ecdc
EUROPEAN CENTRE FOR DISEASE PREVENTION AND CONTROL

TECHNICAL REPORT

Digital technologies for key public health functions: results of an ECDC expert consultation

May/June 2021

www.ecdc.europa.eu

ECDC TECHNICAL REPORT

Digital technologies for key public health functions

Results of an ECDC expert consultation, May/June 2021

This report was commissioned by the European Centre for Disease Prevention and Control (ECDC) to RAND Europe through specific contract ECD.11796 implementing the ECDC framework contract for services ECDC/2019/028 and coordinated by Helena de Carvalho Gomes.

The workshop was conceptualised and led by Helena de Carvalho Gomes (Scientific Methods and Standards Unit), under the sponsorship of Andrea Ammon (Director). The workshop organisation was supported by: ECDC staff Cristian Avram (Digital Transformation Services Unit), Helena de Carvalho Gomes (Scientific Methods and Standards Unit), Petronella Nyakundi (Resource Management Services Unit), Tina D Purnat (Digital Transformation Services Unit), Luciana Muresan (Scientific Methods and Standards), and consultants from RAND Europe Joe Francombe (Analyst), Emily Ryen Gloinson (Analyst), and Salil Gunashekar (Research Lader).

ECDC is grateful for the work and contributions from experts who participated as expert panellists and participants at the workshop: Julien Beauté (ECDC), Milan Blaha (Institute of Health Information and Statistics of Czechia), Paula Braun (US Centers for Disease Control and Prevention), Rob Brisk (Nvidia, representing DIGITALEUROPE), Stefan Buttigieg (European Public Health Association (EUPHA)), Bonnie Cai (Public Health Agency of Canada), Alexandre Canarelli (Santé publique, France), Mike Catchpole (ECDC), Ermanno Cavalli (European Food Safety Authority), Alexandria Clark (Public Health Agency of Canada), Stanislav Danchev (ECDC), Jerome De Barros (European Commission - DG Research & Innovation), Athanasios Demiris (European Chemicals Agency), Yves Dupont (Sciensano, Belgium), Michael Eldenstein (EUPHA), Laura Espinosa (ECDC), Mario Fafangel (Communicable Diseases Centre, Slovenia), Maria Fe Lapeña (Ministry of Health, Spain), Rodrigo Filipe (ECDC), Rita Finley (Public Health Agency of Canada), Finbarr Geaney (ECDC), Ivo Georgiev (National Center of Infectious and Parasitic Diseases, Bulgaria), Joana Gomes Dias (ECDC), Clayton Hamilton (WHO Regional Office for Europe), Laëtitia Huiart (Santé publique, France), Stefan Jensen (European Environment Agency, Jari Kallela (ECDC), Daniel Klimeš (Institute of Health Information and Statistics, Czechia), Piotr Kramarz (ECDC), Spyros Ktenas (ECDC), Licinio Kustra Mano (European Commission - DG SANTE), Paul-Henri Lampe (Santé publique, France), Luís Lapão (Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Portugal), Vicky Lefevre (ECDC), Mathias Leroy (Sciensano, Belgium), Gaetano Marrone (ECDC), Sascha Marschang (European Public Health Alliance), Tino Marti (European Health Telematics Association), Simone Martineau (Public Health Agency of Canada), Blanca Martínez de Aragón (European Chemicals Agency, Elena Vanessa Martínez Sánchez (Ministry of Health, Spain), Marcello Melgara (ARIA S.p.A., Italy), Francois Mestre (ECDC), Teemu Mottonen (Institute for Health and Welfare, Finland), Patricia Ndumbi Ngamala (World Health Organization), Nasser Nuru Mahmud (Public Health Agency, Sweden), Egle Obcarskaite (ECDC), Anna Odone (EUPHA), Daniela Paolotti (Institute for Scientific Interchange Foundation, Italy), Pasi Penttinen (ECDC), Pedro Pereira Rodrigues (CINTESIS, University of Porto, Portugal), Luis Pinheiro (European Medicines Agency), Ray Pinto (DIGITALEUROPE), Georgios Raptis (Standing Committee of European Doctors), Maurizio Sanguinetti (European Society of Clinical Microbiology and Infectious Diseases), Paul-Etienne Schaeffer (Association of the European Self-Care Industry), Robert Scharinger (Federal Ministry of Social Affairs, Health, Care and Consumer Protection, Austria), Alex Settels (Philips, representing DIGITALEUROPE), Ines Steffens (ECDC), Vladimíra Těšitelová (Institute of Health Information and Statistics, Czechia), Alexander Ullrich (Robert Koch Institute, Germany), Marieke van der Werf (ECDC), Isabelle Zablit-Schmitz (Santé publique, France), Phillip Zucs (ECDC).

Further input was provided by additional report reviewers: Katherine Morley (RAND Europe).

Suggested citation: European Centre for Disease Prevention and Control. Digital technologies for key public health functions – Results of an ECDC expert consultation, May/June 2021. Stockholm: ECDC; 2021.

