

TECHNICAL REPORT

Lessons from the COVID-19 pandemic

May 2023

ECDC TECHNICAL REPORT

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Acknowledgements

ECDC would like to thank all the participants, chairs, presenters, moderators, and rapporteurs who attended the country meetings and the lessons learned expert meeting for their contributions, as well as all ECDC staff involved in the lesson-identifying activities.

Suggested citation: European Centre for Disease Prevention and Control. Lessons from the COVID-19 pandemic. Stockholm: ECDC; 2023.

Stockholm, May 2023

ISBN 978-92-9498-634-4

doi: 10.2900/151256

Catalogue number TQ-07-23-183-EN-N

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Abbreviations

AAR	after-action review
CPD	continuous professional development
DG SANTE	Directorate General for Health and Food Safety
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EEA	European Economic Area
EPIET	European Programme for Intervention Epidemiology Training
EU	European Union
EUPHEM	European Programme for Public Health Microbiology
HERA	Health Emergency and Response Authority
IAR	in-action review
ICU	intensive care unit
IHR	International Health Regulations
IPC	infection prevention and control
IT	information technology
JEE	joint external evaluation
LTCF	long term care facility
MediPIET	Mediterranean Programme for Intervention Epidemiology Training
MoU	memorandum of understanding
NFP	national focal point
NPI	non pharmaceutical intervention
PPE	personal protective equipment
WGS	whole genome sequencing
WHO	World Health Organization

Executive summary

This document aims to collate and present the lessons identified from the public health stakeholders who responded to the COVID-19 pandemic. It is intended to serve as input for countries revising their pandemic or emergency preparedness plans.

A structured review of the response to a public health threat in order to learn lessons for future response should be built into the continuous preparedness cycle of anticipation, response and recovery from an incident. The COVID-19 pandemic presents a unique example of public health response to a severe incident and lessons should be quickly identified and used for the updating of pandemic preparedness plans. After-Action Reviews (AAR) and In-Action Reviews (IAR), for which ECDC has developed guidance, are valuable tools to assist countries in this process.

During 2021 and 2022, ECDC carried out a number of activities to identify lessons and collect insights from the response to the COVID-19 pandemic. These activities took the form of an internal exercise with ECDC experts; a review of country lessons reports; discussions with the Member States and two consultation sessions: an expert consultation on the evaluation and implementation of non-pharmaceutical interventions (NPIs), and an expert meeting on lessons learned from the COVID-19 pandemic.

Lessons from these activities were collected systematically, initially in nine thematic areas. The information was then further collated into four lesson areas, each one representing a critical component of the response to a health threat:

- Lesson Area 1: Investment in the public health workforce
- Lesson Area 2: Preparing for the next public health crisis
- Lesson Area 3: Risk communication and community engagement
- Lesson Area 4: Collection and analysis of data and evidence.

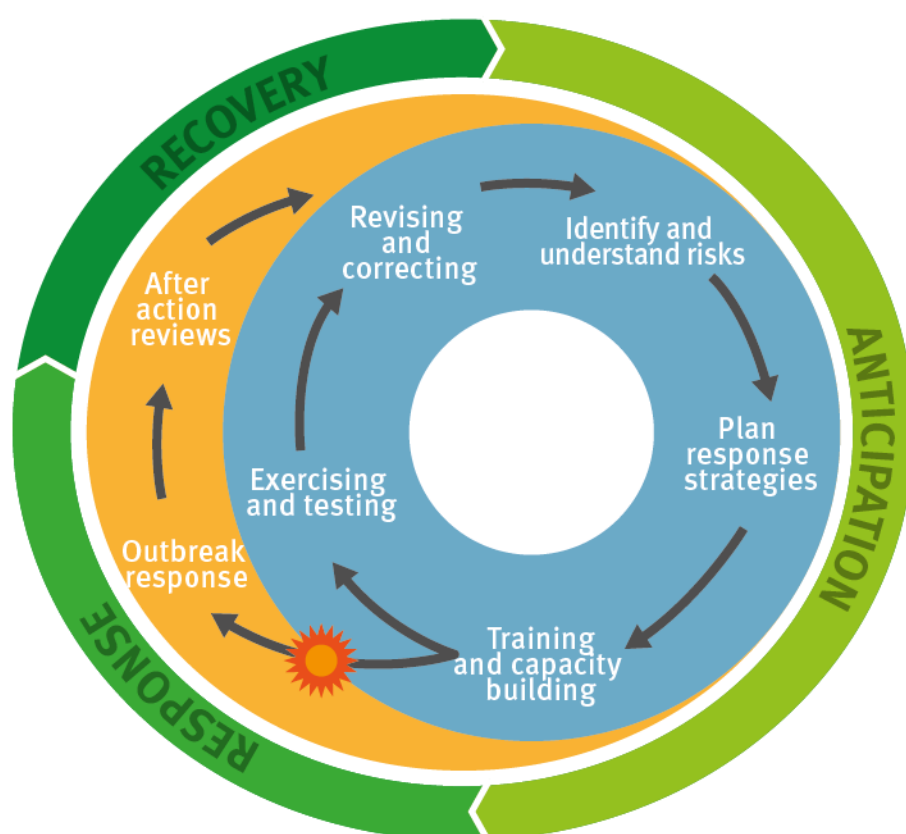
This report presents the lessons identified in each of the areas, together with activities and future action where ECDC can contribute. Discussions on the prioritisation of ECDC follow-up actions are ongoing with the countries of the EU/EEA (European Union/European Economic Area) through the ECDC networks and governing bodies.

1. Background

On 31 December 2019, a cluster of pneumonia cases of unknown aetiology was reported in Wuhan, Hubei Province, China. On 9 January 2020, China CDC reported a novel coronavirus as the causative agent of this outbreak, coronavirus disease 2019 (COVID-19) [1]. This was the start of what would become the COVID-19 pandemic, with over 763 million confirmed cases and over 6.9 million deaths reported globally, up to 16 April 2023 [2]. The global response to the COVID-19 pandemic led to the introduction of a wide-range of non-pharmaceutical interventions (NPIs) and the rapid development of pharmaceuticals (antivirals, monoclonal antibodies and, most importantly COVID-19 vaccines) to control the outbreak. Obtaining insights on the necessity, effectiveness and effects of these response measures should be part of a lessons learned process, as described below.

The preparedness and response cycle (Figure 1) should be seen as a continuous process of planning; identification and prioritisation of risks; training and simulation exercises; after action reviews; evaluation of lessons learned, and implementation of the required organisational actions and changes. A lessons learned process, defined here as the structured review of the response to an emergency, should be incorporated into preparedness plans. Structured review of the response to an emergency, or to a health threat in the case of public health, facilitates analysis of what went well and what did not go so well in the response and identification of areas for improvement or change in the future.

