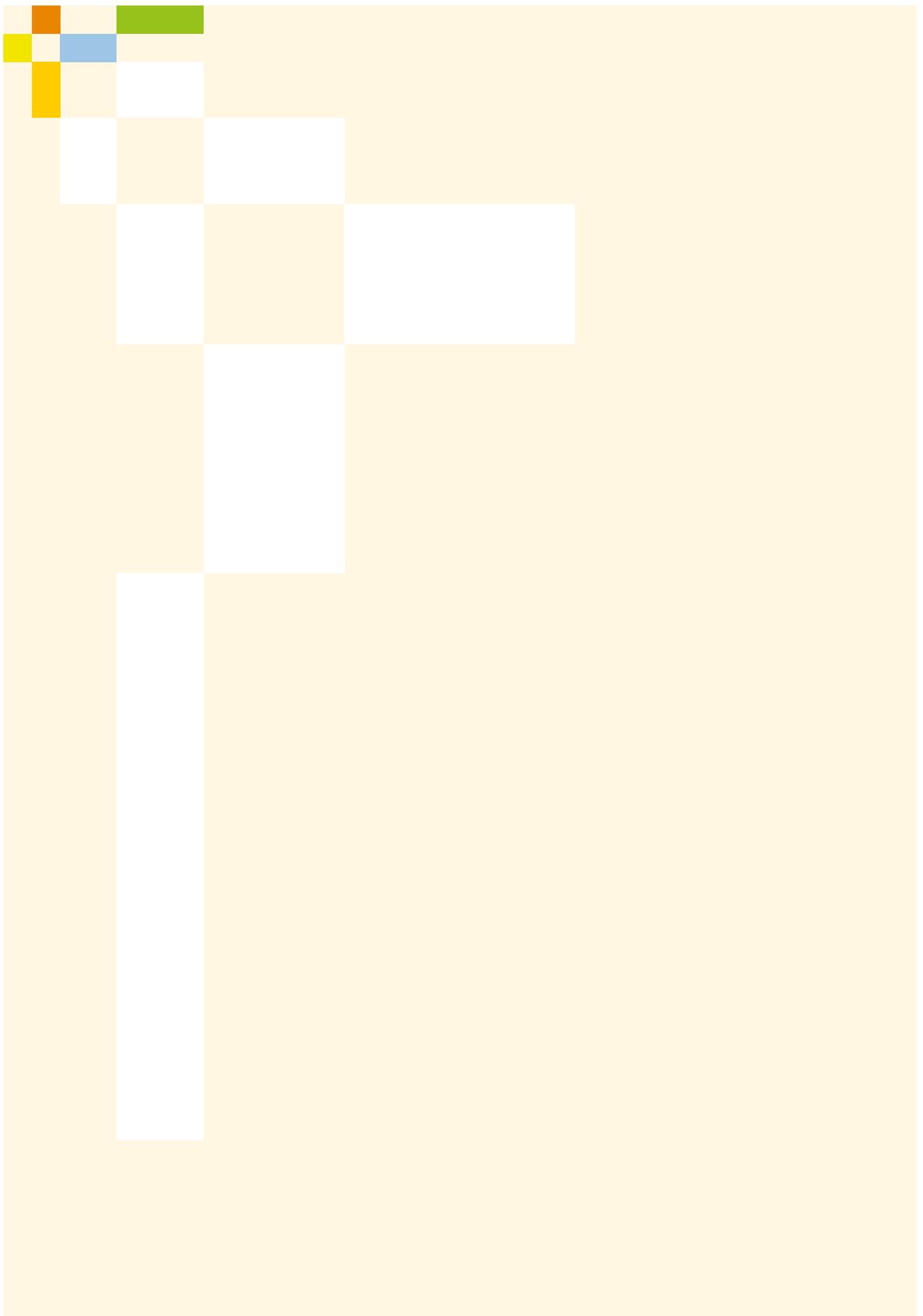




acatech IMPULSE

The Resilience and Performance of the Healthcare System in Times of Crisis

Karl-Heinz Streibich, Thomas Lenarz (Eds.)



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The acatech IMPULSE series

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Contents

Summary and key messages	5
Project	7
1 Introduction	9
2 Information and communication	11
3 Structure of the healthcare system and strategic reserves	13
4 Relationship between the different institutions and actors	17
5 Conclusion and outlook	20
References	21



Summary and key messages

Like other countries around the world, Germany has had to impose temporary restrictions on almost every area of public and private life in order to contain the COVID-19 pandemic. This has required a huge effort from the whole of society. During the first weeks and months of the pandemic, the measures taken made it possible to bring down the number of infections and stabilise them at a low level. However, the number of new infections started to rise again in the autumn of 2020. The first vaccines were approved a few months later, holding out the prospect of an end to the pandemic.

Coupled with the severe strain on the healthcare system, the economic challenges associated with lockdown are having a profound impact on the needs, routines and living conditions of many people. The consequences of the COVID-19 pandemic are likely to be far worse than those of the economic crisis of 2008/2009, which was triggered by events in the financial sector. Unlike that crisis, COVID-19 affects every region in the world, with serious implications for international trade and logistics.

Against this backdrop, it is important to ask **what lessons can be learnt from the current crisis, and what improvements are needed to make the healthcare system more resilient and improve its performance.**

1. One sobering, but nonetheless important answer is that global networking of **early warning systems** must be improved. The European Centre for Disease Prevention and Control (ECDC) and the World Health Organisation (WHO) have a key role to play in this regard.

2. The targeted collection and sharing of **data** – especially during the acute crisis phase – is vital in order to provide a transparent picture of infections. This is key to ensuring that the right measures are taken and continuously adjusted to reflect the latest developments. **Digitalisation** solutions should be systematically implemented and expanded, and all available opportunities for technological solutions should be utilised.

The COVID-19 pandemic has demonstrated that a global crisis of this nature does not only affect the healthcare system – it constitutes a challenge for the whole of society.

3. The strengthening of **preventive healthcare measures** plays an important role. It is evident that preventive measures such as social distancing and quarantine/self-isolation, coupled with systematic tracking and tracing and breaking of chains of infection, played a major part in allowing Germany to cope relatively well with the first wave of the pandemic compared to other countries.

4. However, it is also necessary to ensure targeted **communication** and comprehensive **public** education. Ultimately, preventive measures will only succeed if the public understands why and how they should protect themselves and others. This is a major challenge in a situation where the available knowledge is constantly changing.