Stockholm, November 2021

ISBN 978-92-9498-547-7
doi: 10.2900/891738
Catalogue number TQ-05-21-296-EN-N
Cover picture: Istock

Contents

Figures

Abbreviations

AI	Artificial intelligence
API	Application programming interfaces
COP	Community of practice
DARWIN	Data Analysis Real World Interrogation Network
DPH	Digital public health
EHR	Electronic health records
EMA	European Medicines Agency
EMRN	European Medicines Regulatory Network
EPHA	European Public Health Alliance
EU	European Union
EUPHA	European Public Health Association
EUPHA-DH	European Public Health Association Digital Health
EUPHA-IDC	European Public Health Association Infectious Diseases Control
EUVIS	Europe Vaccines ICT Strategy
FAIR	Findable, accessible, interoperable and reusable
FHIR	Fast Healthcare Interoperability Resources
GDPR	General Data Protection Regulation
GPHIN	Global Public Health Information Network
HL7	Health Level Seven
ICT	Information and communications technology
ISO	International Organization for Standardisation
MoSH	Ministry of Social Affairs and Health
PHAC	Public Health Agency of Canada
PHIRI	Population Health Information Research Infrastructure
REACH	Registration, Evaluation, Authorisation, and Restriction of Chemicals in the European Union
WHO	World Health Organization

Executive summary

- The digital transformation of healthcare, health services, and health systems remains high on the agenda of policy-makers and is receiving increased funding. This creates an opportunity for those involved in public health activities to define how this area can benefit from investment into wider digital health systems.
- The field of Digital Public Health (DPH) has gained in visibility since the start of the COVID-19 pandemic. As with the digital transformation of healthcare, investment in digital technologies in public health first requires that we identify public health practices that can be improved or complemented through the adoption of digital technologies and related participatory and evaluation practices.
- Investments in digital technologies in public health should be based on two perspectives: how an organisation practices DPH through public health functions (function-based perspective), and how it fosters DPH, standards, and governance in the broader DPH ecosystem (digital health perspective).
- Public health impact is reflected in health outcomes specific to each country, so investment in digital technologies for public health must combine digital technology standards and use cases with local contexts and involve health professionals, patients, communities, and the public, as needed.

In a series of workshops held to discuss digital technologies for key public health functions, workshop participants emphasised the following points:

- The design and adoption of digital technologies in public health must focus on ultimately achieving and demonstrating **public health impact**.
- The application of digital technologies to deliver key public health functions **requires a holistic approach**, taking into account factors that determine successful adoption.
- **Standardisation and interoperability** are prerequisites for the effective sharing of data and to deal with systems-level issues related to infrastructure, technologies, and terminology.
- **Data strategy (and governance)** are important enablers to reap the benefits from using different types of data sources, under different data-sharing licenses and analytical needs.
- **Digital and analytics skills building** can help develop multidisciplinary teams that work together to address public health problems and questions.
- **Participatory engagement in co-design, implementation and use of DPH** tools and insight is key to building trust in the digital tools and health information exchange.
- **Multidisciplinary and cross-sectoral collaboration and partnerships** are key to building holistic and integrated public health solutions.
- The need for **robust and widespread monitoring and evaluation** of DPH interventions was highlighted as a key component when discussing digital technologies in the context of delivering key public health functions.

1. Introduction

Scope and purpose of the consultation

In 2019, the European Centre for Disease Prevention and Control (ECDC) initiated a project to assess the possible impact of technical advances on its key functions. The aim of the project is to collate – through means such as scoping reviews, surveys, and technical consultation meetings – information on the current and possible application of new technologies in areas of relevance to ECDC's work, i.e. communicable disease surveillance, prevention and control, and the potential implications of these new technologies for key public health functions. The results of the project will serve as a source of information for ECDC and its main stakeholders in deciding how to prepare for, and possibly benefit from, technological advances to further improve communicable disease surveillance, prevention and control, and achieve desired public health outcomes more widely.

The project encompasses all digital technologies that have or could have a beneficial or negative impact on key public health functions. Examples of digital technologies are data and text-crawling/mining, crowdsourcing and collaborative platforms, natural language and image processing, automation, machine learning, artificial intelligence, and blockchain. Key public health functions of relevance to ECDC are all functions contributing to infectious disease monitoring, prevention and control, such as signal/outbreak detection, disease surveillance, data exchange, data analysis and visualisation, evidence generation and synthesis, trend analysis, forecasting, and preparedness.

As part of this project, ECDC has undertaken a consultation with experts in the field of digital technologies and public health. The overall objectives of the consultation were to review and discuss the results of a series of scoping reviews on digital technologies for key public health functions, to exchange information and experience, to discuss practical examples, lessons learned, opportunities and challenges, and to perform a forward-look exercise covering a period of five to 10 years. The overall results of the consultation will support ECDC's senior management in its decision-making regarding the Centre's digital roadmap currently under development.

Summary of workshop format and participants

A consultation meeting was originally planned to take place in March 2020 as a 1.5-day face-to-face meeting at ECDC's premises. However, the planned consultation had to be postponed at short notice due to the COVID-19 pandemic. The consultation was subsequently rearranged to take place as a series of three shorter virtual sessions, held between May and June 2021, each of around 3.5 hours to allow broad participation, in particular from public health experts who continued to be extremely busy with the pandemic response. The three workshop sessions took place on Wednesday 5 May, Tuesday 25 May, and Tuesday 15 June 2021. The objectives of each workshop are summarised below:

- The objectives of the first session were to discuss the results of a selection of scoping reviews that have examined how digital technologies have been used for key public health functions (focusing on infectious diseases; two scoping reviews focused on COVID-19); to exchange information and experience regarding the development and implementation of digital technologies in public health; and to discuss practical examples. The first workshop also aimed to gather participants' views on the focus of future workshops held as part of the consultation.
- The objectives of the second session were to discuss how public health institutions can maintain and further improve access to epidemiological and scientific data, how to further strengthen collaboration and data exchange without compromising security, privacy, and trust, and to consider examples of policies and approaches that have supported the scale-up of digital technologies to achieve public health goals. The workshop also aimed to consider case studies of specific DPH interventions at both the European Union (EU) and country level, as well as other contexts.
- The objectives of the third session were to review, discuss, and validate a series of overarching themes developed from discussions during the first two workshops, and also to consider presentations on DPH interventions in the EU and observer countries.

The three workshop sessions were attended by a diverse range of stakeholders, including representatives from EU institutions, international partners, European umbrella organisations, public health and technical experts (both from national public health authorities and those attending in an individual capacity), and ECDC. Full participant lists for each workshop are presented in Annex 3.