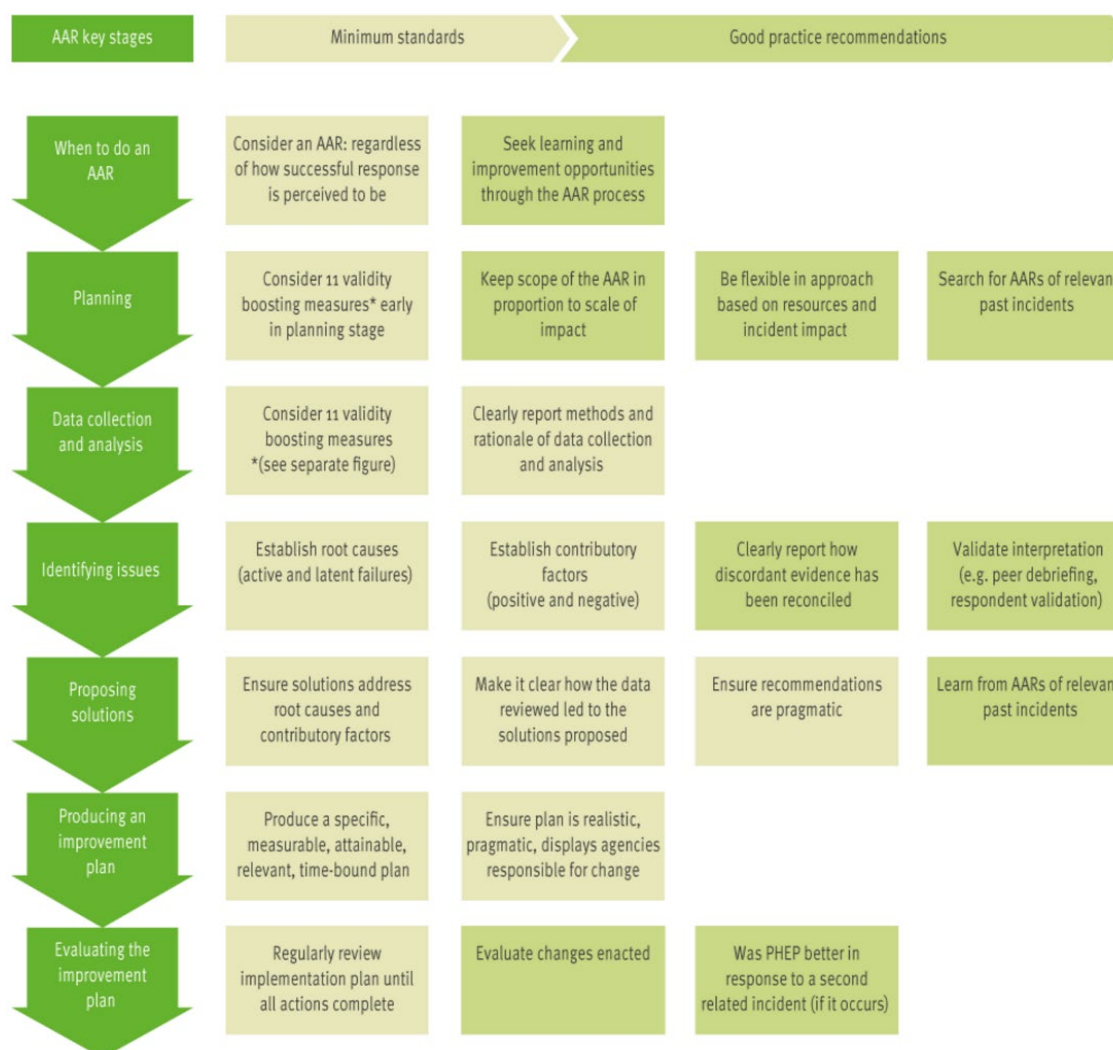
Figure 1. The preparedness cycle



Source: ECDC

Tools such as In-Action Reviews (IAR) and After-Action Reviews (AAR) can assist the identification and collection of lessons learned from the response to an incident. Figure 2 shows an overview of the best practice framework for conducting AARs, produced by ECDC [3]. This framework can be consulted when choosing a methodology. ECDC has also developed a short guide to conducting IARs focused on COVID-19 [4].

Figure 2. Best practices framework for undertaking an after-action review



Source: ECDC

Such reviews should be undertaken as soon as possible after the response as memories fade quickly and staff change positions in organisational structures. A review should not aim to put blame on teams or individuals, but rather it should provide evidence for changes needed in processes, legislation or guidelines. The lessons identified and any subsequent recommendations should be documented, prioritised, implemented and re-evaluated at regular intervals. For the whole process to succeed, there is need for to foster a culture of learning at the organisational level, to have a clear governance of the process and to ensure that it is well-documented, so that progress and improvements can be monitored. The ECDC expert consultation on the implementation and evaluation of NPI measures, organised in June 2022, emphasised the need to conduct structured 'lessons learned' exercises and after-action reviews to identify good practices, challenges, and priority issues related to the COVID-19 pandemic. This should be followed by the necessary revisions to preparedness plans and crisis management structures [5] (see Section 2.3 and Annex 3).

2. Methods

ECDC collected lessons from the response to the COVID-19 pandemic by means of several activities using qualitative and quantitative methods, as well as the tools in the IAR guide [4], both internally at ECDC and with the help of the EU/EEA countries.

2.1 Internal exercise to identify lessons by ECDC experts

In 2021–22, an internal exercise to identify technical lessons was undertaken with the participation of ECDC experts and scientific staff who had been working on the response to the COVID-19 pandemic. One hundred ECDC experts participated in this exercise, and they identified and prioritised more than 120 technical lessons relevant for both ECDC and the EU in general. These lessons have been included in the same framework along with the lessons identified by the countries.

For more information on this exercise please refer to Annex 1.

2.2 Lessons from EU/EEA countries

Missions to EU countries

As part of the efforts to further strengthen future pandemic preparedness, ECDC visited six EU/EEA countries between June and September 2022: Austria, Estonia, Finland, Greece, Latvia and Romania. These Member States accepted the ECDC initiative and responded positively to the proposed visit by experts from the Agency, to facilitate high-level discussions on lessons learned from the COVID-19 pandemic, including international coordination and recommendations for future ECDC support. Each country mission consisted of one- or two-day visits to the host country's Public Health Institute and/or Ministry of Health by a team of one-to-three ECDC experts.

The aim of these missions was to gain insight into the country's response to COVID-19 by bringing together national stakeholders from different sectors, including areas outside of the public health sector. The idea was to discuss and share their experience of the challenges encountered during the COVID-19 pandemic and highlight their successes. The visits were also an opportunity for Member States to provide feedback and offer insight into their expectations from ECDC, in terms of support or guidance during the pandemic; identify areas where ECDC did not meet, or exceeded those expectations, and specify where ECDC can provide support to strengthen future pandemic preparedness.

A questionnaire consisting of open-ended questions (see Annex 2), based on the IAR guide produced by ECDC [4], was distributed in advance of each visit to facilitate high-level discussions. This included questions on pandemic governance, preparedness and response strategies, policies and legislation, crisis management and international coordination. Where possible, the ECDC team included expertise on specific technical areas, requested by the host country, for further discussion (e.g. surveillance, travel measures, etc.)

Review of country reports

A review of grey literature on lessons learned from the COVID-19 pandemic at country level was carried out by examining published reports. An extraction sheet was used to collate data from reports published by twelve EU/EEA countries (Austria [6], Denmark [7], Finland [8], France [9,10], Germany [11,12], Greece [13], Ireland [14], Italy [15], Latvia [16,17], Lithuania [18-20], Norway [18-20], Sweden [21]).

