial resistance is a way to measure the efficacy of the preventive actions and also to identify new threats. In turn, the surveillance of antimicrobial use is a way to measure the adherence to the instructions and the functioning of the antimicrobial policy. The surveillance systems provide us with comparable information on our situation compared with the rest of the world.

Assignment

The resolution n. 67.25 of World Health Assembly requires the Member State to take urgent action to control antimicrobial resistance (3). WHO has published a Plan of Action (4) and instructions for the drafting of national plans of action (5). The Global Health Security Agenda also highlights the issue of antimicrobial resistance (6). The World Organisation for Animal Health (OIE) has issued its own recommendations (7). The European Union requires the Member States to take action to control antimicrobial resistance, and the EU has prepared its own plan of action (8). These recommendations are here presented in a table in Appendix 1. In Finland, the first cross-administrative (STM and MMM) recommendation on the control of antimicrobial resistance and the development of antimicrobial policies was published in the spring of 2000 (9). The Action Plan now prepared has taken the contents of all earlier recommendations issued by various organisations into account.

Areas of operation

1. Training and education

1.1. Training of professionals

Current situation

No survey has been carried out on the training related to antimicrobial resistance in Finland. There is no specific training programme focusing on the issue but the topic is taught in the basic training of physicians, dentists, veterinarians and nurses. Antimicrobial resistance and its control are often on the agenda of various national training events organised by various parties. Moreover, it is possible to focus more profoundly on the issue in specialisation training provided in different fields. There is no national coordination of the training programmes. It is not clear how well aware the healthcare professionals and veterinarians are of the antimicrobial resistance and the actions to impact the spreading of the phenomenon. Likewise, there is no information as to how much social welfare actors and animal keepers and owners know about these issues.

Objectives

Increase the knowledge among social care and healthcare professionals, veterinarians as well as animal keepers and attendants about antimicrobial resistance, the development of the resistance as well as the actions to impact the spreading of resistance. Improve the provision of information on the resistance situation.

Actions

General

1. Include antimicrobial resistance training in professional basic studies, including training on how the use of antimicrobials can be decreased through the use of other therapies and pharmaceuticals.

Responsibility: STM, MMM, OKM, the parties and training units responsible for the competence requirements of training programmes.

2. Support for continuous training in antimicrobial resistance control provided to social care and healthcare as well as veterinary professionals and animal husbandry operators.

Responsibility: STM, MMM, OKM, the parties and training units responsible for the competence requirements of training programmes.

Healthcare and social care

1. Propose the preparation of a compulsory online course in infection control, targeted at healthcare professionals at regular intervals.

Responsibility: STM, THL and hospital districts

2. Enhance and develop the share accounted by infection control, microbiology and clinical pathology of infectious diseases in the basic, further and continuing training programmes of physicians, nurses and other healthcare professionals.

Responsibility: STM, OKM, employers, institutes of higher education and organisers of professional training

3. Develop and utilise the materials in the Duodecim Oppiortti ("Learning portal") and Terveyskirjasto ("Health Library") in the training. In particular, produce web-based training materials.

Responsibility: organisations and employers

4. Invest in the distribution of EAAD materials produced by ECDC, suitable for the situation in Finland.

Responsibility: THL and hospital districts

Animals and food safety

1. Enhance and develop the share of hygiene, microbiology and clinical pathology of infectious diseases in the basic and continuing training programmes of veterinarians and animal keepers as well as animal attendants.

Responsibility: MMM and OKM, institutes of higher education and organisers of professional training.

2. Increase training of veterinarians and other operators on the prudent use of antimicrobials and on their environmental impacts.

Responsibility: industry sector organisations involved in food production animals and fur animals, ETT, SEP, Suomen Kunnaneläinlääkäriliitto ry (Association of Finnish municipal veterinarians, Tuotantoeläinlääkäriyhdistys ry (Finnish Association for Food Animal Practitioners), Sikayrittäjät ry (Association of swine producers), ELDTK, Evira. Veterinarians caring for animals in animal husbandry operator and owner trainings.

3. Intensify provision of up-to-date information on antimicrobials to veterinarians.
 - Highlight better the issues, such as antimicrobial resistance and recommendations of use of antimicrobials, on the websites of Evira and the Zoonosis Centre.
 - To support the work, a permanent veterinary working group representing various stakeholders and focusing on antimicrobials will be established.

Responsibility: Evira

1.2 Education of the general public

Current situation

Eurobarometer surveys have repeatedly shown that the level of awareness about AMR issues is higher in Finland compared with the EU average (10). The AMR issue has been highlighted many times in Finland by the European Antibiotic Awareness Day (EAAD) organised by ECDC, and there have also been campaigns targeted at the Finnish general public. The ECDC website contains materials in the Finnish language. All actors of the sector have had very scarce resources for educating the general public and therefore no extensive visibility has been attained so far. Globally, there is AMR-related information material targeted at the general public as well as teaching materials for students of schools but very little of this material has been translated into Finnish. A good example is the British eBug project

(11). The health guide for tourists includes travelling-related health information, including knowledge about antimicrobial resistance.

Objectives

The objective is to increase the public awareness of antimicrobial resistance and the factors impacting its increased prevalence as well as of the adverse effects of antimicrobials and the correct use of medicines in both human and animal healthcare. Attention is paid to those factors which individuals can affect, and thus contribute to reducing their risk of becoming exposed to resistant bacteria in their everyday life. Many studies show that tourists travelling to developing countries, where antimicrobials are used in abundance, clearly risk being colonised by resistant bacteria. Carried by the tourists, the resistant bacteria spread all over the globe and also arrive in Finland. The educational material targeted at the public must pay attention to tourism as a factor that spreads resistance as well as to the actions that individual tourists can take to reduce the risk of colonisation. Vaccinations play a particular and significant role in combatting antimicrobial resistance. The public awareness of the importance of vaccinations for the prevention of infections as well as for the reduction of antimicrobial use, and thereby also for the control of antimicrobial resistance, must be increased.

Actions

1. Considerably increase public education on the significance of tourism in the spreading of antimicrobial resistance.

Responsibility: STM and THL

2. Propose more efficient utilisation of EAAD materials produced by ECDC for the education of the public. This applies particularly to the utilisation of materials related to infections, vaccinations and use of antimicrobials.

Responsibility: STM, institutes of higher education, Evira, THL, municipalities and hospital districts.

3. Produce materials, for example, for health education teaching at school, e.g. by translating the British e-Bug project material into Finnish. Investigate the opportunity for cooperation with Kustannus OY Duodecim Koulujen terveyskirjasto (School health library at Duodecim medical editors).

Responsibility: STM, THL and institutes of higher education

Animals and food safety

1. Intensify education on antimicrobial use targeted at owners of companion animals and horses, including the environmental impacts of antimicrobials.

Responsibility: Evira, ELTDK, SEP ry, veterinarians caring for animals in animal keeper and owner trainings.

2. Produce materials for consumers on the use of antimicrobials for the treatment of diseases in production and other animals as well as on the resistance risks associated with stuffs.