Structure of this report

This report presents a summary of the key observations from across the workshops. The report is structured as follows:

- Section 2 presents a set of overarching themes emerging from the discussion in the workshops. For each theme, we provide a summary narrative of key points for relevant stakeholders to consider when developing and implementing digital technologies for public health functions.
- Section 3 outlines next steps for ECDC, as well as other public health authorities, following on from the consultation.

2. Overarching themes of the discussion

Overview

In this section, we discuss a series of cross-cutting themes that emerged from the discussions at the workshops. As noted above, these overarching themes were reviewed, discussed, and validated with workshop participants during the third workshop.

The themes presented are those highlighted by the workshop participants. The themes are not exhaustive, nor intended to provide a definitive or comprehensive framework for the strategic introduction of DPH by public health authorities. Instead, the discussion themes are intended to provide a set of considerations that can feed into formal strategy and planning processes at ECDC and other public health authorities when looking to develop and adopt digital technologies to strengthen and innovate in key public health functions.

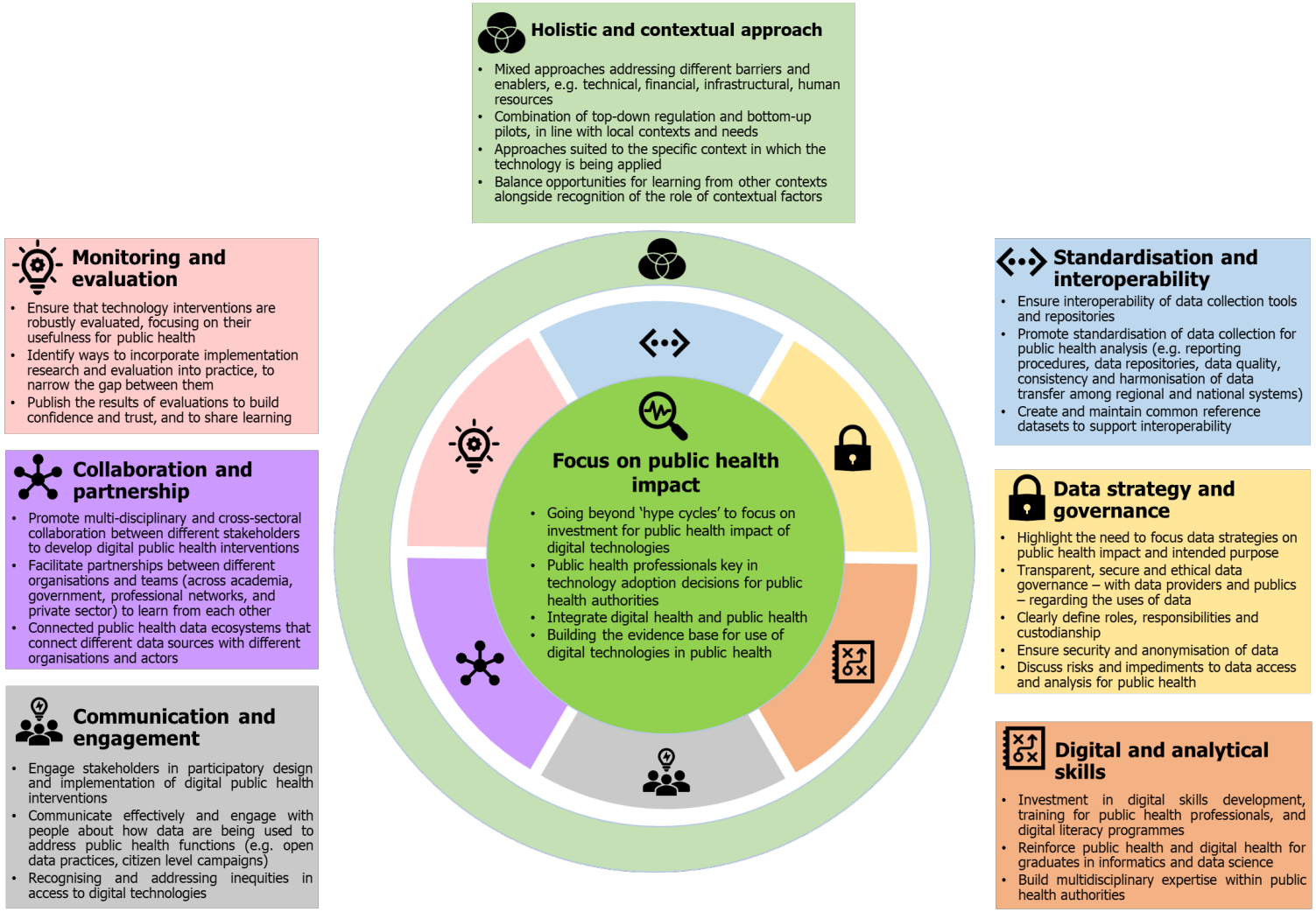
The themes we have identified are intrinsically linked to each other and across the themes. There are inter-related aspects of what might be required for the successful development and implementation of digital technologies at scale. The discussion themes that emerged at the workshop cover processes and actions that are already taking place, as well as some aspects that discussions have highlighted will be important for the future.

The evolving public health ecosystem is complex, challenging, and encompasses numerous stakeholders, each with their own roles and responsibilities. Moreover, the COVID-19 pandemic has highlighted both the opportunities and risks associated with digital technologies in relation to delivering key public health functions. Some of the themes highlighted in this report relate to current developments, while others highlight considerations that may become important as the field develops.

Furthermore, successfully achieving desired public health outcomes will require strong political will and leadership, and the need for all stakeholders involved to adopt a 'learning' mindset, both in terms of what works as well as what has not worked so well. It is therefore crucial to first articulate the core public health needs and impacts where digital technologies might be able to offer the most opportunities, rather than developing technology-based solutions first and then looking for public health needs that the technologies might be able to address.