Reports were included in this exercise if they explicitly described the country response to COVID-19. Relevant aspects were extracted and listed – e.g. information on the main findings, key recommendations, strengths and weaknesses and lessons learned. The collection of further reports is ongoing.

2.3 Expert meetings

In June and September 2022 respectively, two large meetings were organised by ECDC, aiming to bring the national focal points together with other experts to collect information from NPI implementation and lessons learned during the COVID-19 pandemic.

ECDC hosted an **Expert Consultation on the Implementation and Evaluation of Non-Pharmaceutical Interventions (NPIs)** in Stockholm during the period 1–3 June 2022. The meeting brought together 49 external participants (experts from various countries in Europe, Canada and the US, representing a wide range of partners and stakeholders) and 26 ECDC experts. The meeting was also attended by representatives from the European Commission's Directorate-General for Health and Food Safety (DG SANTE), WHO's Health Emergency Programme and WHO's Regional Office for Europe.

Discussions were designed to be open-ended in order to capture a broad range of issues that international and national public health organisations, research communities, and governmental organisations in other sectors might take forward in their activities related to the COVID-19 pandemic and pandemic preparedness planning. The consultation was designed to hear from participants about their experience, insights and expert opinions on the many different aspects of NPIs, not just the medical but also the wider perspectives. For this reason, the format of the meeting included plenary panel discussions and parallel working groups, organised in three workstreams: NPI effectiveness, NPI cost effectiveness and social impacts, and behavioural insights and adherence to NPIs.

On 28 and 29 September 2022, a second expert meeting was organised in Stockholm - **Lessons Learned from the COVID-19 Pandemic**. This meeting brought together around 85 participants from the EU/EEA and neighbouring countries, and the United States. It also included representatives from the Africa Centres for Disease Control and Prevention (Africa CDC), the European Commission's DG SANTE Health Security Unit, the European Commission's Health Emergency Preparedness and Response Authority (HERA), the European Foundation for the Improvement of Living and Working Conditions (EUROFOUND), the Observatory on Health Systems and Policies, WHO's Regional Office for Europe and over 35 ECDC staff members.

The meeting aimed to share country experiences and foster discussions on priorities and needs for future emergency preparedness, including sessions on global and regional lessons learned from European projects and initiatives and on country perspectives. The meeting consisted of presentations, panel discussions, breakout sessions and working groups.

On the first day of the meeting, global and regional lessons learned were shared and this was followed by a panel discussion. ECDC then shared the overall regional lessons learned from the COVID-19 pandemic and outcomes from ECDC assessments, country visits, country reviews and lessons learned publications and this was followed by a panel discussion.

The second meeting day covered a session on European projects and initiatives, a session on country perspectives with a panel discussion, breakout sessions for the discussion of lessons learned by the countries and presentations from the breakout groups.

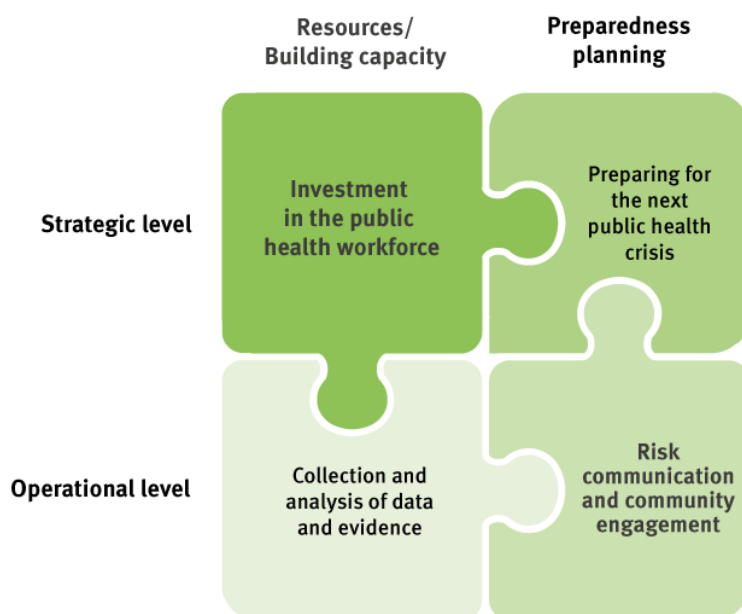
Please refer to Annex 3 for more details regarding both activities.

3. Lessons from the COVID-19 pandemic and the way forward

Lessons from all the above activities were collected under nine thematic areas: collection and analysis of data and evidence; enhancing the response capacity in the EU; networking, risk communication, behavioural and social science insights; decision-making processes; health system issues (including public health system); international coordination/collaboration and preparedness plans.

In a final mapping exercise, all lessons were reviewed and consolidated under four lesson areas, as outlined in Figure 3, to improve readability and understanding of the areas where issues were identified.

Figure 3. Lesson areas identified by ECDC from the COVID-19 pandemic



Source: ECDC

Each one of these four areas represents a critical component of the response to a health threat and has an independent role in the function of public health generally. However, all four areas are closely interconnected and could be considered under the overall heading of pandemic preparedness planning.

Looking at the lesson areas horizontally, the top line includes areas defined as strategic since they require organisational and political commitment and investment at national level. The bottom line represents operational-level areas - i.e. mostly lessons learned on the technical work in the public health sector.

Strategic level areas include:

- Lesson Area 1: Investment in the public health workforce.
- Lesson Area 2: Preparing for the next public health crisis.

Operational level areas include:

- Lesson Area 3: Risk communication and community engagement.
- Lesson Area 4: Collection and analysis of data and evidence.

Conversely, looking at the lesson areas vertically, they can be potentially grouped as resource/capacity building and preparedness planning, respectively.

Resource/capacity building areas include:

- Lesson Area 1: Investment in the public health workforce.
- Lesson Area 4: Collection and analysis of data and evidence.

Preparedness planning includes:

- Lesson Area 2: Preparing for the next public health crisis.
- Lesson Area 3: Risk communication and community engagement, although it should be pointed out that the Member States mentioned the need to strengthen capacity in this area.

The lessons identified under each of the areas, together with ECDC follow-up actions, are presented below.

Lesson Area 1: Investment in the public health workforce

Box 1. Main lessons and follow-up actions for investing in the public health workforce

Lessons identified by countries and the ECDC	ECDC follow-up actions
<ul style="list-style-type: none"> • Having sufficient numbers of trained public health staff is a critical need in almost all Member States for peace-time work, but particularly when responding to crises. • Staff working under significant pressure for prolonged periods of time has resulted in significant burnout, causing staff to leave the workforce or have a decreased capacity to work. • Reversal of budgets for public health activities to pre-pandemic levels in the coming years will negatively affect the retention of new staff employed during the pandemic. • Lack of resources at all administrative levels was reported by the countries, and this will have an impact on future planning activities. • Emergency procedures for surge capacity are required, including basic training of new staff. 	<ul style="list-style-type: none"> • Continue mapping the existing workforce through workforce capacity assessments and forecast Member State workforce needs in the EU, as well as developing country overviews. • Advocacy for recruitment and retention of an adequately skilled public health workforce at the national and international level, and for underpinning public health training programmes (e.g. through ECDC country visits and technical reports, and as part of the EU Global Health Strategy, in collaboration with WHO). • Continue investing in existing workforce capacity development projects and collaborations (i.e. ECDC Fellowship programme (EPIET), MediPIET, ECDC4Africa CDC, Global Field Epidemiology Roadmap and Global Laboratory Leadership Programme) to increase the quality and number of trained specialists for preparedness, surveillance, and response. ECDC will continue to offer EPIET, EUPHEM and MediPIET training programmes. • Advocacy and support for inclusion of processes to meet surge capacity needs as part of preparedness plans at all levels, national, local and EU. This should include mechanisms for mobilising young professionals, experts from countries not affected by the event, or retired staff. • ECDC will continue to offer short courses as part of Continuous Professional Development (CPD) for the European public health workforce, in accordance with training needs. • ECDC will continue to build its Virtual Academy (EVA) and offer free online courses and webinars on various public-health related topics for the European public health workforce. • A new training programme in the area of preparedness (2024) will offer a wide range of courses and workshops to strengthen preparedness capacity in the Member States. • Professional exchanges will be further supported. Participants will be selected via the National Focal Points (NFPs), depending on the Member State priorities. • Encourage Member State representatives taking part in various training activities to further disseminate the knowledge acquired to other colleagues within their organisations.