5. **Coordination and cooperation between the relevant actors** (authorities and institutions) at every level (local, regional, national and EU) is vital to successful crisis management. Particular attention must be paid to Germany's federal structures. This includes coordinated crisis management among hospitals in order to ensure that both COVID-19 patients and all other patients receive the appropriate care.

The situation will only start to improve significantly once sufficient quantities of vaccine are available and widespread immunisation of the population has been completed. The development and distribution of vaccines is thus a priority.

6. As well as providing a framework for accelerated vaccine development, the establishment of a **European innovation ecosystem** would help to improve the healthcare system's overall performance and strengthen Germany's position as a centre of innovation.

In order to ensure that lessons are learnt from the ongoing efforts to tackle the COVID-19 pandemic, actors from science, industry and government should define and model a range of scenarios to help society prepare as well as possible for the next crisis situation. Crisis scenario modelling can provide insights into where and how society and the healthcare system can and must become more resilient.

The connections and interdependencies within the European Union mean that the national perspective must be augmented by a global dimension. The common goal of all measures should be to strengthen resilience throughout Europe while also keeping global requirements in mind.



This is not something that can be achieved in the short term – it will call for medium to long-term reforms and a concerted effort by all the countries of Europe. This is absolutely key to ensuring

that the different healthcare systems are better prepared for future crises and able to adapt to them more rapidly.

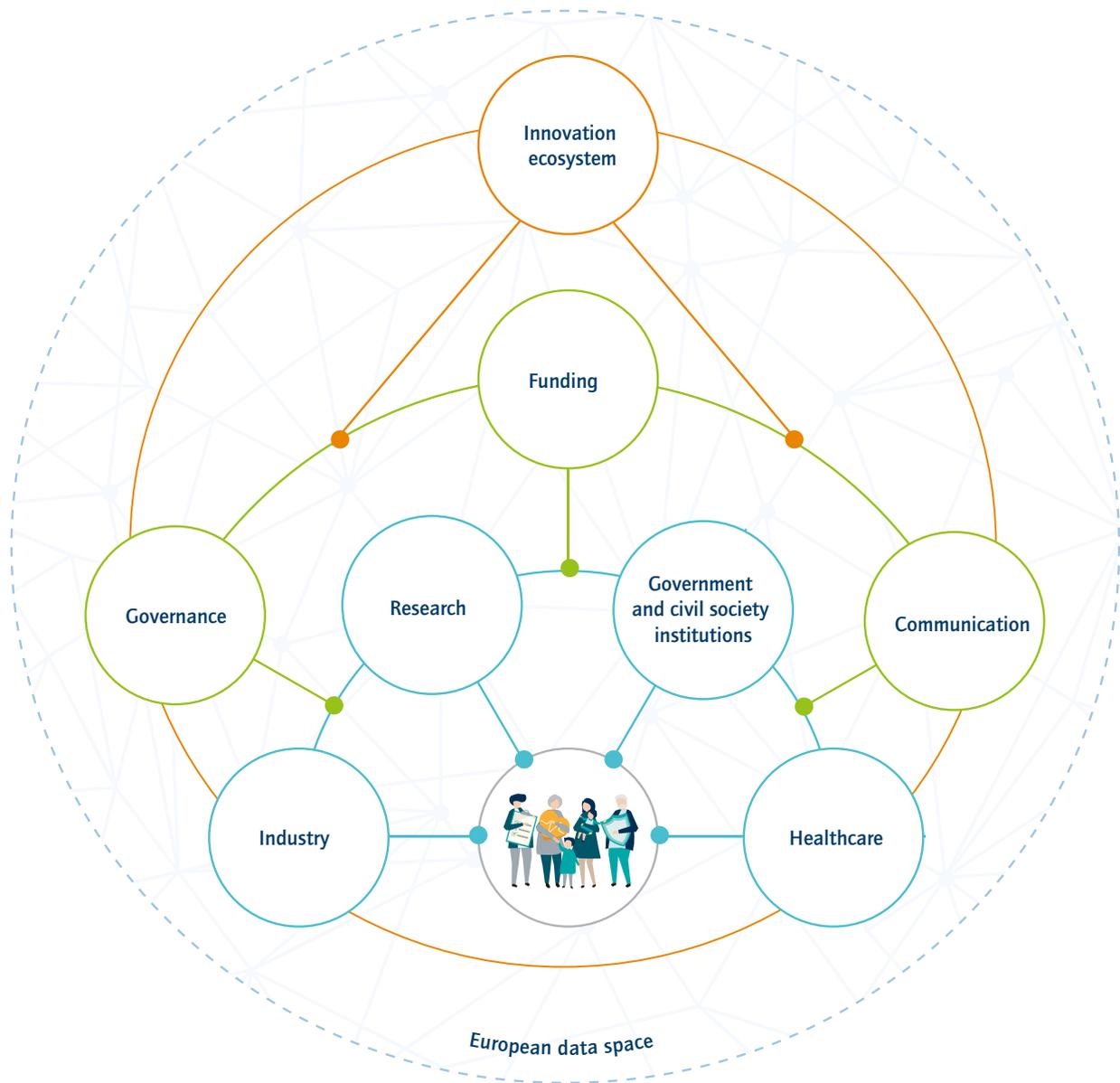


Figure 1: A European innovation ecosystem would help to improve the healthcare system's resilience and performance and strengthen Germany's position as a centre of innovation (source: authors' own illustration/rawpixel.com/Freepik).

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1 Introduction

The COVID-19 pandemic is demonstrating that, in a globalised world, viral infections and other public health crises are no longer just a regional problem and can in fact rapidly escalate into a global challenge. One of the keys to tackling a pandemic is access to data and information – collected and analysed in real time – about the pathogen, how it is spreading in the workplace and the community, and the effectiveness of any countermeasures taken. Science plays a vital role in this context. In a crisis, decisions and communication mechanisms should not be rooted in political speculation, assumptions and opinions. Instead, they should be based on a methodologically transparent, scientific analysis of the situation, careful weighing up of the available options, and the systematic development of solutions.