In Figure 1, we present a summary of the key overarching discussion themes. In the sections below, we summarise key points associated with each theme, drawing on and synthesising the discussions at the workshops.

Figure 1. Summary of key overarching themes arising from the workshops relating to the development and implementation of digital technologies for public health



Summary of the overarching discussion themes

Focus on public health impact

The focus on public health impact is essential when designing and adopting digital technologies for public health interventions and approaches. Technologies and the digital infrastructure are the means to achieve public health impact, rather than ends in themselves. Here, workshop participants highlighted that it is not just about having the appropriate infrastructure, but also ensuring that data are used for public health actions. For instance, to ensure that data and technologies are used to deliver public health impacts, interfaces between healthcare systems and public health should be developed to translate data into public health action. A prerequisite is also that there is a shift beyond relying on technology 'hype cycles', where investments follow technologies that are perceived as particularly innovative and ground-breaking, to more strategic investments in digital technologies with public health impact.

The rationale for the development of data and technologies should be focused on their practical implementation in terms of public health intervention development and how the data generated would be used by stakeholders in the public health system and can add value. For instance, data and technologies can become more actionable by including those who play an active role in their practical implementation and who can ensure public health impact. Emphasising these considerations can re-centre the importance of public health impact.

Although public health should be a central consideration, a consistent approach is needed to ensure that different domains do not work in silos. Participants suggested that it can be helpful to have regulatory frameworks in place to push the needs of public health forward and to scale up interventions. The need to build the evidence base for digital technologies in public health was also highlighted, both in relation to what works and what does not work as well. One example of efforts to build an evidence base is the DPH framework outlined by the European Public Health Association (EUPHA) [1]. The framework is centred around public health domains and public health pillars, which has formed the basis for identifying digital technologies and the features of digitalisation or digital health that can support public health.[1] In another example, the EU Population Health Information Research Infrastructure (PHIRI) project is implementing DPH in practice and at a country level, and is building Digital Public Health Framework 2.0, which links public key functions and detail architectures [2].[2]

Holistic and contextual approach

Workshop participants highlighted that the application of digital technologies to deliver key public health functions requires holistic approaches. This refers to the requirement for multi-dimensional, 'wrap-around' approaches that adopt a rounded view of the various factors that may have an impact on the successful adoption of digital technologies for key public health functions, and for actions to be structured accordingly. A holistic approach also encompasses the need to combine top-down approaches and guidance (e.g. regulation and role of state) and bottom-up initiatives from practitioners and academia. Top-down and bottom-up approaches should ideally inform each other, while also being in line with the local context and needs. Participants felt that it is necessary to integrate mixed approaches that can address different barriers and enablers (and looking to the future, the potential opportunities as well as risks) such as technical, infrastructural, financial, and human-resource-related factors. For instance, it was noted that approaches could focus on integrating systems-thinking that actively considers the constituent elements of the wider digital health ecosystem and public health system. Ideally, all stakeholders that are impacted by, use and could potentially benefit from the digital technologies in question should be involved in the decision-making related to these approaches. It was noted that a way to enable a holistic approach is to consider how multiple data sources could be combined. Examples of data sources that could be combined include genomic data, web scraping, eHealth, environmental data, surveys, and mobility data (such as passenger flows and community mobility reports) to better understand non-pharmaceutical interventions for COVID-19.

Furthermore, the need to account for complex social and ethical considerations was highlighted as important to facilitate holistic approaches. In particular, it was noted that in shaping DPH and health programmes it is important to engage health workforces, civil society, and those being targeted by the intervention/(public) health programme. Moreover, approaches should not only focus on infectious disease surveillance, prevention, and control, but could also incorporate perspectives across other areas of public health. An example of a holistic approach that has brought in different perspectives is a white paper that is currently under development on artificial intelligence (AI) for public health at the Public Health Agency of Canada [3]. The white paper focusses on the impact of AI on aspects such as population health and applications in public health. The white paper integrates the technical and scientific perspectives, as well as the humanities and social sciences viewpoints.

[1] They found that digital features that can bolster public health action are: personalisation and precision, potential brought by automation of processes, the potential of prediction, the potential of Big Data and data analytics, and ensuring that there is interaction between patients/people with health organisations and systems. Annex 1 provides further detail on the case studies.

[2] Annex 1 provides further detail on the case studies.

Workshop participants also noted that approaches should be suited to the specific (local) contexts in which the digital technologies are being applied. While there is value in learning from and across other contexts, there should also be a recognition of the importance of contextual factors – participants highlighted the need for recognition of the role that specific local contextual factors may play, particularly regarding the potential scale-up of DPH interventions. Moreover, participants felt that a significant aspect of contextuality is that technologies should be adapted to specific public health questions, rather than fitting the public health issues to the technology.

This theme can be regarded as an 'umbrella' theme that serves to connect and wrap around all the other themes. It reiterates the importance of needing to consider all the themes together and not in isolation from each other when thinking about digital technologies in the context of public health.

Standardisation and interoperability

Standardisation and interoperability were considered prerequisites for the effective sharing of data and to handle systems-level issues related to infrastructure, systems, and terminology. This topic has received attention in Europe and globally, but more work is needed. There is a need to have robust standardisation and interoperability mechanisms in place to develop health information ecosystems for public health that can combine data from different sources in population health analyses. The need to develop connected public health data ecosystems that are open to use by third-party expertise where appropriate was also highlighted. Another benefit of standardisation is that it can help to increase data quality by making data more accessible to different stakeholders. Standardisation of data transfer among regional and national data collection systems can be facilitated by processes that focus on consistency, data harmonisation and interoperability of data transfer. For example, United States Core Data for Interoperability is a standardised set of health data classes and data elements that aims to achieve nationwide, interoperable health information exchange [4]. It was felt that interoperability can shift the focus from single sources of information, such as electronic health records (EHRs) and registries, to a multitude of different data sources. Interoperability can also contribute to overcoming segmentation between different approaches and stakeholders, as well as some of the challenges posed by data being owned by several different providers. Important enablers of interoperability include standardised reporting procedures, data repositories and data quality, and interoperability standards or frameworks.