Responsibility: respective industry and Evira

2. Nationally coordinated One Health surveillance

2.1 Surveillance of antimicrobial resistance

Current situation

The surveillance of antimicrobial resistance produces comparable information on the trend in the resistance situation, also measuring the efficacy of the control measures. The surveillance also plays a role in the guidance related to antimicrobial use. Resistant bacteria are spreading with unprecedented ease in the wake of increasing globalisation. The rapid identification of the bacteria that are extremely resistant to antimicrobials is vital for the launching of any control measures. In Finland, the identification of individual infections and outbreaks caused by resistant microbes in humans is mainly the responsibility of clinical laboratories and infection teams but the outbreak investigations often also require typing data produced by reference laboratories. There is a need for this both in medicine and in veterinary medicine. The Finnish reference laboratory functions are concentrated at THL and Evira. No environmental antimicrobial resistance surveillance takes place in Finland.

As a main rule, the national reporting on the antimicrobial resistance is in place and operational. The Finnish resistance trend is well illustrated by the Finres, Tartuntataudit Suomessa (Infectious Diseases in Finland) and FINRES-Vet reports, with the latter being published every three years. Moreover, the resistance surveillance data on bacteria isolated from animals and foodstuffs is published in zoonosis reports. There is no nationwide joint report on AMR issues.

Healthcare and social care

The amended Communicable Diseases Act (12) obliges each director of a healthcare and social care unit to monitor the incidence of microbes that are very resistant to antimicrobials. Moreover, the Act obliges laboratories engaged in microbiological diagnostics to

report the results of susceptibility testing to THL (12). The obligations under the Communicable Diseases Act cover both public and private operators.

In Finland, the surveillance of antimicrobial resistance takes place both at the local and the national level. The national surveillance of resistance is based on several sub-areas. The Finres database is produced by FiRe which is a network of clinical microbiology laboratories that has been in operation since 1992. As early as 1997, it started to systematically and comprehensively collect susceptibility testing data on the major bacteria. As from 2008, the data has been stored in the Finres database maintained by TTR. The data collected on cases of multiresistant bacteria (CPE, ESBL, MRSA, VRE, MDR-TB), often completed with the typing data produced by the reference laboratory, is also entered in the TTR, which has been in operation since 1995. Both Finres and TTR are case-based, and their information is forwarded to the surveillance networks such as EARS-Net (13). The hospital infection programme SIRO has been collecting information on the healthcare-associated infections occurring in Finnish hospitals since 1999. The programme also collects data on the antimicrobial susceptibility of the causative pathogens.

Finland is a member of the ECDC surveillance network (EARS-Net), which has a long tradition of focusing on the resistance of certain bacteria isolated from severe systemic infections. The resistance surveillance by ECDC is based on the Decision No 1082/2013/EU of the European Parliament and of the Council with regard to the template for providing the information on preparedness and response planning in relation to serious cross-border threats to health (14). Finland is also participating in Global Antimicrobial Resistance Surveillance System (GLASS) under the auspices of WHO, launched in 2016 (15).

As a collaboration of THL and clinical laboratories, national diagnostic guidelines focusing on multiresistant bacteria have been produced for clinical laboratories (16). The document is comprehensive and still updated but its implementation has not been followed-up. The guidelines related to the national laboratory diagnostics are important tools which can be used to ensure the use of correct and sufficiently coherent diagnostics in all parts of Finland. The Finres and TTR surveillance procedures are based on the information produced by clinical laboratories. Finnish laboratories comply with the pan-European EUCAST standard for their susceptibility testing (19). More resources are required for the follow-up of any amendments of the EUCAST standard and its implementation.

Animals and food safety

The systematic resistance surveillance related to salmonellosis strains isolated from animals and foodstuffs started in the 1980s in Finland. The comprehensive FINRES-Vet programme that focuses on the surveillance of the resistance of zoonosis and indicator bacteria isolated from the most important production animal species started in 2002. More-

over, we follow the resistance situation of certain major animal pathogens and screen ESBL-producing bacteria from the most important production animals and their meat. The incidence of MRSA has been screened in swine and pork meat. The surveillance data is produced by Evira and by the University of Helsinki, Faculty of Veterinary Medicine as far as pets and horses are concerned. The legislation obliges approved laboratories to provide Evira with ESBL and MRSA bacterial strains for further testing.

EFSA plays a central role in the design and steering of the resistance surveillance in the food chain as well as in the collection of EU-wide materials, analysis and publication of the respective results and risk assessments. The work by EFSA supports the preparatory work related to EU legislation. The European Commission's 5-year Plan of Action against the threats of antimicrobial resistance also envisages the development of resistance surveillance programmes (18).

According to the Directive 2003/99/EC (19), Finland sends resistance data related to the bacteria isolated from animals and foodstuffs to the EFSA zoonosis data collection system. In the EU, the harmonised part is based on the Commission's transposition decision 2013/652/EU (20). Therefore, Finland not only has its national objectives but also international obligations to monitor antimicrobial resistance. In line with the Directive 2003/99/EC (19), EFSA and ECDC compile an annual summary report on the outcomes of the EU-wide resistance surveillance related to humans and the food chain.

Objectives

The aim is to cater for local, national and international needs in the Finnish AMR surveillance. The ability to investigate microbial outbreaks must be retained. The requirements of the new Communicable Diseases Act regarding the surveillance of very resistant microbes must be taken into consideration. Moreover, we must also be able to react to unpredicted new future threats. The resistance surveillance focusing on bacteria isolated from animals and foodstuffs must remain at least at the current level while enhancing the surveillance related to pathogenic bacteria. The information on the resistance situation of microbes isolated from humans and animals and the respective trends must be easily accessible and comparable, especially as concerns zoonotic pathogens. The information on the national resistance situation will be communicated on an increasingly real-time basis to the public and the professionals.

Actions

Joint actions

The up-to-date information on resistance must be made available of the social and health-care professionals as well as veterinary professionals and decision-makers by developing

the local, regional and national reporting systems. This will be possible with a common data portal, for example. Moreover, attention must be paid to the usability of the information by linking the resistance data of TTR and Finres with the Duodecim Terveystietä health portal in an easily usable form. The possibilities to implement this must be discussed with Duodecim.

Responsibility: STM, MMM

Healthcare and social care

1. Develop a real-time notification and reporting system of extremely resistant antimicrobial bacteria to support the exchange of information at the local, regional and national levels with the aim of enhancing appropriate control measures.

Responsibility: THL

2. Develop the collection of susceptibility testing data (Finres/TTR) so that such data produced by clinical laboratories can be combined with the typing data produced by the reference laboratories and the data collected in TTR.

Responsibility: THL

3. Improve the collecting of resistance data on both the producer and collecting sides (for example, the XML definition from the Finres database) so that all laboratories can easily transfer their data.

Responsibility: THL

4. Enhance the capacity of clinical laboratories to adopt and maintain international standards (promotion of the EUCAST standard).