The growing specialisation of functional systems and the continuous increase in global interconnectedness and the division of labour mean that society is becoming more and more vulnerable to disturbances. Extreme events are also increasing, and it does not take long for their impacts to travel to Germany and Europe from other parts of the world. The growing interconnectedness of the structures that are vital to people's wellbeing means that even minor disruptions can have serious impacts on the system as a whole. Consequently, critical infrastructures such as the energy and water supply, transport system, information technology and telecommunications systems, food supply and healthcare system are areas that require special protection in a modern society. To ensure that society is better prepared to deal with systemic risks, it will be necessary to increase investment in building resilient systems and in preventive measures. The term "resilience" denotes the ability to reliably keep a system functioning even in the event of unexpected disruption, or return it to a functioning state as quickly as possible.¹

This definition includes the assumption that measures to adapt the system will be implemented after a crisis, so that it is better prepared for external shocks in the future. The visualisation of resilience in the form of a spiral illustrates the fact that rather than returning the system to its original state at the end of the crisis, the aim should be to attain a new, more resilient state (see Figure 2).

Resilience can be broken down into five phases:

- Prepare
- Prevent
- Protect
- Respond
- Recover and Re-Imagine

Resilient societies are able to minimise the human, economic and environmental cost of adverse events. They do this by cushioning the initial blows, mitigating their impacts and adapting flexibly to the new circumstances. This is a challenge that must be met by the whole of society, not least the private sector. Businesses must be conscious of this responsibility and work to build and expand resilient structures. The State can and must offer them the appropriate support. The role of government includes providing the infrastructure for technological solutions, engaging on equal terms in a transparent dialogue with the public, and creating economic incentives in order to strike a balance between private interests and those of society as a whole.

Funding programmes should aim to create resilient structures that can mitigate the harmful impacts of crises on society. Metrics and indicators for evaluating society's vulnerability and resilience are also necessary. In addition, methods should be developed for modelling and simulating complex socio-technical systems. Furthermore, even while in the middle of an acute



Figure 2: Phases of resilience (source: authors' own illustration)

1 | See acatech 2014.



Resilience

Resilience is the ability to prepare for and cope with sudden and hard to foresee adverse events (shocks), and use the lessons learnt to adapt and improve the relevant systems. Resilience is not a static condition, it is a continuous process.

crisis, a resilient society should be able to gather empirical evidence about its impacts. It should also continuously monitor and analyse whether and how the various adaptation strategies and measures are working. Other important requirements include research and development into and implementation of resilient designs and construction methods for critical infrastructure (resilience engineering), strategies to sustainably strengthen citizens' self-reliance in the face of adverse events, and incentives for businesses to increase their resilience. Security research also has a part to play, while digital technology can help to strengthen the resilience of businesses, government agencies and other institutions.

Commissioned by the Federal Ministry of Health (BMG), this IMPULSE paper on the resilience of the healthcare system was

written between July 2020 and February 2021. It draws together the views of experts from science, industry and other institutions. Background research, exploratory interviews and online workshops were employed to build up a diverse picture of different opinions and experiences. The content was subsequently condensed in a series of feedback rounds with the project steering committee. Accordingly, this IMPULSE makes no claim to completeness and is not intended as a scientific paper. Drawing on some of the initial lessons that can be learnt from the COVID-19 pandemic, it is intended as a contribution to the discussion on what needs to be done to make the future healthcare system more resilient.

This IMPULSE sets out to answer the following question:

What lessons can be learnt from the current crisis, and what improvements are needed to make the healthcare system more resilient and improve its performance?

Measures to strengthen the healthcare system's resilience can be taken in a number of different areas. These include **information and communication** (Chapter 2), the **structure of the healthcare system and its strategic reserves** (Chapter 3) and the relationship between the **relevant institutions** (Chapter 4).

2 Information and communication

The current COVID-19 pandemic illustrates how data and information play a key role in successfully coping with and containing a crisis situation. The EU's member states already share data with each other today. For a number of years, both Germany and the EU have been investing significant sums of money in the creation of common digital spaces and data spaces, and these efforts are now starting to pay dividends. Nevertheless, the quality and detail of health data must be further improved throughout the EU to ensure that the data collected and the lessons learnt can be used to rapidly identify the optimal countermeasures and enable an appropriate response to the pandemic. The collection and analysis of additional data specifically focused on the current situation is urgently necessary as part of this process. The following information and communication measures can help to strengthen the resilience of the healthcare system. The measures have been broken down into different areas:

Digitalisation

- A **data space architecture** with common (data) standards should be established, that can be used throughout Europe as a basis for data collection, consolidation and analysis and the dissemination of information in the event of a crisis. This will require a trusted data protection framework with transparent governance (including data sharing regulations for private companies, e.g. in the medical technology and pharmaceutical industries, and for research institutions). At the same time, software independence and hardware sovereignty should be promoted through the *Strategic Forum for Important Projects of Common European Interest* (IPCEIs).
- **Electronic patient records** should continue to be developed at European level, addressing issues such as portability and interoperability, medical image sharing, lab results, simplified data sharing/viewing during virtual consultations, etc. Criteria should be established for evaluating the benefits of digital health applications. The healthcare system's telematics infrastructure (TI) should be expanded under the auspices of Germany's Digital Healthcare Act (DVG). It should be mandatory for hospitals, doctor's surgeries and pharmacies to be connected to the TI, while connection could be voluntary for midwives, physiotherapists, care homes and rehabilitation facilities.

Research networking

- The further expansion of the existing COVID-19 **research network** is an important first step in the development of a national research data infrastructure. The knowledge sharing between Germany's university hospitals that this enables will serve to pool and strengthen research into tackling the current pandemic. The Federal Ministry of Education and Research (BMBF) has awarded the network funding to the tune of almost EUR 300 million.
- All (research) data generated and collected should be incorporated into the **European Health Data Space**. One possible blueprint is the *Health Data Hub* (HDH), a nationwide data platform established by the French government as part of its *National Health Strategy 2022* with the aim of facilitating the exchange and use of big data in the healthcare system. There may be an opportunity to generate synergies in this context.
- **The relevant data** includes people's mobility, contact and reporting data, identified chains of infection, the pathogen's molecular biology data such as its genome sequence and the complete microbiome and/or virome of the test sample, and the patient's molecular biology data (genome, transcriptome, proteome, etc.) and clinical data (although accessing this can be difficult due to data protection regulations).
- The **translation of research findings** from science and industry into community practice should also be strengthened. This will require a functioning and reliable digital infrastructure. Different national strategies should be evaluated to determine how to proceed on this front.
- Data protection compliant **artificial intelligence (AI) techniques** should be employed to pool patient data and enable data-driven healthcare. AI supports faster and more efficient diagnosis, as well as predictive capacity management for acute cases and follow-up of recovered patients. The application of AI techniques to the analysis and utilisation of CT data can also be extremely valuable for predicting individual patients' disease progression and thus for enabling better patient care.²
- A **global research sharing platform** could also be established. The EU project SAPEA (Science Advice for Policy by European Academies) could provide a starting point for an appropriate platform.