Interoperability and standardisation can be facilitated through different approaches. Interoperability can be ensured by developing standards, such as the initiative to establish standards by the European Medicines Agency (EMA).[3] It can also be ensured by starting small and creating common reference data that focusses on metadata. Here, interoperability can be ensured by maintaining common reference data and data sets for training and validation of analytical methods, and for validation guidance. The sharing of standards can be facilitated by using, for example, different application programming interfaces (APIs). APIs can make data more open, as well as ensure that stakeholders are empowered to use the resources created by projects. For instance, the HL7 Fast Healthcare Interoperability Resources (FHIR) standard pertains to data formats and elements, and an application programming interface for the exchange of EHRs [6]. There is also potential for federated approaches to data access, such as EMA's Data Analysis Real World Interrogation Network (DARWIN) project, which aims to 'deliver a sustainable platform to access and analyse healthcare data from across the EU [7].[4]

Data strategy and governance

While standardisation and interoperability were considered prerequisites for the effective sharing of data, the importance of data strategy and governance were also emphasised. Here, workshop participants highlighted the need for clearly defined data collection strategies and roles, including cataloguing of the available data sources, the data license models in use, public health data pipelines and data science expertise to support the flow of data, and the types of analyses that can create public health impact. The need for effective data visualisation was also noted as important to make data accessible. For example, the COVID-19 dashboard in the Netherlands illustrates how data was visualised in a way that was understandable and accessible to a wider audience[5]. It was felt that the dashboard was more accessible as it used simple language that was easy for the public to understand.

The need to focus data strategies on impact was also stressed. Rather than 'collecting data for data's sake', data strategies should be driven by a clear sense of the intended purpose and the links to public health functions and goals. It was suggested that 'data storytelling'[6] or 'data stories' will be important in the future to identify public health needs that DPH can fulfil at an early stage in a project or intervention. As part of data strategies, public health authorities should also be aware of the potential risks and impediments to data access and analysis,

[3] EMA is currently in the process of implementing standards that were developed by the International Organization for Standardization (ISO) for the identification of medicinal products [5].

[4] Further details on this case study are provided in Annex 1.

[5] The Dutch coronavirus dashboard can be found here: https://coronadashboard.government.nl

[6] Data storytelling refers to the practice of creating a narrative around a dataset and its visualisations to convey the meaning of those data.

including potential biases within the collected data, and should identify mitigation strategies. The need to make data strategies as user-friendly as possible was also highlighted. Establishing and maintaining data-sharing agreements with key stakeholders were viewed as key to the effective implementation of data strategies. The requirement to have data strategies in place early on was also noted as important in this respect.

The need for transparent, secure, and ethical data governance was also highlighted. A key requirement raised in this respect was transparency and openness – both with data providers and broader publics – regarding uses, benefits, and risks of health data, as well as clearly defined roles and responsibilities for data custodianship and the potential secondary uses of data. Ensuring the security and privacy of data was also considered paramount. For this purpose, participants also discussed the potential of new technologies, such as data redaction software, to anonymise personal data, as well as data that are protected by intellectual property rights.

Participants discussed the potential of different approaches to good data strategy and governance. Examples discussed included MyData[7] approaches to improve individual ownership of data and to more actively incorporate trust and privacy aspects into data collection processes, as well as the establishment of data trusts[8], as a way of looking after and making decisions about data (see Annex 1 for further details on these examples). Federated approaches to data collection may also help to ensure good data governance, for example, by allowing data to remain where it was generated while being exchanged under agreed conditions and mechanisms, thereby building trust with data providers.

Digital and analytical skills

Digital skills are important for digital approaches for key public health functions, but there can also be gaps between the skills needed to implement DPH approaches and the skills public health practitioners have. Participants highlighted the need to develop both the digital and analytical skills of people involved in the public health ecosystem (including health, non-healthcare, and public health professionals) to address this skills gap. Digital and analytical skills development could encompass training programmes for both health and non-healthcare professionals and should address different levels of competence. Participants noted that digital skills could be developed by collaborating with academic institutions at different levels (in vocational programmes, graduate, and undergraduate). It was suggested in the workshop that digital health and DPH could be integrated into formal education and within education courses that already exist with the aim to bridge the gap between analysis and policies. For example, in Portugal, there have been efforts to reinforce public health functions within relevant graduate courses, including master's courses in medicine, medical informatics, and PhD programmes in health data science. There is also a need for digital skills development and training programmes for public health professionals. In 2021, a Canadian team of investigators are launching the AI for Public Health course, which focusses on trainees and researchers in public health domains to train them in implementing AI from a public health perspective. The need to invest in digital literacy was also highlighted as a way to enable stakeholders to understand the approach and purpose of digital technologies.[9]

Participants at the workshop highlighted that it is important that digital and analytical skills programmes can help facilitate the development of multidisciplinary teams that can work together to solve public health problems and questions. Another important consideration is how skills can be applied in digital health interventions. In some cases, it might be necessary to collaborate with other organisations and stakeholders to fill skills gaps. It was mentioned that programmes should not solely be focussed on building technical expertise but should also incorporate humanities and social science perspectives. To improve access to data for public health, it is also necessary to develop soft skills, such as communication and collaboration skills.