Responsibility: THL

5. Influence the objectives related to AMR surveillance issued by ECDC and the respective implementation. It is of extreme importance and urgency that we promote the creation and introduction of common European standards for the surveillance of resistant bacteria, especially as concerns modern molecular microbiological methods.

Responsibility: STM

6. Propose, in view of more efficient surveillance and steering of antimicrobial use, that an expert group be established (if it does not already exist) in hospitals to follow and control AMR and steer the use of antimicrobials. The hospital management will set up the group that reports back to the management. The hospital will decide on the composition of the group but as the management's commitment is important it should therefore be represented in the group. The group will analyse the antimicrobial consumption figures and indications of use at regular intervals, giving feedback to those who have prescribed the antimicrobials.

Responsibilities: municipalities and hospital districts

7. Develop the surveillance of AMR related to viruses and fungi.

Responsibility: THL, FiRe laboratories

Animals and food safety

1. Increase the efficiency of FINRES-Vet surveillance and utilisation of materials.
 - Enhance the surveillance of resistance related to animal pathogens for all species
 - Produce targeted information on the resistance situation to veterinarians and animal owners (animal pathogens, indicators, MRSA situation).
 - Produce information targeted at consumers on the resistance in foodstuffs of domestic and foreign origin
 - Increase a more analytic reporting of materials produced through the programme (publication of trend data)

Responsibility: Evira

2. Promote the use of reliable and rapid laboratory diagnostics and susceptibility testing to support animal pharmacotherapies.
 - Provide guidance to commercial veterinary laboratories on the principles and quality requirements for antimicrobial susceptibility testing

Responsibility: Evira

- Remind veterinarians of the importance of sampling and the reliable testing of antimicrobial susceptibility of animal pathogens since the resistance data directs the use of medicines

Responsibility: Evira and ELTDK

3. Continue the surveillance of zoonotic, pathogen and indicator bacteria resistance following the EU legislation and national decisions.

- The FINRES-Vet programme is updated annually, assessing its sufficiency, coverage and materialisation taking international and national findings, research outcomes and risks into account

Responsibility: Evira

- Extend coverage of monitoring of foodstuffs of foreign origin

Responsibility: Evira

- For poultry, implement the ESBL/AmpC/carbapenemase producer monitoring based on the ETT importation instructions

Responsibility: ETT, respective industry and Evira

- Implement the resistance monitoring related to the E. coli strains (APEC) in poultry

Responsibility: Evira, the samples for testing delivered by the respective industry

2.2 Surveillance of antimicrobial use

Current situation

Healthcare and social care

Finnish Medicines Agency Fimea produces statistics on the overall use of antimicrobials in Finland whereas the national insurance institution Kela has the opportunity to compile statistics on the reimbursable prescription-only medicines of humans. The antimicrobial committees and hygiene working groups instituted in certain hospitals have monitored the consumption of antimicrobials. Use information can also be retrieved from the hospital pharmacy systems and patient information systems. All Finnish university and central hospitals have a commercial surveillance system of antibiotics and infections which makes it possible to monitor their antimicrobial use. The information of antimicrobials use in outpatient care can also be retrieved from the primary healthcare outpatient treatment information system Avohilmo.

ESAC-Net is a European monitoring network (21) that has been collecting antimicrobial use data since 1997. THL has forwarded the materials received from Fimea to the network

since the beginning of its operation. The fact that the Fimea statistics cannot separate the information on antimicrobial use by acute hospitals and long-term care facilities has been a problem in these materials. Since 2011, Finland has conducted prevalence studies comprising all EU Member States on healthcare-associated infections and antimicrobial use in hospitals (22). SIRO coordinates these studies made in Finland, cooperating with ECDC.

Currently, there is no reliable understanding of how the Finnish hospital antimicrobial use has been developing in comparison with other European countries since the Fimea statistics do not allow for the separation of the antimicrobial use data in acute hospitals and long-term care facilities. Based on the prevalence studies, Finnish hospitals use more antimicrobials than the hospitals in other Nordic countries. Moreover, the production and utilisation of the antimicrobial use data retrievable from hospital pharmacy systems and patient data systems has not been systematic. In order to have comparable surveillance data, developing various statistics and information systems is of primary importance.

Based on the ESAC-Net statistics (21), cephalosporins are in clearly more frequent use in Finnish outpatient care, compared with Sweden and Denmark, for example, and correspondingly the use of narrow-spectrum penicillins is far less frequent here than it is in the above countries. In fact, Finland ranks first in all Europe (all countries included in ESAC-Net) in the use of first-generation cephalosporins. However, the hospital districts differ markedly regarding their overall consumption of outpatient antimicrobials (23).

Animals and food safety

Fimea monitors the quantity of antimicrobials used on animals on the basis of sales statistics provided by the pharmaceutical wholesalers. The consumption has been monitored since 1995 on the basis of weight unit reporting (kg of the active ingredient) by pharmaceutical group. The current surveillance system does not cover the usage of human antimicrobials to companion animals. In proportion to the estimated number of companion animals, the sales numbers of tablet products approved for companion animals are higher in Finland than in the other Nordic countries.

Finland has been involved in the project for the European Surveillance of Veterinary Antimicrobial Consumption (ESVAC) since the beginning. The project takes the numbers of production animals into account. The sales of antimicrobials in proportion to the numbers of production animals have gone down in the 2010s while certain pharmaceutical groups show growth. The sales statistics do not provide information on the distribution of the use by animal species and therefore the reasons for the change are difficult to estimate. However, it is known that the intensive mode of beef production, for example, has increased the need for antimicrobial treatments.

Objectives

The objective is to improve the surveillance and statistics of antimicrobial use in Finland, taking local, regional, national and international needs into account. In the monitoring of human medicines this means that the problems affecting Fimea's statistics need to be rectified. Moreover, the information systems must be developed, particularly as concerns the local-level surveillance. The information on antimicrobial use must be easily accessible in an updated form from each hospital by speciality and from the outpatient care from the healthcare centre inpatient wards. This information must be placed in proportion with the scale of the operations and be given as feedback to the relevant operators. Information comprising the whole of Finland must also be produced in order to gain data for comparisons.

As concerns veterinary antimicrobials, we need a system to compile information on the use of the antimicrobials per animal species. Such information is needed in order to be able to recognise the heavy users of antimicrobials and to target instructions, advice and training measures at them.

Actions

Healthcare and social care

General actions

1. Fimea's statistics and IT systems on antimicrobial use must be developed to allow for an itemised analysis of antimicrobial consumption data of hospitals and long-term care facilities. Moreover, the reporting tools must be developed so that the compiled information can be utilised for local, national and international needs related to antimicrobial use.

Responsibility: STM and Fimea

Hospitals

1. In view of more efficient surveillance and steering of antimicrobial use, it is proposed that an expert group be established (if it does not already exist) in hospitals to follow and control AMR and steer the use of antimicrobials. The hospital management will establish a group that reports back to the management. The hospital will decide on the composition of the group, but as the management's commitment is important, it should also be represented in the group. The group will analyse the antimicrobial consumption figures and indications of use at regular intervals giving feedback to those who have prescribed the pharmaceuticals.