Voluntary vs. mandatory data sharing

- In global disaster scenarios such as pandemics, the necessary **information sharing efficiency** cannot be achieved on a purely voluntary basis. If a lack of data is making it impossible to combat the pandemic, compulsory data sharing may need to be considered as a last resort. However, this will require high data protection standards.
- It will also be necessary to establish **transparency mechanisms** that make it easy for people to see how their data is subsequently stored and analysed.
- Finally, it will be essential to guarantee that (voluntarily or compulsorily) shared personal data can only be used for very limited and clearly defined purposes.
- Industry should also be granted access to (health) data so that it can develop innovative, future-proof AI solutions and algorithms.

Indicators for combatting the pandemic

- Indicators should be used to provide a picture not only of infections but also of capacity for treating serious and critical cases, contact tracing capacity, the interruption of chains of infection, and virus monitoring (for example by testing representative samples). A European committee of experts on combatting the pandemic could clearly define

the relevant indicators, adjust the weighting of different indicators to the current situation, and communicate them to the public.³

Public communication

- Restrictions of fundamental rights in the interests of public health must be continuously and carefully weighed up and reviewed to ensure their proportionality. Government should only be allowed to curtail civil liberties if doing so is necessary to prevent the healthcare system from being overwhelmed. The measures taken by government to maintain healthcare services and avoid having to make difficult decisions about which patients to treat should be based on a multi-dimensional risk analysis that includes all the relevant perspectives and risks. The policymaking process should be communicated completely transparently so that the public accepts and supports the measures in question.
- This means that decisions must be taken transparently and communicated using insights from communication psychology. In other words, government's communication strategy should be designed to allay the public's fears. Communication, cognitive and behavioural scientists should develop communication tools that reflect the state of the art in communication research in terms of ease of understanding and suitability for the relevant target groups.

3 | For additional indicators, see the recent study by Schrappe et al. 2020.

3 Structure of the healthcare system and strategic reserves

The capacities and structures of the healthcare systems in the European Union vary significantly, as illustrated by the different numbers of intensive care beds, for example. There are healthcare systems

- that provide mainly outpatient care,
- that provide inpatient and outpatient care together in local medical centres, and
- that provide separate specialist inpatient and outpatient care.

Even within the German healthcare system, there are regional differences in care provision. And yet, the healthcare system's structures are key to its ability to cope with crisis situations. For instance, the evidence gathered so far indicates that the pandemic is contained more effectively if testing and the treatment of asymptomatic people and people with mild symptoms is carried out in an outpatient setting, and seriously and critically ill patients are treated as inpatients in tertiary care hospitals. As well as its reserve capacity, another factor that can be used to measure a healthcare system's resilience is its ability to rapidly switch from "normal" service to "crisis" mode.

In addition to the number of intensive care beds with ventilators, which has featured so prominently in the public debate, reserve capacity first and foremost includes the general availability of diagnostic and therapeutic medical devices, laboratory and testing capacity, the availability of drugs and vaccines and – most important of all – the healthcare system's staff resources.

The following measures are recommended to strengthen the healthcare system's resilience in the area of infrastructure and reserve capacity:

Medical care (including hospital and intensive care bed capacity)

- Outpatient **care structures** (community health centres, outpatient surgery centres) should be strengthened so that a certain number of medically necessary elective operations

can still be carried out, even during a pandemic. It is important to ensure that hospitals can keep providing the best possible standard care for serious acute and chronic conditions (oncological diseases, cardiovascular diseases, neurological disorders, etc.). This will require them to carefully weigh up when to switch between elective, primary and pandemic care mode, based on patient numbers and incidence rates in their catchment area.

- The German government should appoint a crisis management team that includes hospital representatives alongside other actors. The team should develop a strategy for pandemic situations that makes it possible to rapidly repurpose acute and intensive care capacity, including the technologies required for precision diagnosis and personalised medicine. Treatment of seriously and critically ill patients should be consolidated in tertiary care hospitals, and **patient flows** should be diverted to facilities with spare capacity.
- **Artificial intelligence** techniques can save resources by providing efficient support for decision-makers. For example, if the maximum hospital and intensive care bed capacity is known, mathematical models and algorithms can be used to predict hospital occupancy for different infection dynamics and associated case numbers. Regional strategies can then be developed, although it is important to ensure that they also fit into the overarching infection picture. The predictions can only be short-term and must be continuously adjusted to reflect the latest developments in the pandemic, which can alter rapidly as a result of policy measures, changes in people's behaviour and other factors. Complementary modelling approaches that can provide a more detailed reflection of factors such as the local demographic structure, labour market and education landscape would also enable accurate predictions for individual regions.
- It is recommended that **model-based predictions** should be employed to plan (reserve) capacity. The models should cover different scenarios and eventualities, for example different modes of viral transmission or the periodic pattern of pandemics. Algorithms and intelligent decision support systems can assist with diagnosis and treatment decisions throughout the disease-specific clinical pathway and provide clinicians with faster, more precise and more treatment-focused recommendations. Applications of this kind employ data integration and AI to enable personalised and standardised patient management. Key performance indicator analysis provides valuable insights into how processes can be optimised.



- Digital twins (**digital representations and models**) of hospitals could be used to simulate contamination risks, logistics flows and resource planning. Simulating how viruses spread through the air could improve our understanding and reduce the risk of infection for doctors, nurses and patients. This approach can also help with risk assessments for
 - the construction of new healthcare facilities (field hospitals, etc.),
 - the repurposing of existing healthcare facilities and intensive care units, and
 - room layouts within facilities (bed positioning, room disinfection, occupancy limits, etc.).