Communication and engagement

In discussing the potential applications of digital technologies for public health, participants at the workshops underscored the key role of engagement. When it comes to the design, implementation, and evaluation of DPH interventions and tools, it was emphasised that public health authorities have a responsibility to engage stakeholders – including data providers, collaborators, and the broader public – in 'participatory' and 'human-centred' design and implementation approaches, thereby making them active partners in the resulting systems. For example, participatory co-design and implementation practices can be crucial in improving surveillance and clinical decision-support systems, as in the example shared in the context of monitoring antibiotic resistance and improving antibiotic prescription [10]. It was noted that COVID-19 has illustrated the need for timely engagement with a wide range of public and private stakeholders in data and analyses in order to build trust.

[7] MyData is a human-centred approach in personal data management that combines industry needs for data with digital human rights [8].
[8] Data trusts are where one party authorises another to make decisions about data on their behalf for the benefit of a group of stakeholders [9].
[9] Further details on this example are provided in Annex 1.

The role of communication in engagement was also highlighted, particularly with respect to the collection of data for public health purposes. The provision of timely and accessible information to stakeholders regarding the uses and results of data collection activities, for example, can play an important role in inspiring other stakeholders, increasing stakeholder acceptance of and 'buy-in' for those activities. Communication formats that may be used for this purpose include open access publications, websites (including dashboards and other visualisation tools), lighthouse projects[10], technology evangelists (who can lead and provide their own examples), creating cross-organisational directives that can set the stage, and citizen-level campaigns regarding the uses of health data.

Examples of participatory strategies to engage the public with digital technologies and health data for public health were highlighted in the workshops. France created the MyHealthSpace that provides a person with control over own health data for all French citizens.[11] In Canada, a series of directives has been published, including a commitment to increase access to federal data for the public while ensuring security and confidentiality, an open science roadmap, and the Digital Strategy Roadmap for the Federal Public Service.

The importance of open data practices, including the establishment of open and accessible databases, was also discussed. Beyond communication activities surrounding data collection, workshop participants also stressed the importance of broader communication activities and plans to promote the value of DPH interventions. Workshop participants also highlighted the need for recognition of inequalities in resources across health systems, as well inequalities in access to digital technologies across populations. It was noted that action should be taken to consider the implications of such inequities for the use of DPH.

Collaboration and partnership

The need for collaboration and partnership was another key theme highlighted in the workshops. Such collaboration should be both multidisciplinary and cross-sectoral, drawing on different organisations and networks to build holistic and integrated public health solutions. The need for a collaborative approach at different levels (within public health teams, local, national, regional, international) was also emphasised. Various potential benefits of collaboration and partnership were discussed, including the pooling of resources, knowledge exchange and cross-fertilisation, data-sharing, ensuring buy-in from diverse stakeholders, and cultivating shared responsibilities among stakeholders.

For public health authorities, opportunities for collaboration and partnership include working with other government agencies, academic researchers, industry, as well as broader professional networks. During the course of the workshops, several specific modes of collaboration and partnership opportunities were discussed. These included collaboration with academic research communities through controlled crowdsourcing (for example drawing on the example of the Human Genome Project), working with regulators to identify practical paths for the use of digital technologies and data analysis for public health, and working with private sector partners to co-create new DPH interventions and to overcome challenges with data ownership. Related to public health practitioners, it was suggested that the integration of digital technologies should be carried out in collaboration with practitioners. In the context of private sector collaborations, the need for transparent, independent procurement processes was also underlined.

Participants discussed examples of collaboration and partnership that they perceived as offering some ideas of good practice.[12] These included the development of Malta's COVID-19 contact tracing app, where a range of stakeholders were involved to develop the app in a short time frame. In Canada, consultations have been carried out with users of DPH, researchers, policy-makers, and the public on how to build DPH strategies centred on partnership, equity, and interdisciplinarity. The Public Health Agency of Canada has also established a community of practice (COP)[13] to break down silos between different branches and federal departments.[14] Another example that was discussed from outside of the public health domain was Registration, Evaluation, Authorisation, and Restriction of Chemicals in the European Union (REACH) regulation. The process for the regulation prepared the infrastructure, tools, and regulation formats from the onset, and involved frequent interactions with academia, industry, and other stakeholders to ensure their involvement and buy-in.

[10] A lighthouse project is defined as a project that is short-term, well defined and measurable that can act as a model, or 'lighthouse', for other projects that are similar in a broader digital transformation initiative [11].

[11] From January 2022, 69 million French citizens will receive notifications and get access to health data. Further details on this example are provided in Annex 1.

[12] These examples are based on the information that participants shared at the workshops. It is beyond the scope of this workshop report to conclusively ascertain the nature and impact of the good practice.

[13] COPs are groups that are self-organising and self-governing. The people in a COP often share a passion for their working patterns and aim to be better practitioners by developing and sharing knowledge, capabilities, practices, and organisational capacity [12].

[14] The COP met monthly before the pandemic hit. It was highlighted that the COP was a good platform to bring together current users and to establish networks where best practice, examples, and answers to common challenges were shared.

Monitoring and evaluation

The need for robust and widespread monitoring and evaluation of DPH interventions was highlighted by several workshop participants. It was noted that although the evidence that supports the impact that digitalisation has on public health has been increasing, significant gaps still exist. The need for implementation and operational research to monitor and evaluate how digital technologies have been used, determining their effectiveness and impact, and identifying potential enablers and barriers to adoption or scaling up, were mentioned as key points in this regard. The requirement to put in place retrospective and parallel evaluations of interventions was also highlighted. Notably, there are links between these observations and the findings of the scoping reviews conducted by RAND Europe and ECDC prior to this expert consultation, all of which found that many publications on digital technologies for infectious disease surveillance, prevention and control reported on technologies at an early stage of development, with limited evidence regarding monitoring and evaluation [13]–[15].