Having a strong, agile **public health workforce** which is trained and up-to-date in the use of new systems and methodologies is vital for implementing lessons learned and preparing for potential health crises. Public health and health system **resources** were mentioned as important issues across all activities to identify lessons learned. While the focus of this report is on the lessons for public health, the observed shortages of healthcare staff (nursing and medical health care workers) and hospital beds, and the need for surge capacity in these key resources, have also been identified as critical lessons learned from the response to the COVID-19 pandemic.

Here we refer in particular to public health professionals, including public health doctors, epidemiologists and all other specialists (e.g. public health/community nurses, health inspectors, public health microbiologists, statisticians, etc.) manning the public health systems in the Member States, and dealing with the detection and control of communicable diseases, health promotion and environmental health issues. In many EU/EEA countries, the public health workforce at federal, regional and local levels became depleted during the years of the EU financial crisis (2008–2014). A lack of sufficient staff and expertise in particular areas - e.g. the provision of advice/guidance on Infection Prevention and Control (IPC) - was also reported.

Without **investment in the retention, recruitment and training of public health professionals**, none of the other components in Figures 1 and 3 can function in a public health crisis. In addition, a demographic crisis is looming within the existing public health workforce in the EU which, along with the EU population, is ageing. Incentives to attract young professionals to the field of public health are urgently needed.

Many countries hired new temporary staff to help respond to the COVID-19 pandemic. Emergency hiring, as well as the need to train new recruits, put additional pressure on the regular public health staff. Surge capacity staff (e.g. volunteers from other sectors) also needed training and induction. These are issues that should be addressed in the preparedness planning at national level.

Unfortunately, according to country representatives, 'emergency staff' were considered unlikely to remain as permanent staff to reinforce public health structures. Short-term contracts, lack of sustainable funding, budgets which were already decreasing and reprioritisation of activities did not make public health positions attractive to new employees.

Burnout due to increased pressure and long working hours in a prolonged crisis environment, along with staff retirements have led to a diminished public health workforce. At the same time, it is recognised that, in addition to carrying out routine surveillance and response tasks, public health staff need to recover from the crisis and embark on work to prepare for future public health crises.

Some countries requested a set of minimum requirements for the national public health workforce, to determine the capacities and capabilities to complete peacetime tasks. Unfortunately, a lack of resources for future planning activities was repeatedly mentioned in relation to the implementation of lesson area 2.

Public health professionals work in various public health administrative systems in the EU/EEA countries, some centralised and some de-centralised at regional level. Several lessons were identified from both settings. In countries with a decentralised public health system, the harmonised collection of data and implementation of public health measures presented challenges. On the other hand, in centralised systems there were bottlenecks for decision-making and a handful of public health professionals were managing the needs of the whole country, which was not sustainable. In the event of a crisis, specific procedures are needed in both centralised and de-centralised systems to facilitate the public health sector response, and this should be implemented as part of lesson area 2.

Lesson Area 2: Preparing for the next public health crisis

Box 2. Main lessons and follow-up actions to prepare for the next public health crisis

Lessons identified by countries and the ECDC	ECDC follow-up actions
<ul style="list-style-type: none"> Updated, generic/all-hazard, flexible, scalable preparedness plans are needed. Formalise the role of public health in decision-making and crisis management structures. Intersectoral work in preparedness and response to public health crises is very important. Organise procedures to achieve surge capacity for staff (healthcare workers, public health staff) ahead of the crisis. Update legislation governing communicable disease control during preparedness planning, taking into account ethics/human rights, intersectoral effects and the outlining of responsibilities International cooperation, coordination and solidarity needs improvement. 	<ul style="list-style-type: none"> Develop guidance on generic preparedness planning, based on the lessons identified. Facilitate sharing of national preparedness plans among the Member States. Facilitate intersectoral advice and work with stakeholders and experts outside the public health sector. Organise a feedback mechanism for ECDC outputs. Provide assistance to conduct simulation exercises by offering staff, training or training material. Facilitate sharing of lessons learned from the COVID-19 pandemic among the Member States. Continue work with countries to perform In-action reviews and After-action reviews, as requested. Communicate and share results of systematic literature reviews on NPIs, lessons learned and other scientific questions on COVID-19 response. Facilitate evaluation and monitoring of the implementation of NPIs (e.g. development of guidance and/or training). Define indicators for preparedness planning. Assess Member State prevention, preparedness and response plans every three years.

Several lessons identified through the above activities refer to the existence of an **emergency plan**. Even though many countries had a pandemic preparedness plan available at the beginning of 2020, these were mostly influenza pandemic plans and, in many cases, they were outdated. According to the discussions with country representatives, the characteristics of an ideal preparedness plan are:

- that it includes various scenarios, even worst case scenario(s), and algorithms of response;
- that it addresses various pathogens and hazards;
- that it is flexible and scalable, depending on severity and duration of the crisis;
- that it addresses all-government intersectoral response with clear roles and responsibilities;
- that it address surge capacity issues for staffing;
- that it is tested through simulation exercises and updated regularly, including sectors beyond health;
- that it addresses risk communication, community engagement and community response extensively (see also lesson area 4).

In addition, one of the conclusions of the ECDC expert consultation on the implementation and evaluation of NPI measures [5], for the updating of the preparedness plans, is that they should **account for the implementation of NPIs**, based upon factors such as the phase of the pandemic, the expected effectiveness of the NPI in a given socio-economic and political context, behavioural insights, socio-economic impacts, and levels of uncertainty.

A group of lessons related to **decision-making processes** is included in this area, where countries reported the need to establish a **formal role for the public health institutes** in giving evidence-based advice and avoiding politicisation of this advice or the overall response to health threats. Better representation of public health expertise at higher levels in decision-making bodies and crisis management structures is required. Similarly, a clear distinction should be made between political decisions and expert opinions. Lack of evidence, competing or conflicting priorities and recommendations provided by different advisory bodies, unclear roles and the fragmentation of the health system slowed down decision-making or made it difficult during the COVID-19 pandemic.

