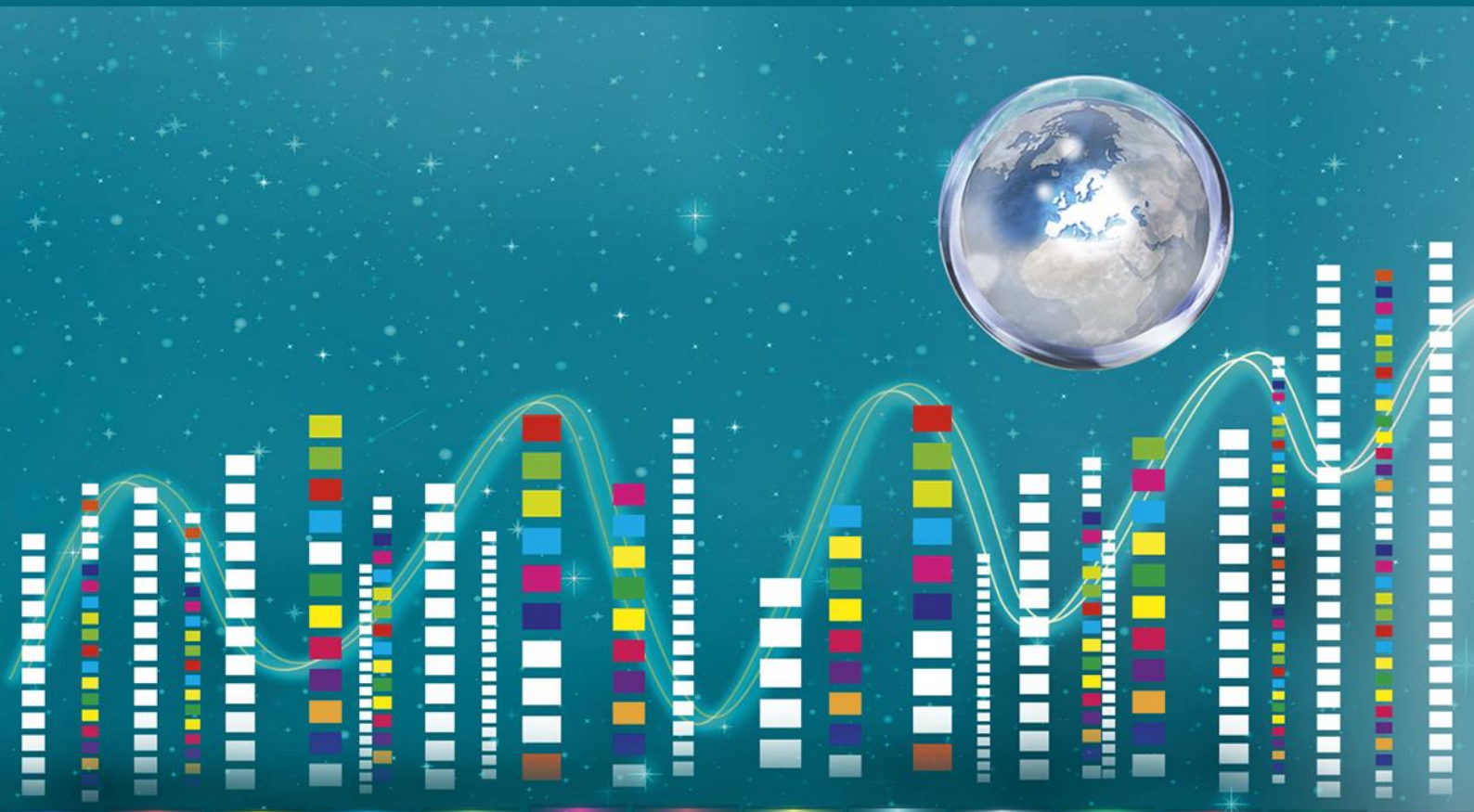
European Commission

Foresight

Defeating Communicable Diseases

Targeted scenario N°6

Glimpses of the future from the BOHEMIA study



***Defeating Communicable Diseases* - Targeted scenario N°6**

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EUROPEAN COMMISSION

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Glimpses of the future

from the BOHEMIA study

Directorate-General for Research and Innovation

2018

About BOHEMIA

BOHEMIA is a foresight study (contract N° Contract PP-03021-2015) designed specifically to support the preparation of the next framework programme.

The study put forward policy recommendations for the next framework programme, based on a foresight processes involving scenario development, a Delphi survey and an online consultation.

As part of its recommendations, the study identified 19 likely future scenarios with disruptive implications and associated priority directions for EU research and innovation.

The full range of the results of the study is available at https://ec.europa.eu/research/foresight

Targeted scenario N° 6

Defeating Communicable Diseases

Summary

It is 2040. Communicable Diseases (viral infections as well as biotic diseases) that reduce the quality of life of people and cause huge economic losses are being defeated. The number of people dying from Communicable Diseases is steadily decreasing. New approaches, including replacing antibiotics and ways to avoid infections have been developed in international collaboration.