Responsibility: municipalities and hospital districts

2. The surveillance of local use is improved by developing information systems. Local surveillance is based, on the one hand, on the data of antimicrobial deliveries from hospital pharmacies and, on the other, on the information about antimicrobial use and indications retrievable from patient information systems. Both surveillance systems must be developed and the existing systems put to more efficient use.

Responsibility: municipalities, hospital districts, THL and Fimea

3. Ensure Finland's participation in the prevalence studies conducted in EU Member States.

Responsibility: STM, THL and hospital districts

Outpatient care

1. Fimea will investigate the possibilities of use of the electronic prescription database as a tool for more detailed antimicrobial consumption follow-up, also regarding the prescriptions that do not entitle the patient to reimbursements. The objective is to use the data of the dispensed electronic prescriptions as a tool for more detailed surveillance of the consumption of antimicrobial. This will allow access to user numbers categorised by gender and age groups.

Responsibility: Fimea

2. Investigate the possibilities of utilising the data on Avohilmo system.

Responsibility: STM and THL

3. Investigate how the Kela statistics on reimbursable prescription-only medicines could be used in the surveillance of antimicrobial use in outpatient care.

Responsibility: STM and Kela

Animals and food safety

1. Construct an information system to collect user data on antimicrobials covering all animal species.
 - The information system will allow the veterinarians and farms to benchmark their own level of usage, based on the collected use data. The information will also be

used for surveillance and for identifying the objects of possible surveys of antimicrobial resistance.

- The IT system would also allow the surveillance of separately chosen antimicrobial groups:
 - For all animal species, use of antimicrobials that are critically important (fluoroquinolones, macrolides and third and fourth generation cephalosporins)
 - Use of antimicrobials on companion animals

Responsibility: MMM, Evira

2. Provide the authorities with access to the national compilation data (quantities, active ingredients, indication) on poultry antimicrobial medication through ETT. Develop the capability to provide the corresponding national compilation data on swine (Sikava) and on cattle (Naseva).

Responsibility: ETT and the respective industry sectors

3. Preventing infections and controlling the spread of multidrug-resistant bacteria

3.1. Preventing infections

Current situation

In the WHO's Action Plan on Antimicrobial Resistance, the prevention of infections plays a major role for the combat against antimicrobial resistance (4). Improved hygiene and vaccinations are the most important measures on the global scale. In Finland, the prevention of infections can be a tool to decrease the use of antimicrobials. For example, the use of pneumococcus vaccines has diminished the incidence of serious infections caused by pneumococcus but also reduced antimicrobial resistance and the use of antimicrobials in certain age groups. Correspondingly, the influenza vaccine can be used to prevent not only the actual influenza infection but also bacterial secondary diseases, such as infections of the respiratory tract caused by pneumococcus. Among the tourist vaccines, the typhoid vaccine protects against the resistant *Salmonella typhi* bacteria that have become more common over the past few years. Besides outpatient care, the prevention of infections also applies to healthcare facilities. Hospitals have local and regional instructions of infection prevention. Various measures and practices of infection prevention have been compiled in a Finnish-language book that will be updated during 2017 and published online.

For several decades, Finland has aimed in reducing the need for antimicrobial medication in animals by eradicating animal diseases as well as by carrying out efficient herd health work by the industries themselves. Good animal production and living conditions together with herd health measures constitute the primary ways to prevent infectious diseases. However, this is not enough. The breeding animals as well as companion animals imported from abroad introduce resistant microbes in Finland, including ESBL strains. Companion animals also carry multidrug-resistant bacteria. They can also be transferred to the humans in contact with the animals. In turn, human pathogens can transfer to animals and from them back to humans (e.g., MRSA).

Objectives

The objective is the prevention of infections to reduce the overall need to use antimicrobials. Another objective is to keep the risks caused by the travelling of humans and animals as well as by the importation of animals and foodstuffs to the disease and resistance situation at a reasonable level. Moreover, efficient herd health measures will prevent the spread of pathogens and resistant microbes in the Finnish animal population, improve animal health and diminish the need for medication.

Actions

Healthcare and social care

1. Prepare national recommendations for infection prevention at hospitals and long-term care facilities.

Responsibility: STM, municipalities, THL and hospital districts

2. Create a web portal for all healthcare professionals, which contains links to the infection prevention instructions of various hospital districts and to the textbook called *Hoiton liittyvien infektion torjunta* (Combat of healthcare-associated infections).

Responsibility: THL and hospital districts

3. Develop the surveillance system of the burden of infectious diseases.

Responsibility: THL and hospital districts

Animals and food safety

1. The food industry implements - as instructed by ETT and exceeding the statutory requirements - quarantine and examination practices for the importation of all production animal materials to prevent the entry into Finland of predisposing viral infections and difficult-to-manage bacterial infections.

Responsibility: relevant industries, animal importers and ETT

2. The production structure of production animals will be retained so that the animal welfare and health can be maintained, reducing the use of antimicrobials.

Responsibility: the industry in question, producers and ETT

3. Prepare a biosecurity plan for all production animal farms to prevent the spread of infectious diseases.
 - Biocheck will be introduced for the evaluation of both the farm's internal and external biosecurity. The farm will identify the items, which it must focus on in its operations.

Responsibility: the industry, ETT, production chain and veterinarians responsible for the herd health of the farms

4. Intensify measures to ensure the availability of medicines in the Finnish market.
 - Ensuring the availability of vaccines necessary for the prevention of diseases
 - Ensuring the availability of narrow-spectrum antimicrobials such as penicillin, in particular, as well as other old antimicrobials.
 - The production animal industry, veterinarians and Evira's expert groups for different animal species will highlight the problems

Responsibility: MMM, STM, Evira, Fimea and pharmaceutical branch operators

5. In target programmes focusing on canine breeding, a clearly negative stand will be taken on the use of atopic and allergic dogs in breeding. Likewise, anatomic features making dogs susceptible for infectious diseases, such as excessive folding of the skin, will be eradicated in breeding, also through the training and instruction of judges in dog shows.

Responsibility: The Finnish Kennel Club and breed associations

6. In fur animal production, the health and welfare of animals will be maintained in order to be able to reduce the use of antimicrobials.

Responsibility: Fur industry

3.2. Combat of multidrug-resistant bacteria

Current situation

Healthcare and social care

Multidrug-resistant bacteria (CPE, ESBL, MRSA, VRE, MDR-TB, MDR-Pseud, MDR-Aci) constitute a severe problem globally. Research has shown that in developing countries, the colonisation of populations by multidrug-resistant bacteria, such as the ESBL-producing *E. coli* strains are very common. Every year, about 350,000 people travel from Finland to such

countries, and about one third of these tourists becomes colonised by multidrug-resistant bacteria during their trip (24). We have very limited possibilities to impact the global spreading of multidrug-resistant microbes. Therefore, the focus of prevention must be on the control of the resistance carried to the country and in the prevention of local spreading. It is mostly a question of patients with no symptoms carrying the bacteria, and more rarely of infections with clinical symptoms.