The importance of **intersectoral work** was stressed in many lessons, from the regional to the inter-ministerial level, as was the need to embed this work in preparedness plans through memorandums of understanding, common exercises, etc. Advisory/pandemic committees should be intersectoral and risk should also be assessed across sectors, not only from a public health perspective. Intersectoral work will also assist during the recovery phase of the COVID-19 pandemic, such as when assessing the effectiveness of NPI measures for future reference. The importance of following and fostering a 'One-Health' approach in preparedness planning was also underlined for future preparedness needs, due to the high number of zoonotic health threats emerging and the many effects of climate change [22].

Another group of related lessons refer to emergency pandemic or **communicable disease control legislation**. Several countries reported that their legal frameworks and legislation governing the pandemic response was outdated or non-existent and that developing new legislation during the crisis added significant pressure. Therefore, it is important to consider the importance of having updated legislation governing the control of communicable diseases. This legislation should support emergency plans while taking into consideration human rights and data protection issues.

International cooperation and solidarity among countries is also important in this area and, reportedly, in many cases this was not optimal during the COVID-19 pandemic. International cooperation needs to be improved during peacetime, and agreements developed and implemented for the sharing of data, equipment and even resources.

Finally, many countries are currently considering developing and maintaining stockpiles of personal protective equipment (PPE), pharmaceuticals, testing and other equipment. These activities are being addressed at EU level by the European Commission's Health Emergency and Response Authority (HERA).

Lesson Area 3: Risk communication and community engagement

Box 3. Main lessons and follow-up actions for improved risk communication and community engagement

Lessons identified by countries and the ECDC	ECDC follow-up actions
<ul style="list-style-type: none"> • Risk communication and community engagement were identified as a significant challenge throughout the COVID-19 pandemic. • Communication capacity with the public and the media should be strengthened. • Management of media requests, and control of the mis-/disinformation put additional pressure on public health staff. In some cases, little or no skills or capacity existed in public health institutes for the management of misinformation. • The Member States and ECDC also identified the need to include behavioural and social science input in their guidance documents. • During the pandemic, there was a need for more coordination of messages at EU level. • Several needs for training were identified, along with different sets of guidance on risk communication and community engagement. 	<ul style="list-style-type: none"> • Organise trainings in risk communication for European public health professionals. • Foster social and behavioural research in preparedness planning and during response to outbreaks. • Coordinate a community of practice across the EU/EEA for behavioural and social scientists in public health. • Increase ECDC communication activities - e.g. production of videos, infographics and material that can be re-used by the Member States - and increase use of social media.

Risk communication and community engagement activities are critical during the response to outbreaks and a chapter addressing these is included in most preparedness plans. In reality, this area is part of Lesson Area 2, however, it has been consistently identified as the weakest point and/or the most significant challenge for countries responding to the COVID-19 pandemic. Risk communication has also been consistently identified as an area for improvement since the last influenza pandemic in 2009–2010, and following several simulation exercises carried out to date.

Public health institutes need to strengthen their **capacity to communicate**. Staff should be trained ahead of time to develop and deliver messages when speaking at press conferences and to the media. **Leadership** in communication and good coordination among the various stakeholders is needed during the crisis. Many countries gave frequent (even daily) press conferences that included public health professionals/epidemiologists and policymakers to update the public on the situation. Messages should be developed by multi-disciplinary teams and the capacity to use and take advantage of new technologies to communicate was also identified as significant (e.g. creation of videos, infographics, timelines of events during the crisis, social media messaging, etc.) **Analysis and presentation of epidemiological data tailored to the needs of the audience** (e.g. policymakers or the public) was also identified as an important lesson.

During the COVID-19 pandemic, it progressively became clear that **behavioural and social science insights** were needed when developing public health guidance, monitoring the implementation of NPI measures and assessing their effectiveness in society. **Transparent communication** and **trust** in governments and institutions has been recognised as an important factor influencing adherence to national guidance. However, it is not usually possible to build trust during a crisis and foundations have to be laid during peacetime. Therefore, efforts to build trust and engage with communities must be made prior to outbreak response. This lesson converges with one of the conclusions of ECDC's expert consultation on the implementation and evaluation of NPI measures [5]. The experts stressed the need to advance in the field of risk communication and community engagement by developing longer-term work to build trust, ensure transparency and deploy behavioural insights.

Countries requested **more training and guidance on behavioural and social sciences research for operational purposes, community engagement for preparedness and response, and risk communication**. A stronger understanding of how to engage with hard-to-reach populations should also be developed. **Guidance on the management of mis- and dis-information** was also requested. **Behavioural scientists** working in the area of public health in the EU/EEA countries would benefit from a **community of practice** through which they could communicate and organise activities or research.

Lesson Area 4: Collection and analysis of data and evidence

Box 4. Main lessons and follow-up actions for improved collection and analysis of data and evidence

Lessons identified by countries and the ECDC	ECDC follow-up actions
<ul style="list-style-type: none"> • Digitalised systems for COVID-19 surveillance helped to monitor the epidemiological situation and will continue to be used. • Digitalisation of surveillance tailored to public health needs including a built-in interface with other registries (e.g. cause of death registers, immunisation registries). • Surveillance systems should be agile and adaptable, robust but also flexible and scalable. • Analysis, interpretation and presentation of epidemiological data should be strengthened and tailored to the needs of policymakers and the public. • During the pandemic, the scale-up of the capacity for testing and sequencing SARS-CoV-2 was slow. • Information systems handling public health data need to be strengthened and redundancy should be built-in ahead of time. • Data protection and data governance should be taken into consideration when building new systems and in all transfers of public health data. 	<ul style="list-style-type: none"> • ECDC is prioritising diseases under EU/EEA surveillance to ensure that sufficient resources are available for diseases with the highest impact and degree of preventability. This entails developing objective-driven systems and relying more on rapid event reporting to EpiPulse. • ECDC is re-engineering and integrating the IT systems supporting EU/EEA surveillance. • Digitalisation and automatisisation in the collection of all surveillance data should be encouraged in the EU/EEA countries <ul style="list-style-type: none"> – a joint action on surveillance systems, financed by the EC, is currently underway. – EC EU4Health programme allocated increased budget to strengthen Member State surveillance systems in 2023. • Support to Member States to increase laboratory capacity for genomic sequencing will be continued. • Training in sequence analysis and applied genomic epidemiology will be provided to Member States. • Tools to assess Member State laboratory capacity will be improved. • Pre-design web outputs for situation awareness in a crisis. • Pre-design and pilot operational research protocols (e.g. first-few-hundred cases) and provide training for available tools (e.g. Go.Data, REDCap, etc.)

The collection and interpretation of data was central to the monitoring and decision-making during the global response to the COVID-19 pandemic. Several lessons were identified in relation to the systems, processes and analysis of data for all activities.

Many countries managed to develop **new electronic surveillance systems for COVID-19** with direct links to laboratory, and in some cases, clinical records. Many Member States plan to integrate all the diseases under surveillance in new electronic systems. Several comments also referred to the need for **surveillance systems to be robust but flexible and scalable**, with built-in redundancies. **Automatisation** in the collection of data has been identified as a necessity. In a pandemic, every surveillance system should be able to provide comparable data for the unbiased monitoring of trends in time, place and person; an ongoing assessment of disease severity through integrated population-based primary and secondary care based systems, and a representative collection of clinical samples for microbiological assessment (e.g. whole genome sequencing (WGS)). In addition, surveillance systems should be built to provide answers to operational research questions for the early assessment of pandemic threats - i.e. transmissibility of the pathogen, transmission routes, risk factors for severity, assessment of severity, and monitoring of the effectiveness and impact of public health interventions.