UN Sustainable Development Goals (SDGs) most relevant to this scenario:

The scenario

It is 2040. The relations between nutrition, the mass application of antibiotics in agriculture, the cycles of infections and human immune reactions are well understood. The battle against antibiotic resistance has become a global mission. The systematic scanning of biodiversity to identify potential pharmaceutical substances was launched as a major global collaborative project in the 2030s. New antibiotics have been derived from the discovered substances, and new methods of treatment have been developed.

Mapping the microbiome, combined with cheaper screening and data from patients has given rise to different approaches to researching for new antibiotics and to treating microbial infections. As our fundamental understanding of the human microbiome and biological processes evolves, new approaches that utilize the body's immune system, and the microbial colonies that inhabit it, are being employed to neutralize microbial and viral infections. Sepsis, a major killer until the 2020s, has been reduced by one third worldwide. New approaches to disease treatment include the activation of individuals' personal microbiome, and the use of natural resistance to fight new incoming bacteria.

The fight against viruses is still ongoing. New immunizations have led to a reduction in the number of viral infections in the EU by 50% (compared to 2016). While the medical arsenal continues to grow, prevention is now more in the forefront than ever before. Education for a healthy lifestyle is part of the endeavour as substantial funding and research has been directed toward the prevention of pandemics or mass-infections.

Relevance for Europe

Health and medicine are areas of key concern for every European citizen. The number of cases of communicable disease is still increasing, in Europe and all over the world. Travelling and the density in urban areas contribute to this increase even though the hygienic situation in most European countries has improved. The application of prevention measures is still uneven. Many virus infections cannot be cured at all, and they cause huge deficits in quality of life and create very large economic losses. Antibiotic resistance is a major threat for humanity. The number of superbugs will likely increase[1]. Health and medicine are industries in which Europe is very competitive and the markets they address continue to grow.

Contribution towards the Sustainable Development Goals (SDGs)

Communicable diseases are a worldwide problem. They are known to relate to poverty (SDG 1 reduction of poverty). The poorer countries are often those with less education, a worse hygienic situation, less or no access to public health services and more infectious diseases. With less poverty, communicable diseases can be reduced. The hygienic situation is directly linked with improvement of water supply and sanitation (SDG 6). If communicable diseases can be prevented, treated and cured, the health SDG (3) could be fulfilled.

Even though in industrial countries the hygienic situation has improved, in some parts of the world with very dense urbanizations, new infections occur which spread fast through migration and mobility. Various types of infections are also linked to environmental management (e.g. typhoid, bronchitis, malaria), hence impacting related SDGs (11, 12). Reducing hunger (SDG 2) can help defeat communicable diseases as If hunger is reduced, the immune system of patients will be strengthened and the prevalence of communicable diseases will be reduced.

[1] http://www.who.int/antimicrobial-resistance/publications/infographic-antimicrobial-resistance-20140430.pdf?ua=1

Implications for EU policy

The challenge of Communicable Diseases relates to EU policies in health, food and agriculture. As the diversity of diseases and treatments increases, health insurance systems face mounting challenges. Appropriate pricing regulations to incentivize research in face of growing costs for developing new drugs and treatments while keeping market prices reasonable are essential problems to solve.

Due to the weakness of EU competence in health policy, the Union's research and innovation policy is the most relevant EU policy agenda. Developing treatments for infectious diseases requires investments in research that do not promise high revenues (not only in the case of orphan drugs, where it is obvious). Investments in Public Private Partnerships can be part of the solution.

EU R&I, health and agricultural policies have to be coordinated. Excessive use of antibiotics in animals and plants worldwide is a source of antibiotic resistance. Policies concerning data security and ethical questions are also important.