The combat of multidrug-resistant bacteria in healthcare facilities includes screening for the bacteria and prevention of their spreading. There are national guidelines of prevention (25), which are used by the hospital district to produce their regional instructions. Likewise, there are national guidelines of laboratory diagnostics (16), based on the recommendation of the EUCAST expert working group. THL, especially its reference laboratory, plays a central proactive, instructive and converging role in the combat against the spreading of multidrug-resistant bacteria. The registers maintained by THL, on the one hand, and the classification of bacterial strains by the THL laboratories, on the other, play a key role in the surveillance of multidrug-resistant bacteria. Typing data is also needed to support the investigation of local outbreaks.

Multidrug-resistant bacteria are carried to Finland by tourists and patients discharged from foreign healthcare facilities. For example, according to THL statistics in 70% of the CPE findings, the patient had a preceding foreign contact. The educational material targeted at the public must deal with tourism as a factor that spreads resistance as well as to the actions that individual tourists can take to reduce the risk of colonisation.

Animals and food safety

Finland has issued national objectives related to the salmonellosis in poultry, swine and cattle. However, there are no corresponding objectives issued in relation to the incidence of multidrug-resistant bacteria. For example, the grandparent and preceding generations of poultry carry ESBL bacteria to Finland. Likewise, there are MRSA bacteria in swine.

The means to prevent the spreading of multidrug-resistant bacteria in animals are largely the same as for infection prevention. The relevant industry is introducing the assessments of disease protection for swine farms. The hygiene measures of veterinary clinics and hospitals, can prevent the spread of resistant bacteria. However, there are no national guidelines for this.

Objectives

The objective is to prevent the outbreaks caused by the multidrug-resistant bacteria (the most important among them being CPE and MRSA) in healthcare facilities. Another ob-

jective is to try to identify means to combat resistance carried across borders. National objectives will be set regarding the incidence of the major multidrug-resistant bacteria in animals, and the control measures will be agreed upon.

Actions

Healthcare and social care

1. Develop a real-time notification and reporting system focusing on extremely antimicrobial-resistant bacteria to support the exchange of information at the local, regional and national levels and to ensure appropriate control measures.

Responsibility: STM and THL

2. Ensure the operating conditions of THL in the AMR surveillance and outbreak investigations by allocating sufficient funding.

Responsibilities: STM and THL

3. Ensure that the national and local recommendations for control multidrug-resistant bacteria are current and updated and that healthcare staff receive training.

Responsibility: STM, municipalities, hospital districts and THL

4. Increase tourist information regarding the role of tourism in the spreading of multidrug-resistant microbes. In addition to informing, the education must focus on the ways the tourists can decrease the risk of colonisation during their travels.

Responsibility: STM and THL

Animals and food safety

1. Produce guidelines on the prevention of infections caused by work-related resistant bacteria of animal origin and draft joint operational principles for health and environmental health professionals to investigate and control the occurrence of human diseases caused by resistant bacteria of animal origin.

Responsibility: TTL, THL and Evira

- Set national objectives for the control measures focusing on major pathogens:
- Set the appropriate level of protection (ALOP) for the incidence of zoonotic pathogens (such as LA-MRSA, ESBL) and resistant microbes in production animals and foodstuffs
- Agree on national control measures

Responsibility: MMM, STM, THL and Evira

2. Enhance the competence in infection control at animal health clinics and hospitals, and provide them with information on good practices.

Responsibility: Evira, ELTDK and veterinarians in charge of the disease controls at the clinics and animal hospitals

4. Guidelines on antimicrobial use for professionals

Current situation

Healthcare and social care

The use of antimicrobials is a major resistance-increasing factor. The actions proposed by international communities recommend curbing the excessive use of antibiotics. In the western world, the three most common reasons for unnecessary antibiotics use include viral infections of the upper respiratory tract, symptomless bacterial growth in urine (bacteriuria) and tourist diarrhoea.

According to the information gathered by the ESAC-Net network, the Finnish use of antimicrobials exceeds the Swedish, Norwegian and Danish levels (20), although the difference compared with Norway and Denmark is small. Most of the antimicrobials are used in outpatient care, accounting for about 87% of the whole consumption in 2015. Throughout the 2000s, the overall use of antimicrobials has decreased in Finland. However, there are major qualitative differences in the use of antimicrobials. In Finnish outpatient care, the use of cephalosporins is clearly more frequent than, e.g., in Sweden or Denmark, while narrow-spectrum penicillins are used more rarely. In fact, Finland ranks first in all of Europe (all countries included in ESAC-Net) in the use of first-generation cephalosporins.

The use of antimicrobials has been the object of national steering since the 1990s, with the Current Care Guidelines coordinated by the medical society Duodecim since 1999. The Current Care Guidelines have become an important healthcare tool (Table 2). There are national-level guidelines for acute and intensive care therapies, which also include instructions on antimicrobial use. In addition to these recommendations, almost all hospitals have their own antimicrobial guidelines and instructions. However, there is no general-level national recommendation on the use of antimicrobials in outpatient care. The European Council issued its recommendation on antimicrobial use as early as 2001 (26). Moreover, the Commission collaborated with ECDC to publish new general guidelines on the use of antimicrobials (27). Finland does not have a corresponding national recommendation on the use of antimicrobial therapies.

Table 2.

Current care guidelines	Published/latest update
Diabetes-related foot problems	29 June 2009
Antimicrobials in acute dentistry	27 May 2011
Bacterial skin infections	8 November 2010
Pharyngitis	12 March 2013
Sepsis	2 January 2014
Fungal infections of the skin, hair and nails	12 March 2010
Sinusitis	10 June 2013
STD	30 June 2010
Acute otitis media	11 January 2010
Lower respiratory tract infections in adults	2 January 2015
Lower respiratory tract infections in children	26 June 2015
Urinary tract infections	4 December 2015

Animals and food safety

The control of antimicrobial use in animals through legislation and recommendations has existed for long time in Finland. As early as in 1996, the Ministry of Agriculture and Forestry issued the first examples of antimicrobial use for the major infectious and contagious diseases affecting animals in Finland. Since then, they have been updated three times in the form of recommendations of use. The changes in animal morbidity, treatment conceptions and pharmaceutical selections have been taken into account in the updated recommendations (28). The industry itself has detailed instructions for the prevention and treatment of the major diseases but more are needed. All in all, the measures promoting prudent use of antimicrobials have focused on production animals.

Objectives

The objective is the prudent use of antimicrobials, in other words, to use antimicrobials for the treatment of infections on medical grounds in humans and veterinary medicinal grounds in animals. If necessary, samples are taken to analyse the antimicrobial susceptibility of the pathogen using reliable methods. The medication chosen is an optimally efficient option that targets the cause of the infection with optimal precision. Antimicrobials are disposed of in an appropriate manner. Infections are treated with therapies and medicines other than antimicrobials whenever possible. Moreover, measures are taken to prevent infections. Humans and animal owners are educated in antimicrobial use and AMR. The objective is to reduce AMR and the adverse impacts caused by the antimicrobials to human and animal patients, the population at large and the environment.