It was noted that monitoring and evaluation can be important to building public trust and understanding lessons learned. It was felt that publishing evaluations of pilots and proofs of concepts can help achieve these outcomes. A key requirement raised by participants was to consider how technologies will be implemented before the evaluation has begun. Here, it is important to identify ways to incorporate implementation research and evaluation in practice in order to narrow the gap between them. Participants emphasised that it is important to learn from failures as well as successes when designing public health interventions. For example, it was highlighted that in France stories of the challenges associated with eHealth, such as the design of five eHealth programmes in different regions that had challenges communicating with each other because of a lack of standardisation, had informed France's current approach. The current approach still has regional innovation and action plans but is strongly rooted in national or international standards that could connect the different programs.[15]

[15] Further details on this example are provided in Annex 1.

3. Next steps

The workshop aimed to bring together practitioners in public health and digital transformation to share their experience and expertise in the fast-changing area of applying digital technologies for public health. Between the time this workshop was conceptualised in late 2019 and when it was implemented in early 2021, health systems and public health have been challenged in unprecedented ways by the COVID-19 pandemic. The recent experience in pandemic response has shown the importance of health systems having a nimble response to an outbreak, based on the best available evidence. Digital technologies can strengthen public health systems and the relevant response of key public health functions. However, DPH should build on the experience of digital health and digital transformation of healthcare, as well as on innovations in public health intelligence.

The digital transformation of healthcare, health services, and health systems remains a high priority for policy-makers. Those working in public health should seek to capitalise on investment in this area by identifying how public health efforts can benefit from the development of DPH strategies and implementation approaches. Digital transformation approaches must therefore be met by those involved in public health to develop DPH strategies and implementation. The field of DPH is evolving and still forming. It is therefore especially important that practitioners, policy-makers and researchers take an adaptive approach to their work. Those working in European DPH can learn from examples in other regions of the world to define approaches to DPH that are aligned with the vision of the European Health Union. Especially relevant for European countries and infectious disease prevention and control will be systematic thinking such as the Digital Public Health Framework 2.0 under development by the EU project PHIRI [1, 2] and the digital public health interface between research and policy promoted by EUPHA [1, 2].

The themes identified in this report, while dependent on the mix of practitioners present at the workshop, can be used as a check-in with practitioners and input into future discussions about how to steer and implement DPH in practice:

- ECDC will use the expert feedback from this workshop as an input into the formation of its approach to fostering and developing DPH practice in the EU, and in its strategic redesign and digitalisation of surveillance in the EU.
- Other stakeholders and partners can use this report as a snapshot and input into their own positioning and work in international DPH, as the public health community is developing this area of work.

The workshop discussion showed the significance of facilitating and encouraging cross-functional and inter-disciplinary conversations in digital public health, and the demand among practitioners to share experience and expertise. A digital public health community of practice would provide a network for practitioners, as the field of digital public health is still developing.

References

1. Odone A, Buttigieg S, Ricciardi W, Azzopardi-Muscat N, Staines A. Public health digitalization in Europe: EUPHA vision, action and role in digital public health. European Journal of Public Health. 2019 October 1;29(Supplement_3):28–35.
2. Lapão L. Digital public health framework 2.0: some hints for a research agenda. ECDC consultation on digital technologies in public health; 2021 May 25.
3. Public Health Agency of Canada. Artificial Intelligence in Public Health. Canada Communicable Disease Report. 2020; 46(6). Available at: https://www.canada.ca/content/dam/phac-aspc/documents/services/reports-publications/canada-communicable-disease-report-ccdr/monthly-issue/2020-46/issue-6-june-4-2020/ccdrv46i06-eng.pdf
4. The Office of the National Coordinator for Health Information Technology. United States Core Data for Interoperability. The Office of the National Coordinator for Health Information Technology; 2020. Available at: https://www.healthit.gov/cures/sites/default/files/cures/2020-03/USCDI.pdf
5. European Medicines Agency. Data on medicines (ISO IDMP standards): Overview. European Medicines Agency. 2018. Available at: https://www.ema.europa.eu/en/human-regulatory/overview/data-medicines-iso-idmp-standards-overview
6. NHS Digital. Fast Healthcare Interoperability Resources. NHS Digital. 2021. Available at: https://digital.nhs.uk/services/fhir-apis
7. European Medicines Agency. DARWIN EU (Data Analytics and Real World Interrogation Network). European Medicines Agency; 2020. Available at: https://www.ema.europa.eu/en/documents/presentation/presentation-proposal-darwin-eu-data-analytics-real-world-interrogation-network-parlett-ema_en.pdf
8. Langford J, Poikola A, Janssen W, Lahteenoja V, Rikken M. Understanding MyData Operators. MyData Global; 2020. Available at: https://mydata.org/wp-content/uploads/sites/5/2020/04/Understanding-Mydata-Operators-pages.pdf
9. Open Data Institute. What is a data trust? Open Data Institute. 2018. Available at: https://theodi.org/article/what-is-a-data-trust/
10. Simões AS, Maia MR, Gregório J, Couto I, Asfeldt AM, Simonsen GS, et al. Participatory implementation of an antibiotic stewardship programme supported by an innovative surveillance and clinical decision-support system. J Hosp Infect. 2018 November;100(3):257–64.
11. Williams D. Why Lighthouse Projects, Not PowerPoints, Will Unlock Your Transformation Value. Contino | Global Transformation Consultancy. 2017. Available at: https://www.contino.io/insights/why-lighthouse-projects-not-powerpoints-will-unlock-your-transformation-value
12. Garrod B, Ling T. System change through situated learning: Pre-evaluation of the Health Innovation Network's Communities of Practice. 2018 March 20; Available at: https://www.rand.org/pubs/research_reports/RR1821.html
13. RAND Europe. Scoping review to assess the implementation of technological innovations to tackle COVID-19: academic sources – Deliverable DL1.1.3. Cambridge, England: RAND Europe; 2021.
14. RAND Europe. Scoping review to assess the implementation of digital technological innovations to tackle COVID-19: non-academic sources - Deliverable DL.1.1.3. Cambridge, England: RAND Europe; 2021.
15. RAND Europe. Assessment of digital technologies for infectious disease surveillance, prevention and control: Final scoping review report - Deliverable DL.1.1.4. Cambridge, England: RAND Europe; 2020.
16. CIFAR, Canadian Institutes of Health Research. Application of Artificial Intelligence Approaches to Tackle Public Health Challenges. Toronto, Ontario: CIFAR & CIHR; 2018. Available at: https://cihr-irsc.gc.ca/e/documents/artificial_intelligence_approaches-en.pdf
17. Finley R. AI in Public Health in Canada. ECDC consultation on digital technologies in public health; 2021 June 15.
18. Glanville D. Data Analysis and Real World Interrogation Network (DARWIN EU). European Medicines Agency. 2021. Available at: https://www.ema.europa.eu/en/about-us/how-we-work/big-data/data-analysis-real-world-interrogation-network-darwin-eu
19. Brun N, Arlett P. PCWP/HCPWP joint meeting; Head of Medicines Agencies & European Medicines Agency. Available at: https://www.ema.europa.eu/en/documents/presentation/presentation-implementation-hma-ema-big-data-steering-group-deliverables-parlett-ema-nbrun-dkma_en.pdf
20. Head of Medicines Agencies, European Medicines Agency. HMA-EMA Joint Big Data Taskforce Phase II report: "Evolving Data-Driven Regulation". Head of Medicines Agency & European Medicine Agency; 2019.