Future Directions for EU R&I policy recommended by the public consultation

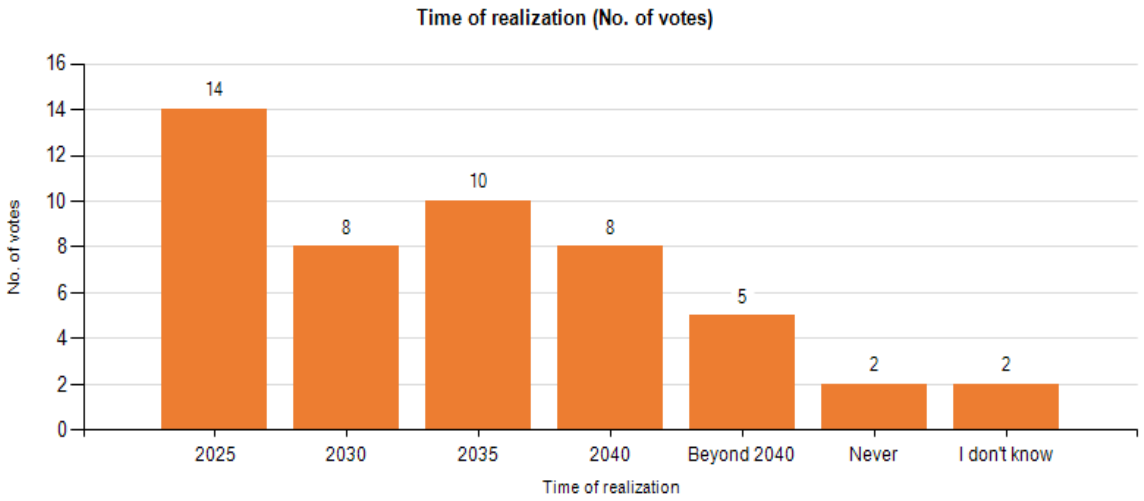
- **Effective public health education about communicable diseases, incl. prevention, treatments, hygienic questions, disinfection**
- **New vaccines and new approaches to vaccination**
- **Understanding the biology of immunity in animals and humans**
- **Big Data applications for microbiome research, incl. sharing data for boosting multicentric research and clinical trials**
- **Developing new antibiotics**
- **Safety and medical regulation, including risk assessment**
- **Alternative/ new means of fighting biotics**
- **Helping people to preserve health by making cities safer, water and air purer, food more wholesome**
- **Data exchange in epidemiology**

Annex: Delphi Statements

The Delphi survey of the BOHEMIA study asked experts about the time of realization of 143 statements about the future, and about the relevance of Research and Innovation for that realization, or about the relevance of the realization for Research and Innovation policy. The experts were asked to justify their judgements with arguments. The whole data set has been published and can be found at: https://ec.europa.eu/research/foresight

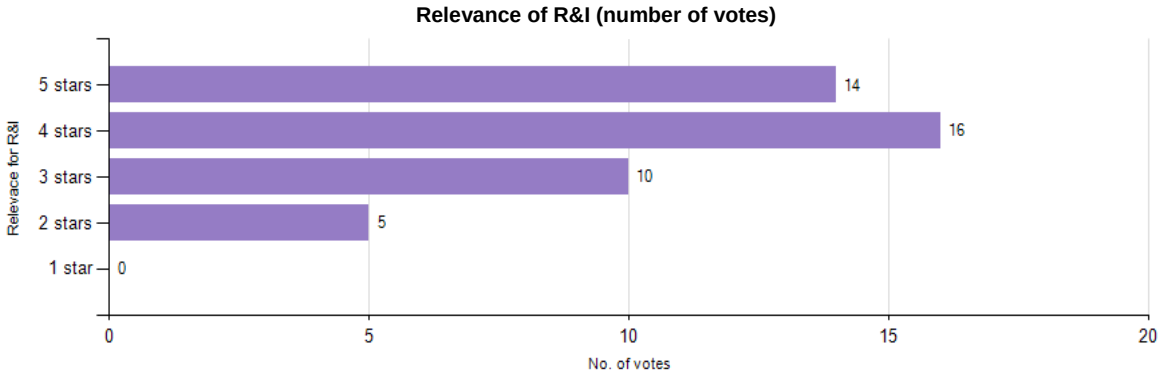
This annex includes the parts of the data set that are relevant to this scenario.

Stopping sepsis has resulted in a 30% or more reduction in mortality worldwide (share of global death rate due to sepsis was 33.3 % in 2016)



Number of respondents: 47

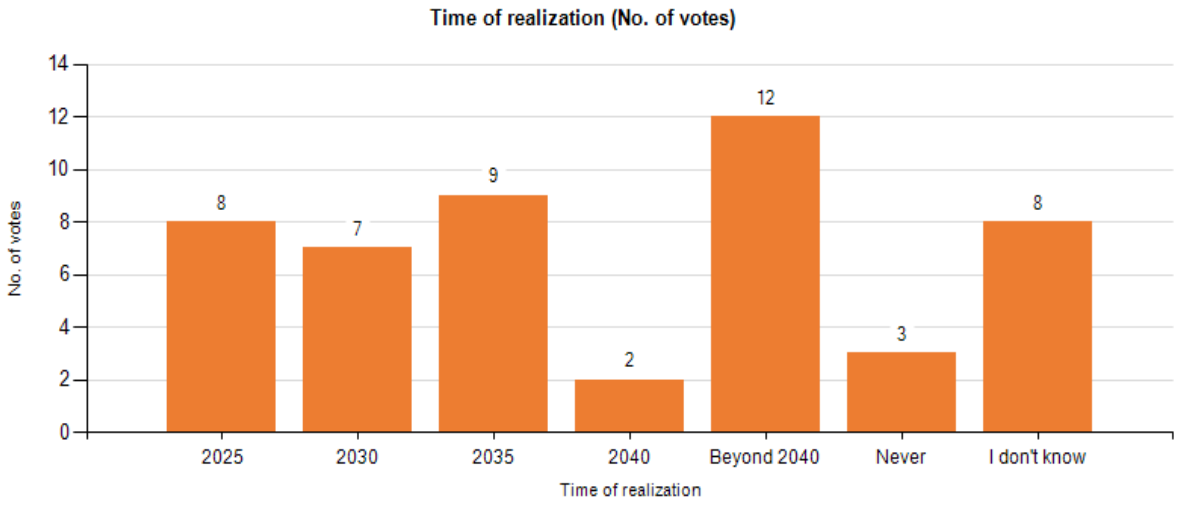
Arguments regarding the time of realization	**No. of votes**
Improved methods for the early diagnosis of sepsis are urgently required.	38
Presently, there are no estimates of the burden of sepsis and septicemia at the global level; and it was not included in the initial Global Burden of Disease study (see NCBI).	21
Development of new antibiotics and methods to improve the immune system by means of synthetic biology is needed.	15
Even in the EU countries, cases of sepsis show high figures but the statistics are often unreliable. In England, the incidence is 232 cases per 100,000 population.	10
Using death certificate data for the period 1999–2014, the US Centers for Disease Control and Prevention (CDC) found that a total of 2,470,666 deceased (6% of all deaths) had sepsis listed among the causes of death (sepsis-related deaths).	5
Sepsis will not be stopped. Diagnostics and therapies can improve but the incidence of sepsis will not decrease.	4
Ultra-fast diagnostic innovation/technology to identify the cause of sepsis for each individual is required to use precision treatments.	1