Healthcare and social care

The objective is to reduce the overall consumption of antimicrobials in hospitals, long-term care facilities and in outpatient care to the common Nordic level. At the same time, the objective is to replace the broad-spectrum antimicrobials, as applicable, by narrow-spectrum antimicrobials.

Animals and food safety

The objective is that the overall use of animal antimicrobials will not increase and the use of critically important antimicrobials will decrease, in production animals the antimicrobial use will not increase and the use of narrow-spectrum antimicrobials will remain at the current level. Moreover, the objective is to reduce the use of antimicrobials in companion animals.

Actions

Healthcare and social care

1. Prepare a national antimicrobial manual for outpatient healthcare to cover the antibiotics choices, dosage and duration of the treatment of usual infections treated in outpatient care.

Responsibility: STM

2. Continue the updating of existing Current care guidelines, taking the medication use objectives stated above into account (choice of antibiotics and duration of therapies). New recommendations are also needed, such as the Vältä viisaasti (Avoid rationally) recommendations and the national antimicrobial prophylaxis instructions for surgical fields.

Responsibility: STM

3. In view of more efficient surveillance and steering of antimicrobial use, it is proposed that an expert group be established (if it does not already exist) in hospitals to follow and control AMR and steer the use of antimicrobials. The hospital management will set up the group that reports back to the management. The hospital will decide on the composition of the group, but as the management's commitment to the issue is important, it should also be represented in the group. The group will analyse the antimicrobial consumption figures and indications of use at regular intervals giving feedback to those who have prescribed the pharmaceuticals.

Responsibilities: municipalities and hospital districts

4. Propose that all hospitals should have their own recommendations for the use of antimicrobials in infections.

Responsibility: municipalities and hospital districts

Animals and food safety

1. Set national objectives for the volume of antimicrobial use in animals
 - For all animal species, use of antimicrobials that are critically important (fluoroquinolones, macrolides and third and fourth generation cephalosporins)
 - Decrease in use of antimicrobials on companion animals, with a volume objective set for the decrease

Responsibility: MMM, Evira

2. The respective industry will consider the setting of its own objectives in order to limit the use of critically important antimicrobials in production animals.

Responsibility: industry and ETT

3. Recognise animal groups with a higher use of antimicrobials compared with other groups, and take measures to reduce the need to use them.

Responsibility: industry, ETT, veterinarians and animal health authorities

4. Update the recommendations of use of animal antimicrobials at regular intervals, and publish the recommendations in the form of a mobile application.

Responsibility: Operative responsibility Evira, expertise ELTDK, ETT, SEP, TEY and other experts in veterinary medicine

5. Instructions with significant impact on the decrease in the use of antimicrobials and zinc oxide.

- Update the piglet weaning guidelines, with respective training

Responsibility: MMM, ETT, industry, feed industry, advisory parties, slaughterhouses, structural planning experts, Evira and other expert parties

- Poultry medication guidelines and operating instructions for poultry farms in view of botulism

Responsibility: ETU poultry groups

6. Highlight the aspects of prudent use of antimicrobials actively in marketing authorisation procedures.

Responsibility: Fimea

5. Research

Current situation

During the years 2011–2016, the government funding allocated to the research in healthcare has decreased more than in any other discipline. According to TEM, the healthcare research funding in 2016 was only 37% of what it used to be in 2011. A small speciality such as the research in AMR has not been able to obtain the necessary funding from the national research financing parties. Through the Academy of Finland, Finland has been a member of the EU-wide Joint Programming Initiative on Antimicrobial Resistance, JPIAMR since the launching of its planning stage in 2008. To date, the Academy of Finland and Tekes have not participated, as far as financing is concerned, in the JPIAMR funding application rounds and therefore the Finnish researchers have not qualified as applicants. There have not been any rounds of national funding applications focusing specifically on AMR. During the past decades, the Finnish AMR research has been well represented in the international fora. Since Finland cannot combat AMR on its own, the importance of international contacts should be particularly emphasised in the future.

The research on AMR has been carried out not only by the universities and university hospitals but also by THL and Evira. The government austerity measures have clearly reduced the proportion of research in THL's operations, with the activities concentrated merely on the tasks imposed by the Infectious Disease Act, such as the AMR surveillance and outbreak investigations. The focus of research operations has shifted increasingly to the universities and university hospitals. However, THL still compiles and maintains a sizeable collection of microbial strains and extensive population-level materials that can be used for research purposes. Individual research projects have focused on the environmental issues related to AMR.

The diagnostics industry has a long tradition in Finland. This also applies to microbiological diagnostics. Moreover, there are new Finland-based business operations focusing on diagnostics. There have also been several joint research projects in Finland carried out in partnership by universities and businesses and some of them have at least partially been related to AMR and microbiological diagnostics. Diagnostic development requires persistent collaboration by several sectors, including combinations such as research institutes,

industry and clinics, and laboratories and clinics. As enablers of this collaboration, the measures taken by public funding sources play a central role: Finland would have good potential to create a well-functioning innovation ecosystem in the diagnostic sector by supporting the existing programmes and making new strategic openings. WHO has declared that the combat against AMR is a global priority. It is probable that these significant and comprehensive objectives will generate future opportunities to develop commercial products, especially in the field of microbial diagnostics. In particular, rapid and reliable point-of-care diagnostics will be in demand in connection with the objective of reducing the use of antimicrobials.

JPIAMR performed a survey on the public research funding allocated to AMR in 2007–2013 in 19 different countries. In Finland, the survey only focused on the research funding by the Academy of Finland and the EU. According to plan, the survey will be repeated in 2017.

Objectives

The research on AMR and infectious diseases is the most efficient way to ensure the Finnish expertise in the field. It is vital to conduct basic research in AMR to understand the various factors of resistance origination and mechanisms. There will be no applied science unless there is preceding basic research. State-of-the-art research also provides international visibility which is vital for making international contacts. The primary objective is to get the significant Finnish research funding parties, such as the Academy of Finland and Tekes, to allocate resources to the research in AMR and infectious diseases in Finland, thereby promoting the wellbeing of Finnish people. In addition to ensuring the research funding to sectorial research institutes or universities, the development of the Finnish diagnostic industry must also be supported to enable it to respond to the current and future needs. The networking of various actors must be enhanced significantly. To be able to assess the need for any further measures, it is necessary to have basic information on the presence and impacts of antimicrobials in the environment as well as on the incidence and spread of AMR through the environment.

Actions

1. Map the activities of the research groups operating in this sector in Finland, supporting the networking of the research and other actors both in Finland and internationally.

Responsibility: OKM, universities and research institutes

2. Propose a basic research programme to be instituted by the Academy of Finland, with special focus on AMR and other infectious disease research as well as on related environmental issues.