However, in addition to the classic epidemiological surveillance data, **several other data sources** were explored and used for response during the COVID-19 pandemic. Some examples include hospitalisations/new admissions (regular and ICU); bed capacity (regular and ICU); contact tracing data; data from long-term care facilities; school attendance; monitoring of border controls and implemented measures; participatory surveillance (crowdsourcing), and monitoring web searches or hotline calls. **Lack of digitalisation** in other sectors or lower administration levels (e.g. at regional level) was considered to be an issue in some countries. In many Member States the collection of data was fragmented and incomplete, particularly at the beginning of the pandemic, but it gradually improved as new systems or communication routes were put in place. **Data protection and data governance** have also been identified as challenges, particularly during the development of new systems in a crisis.

The need to scale-up **capacity for laboratory testing and genomic sequencing** was also one of the lessons learned, and most countries mentioned this as one of their challenges during the pandemic. It is important to strengthen this capacity during peace time. However, it would be important to have pre-defined sampling schemes which provide representative samples throughout the pandemic, and are not affected by testing performed for other purposes, such as disease prevention and control.

The need for careful **analysis, interpretation and presentation of data** has been identified as another lesson from the pandemic. The capacity to manage and analyse epidemiological data appropriately needs to be strengthened, and this includes a possible automatised capacity for the production of reports and web outputs.

In direct connection with Lesson Area 3, careful analysis and presentation of key messages **tailored to policy makers and public needs** was considered to be an important lesson. However, the only way to deliver information for action is to design surveillance systems that are fit-for-purpose - i.e. system characteristics and attributes are set to address specific questions that are common across the various pathogens that can cause pandemics.

Analysis and follow-up of the emerging scientific literature during the COVID-19 presented a challenge to all institutions. New tools and rules are needed for such events to enable the screening of new literature and rapid synthesis of new evidence reports to support recommendations and decision-making. Living systematic reviews were identified as a good practice, providing a dependable source of evidence-based information for some aspects (e.g. therapeutics and management of COVID-19 cases, IPC practices, etc.)

Finally, the ability to carry out **operational research**, based on data collected during the response to a health threat, was identified as a significant weakness, both at ECDC and at Member State level, mainly due to lack of resources. ECDC should be able to foster and/or coordinate such activities (e.g. through the foreseen EU Health Task Force). Pre-designing and piloting operational research protocols (e.g. first-few-hundred cases, definition of secondary attack rate, etc.) and working with existing networks in peace time can facilitate the implementation of this type of research during the initial phases of response to a new crisis.

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Annex 1. Internal exercise to identify lessons by ECDC experts

In response to the COVID-19 pandemic, ECDC initiated Public Health Event (PHE) level 1 COVID-19 on 21 January 2020, which was upgraded to PHE level 2 on 31 January 2020; ECDC operated in PHE Level 1 – maintenance level from 9 June 2022 until 31 March 2023 and is currently at PHE Level 0 COVID-19 -recovery phase.

Twelve different groups of scientific staff supported ECDC's PHE work for COVID-19, including antimicrobial resistance and healthcare-associated infections/infection prevention and control (ARHAI/IPC), emergency preparedness and response support, microbiology, surveillance, PHE managers, modelling, epidemic intelligence, behavioural science team, COVID and influenza, communications, vaccine-preventable diseases and immunisation (VPI) and international and EU relations. Since the start of the pandemic, at least 112 ECDC experts, scientific officers, administrative and interim staff from the different scientific groups have worked to cover the needs of the PHE COVID-19.

A combination of qualitative and quantitative methodology was used to collect the opinions of ECDC scientific staff on technical lessons identified during the pandemic. All 12 groups involved with the PHE were approached and a 30-minute open discussion session was organised, where participants were asked to identify technical lessons for ECDC and at EU level. The technical lessons identified were included in a short follow-up electronic survey which was shared with the group asking them to prioritise. A final prioritisation exercise was run at a meeting with all scientific staff after the group sessions.

As a result of the meetings with the 12 teams, a total of 85 technical lessons were identified for ECDC and 30 of these were characterised as short-term priority by their respective groups.

Technical issues for ECDC were grouped into the following thematic areas:

- Collection and analysis of data and evidence;
- Preparing for the next public health crisis;
- Networking and feedback;
- Risk communication;
- Behavioural science insights.

At EU level, a total of 40 technical lessons were identified, 16 of which were characterised as short-term priority.

Technical issues for the EU level were grouped into the following thematic areas:

- Data reporting;
- Enhancing response capacity;
- Maintenance of networking;
- Enhancement of risk communication and community engagement.

Annex 2. Lessons identified by EU/EEA countries

The protocol used for the country visits organised by the ECDC is presented below.

Aim

The aim of ECDC's COVID-19 country visits was to bring together national stakeholders from different sectors, including areas outside of the health sector, to discuss and share their experiences of the strengths and challenges faced by the country during the pandemic. A country visit questionnaire consisting of open-ended questions was used to facilitate high-level discussions on lessons learned from COVID-19, including international coordination and recommendations for future ECDC support.

The main focus of country visits is to foster discussions within the country and between the country and ECDC, as a means of hearing and learning from the national public health institutes (ECDC's technical counterparts) on their successes and challenges in responding to COVID-19.

Format

Half-day to one and a half-day visit by a small team of two-to-four people, led by experts from ECDC's Emergency Preparedness and Response section (EPRS).

Approach

The approach/visit is divided into two sections. The first section covers the areas of governance and overall strategies for COVID-19 response and is implemented for each country visit. The second section covers various technical areas and may be implemented, based on the priorities of the respondent countries and the duration of the visit.

The areas and topics have been adapted from the publicly available ECDC One-day In-action Review (IAR) protocol in the context of COVID-19 [4]. Using the pre-defined areas and topics (as well as pre-defined questions) ensures a standardised approach, thereby also ensuring comparability between the country visits.

As mentioned above, for the purpose of these country visits the areas can be divided into two main sections:

- **Section 1: Pandemic governance and preparedness and response strategy**
- **Section 2: Technical areas.**

Section 1 was kept the same for each country visit - i.e. all areas listed in Section 1 are discussed during each country visit. Pending each country's specificities and requests, areas from Section 2 were selected accordingly.

For each area, a list of open-ended trigger questions is provided. Using these questions ensures standardisation and comparability between country visits and discussions. As the country visits will be limited in time (0.5–1.5 days), general, open-ended questions are used.

Section 1: Pandemic governance and preparedness and response strategy

- Overall – introductory discussion points/question (see reference directly);
- Emergency preparedness planning and national coordination
 - Preparedness planning
 - Legislation and policy
 - Crisis management function and national coordination.
- International coordination and collaboration (e.g. travel restrictions);
- Cross-sectoral coordination and collaboration.

Section 2: Technical areas

- Incident management
 - Emergency operations centres
- Situational awareness
 - Epidemic intelligence, early warning and epidemiological modelling.
- Surveillance;
- Laboratory systems and testing strategies;
- Case investigation and management
 - Contact tracing.
- Healthcare and long-term care facilities
 - Infection prevention and control in healthcare settings
 - ICU capacity and crisis standards of care.