Average: 3.87 **Dispersion:** 0.93

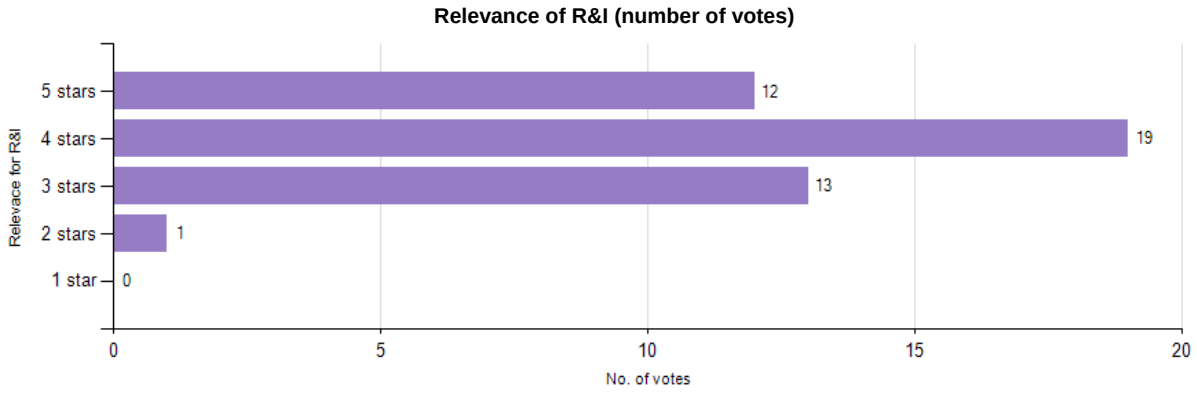
Arguments regarding the relevance of R&I	**No. of votes**
To stop sepsis and bacterial infections in general still requires a lot of research: to develop new antibiotics on the one hand, but also to achieve speedy diagnosis.	42
Research on the treatment and cure of sepsis has to be fostered and coordinated internationally.	29
Empirical studies on the number of sepsis cases worldwide are needed.	12
R&I efforts have to be accompanied by an effective and global hygiene strategy.	8
The US example above is a pragmatic way to get reliable figures.	1

New immunizations against viruses lead to a reduction in the number of viral infections in the EU by 50% (compared to 2016)