Medical technology, laboratories and testing capacity

- **Networking of medical actors and devices:** The different actors and institutions can exchange and use data to improve the quality of medical care. They can also analyse the utilisation of their medical devices and give devices that they do not require to other facilities where they are urgently needed. This networking could take place at both national and EU level.
- The available **medical technology solutions** should be expanded, modernised and digitalised. For example, the use of artificial intelligence in the field of imaging can enable completely new and flexible diagnostic and therapeutic approaches and also save the healthcare system money.
- Laboratories should keep exploring new **testing procedures** and methods, and the public sector should create a financial framework that allows them to do so. In addition, networking and closer cooperation between laboratories and health authorities is necessary in order to prevent a backlog of tests. Simple, automated, less labour-intensive testing procedures and rapid tests should also be developed, while mobile labs and testing units are required for flexible deployment in local hotspots, at airports and in care and nursing homes.
- During a pandemic, it is also necessary to increase investment in **precision and preventive medicine** in order to ensure that every patient receives the right treatment at the right time.

Reserve capacity for strategic drugs and medical devices

- It is recommended that an expert committee should be appointed to advise on the **supply of critical drugs and medical devices** required by Germany and the EU. When analysing the required supply of drugs, the experts could draw on existing lists of critical drugs from other countries, and on a list drawn up by the Federal Institute for Drugs and Medical Devices (BfArM) that catalogues supply-relevant agents. BfArM has established an advisory board in which representatives of the key associations, organisations and authorities discuss delivery and supply shortages.⁴ The advisory board should cooperate and join forces with higher-level bodies, for example at EU level. A survey of hospitals, health insurance providers, medical associations, translational research institutions, and medical technology and pharmaceutical companies could help to complete the needs assessment and inventory taking process.
- Globalised supply chains mean that it is unrealistic to expect Germany and Europe to be completely self-sufficient. Consequently, it makes sense to build up stocks of a manageable portfolio of medical and intensive care products for a limited period of time. All countries should maintain **minimum stocks of drugs and other resources** as a central part of their crisis management system. To ensure that they are well prepared for future pandemics, they should also build up a basic stock of the materials needed to produce diagnostic tests. Although new tests must be developed to detect new pathogens, molecular and serological tests are based on just four standard formulations – one for molecular tests and three for antibody tests – that can be rapidly adapted to new pathogens. In this context, it is necessary to strike a balance between public health and industrial policy interests.
- The establishment of a **mandatory common European electronic reporting system** for the procurement and availability of drugs and medical devices would also help to determine the relevant requirements. AI solutions could help to optimise this system, which would require binding common European rules for reporting to the responsible national authorities. In other words, pharmaceutical companies, wholesalers and pharmacies throughout Europe should be required to report existing or impending shortages to the responsible authorities. Since delivery shortages do not necessarily equate to supply shortages, the drugs, agents and medical devices that are supply-relevant should be jointly determined at European level.

4 | In accordance with § 52b(3b) of the Medicinal Products Act, which addresses supply and delivery bottlenecks.

- Imaging systems are one of the most important specific **medical devices** for which stocks should be built up, since without them it is almost impossible to comply with the relevant patient treatment guidelines. These systems include X-ray machines and CT, MRI and ultrasound scanners. However, it is important to bear in mind that many medical devices can quickly become obsolete due to the fast rate of innovation. This can make it difficult or even impossible to build up longer-term stocks.
- It is also necessary to build up **stocks of laboratory equipment, analysers** and the relevant test materials. Hospitals should equip their wards and operating theatres with the medical devices identified by disaster medicine experts as urgently necessary for treating patients. These include e.g. monitoring equipment and ventilators, and appropriately equipped surgical units. Government must either create the financial framework needed to make this possible or make the necessary funding available. All stocks should be centrally managed and distributed among the regions in a manner that ensures their availability at all times. It is also vital to maintain stocks of personal protective equipment for medical, nursing and service staff, while specialists should be exempted from travel restrictions. This will require national health management emergency response plans based on EU guidelines and plans.
- Sufficient stocks of personal protective equipment should be built up to bridge the gap until the start-up/ramp-up of production in Europe.

Security of supply and supply chain diversification

- **Europe's production capacity** should be strengthened. This also includes securing supply chains, where necessary in cooperation with third countries, in order to facilitate trade flows. The European Commission has already taken the first step with the adoption of a guidance note making the exportation of certain products subject to export authorisation. Its aim is to preserve the integrity of the single market, and more generally the production value chains and distribution networks, and to secure the supply of the necessary items to the healthcare system.⁵ It is also necessary to safeguard "virtual" value creation in the field of software engineering, which has been outsourced in recent decades, mainly to Asia. It will not be possible to reshore this know-how in the short to medium term. The Foreign Trade and

Payments Ordinance is an instrument that allows Germany to define strategically relevant industries and production sectors and prevent them from being "accessed by countries outside the European Union". The "Europeanisation" of this type of instrument should be discussed at EU level.

- **Supply chain diversification** is desirable in principle, although it will not be possible for all the relevant commodities. When reviewing supply chains, it will be important to ensure that critical components are safeguarded, for example through backup suppliers, local and regional sourcing and domestic production.⁶
- By **cooperating with the private sector**, Germany can draw on industry's know-how of the production, storage and distribution of the relevant materials in order to ensure that a stable domestic supply is maintained during a pandemic. For example, manufacturers could pledge to maintain stocks of the materials required for diagnostic tests or the production of personal protective equipment. The public authorities could then call on these supplies as and when necessary. A partnership of this nature would significantly reduce wastage of materials that have to be thrown away because they are past their expiry date. The fact that the private sector can manage materials to ensure that they are used before their expiry date and can build up new stocks at any time would ensure that an adequate supply was always available.
- Support can be provided by **digital solutions** such as e-labels (eIFUs, Electronic Instructions for Use) and data platforms that record the products' distribution. However, it is important to ensure that simplified regulatory procedures do not undermine patient protection standards.

Framework for innovation

- In order to strengthen European cooperation in innovation networks, it will be necessary to establish an **innovation ecosystem** to promote entrepreneurship and innovation. Relaxation of the regulatory framework would help to promote company start-ups. A venture capital fund could help to maintain companies' liquidity while they are working on innovations but are not yet able to generate a return on investment. A government investment initiative could foster innovation, research and development. Agile public-private partnerships could also be used to encourage technological innovations.

5 | See BVMed 2020.

6 | See Kagermann et al. 2021.