Responsibility: universities and research institutes

3. Propose applied R&D projects to Tekes, focusing on AMR diagnostics and, more extensively, on infectious disease diagnostics.

Responsibility: universities, research institutes and the diagnostics industry

4. Propose the combat of AMR as one of the strategic areas of the research funding allocated by the VNK.

Responsibility: STM

5. Ensure the continued future funding of local research operations (university hospitals, central hospitals).

Responsibility: municipalities, hospital districts, STM and OKM

6. Promote and support the research on AMR and infectious diseases in the veterinary science, focusing on the MAKERA priorities: disease combat, disease protection and production methods; development of rapid and reliable diagnostic tests; measures to promote prudent use of antimicrobials; combatting resistance and its incidence in animals and foodstuffs; as well as the research in resistance mechanisms.

Responsibility: MMM, universities and research institutes

6. Administrative structures

Current situation

The central ministries for the combat of AMR are the Ministry of Social Affairs and Health STM, the Ministry of Agriculture and Forestry MMM, the Ministry of the Environment YM and the Ministry of Education and Culture OKM. The Ministries and the agencies and research institutes under their umbrella, the institutes of higher education and organisers of vocational education as well as labour market organisations and other actors all collaborate to ensure that the One Health approach is followed in the combat of AMR. The respective legislation is listed in Appendix 2.

The STM is responsible for the legislation on the prevention of infectious diseases, general planning, steering and surveillance, including the combat against AMR. The objective is to prevent infectious diseases and their proliferation. The preventive work takes place primarily within the social care and healthcare system, with the expert support provided by THL. Enacted in March 2017, the new Communicable Diseases Act attributed the responsibility for combat of AMR not only to the healthcare operative units but also to the social care units which collaborate with the regional infection experts. STM is also responsible for the legislation on the protection of health and chemical surveillance as well as on the steering of the prevention of environmental health hazards. The Finnish Medicines Agency Fimea is responsible for the marketing authorisations of pharmaceuticals as well as the supervision of pharmaceutical wholesalers and pharmacies.

MMM is responsible for the legislation on animal diseases, animal welfare and medication as well as food safety, and for general planning and steering. The combat against AMR is a part of the above sectors. The central actors include veterinarians, animal owners, companies, interest organisations and training units. The Faculty of Veterinary Science of the University of Helsinki is responsible for the professional basic education of veterinarians. As the superior authority in the sector, MMM steers and supervises the use of medicines and medicated feeds administered to animals. The Finnish Food Safety Authority Evira is the central government authority to steer and supervise the implementation of and compliance with legislation on animal medication. Regional State Administrative Authorities take

care of the supervision and instructions related to animal medication in their respective areas of competence.

In accordance with its competence area, YM adds the environmental protection perspective to the combat against AMR. The environmental administration does not have any legislation-based role in this issue. The environmental permits of farms or wastewater treatment plants covered by the Environmental Protection Act do not regulate the releases of antimicrobials or resistant microbes into the environment, and are thus neither supervised by the Centres for Economic Development, Transport and the Environment (ELY centres). The Finnish Environment Institute performs research on the environmental impacts of pharmaceutical substances.

OKM is responsible for the education and science policy. This administrative sector is responsible for the planning and implementation of the policies of higher education and science, also preparing the respective legislation. OKM also steers the system of institutes of higher education and research, supporting the operative conditions of research organisations. OKM prepares the vocational training legislation and steers and supervises the respective field. OKM issues the authorisations to organise training and the contents related to the authorisation.

Objectives

- Ensure the inclusion of combat of AMR in the legislation of the appropriate administrative sectors.
- Maintain and enhance the conditions for reaching the national and international objectives in the combat of AMR in collaboration between the various administrative sectors and stakeholders. For example, WHO, EU, OIE, FAO and Codex Alimentarius have issued several objectives which Finland is also committed to (Appendix 1).
- Adopt an order of priority and urgency for the measures.
- Ensure the appropriate sufficiency of resources.
- Ensure the inclusion of the regulations related to the combat of AMR in all legislation to be modified in the context of the reform of the regional and social care and healthcare systems.
- Steer and support the implementation of the new obligations under the Infectious Disease Act in order to prevent treatment-related infections and AMR.
- Enhance the legislative development on antimicrobials, veterinary medicines and medicated feeds at the EU and national level.
- Develop and strengthen the collaboration and commitment to the combat against AMR in the appropriate industries and branches.
- Support and promote introduction of international standards in Finland.

Actions

1. Ensure the inclusion of the combat of AMR in the legislation of the appropriate administrative sectors. Each Ministry will be responsible for the implementation of the specific actions related to their own administrative sector.
2. Enhance administrative cooperation across and between branches and stakeholders by consolidating the operations of the national expert group (MTKA) through, for example, a legislative decree.
3. Agree on the order of priority and urgency of the actions as well as on the time-frame of the measures, organising the necessary resources in terms of time and personnel.
4. Monitor the implementation and outcomes of the national action plan on AMR through annual reports and develop the action plan if necessary.
5. Impact the legislation at the EU level.
6. Continue to engage in international cooperation and commitment to the prevention of AMR on all sectors.

Responsibility: STM, MMM, OKM, YM

Follow-up of the implementation of the Action Plan

The implementation of the Action Plan calls for an active contribution by several actors. The central actors include, among the Ministries, STM, MMM, YM, OKM, TEM and the agency under their auspices (THL, Evira, the university, the Academy of Finland, TEKES, OPH), hospital districts, other municipal and private healthcare and animal herd health operators, the actors in the laboratory sector and food safety as well as the diagnostics and pharmaceutical industries. Some of the measures will also require separate funding. Instituted by THL, MTKA will follow the implementation of the programme at the national level. It has the annual task of assessing the implementation of the programme and reporting on the situation to the Ministry of Social Affairs and Health and Ministry of Agriculture and Forestry

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Appendix 1

Action Plan on Antimicrobial Resistance	Strategic objectives and areas of operation grouped on the basis of the WHO Action Plan						
	Training and education	Monitoring and surveillance	Preventing resistance and infections	Steering of use of antimicrobials	Research	Administration	Other
WHO Global Action Plan on Antimicrobial Resistance 2015 http://www.pro.who.int/enti-ty/drug_resistance/resources/global_action_plan_eng.pdf	Objective 1: Improve awareness and understanding of antimicrobial resistance through effective communication, education and training	Objective 2: Strengthen the knowledge and evidence base through surveillance and research	Objective 3: Reduce the incidence of infectious diseases through effective sanitation, hygiene and infection prevention measures	Objective 4: Optimize the use of antimicrobial medicines in human and animal health	Objective 5: Develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions		
Finland National Action Plan on Antimicrobial Resistance 2017–2021	Area of operation 1: Training of professionals and education of general public	Area of operation 2: Nationally coordinated surveillance Monitoring of AMR and use of antimicrobials	Area of operation 3: Preventing infections and controlling the spread of multi-drug-resistant bacteria	Area of operation 4: Guidelines on antimicrobial use for professionals	Area of operation 5: Research	Area of operation 6: Administrative structures	