Number of respondents: 48

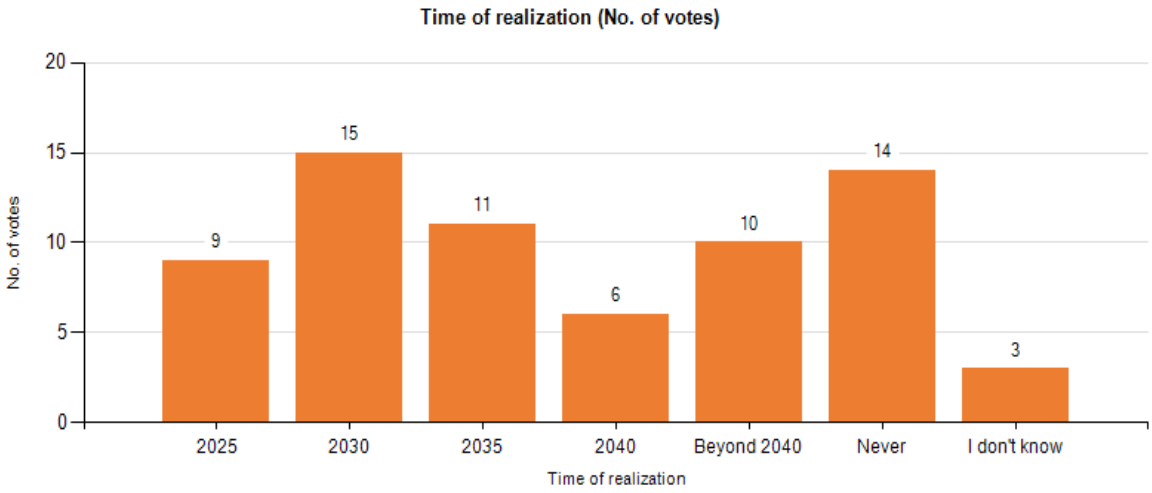
Arguments regarding the time of realization	**No. of votes**
The global burden of respiratory infections is very high. Mainly seasonal influenza is examined (WHO, many surveys), but the numbers are very high and can only be estimated (see NCBI). Calculating a reduction on the time frame is therefore very difficult.	34
Too many factors are influencing the rate of infections. Making a projection is not possible.	24
Seasonal influenza is responsible for the majority of viral infections and due to the genetical variance of the causing agent over time, 50% reduction is too ambitious.	11
Research into the natural immunity of individuals against a range of infections is likely to lead to treatments and public health measures that can reduce the incidence of infections.	11
AI for better surveillance and identification and knowledge of infectious diseases.	4
Broad availability of individual DNA plus systematic understanding of the physiology of the individuals including their microbiome is likely to lead to more rapid development of vaccines.	3



Average: 3.93 **Dispersion:** 0.67

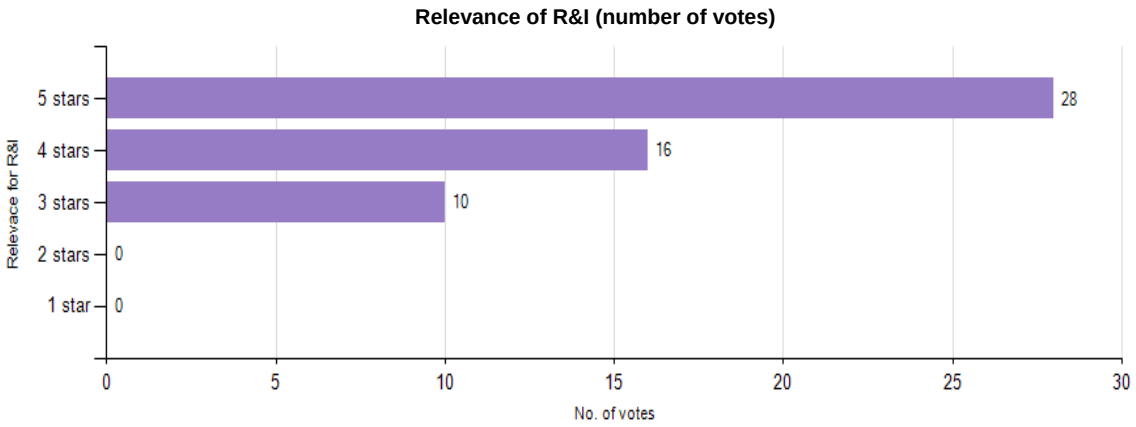
Arguments regarding the relevance of R&I	**No. of votes**
Real data about virus infections and their spread is needed. The current data consists of limited estimations (see WHO; NCBI).	40
New methods for rapid detection are required.	26
Research on the genetic variance of influenza viruses and development of effective vaccines are needed.	20
More research is needed into natural immunity to viral infections across large populations to identify potential treatments and prevention measures.	15