- The development of a **European Vaccine Initiative** (modelled on CEPI) should be accelerated so that urgently needed vaccines become available more quickly. The Coalition of Epidemic Preparedness Innovations (CEPI) is an example of the impressive progress that can be achieved through multilateral cooperation. Thanks to this initiative, it has proven possible to cut the time needed to develop a vaccine from around seven years to between 12 and 18 months. Policymakers would therefore be well advised to discuss a European Vaccine Initiative in order to ensure that Europe is better prepared for the next pandemic. The details should be worked out among representatives of science, industry and government. While strengthening research, science and production in Germany and Europe cannot completely eliminate shortages and dependencies, it can increase the resilience of countries' own systems.

Personnel

- A central **database of medical personnel** and people formerly employed in the healthcare sector would provide a clear picture of personnel availability and facilitate their targeted deployment. The database should also include details of medical professionals' specialist skills and education. Ongoing training and cross-departmental professional development can facilitate flexible staff deployment. Staff should also receive regular training on how to maintain healthcare services in different disaster scenarios. Hospitals should make greater use of robotic and telemedicine solutions to minimise the risk of infection for medical personnel.
- The Pact for the **Public Health Service** (German: Pakt für den Öffentlichen Gesundheitsdienst) aims to modernise and network local health authorities throughout Germany and increase their staff numbers. The IT infrastructure must be upgraded and expanded without delay so that the health service can share information more quickly and coordinate measures more efficiently. In crisis situations, mobile task forces should provide additional support to prevent hospitals from being overwhelmed. The task force members could be recruited from the medical staff of the armed forces or aid organisations. At European level, a mobile *EU Health Task Force* could be established at the European Centre for Disease Prevention and Control (ECDC) to provide disaster medicine support in regions that are under particularly severe strain.
- The manner in which the **general public** is mobilised during a crisis situation should be reviewed. It will be necessary to expand and make greater use of digital solutions for training, recruiting and deploying voluntary helpers. Apps can be used to help the volunteers make arrangements among themselves and for communication with the civilian population. Digital training could be made available to medical personnel and to the general public.

4 Relationship between the different institutions and actors

During the pandemic, the Robert Koch Institute (RKI) has been perceived as the leading crisis response centre by the German public. The core mission of the national public health centre – a role that is at present largely being performed by the RKI – is to detect, prevent and combat diseases, especially infectious diseases. Various other agencies also play an important role in combatting pandemics, as illustrated in Figure 3. The multitude of different actors at national and regional level hampers targeted emergency response coordination. For instance, because of its legal structure, the Federal Office of Civil Protection and Disaster Assistance (BBK) has only been able to make limited use of its existing infrastructure. In accordance with the International Health Regulations (IHR), the Joint Reporting and Situation Centre of the Federal Government and the Länder (GMLZ) is the national IHR focal point in Germany and the point of contact with the WHO. The BBK runs the GMLZ, which comes under the responsibility of the Federal Ministry of the Interior (BMI). However, the German Infection Protection Act (IfSG) confers certain roles and responsibilities in connection with infectious diseases on the RKI. Communication and education with regard to (infectious) diseases should be coordinated by a central actor, especially in acute crisis situations. For instance, it might be possible to strengthen the role of the Federal Centre for Health Education (BZgA) in order to ensure that public information is as centralised and consistent as possible.

The central institutions for international health threats are the European Centre for Disease Prevention and Control in Europe, and the World Health Organisation (WHO) at a global level. By supporting research, dialogue and harmonisation, these institutions play a key role in combatting pandemics and networking the relevant actors. In view of the international threat posed by viruses and bacterial diseases, measures and reforms should address not only the national perspective but also the European and international dimensions. The COVID-19 pandemic has exposed the limitations of European and indeed national federalism and highlighted friction between the different levels. It is thus necessary to establish whether there are any ways in which federalism can strengthen resilience, or whether certain federalist principles are actually a barrier to a resilient healthcare system.

In the interests of credibility and transparency, pandemic plans and the actions of federal authorities should be consistent with the regulations and measures adopted at higher levels. In other words, the smaller unit should always be guided by the larger unit when implementing its measures. Efficient structures and appropriate measures for the crisis in question can be ensured by clear allocation of responsibilities and by European guidelines that provide a common point of reference for all the institutions and authorities in the individual member states. Transparent structures and a consistent approach can also help to increase public acceptance. All the national authorities should therefore cooperate closely with the relevant European partners and agencies. Better coordination among the EU member states, for example with regard to European drug pricing policy or similar payment models, will ensure that the European healthcare system is better prepared for future pandemics or other similar crises.

Implementation of the following recommendations would help to improve coordination of the relevant actors and facilitate the interactions between them:

- The **World Health Organisation (WHO)** could be established as the coordinating institution for R&D initiatives in the field of public health. To do this, it would require a more transparent and accountable governance structure. Once this was in place, it would be able to award research funding independently, and it would also be possible to consider extending the WHO's mandate, making it into a regulatory and normative agency with a policy emphasis.
- The role of the relevant European institutions should be analysed and strengthened. This applies in particular to the **European Centre for Disease Prevention and Control (ECDC)**, so that it is better equipped to perform the role of a European crisis management centre. European research networking should also be strengthened and expanded through the *Joint Research Centre (JRC)*.
- A **comprehensive analysis of the areas of expertise of the relevant federal and regional agencies** should be carried out so that their profiles can be refined. The relationships between the federal and regional ministries and their agencies should also be defined clearly and transparently. A review of crisis communication competence and internal mobilisation times in the event of a crisis should be conducted for all the relevant departments.