- Vaccination strategy;
- Non-pharmaceutical interventions
 - Implementation, (re)-evaluation and duration of interventions.
- Risk and crisis communication
 - Communication to healthcare workers
 - Communication to the public and community engagement.
- Research and development.

Structure of the visit

The table below sets out questions for each area and is based on the IAR guide [4]. The questions serve as a guide/support to initiate discussions, and therefore they might not all be asked. In short, for each area, the questions aim to understand:

- What worked well?
- What did not work well/what were the challenges?
- What needs to be improved/changed/introduced in the future/to prepare for new emergencies?

These discussions will also guide ECDC in identifying priority areas of work for the future.

Pool of questions

Section 1: Pandemic governance and preparedness and response strategy

Response area		Questions
Overall		<ol style="list-style-type: none"> Overall, what were the major perceived successes during the emergency response? What went well and why did it go well? What were some of the main challenges of the response? Why were they a challenge? Where do you think improvements are still needed? What would be needed to make these improvements happen? What lessons did you learn during the COVID-19 pandemic that would be applicable in future emergencies? What are the specific actions to be taken now in order to improve future response capacity?
Emergency preparedness planning and national coordination	Preparedness planning	<ol style="list-style-type: none"> What do you see as your main institutional strength in terms of preparedness for a respiratory virus pandemic? Which elements of preparedness were the main enablers of the response? What could be done to improve emergency preparedness planning in the future? Did the response to COVID-19 expose any good practices or gaps in the preparedness process and existing plans?
	Legislation and policy	<ol style="list-style-type: none"> How did the existing and/or newly adopted legislation and policies enable the response? If applicable, what were the mechanisms for policy monitoring and evaluation? How did this knowledge improve policy efficiency and effectiveness? Did the pandemic lead to long-term changes in legal frameworks and policies, if yes, how?
	Crisis management function and national coordination	<ol style="list-style-type: none"> If there was a coordination mechanism, was it effective? Why or why not? Did the established coordination mechanism enable rapid information exchange between the national crisis team and stakeholders/sectors, and decision-makers? If not, what were the main challenges? How could national coordination be improved?
International coordination and collaboration (e.g. travel restrictions)		<ol style="list-style-type: none"> How effective was the coordination between the Ministry of Health, Public Health Agency, and the Ministry of Foreign Affairs? Was information sharing with international partners effective? Was information timely and relevant? What dimensions in international coordination went well, and what could be improved?

Response area		Questions
Cross-sectoral coordination and collaboration		1. Are there any examples of effective cross-sectoral action taken in the response to COVID-19?
		2. Are there any examples of sub-optimal cross-sectoral action in the response to COVID-19?
		3. What can be improved upon?

Section 2: Technical areas

Response area		Questions
Incident management	Emergency operations centres	<ol style="list-style-type: none"> 1. What were the main challenges for the emergency operations centre during the response? What worked well? 2. Were the available resources (equipment, trained staff) sufficient to ensure effective and efficient management of emergency response operations during the COVID-19 pandemic?
Situational awareness	Epidemic intelligence, early warning and epidemiological modelling	<ol style="list-style-type: none"> 1. What were the main challenges for epidemic intelligence and early warning during the responses? What worked well? 2. Were resources sufficient to ensure continued epidemic intelligence activity throughout the pandemic? 3. Was early warning exchange with neighbouring and partner countries timely and useful? 4. Were some epidemic intelligence activities dropped or not implemented during the response?
Surveillance		<ol style="list-style-type: none"> 1. Were there any challenges in analysing or gaps in receiving epidemiological or early warning data that would have enabled a better response during the initial response phase? 2. Were there any significant delays in detection/confirmation of suspect or confirmed cases that hindered the public health response? 3. What challenges were there in establishing a surveillance system for COVID-19? 4. What worked well? Which actions taken enabled an efficient and timely detection of the event?
Laboratory systems and testing strategies		<ol style="list-style-type: none"> 1. How did the capacity to test the effect of the overall response to the pandemic? 2. What worked well in establishing a system for laboratory confirmation of SARS-CoV-2? 3. Was scaling-up of testing for SARS-CoV-2 effective? What were the challenges and good practices that emerged through scaling-up? 4. What could be improved upon?
Case investigation and management	Contact tracing	<ol style="list-style-type: none"> 1. How effective and efficient was contact tracing/management? If new technologies or volunteers were used/engaged, what were the best practices or challenges? 2. What was the maximum number of confirmed cases for which contact tracing has been performed? Was the capacity to conduct contact tracing an issue during the response? 3. What could have been done better?
Healthcare and long-term care facilities	Infection prevention and control in healthcare settings	<ol style="list-style-type: none"> 1. What best practices for IPC for COVID-19 were practiced/developed? 2. What were the challenges in implementing IPC measures in healthcare settings? 3. What challenges were there for IPC in healthcare settings during the COVID-19 pandemic?
	ICU capacity and crisis standards of care	<ol style="list-style-type: none"> 1. Was it feasible or productive to pool medical resources and ICU capacity? 2. Were CSC effectively implemented for COVID-19? 3. Were ethical guidelines able to provide clinicians with adequate support for making triage decisions? 4. How effective was national data on ICU capacity for informing decision-making? 5. What worked well, and what did not, in terms of optimising ICU capacity usage throughout the COVID-19 pandemic? 6. What can be improved when it comes to optimising ICU capacity during public health emergencies?

Response area		Questions
Vaccination strategy	Implementation, evaluation	<ol style="list-style-type: none"> 1. Is there a NITAG advising the Ministry of Health? 2. What is the process for providing advice on vaccination against COVID-19? 3. How was the vaccine roll-out implemented for the COVID-19 vaccines? 4. How is the roll out monitored? 5. Are vaccine efficacy studies implemented? 6. How was the communication around the vaccination strategy organized? 7. Were representatives of civil society included in formulating the communication strategy? 8. Was mis-/dis-information around the COVID-19 vaccines monitored and/or addressed?
Non-pharmaceutical interventions	Implementation, (re)-evaluation and duration of interventions	<ol style="list-style-type: none"> 1. How was the advice and decision-making process for the implementation of NPIs? 2. How was the implementation of NPIs monitored? 3. How was the adherence to the NPIs monitored? 4. Did you or do you plan to evaluate the effectiveness and effects on the [country's] society of the NPIs implemented?
Risk and crisis communication	Communication to healthcare workers	<ol style="list-style-type: none"> 1. Was communication to healthcare workers timely and effective in ensuring they had a common and consistent approach to the response to COVID-19? 2. What challenges were there in communication to healthcare workers? What were good practices?
	Communication to the public and community engagement	<ol style="list-style-type: none"> 1. Was public communication effective in conveying public health messages and establishing public trust? If so, how has this been assessed? 2. What challenges were there in public communication? What were good practices from the outbreak of COVID-19?
Research and development		<ol style="list-style-type: none"> 1. What challenges existed in launching work to develop and/or procure a vaccine against SARS-CoV-2? 2. What worked, and what needs to be improved for a future pandemic?

Annex 3. Expert meetings

A two and half day expert consultation on the implementation and evaluation of non-pharmaceutical interventions (NPIs) was hosted by ECDC in Stockholm from 1-3 June 2022, to explore how insights from the implementation of NPIs during the COVID-19 pandemic may guide further preparedness for COVID-19, as well as pandemic preparedness and response work in the EU in general.