Breakthroughs in science stop the threat of antibiotic resistance



Number of respondents: 68

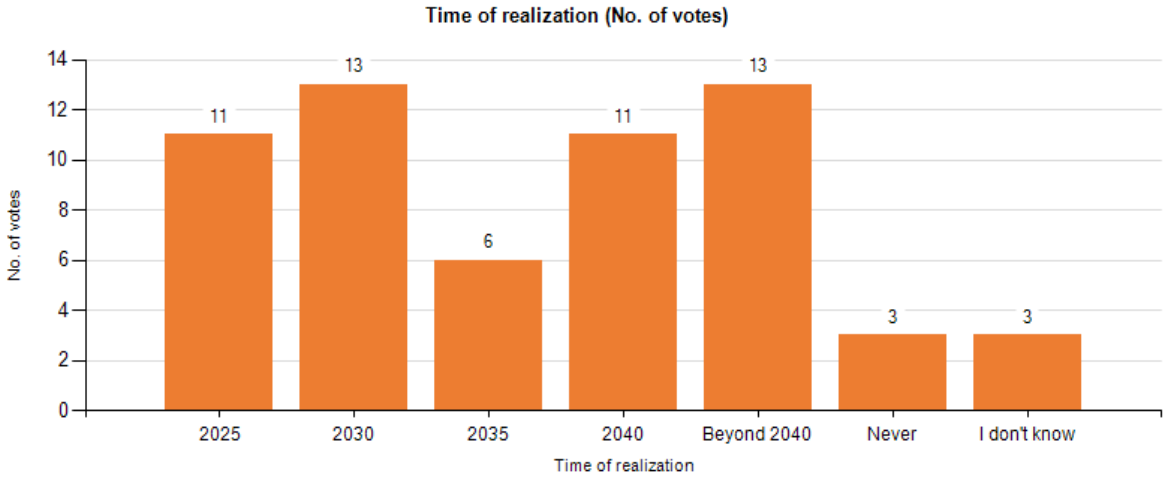
Arguments regarding the time of realization	**No. of votes**
The breakthrough in science also needs to be affordable for developing countries and their public health systems should be radically upgraded. Otherwise, new viruses will appear or re-appear.	43
New approaches to controlling antibiotic resistant diseases are required.	41
The search for new classes of antibiotics is important for the society and profitable for pharmaceutical industry.	33
Bacteria will always develop resistance mechanisms to new drugs.	31
Antibiotics should be considered as scarce resource and their usage should be regulated strongly, similarly to other scarce resources on the planet.	13
Natural resistance to infection is often present in some individuals against some infections. Availability of information on people who do not get sick can lead to understanding and better treatment.	9
Companies are not interested in investing is the needed research: they prefer treatments for chronic diseases, not acute ones; the customers stick around longer.	6
Important to look at One Health. The holistic perspective. Antibiotic resistance comes from many sources, e.g. animals, food, etc.	4
Teixobactin, discovered in 2017, the first new antibiotic in the last 30 years, paves the way for a new generation of antibiotics.	4
A strain-specific tailored combination of various approaches (e.g., antibiotics, bacteriophage, and small molecules) might make it possible to deal with resistance.	3
Antibiotics resistance has been caused by animal breeding. Strong rules for limiting the use of antibiotics in meat industry could help avoiding human antibiotics resistance.	2
Vaccination and use of antibiotics? Which is the solution and which is the problem?	1
AI (artificial intelligence) would be a point-of-care test identifying between viruses and bacteria.	1



Average: 4.33 **Dispersion:** 0.62

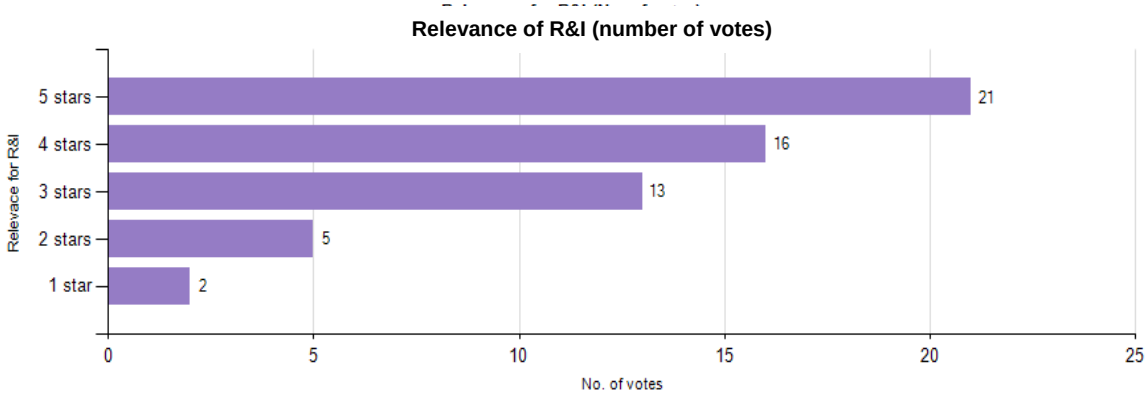
Arguments regarding the relevance of R&I	**No. of votes**
New science and technologies wherever they emerge need to be supported, traditional pathways may not bring the expected outcomes.	40
There is a clear urgency: a woman in the USA died in 2017 of a superbug resistant to every available antibiotic.	25
Emerging nanoscale technologies promise rapid evaluation of antibiotic resistance for different bugs.	15
R&I efforts have to be accompanied by an effective and global hygiene strategy.	12
A better understanding of resistance mechanisms, as well as research into new types of antibiotics, is required.	11
Why some people stay well can now be studied across large populations with individual DNA and systemic analysis available on those identified. Is the source of their wellness transferable?	5
The use of nanotechnologies will improve the efficacy of antibiotics.	3
AI - to be developed in alignment with better tools for diagnostic (with cheaper point of care test for third countries)	3

Data on interactions between patients and their personal environment (including abiotic and biotic factors) are routinely and systematically collected for diagnosis and the creation of personalized therapy plans