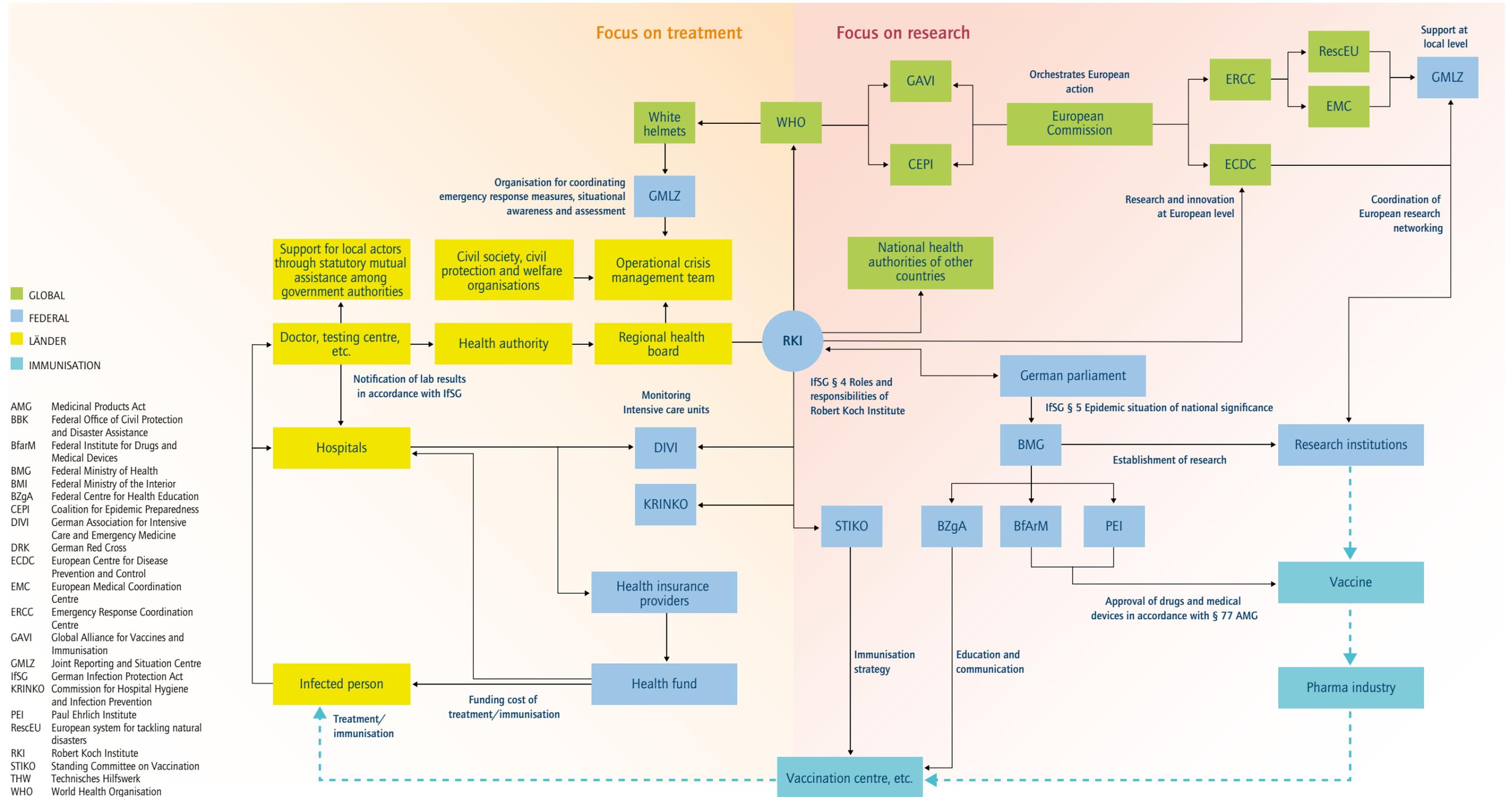


Figure 3: Relationship between the different actors (source: authors' own illustration)



5 Conclusion and outlook

This IMPULSE publication clearly demonstrates that strengthening the resilience and adaptability of the healthcare system so that it can cope with future challenges is a continuous process. While the proposals brought together in this document are not exhaustive, they do highlight some relevant starting points and potential solutions for creating a more resilient healthcare system. It is essential to prepare the healthcare system for new challenges by pressing ahead with its digitalisation, ensuring access to robust data, coordinating its processes and taking the human factor into account, not just as a vital resource but also in terms of respect for people's fundamental rights and freedoms. The lessons learnt from the COVID-19 pandemic do allow concrete recommendations to be formulated about how best to prepare for potential crisis scenarios. However, it is not possible

to predict the exact nature of the next crisis,⁷ since global health depends on the interactions between humans, animals and the environment.

It is vital to ensure that the measures to tackle the acute pandemic phase and the preparations for future crisis situations do not overlook the human factor – people must be at the heart of all these actions and must be afforded better protection through stronger preventive health measures. While this of course applies to medical personnel, there is also a need for appropriate measures and systems to raise awareness of future threats among the general public and ensure that they are better equipped to cope with them. One-off measures will not suffice – rather, it will need to be a process that harnesses current and future technological solutions, anticipates developments in scientific knowledge and takes account of changes in society.

7 | The WHO drew up a list of potential threats and disaster scenarios in 2019 (WHO 2019).