The consultation was designed to hear from participants about their experience, insights and expert opinion on the many different aspects of NPI, not just the medical but also the wider perspectives. For this purpose, the format of the meeting included plenary panel discussions and parallel working groups, organised in three workstreams:

- Stream A: NPI Effectiveness
- Stream B: NPI Cost effectiveness and social impacts
- Stream C: Behavioural insights and adherence.

Each workstream was asked to discuss four specific topics, and then report upon the findings in the final plenary session.

The overall conclusion from this meeting was that significant gaps in global operational research capacity remain and public health agencies, often working in a 'advisory' function, have generally struggled to monitor and assess the implementation of NPIs within their jurisdictions or the many socio-economic effects associated. Experts from all meeting streams agreed on the following:

- Invest in conducting **structured lessons learned exercises and after-action reviews** focused on identifying good practices, challenges, and priority issues related to the COVID-19 pandemic.
- **Pandemic preparedness plans and crisis management structures should be revised based upon lessons learned** and should account for the implementation of NPIs, based upon factors such as the phase of the pandemic, the expected effectiveness of the NPI in a given socio-economic and political context, behavioural insights, socio-economic impacts, and levels of uncertainty.
- Strengthen international, national and sub-national **capacities for evaluating and monitoring the implementation of NPIs** through the development of guidance, training, improved methodological effectiveness, and the identification and collection of appropriate datasets.
- Foster a **greater range of collaboration and knowledge exchange across public health and other disciplines**, notably economics, policy sciences, and social sciences including behavioural insights.
- Develop **better awareness and understanding of the complexity of policy-making** among public health actors, strengthen linkages to decision-making communities, and improve the timeliness, salience, and credibility of evidence delivered to policy-makers during health crises.
- **Advance the state-of-the art in the field of risk communication and community engagement** by developing longer-term work to build trust, ensure transparency, and deploy behavioural insights.
- Continue to **conduct studies on the long-term impacts**, both direct and indirect, of the COVID-19 pandemic through multi-disciplinary research coordinated at national and international levels.

A report from this meeting has been published by ECDC [5].

A one and a half day expert meeting on lessons learned from the COVID-19 pandemic was organised by ECDC in Stockholm between 28-29 September 2022.

The first day of the meeting covered ECDC, regional and global lessons learned, followed by a panel discussion. The European Observatory on Health Systems and Policies presented lessons learned from an overview of the wider health systems and health policy approach, pointing out the narrow political window of opportunity to implement the necessary reform, due to competing crises and the fact that the persistent workforce shortage combined with widespread backlogs among others in mental care, only added to the urgency. Immediate challenges include care backlogs, workforce maintenance and support, mental health issues and implementing new models of healthcare.

ECDC shared with participants overall internal lessons learned from the COVID-19 pandemic (see Annex 1), outcomes from the assessment and implementation of NPIs, findings from the ECDC country visits, country reviews and lessons learned publications.

During the second day there was a session on European projects and initiatives, a session on country perspectives with a panel discussion, breakout sessions and presentations of the breakout groups. Information was given on the four-year initiative 'Joint Action SHARP' on International Health Regulations (IHR) preparedness and response planning, aiming to strengthen preparedness in the EU against serious cross-border threats to health and support the implementation of IHR and the outcomes of the non-pharmaceutical interventions on Europeans' work-life balance and this was discussed during the 'European projects and initiatives' session.

Lessons learned from national perspectives during the COVID-19 pandemic were discussed (Sweden, Finland). The EU experience and high-level findings from studies in EU/EEA countries (Croatia, Finland, Germany, Italy, and Spain) during the first phase of COVID-19 were also discussed. Preliminary results from After Action Reviews on evidence-based decision-making (University of Amsterdam) in long-term care facilities and schools were also shared, along with outcomes (good practices, gaps, and challenges) of the IAR on COVID-19 response in Ireland.

Group discussions in breakout sessions

Prior to the meeting, the participants had been requested to identify and reflect upon three best practices or issues that were resolved in their country in the context of the COVID-19 pandemic, which could be of interest to other countries (e.g. legislation, education, preparedness planning, risk communication, others). The objective was to initiate discussions by looking at positive experiences before gradually moving on to challenges, reflecting and discussing on specific questions and topics raised by the moderators, using specific and valuable examples from countries.

The participants were divided into three groups to work in breakout sessions, which followed the phases of the cycle of preparedness (Fig.1). All groups rotated in each of the three breakout experience sharing-and-discussion sessions, with the focus on lessons learned from the anticipation phase, the response to COVID-19 and the recovery phase. The key questions discussed were:

- What went well?
- What did not go well?
- What should be put in place for future events?
- What should ECDC do?

What went well?

Participants commented that in some countries, legislation, good communication with pre-established/multi-sectorial networks, and useful outcomes from previous preparedness assessments (joint external evaluations) and experience from preparedness activities (such as simulation exercises) were available in the anticipation phase that could be applied in the response to the pandemic. Many countries developed new informatics systems linking different databases, and/or electronic surveillance systems for COVID-19.

During the response phase, coordination of the response between national and regional/local levels, risk communication (with transparency and on a daily base) to the public, fast mobilisation of resources (e.g. human resources) and epidemiological and laboratory data collection were improved throughout the pandemic.

The momentum to retain political attention and a positive change to strengthen surveillance systems and the multisectoral approach in the response (involving also sectors like civil protection) were presented as lessons identified and implemented on an ongoing basis during the response that could be refined in the recovery phase.

What did not go well?

In the anticipation phase, it was stressed that legislation for the control of communicable diseases was not in place and trust of the authorities had not been established. The preparedness and response plans mainly addressed pandemic influenza, were not flexible and not able to address the severity, duration, or the major uncertainties of the COVID-19 pandemic. In addition, they did not address all of the government or involve the whole of society, or offer measures to support vulnerable populations.

During the response and due to the complexity of the COVID-19 pandemic, legislation had to be revised in several countries. Indicators that would inform decisions were urgently needed but hard to define. Communication was highlighted as a major problem, particularly concerning measures and vaccination strategies. The frequently changing regulations, the heterogeneity of measures among countries and the different strategies resulted in challenges to public communication or communication with hard-to-reach populations.

What should be put in place for future events?

In the future, the role of non-health sectors (including other ministries, key stakeholders, actors in civil society) should be explicitly outlined and generic pandemic preparedness plans should consider legislation, a variety of diseases, NPIs and travel restriction measures and their time of implementation. In addition, systemic shortcomings, and resource issues, such as the need to strengthen IT, reinforce the public health staff, develop robust but flexible and scalable surveillance systems, strengthen capacity for genomic analysis, stockpiling or mapping of the existing PPE and pharmaceuticals and research protocols, should be put in place prior to an emergency.

Maintaining the improvements in the surveillance systems and possibly expanding them to other diseases, and revising pandemic plans, implementing algorithms and protocols (based on different scenarios and hospital capacity), establishing procedures for surge capacity in terms of healthcare workers, and planning for the involvement of civil society in the response were all pointed out as lessons identified which needed to be implemented in the recovery phase.

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of the European Union

ISBN 978-92-9498-596-5