Number of respondents: 59

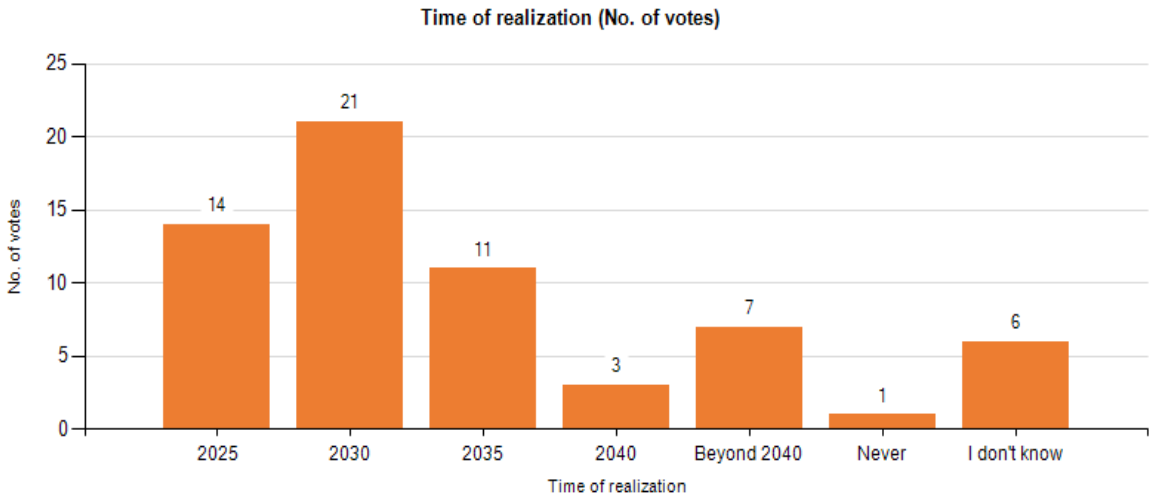
Arguments regarding the time of realization	**No. of votes**
Combining structured data (genotype, phenotype, genomics) with semi- or unstructured data (lifestyle, environmental, health economics data) still poses multiple challenges.	48
There is a huge step between the identification and collection of data, on the one hand, and the creation of therapy plans as a common practice, on the other.	40
This asks for a holistic human perspective that is much broader than the medical perspective on health.	13
Deep learning will help in the analysis of the data, structured data and unstructured data are quite helpful, if pattern can be found.	9
This is inevitable provided the ethical use of data can be properly managed.	8
The combination of structured and unstructured data will be extremely useful in the quest for patterns by means of AI strategies.	7
The US government's Precision Medicine Initiative (PMI) supports research looking beyond genetics and biology, at behavioral and environmental factors.	5
A clear legal and ethical framework is needed to prevent misuse and misinterpretation of such complex data sets, including IT security measures.	5
Just because data collection is uninformative does not mean it will not be done.	3



Average: 3.86 **Dispersion:** 1.24

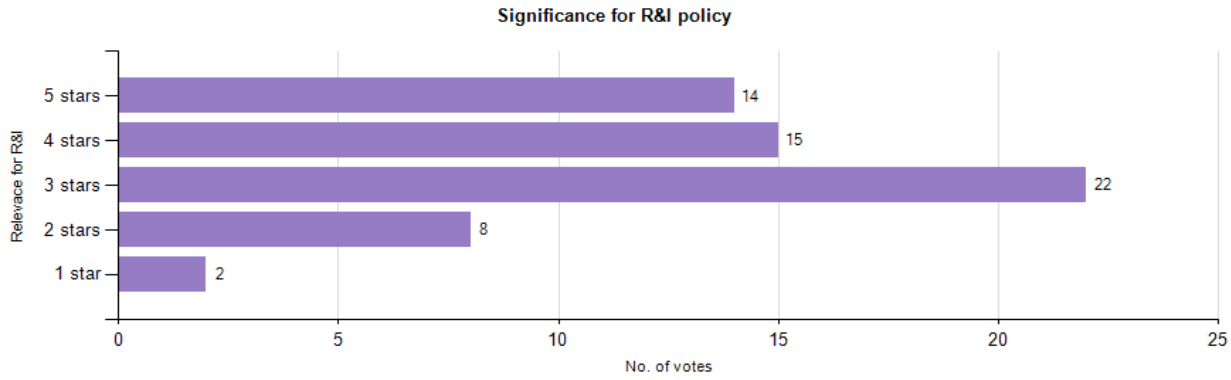
Arguments regarding the relevance of R&I	**No. of votes**
The correlations between the different factors still have to be identified and analysed on a scientific basis.	49
Scientific databases have to be build up and filled with data.	33
The EU needs something analogous to the U.S. Precision Medicine Initiative involving 1 million volunteers providing genetic, environmental and other data to succeed.	12
Self-learning systems such as IBM Watson will drive this development.	10
Sharing of data between countries is difficult and a barrier for innovation in this field. Data on register level and easier collaboration between EU countries id needed and discussed ethically.	8

Systematic scanning of biodiversity to identify substitutes for drugs has become a global research endeavour