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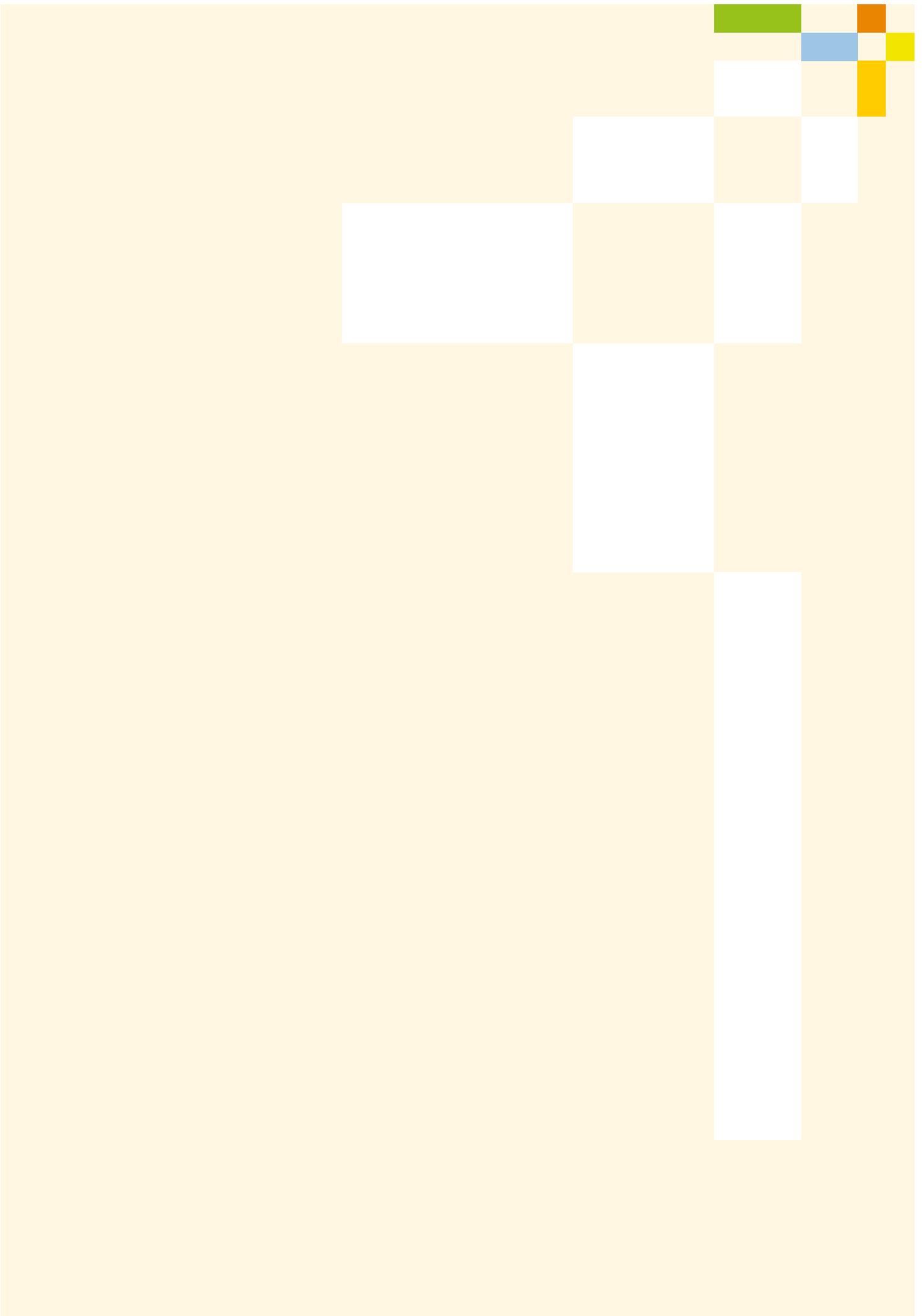
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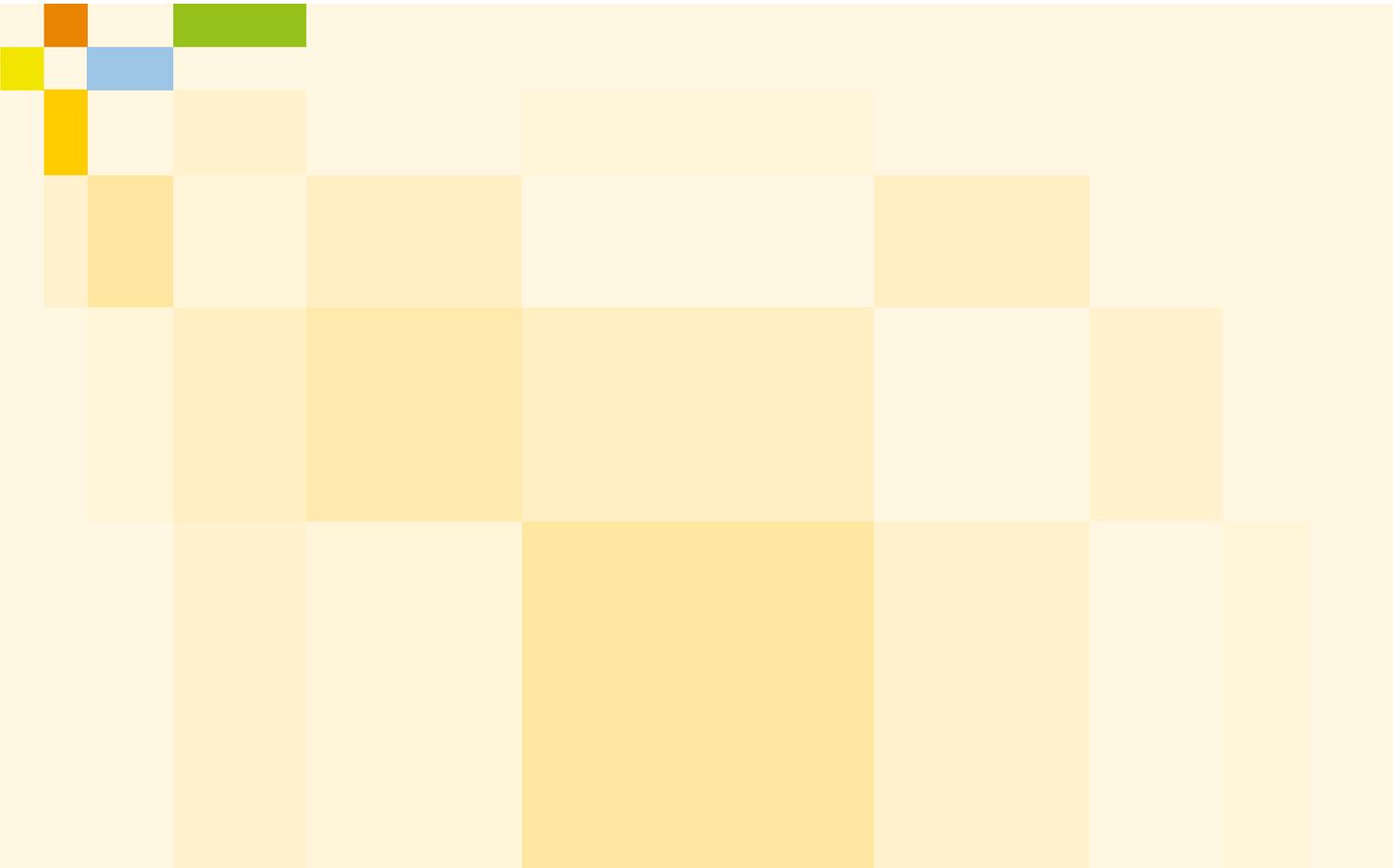
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According to the recommendations of an interdisciplinary group of experts led by Karl-Heinz Streibich and Thomas Lenarz, digitalisation, networking and increased innovation and cooperation can help to ensure that the healthcare system is better prepared for future crises. Their analysis of the COVID-19 pandemic also shows that one of the keys to strengthening resilience is the collection and sharing of data relevant to studying and combatting the crisis and adapting the corresponding measures. Other key pillars of an adaptable, resilient healthcare system that is able to cope with future challenges include the accumulation of strategic reserves, the development of an innovation ecosystem and appropriate public communication strategies.