Action Plan on Antimicrobial Resistance	Strategic objectives and areas of operation grouped on the basis of the WHO Action Plan						
	Training and education	Monitoring and surveillance	Preventing resistance and infections	Steering of use of antimicrobials	Research	Administration	Other
<p>European Commission</p> <p>Communication from the Commission to the European Parliament and the Council</p> <p>Action plan against the rising threats from Antimicrobial Resistance 2011-2016</p> <p>Contains 12 actions for implementation with EU Member States and identifies 7 areas where measures are most needed</p> <p>http://ec.europa.eu/dgs/health_food-safety/docs/communication_amr_2011_748_en.pdf</p>	<p>Area 7: Improving communication, education and training</p> <p>Action n° 12: <i>Survey and comparative effectiveness research</i></p>	<p>Area 5: Improving monitoring and surveillance in human and animal medicine</p> <p>Action n° 9: <i>Strengthen surveillance systems on AMR and antimicrobial consumption in human medicine</i></p> <p>Action n° 10: <i>Strengthen surveillance systems on AMR and antimicrobial consumption in animal medicine</i></p>	<p>Area 2: Preventing microbial infections and their spread</p> <p>Action n° 4: <i>Strengthen infection prevention and control in healthcare settings</i></p> <p>Action n° 5: <i>Introduction of the new Animal Health Law, which will focus on prevention of diseases, reducing the use of antibiotics and replacing current Animal Health provisions based on disease control</i></p>	<p>Area 1: Making sure antimicrobials are used appropriately in both humans and animals</p> <p>Action n° 1: <i>Strengthen the promotion of the appropriate use of antimicrobials in all Member States</i></p> <p>Action n° 2: <i>Strengthen the regulatory framework on veterinary medicines and on medicated feed</i></p> <p>Action n° 3: <i>Introduce recommendations for prudent use in veterinary medicine, including follow-up reports, using the same approach as 2002 Council Recommendation on prudent use of antimicrobial agents in human medicine</i></p>	<p>Area 6: Promoting research and innovation</p> <p>Action n° 11: <i>Reinforce and coordinate research efforts</i></p>	<p>Area 4: Joining forces with international partners to contain the risks of spreading AMR from international trade and travel and via the environment</p> <p>Action n° 8: <i>Develop and/or strengthen multilateral and bilateral commitments for the prevention and control of AMR in all sectors.</i></p>	<p>Area 3: Developing new effective antimicrobials or alternatives for treatment</p> <p>Action n° 6: <i>To promote, in a staged approach, unprecedented collaborative research and development efforts to bring new antibiotics to patients</i></p> <p>Action n° 7: <i>Promote efforts to analyse the need for new antibiotics into veterinary medicine</i></p>

Action Plan on Antimicrobial Resistance	Strategic objectives and areas of operation grouped on the basis of the WHO Action Plan						
	Training and education	Monitoring and surveillance	Preventing resistance and infections	Steering of use of antimicrobials	Research	Administration	Other
<p>OIE The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials 2016 http://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE-AMRstrategy.pdf</p> <p>Codex Alimentarius Codex texts on foodborne antimicrobial resistance 2015 http://www.fao.org/fao-who-codexalimentarius/standards/thematic-compilations/en/</p> <p>FAO The FAO action plan on Antimicrobial Resistance 2016–2020 http://www.fao.org/3/a-i5996e.pdf</p> <p>Nordic Council 12 Initiatives. Nordic co-operation on combating antimicrobial resistance. A white paper outlining new Nordic initiatives, 4.4.2017. http://norden.diva-portal.org/smash/get/diva2:108606z/FULLTEXT01.pdf</p>	<p>Objective 1: Improve awareness and understanding</p>	<p>Objective 2: Strengthen knowledge through surveillance and research</p>	<p>General Principles of Food Hygiene</p>	<p>Code of Practice on Good Animal Feeding</p>	<p>Several Codes of hygienic practices for different commodities (e.g. milk and milk products)</p>	<p>Objective 3: Support good governance and capacity building</p>	<p>Objective 4: Encourage implementation of international standards</p>
	<p>Focus Area 1: Improve awareness on Antimicrobial Resistance and related threats</p>	<p>Focus Area 2: Develop capacity for surveillance and monitoring of Antimicrobial Resistance and antimicrobial use in food and agriculture</p>	<p>1. Reduction of the need for antibiotic treatment through vaccination and prevention of infection</p>	<p>Focus Area 4: Promote good practices in food and agriculture systems and the prudent use of antimicrobials</p>	<p>Focus Area 3: Strengthen governance related to antimicrobial use and Antimicrobial Resistance in food and agriculture</p>		
	<p>6. Improving the dissemination and sharing of best practices</p>	<p>3. Collation of knowledge of distribution patterns and the spread of antimicrobial resistance</p>		<p>2. Rationalisation of the use of antibiotics for the treatment of humans and animals</p>	<p>4. Collation of knowledge of the optimal use of existing antibiotics and vaccines</p> <p>5. Providing incentives for the development of new health technologies, innovative medicines and vaccines</p>	<p>7. Political pressure and dialogue via international co-operation</p>	

Appendix 2

National legal provisions related to communicable diseases (www.finlex.fi)

Food Act
Act and Decree on Animal Welfare
Animal Diseases Act
Act on Specialised Medical Care
Act on Administrative Courts
Personal Data Act and Decree
Aviation Act
Waste Act and Decree
Act on the Administrative Experiment in Kainuu
Primary Health Care Act and Decree
Act on the State Subsidies to Municipalities
Act and Decree on the Municipality of Residence
Act on Veterinary Border Controls
Act on Animal Medication
Act on the National Institute for Health and Welfare
Act on Municipal Officials
Act and Decree on Children's Day-care
Act on the Finnish Medicines Agency Fimea
Act on the Status and Rights of Patients
Act and Decree on the Customer Charges in Social Welfare and Healthcare
Act on Healthcare Professionals
Act and Decree on Medical Devices and Supplies
Act and Decree on National Personal Data Files on Healthcare Professionals
Act and Decree on Private Healthcare
Act on the National Supervisory Authority for Welfare and Health
Valvira
Act on the Openness of Government Activities
Medicines Act and Decree
Act on the Treatment of Persons in Police Custody
Patient Injuries Act
The Criminal Code of Finland
Health Insurance Act and Decree
Communicable Diseases Act and Decree
Healthcare Act
Health Protection Act and Decree
Act on Court Fees
Detention Act
Occupation Accidents, Injuries and Diseases Act and Decree
Occupational Health Care Act
Occupational Safety and Health Act
Government Decree on the Investigation of Epidemics Spread via Food and Water
Government Decree on the Prohibition of Use of Certain Pharmaceutical Substances in Animals
Government Decree on the Advisory Committee of Communicable Diseases
Government Decree on the Zoonosis Centre



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