Number of respondents: 60

Arguments for time of realization	**No. of votes**
Different conditions around the planet offer a much greater diversity to search in than any individual country could.	58
Citizen science around the world could help considerably but the political will and digital infrastructures will take some time to build up.	41
Understanding mechanisms and laws for the interactions of drugs and organisms is very far from realization. Non-equilibrium states, multiscale approaches in machine learning and context dependent modeling are needed.	22
A nation state and the EU alone do not have the capacities.	16
Being aware of the side effects of drug therapy, modern solutions should be directed towards selective and personalized therapies, which can be achieved, e.g., by increased systematic scanning of biodiversity.	13
Scientific inertia ('labs and hard science' vs. 'softer science and the real world'), scientific arrogance (inventions vs. harnessing what already exists) and patentability reduce R&I efficiencies.	11
It is easier to find synthetic drugs instead of exploiting the last resources on earth.	10
This knowledge is available, but a global knowledge base is needed.	6
Economic interests being dominant in the medical field of research, no significant change could occur for now without evolution of the scientific democracy.	2



Average: 3.51 **Dispersion:** 1.16

Arguments regarding the significance for R&I policy	**No. of votes**
This requires a more open scientific endeavour, shorter patent times, the opening of the laboratory to the world, the breaking down of scientific silos, the opening up of the 'scientific method'.	44
Global challenges need global answers. But there is so much disagreement in the political world that a lot of science diplomacy is required.	37
Citizen scientists could very well decide to go faster than policy-makers in establishing the needed digital infrastructure to progress around health related matters (e.g. to food/lifestyle).	35
The teaming up of scientists and global diplomats is necessary for this to be achieved.	23
This requires also competencies in how to link up different innovation actors with different types of economic interest.	7
The main role of European policy is in regulating biodiversity. The role for EU R&I policy is more limited.	1
Research funding should end with the growth finality: drugs development generates cash when biodiversity solution doesn't.	1
There is a lack of evidence that such replacements will be effective.	1

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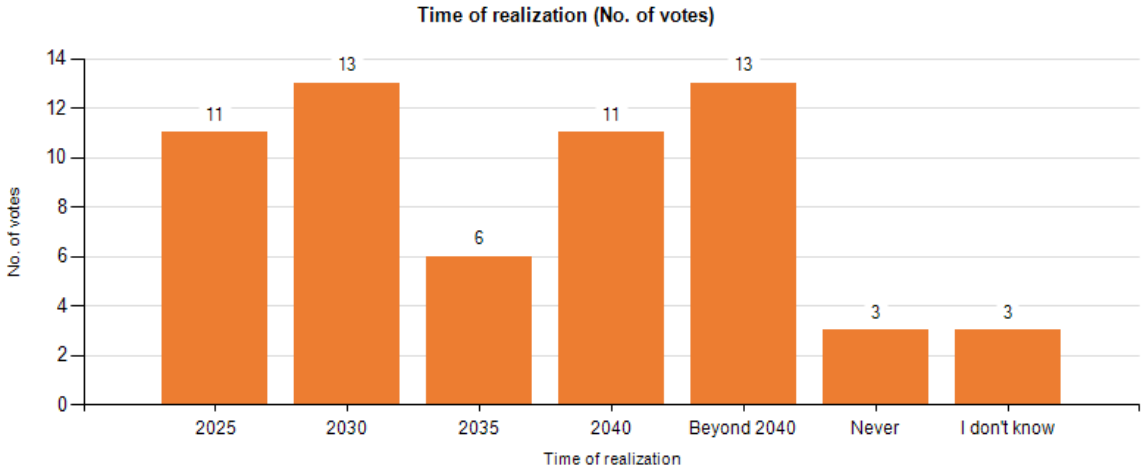

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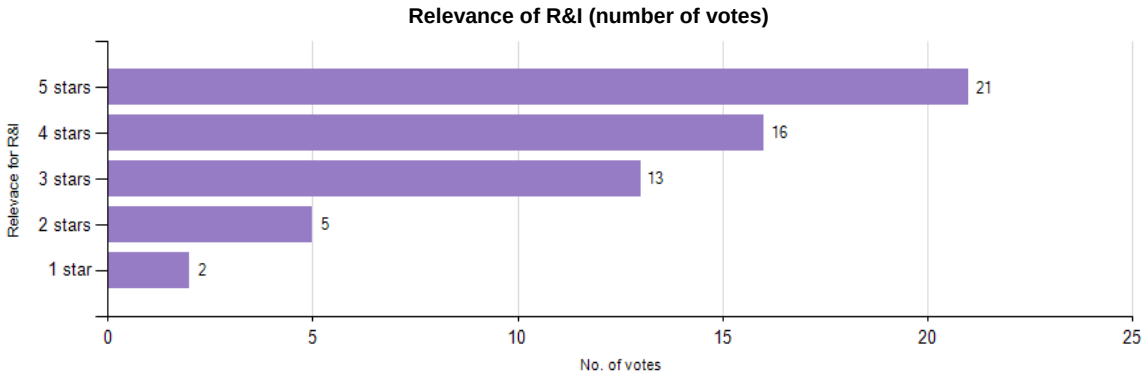

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Studies and reports

Publications Office