Available at: https://www.ema.europa.eu/en/documents/other/hma-ema-joint-big-data-taskforce-phase-ii-report-evolving-data-driven-regulation_en.pdf

21. HL7 FHIR Release 4. Overview - FHIR. HL7 FHIR. 2019. Available at: https://www.hl7.org/fhir/overview.html
22. HL7 FHIR Release 4. Summary - FHIR v4.0.1. HL7 FHIR. 2019. Available at: https://www.hl7.org/fhir/summary.html
23. HealthITAnalytics. 4 Basics to Know about the Role of FHIR in Interoperability. HealthITAnalytics. 2016. Available at: https://healthitanalytics.com/news/4-basics-to-know-about-the-role-of-fhir-in-interoperability
24. HL7 International. HL7 FHIR ACCELERATORTM Program | HL7 International. HL7 International. 2021. Available at: http://www.hl7.org/about/fhir-accelerator/
25. Agence Du Numerique en Sante. Mon Espace Santé. 2021. Available at: https://esante.gouv.fr/mon-espace-sante
26. Ministere Des Solidarites et de la Sante. Mon Espace Santé. G_NIUS. 2020. Available at: https://gnius.esante.gouv.fr/reglementation/fiches-reglementation/mon-espace-sante
27. Graeve C. e-Health in France: Spotlight on the National Healthcare Digitalization Strategy. Health Advances Blog. 2020. Available at: https://healthadvancesblog.com/2020/03/24/e-health-in-france/
28. Zablit I. Accelerating e-health implementation with MyHealthSpace and the renewed role of the state as a platform. ECDC consultation on digital technologies in public health; 2021 June 15.
29. EUPHA. Annual Report 2020: EUPHA Digital Health Section (EUPHA-DH). EUPHA; 2020. Available at: https://eupha.org/repository/sections/dh/EUPHA-DH%20Annual%20report%202020.pdf
30. Odone A, Frascella B, Balzarini F, Oradini Alacreu A, Signorelli C. A systematic review of email-based reminder interventions to increase vaccine uptake. European Journal of Public Health. 2019 November 1;29(Supplement_4). Available at: https://doi.org/10.1093/eurpub/ckz186.519
31. Oradini-Alacreu A, Balzarini F, Frascella B, Signorelli C, Odone A. The Europe Vaccines ICT Strategies (EUVIS) Project: Information & Communication Tehcnology to enhance immunization in Europe. Journal of Preventive Medicine and Hygiene. 2019;60(3).
32. Signorelli C, Odone A, Merli C, Lopalco P. Information & Communication Technology to enhance immunization in Europe: the EUVIS project protocol: Carlo Signorelli. European Journal of Public Health. 2015 October 1 i;25(suppl_3). Available at: https://doi.org/10.1093/eurpub/ckv167.041
33. Draguet V. European Health Data Space. Public Health - European Commission. 2020. Available at: https://ec.europa.eu/health/ehealth/dataspace_en
34. Hansen J, Wilson P, Verhoeven E, Kroneman M, Kirwan M, Verheij R, et al. Assessment of the EU Member States' rules on health data. European Comission - DG Health and Food Safety; 2021. Available at: https://ec.europa.eu/health/sites/default/files/ehealth/docs/ms_rules_health-data_en.pdf
35. Verhoeven E, Kroneman M, Wilson P, Kirwan M, Verheij R, van Veen E-B, et al. Country fiches for all EU MS: Annex to the study 'Assessment of the EU Member States' rules on health data in light of GDPR'. European Comission - DG Health and Food Safety; 2021. Available at: https://ec.europa.eu/health/sites/default/files/ehealth/docs/ms_rules_health-data_annex_en.pdf
36. European Commission. Open public consultation on the European Health Data Space. EC; Brussels: 2021. Available from: https://ec.europa.eu/commission/presscorner/detail/en/ip_21_2083

Annex 1. Case examples collected during workshop

Case example: Artificial intelligence in public health in Canada

Plain-language summary: The Public Health Agency of Canada works across public health, policy, research, and regulatory fields to develop capacities, infrastructure, and a strategy for AI use in public health, focused on partnership, equity, and interdisciplinarity.

Background: The responsibility for delivering health and social services in Canada belongs to the countries' 13 provinces and territories. The federal minister of health oversees agencies supporting federal health policy, public health, health research, and regulation. The Public Health Agency of Canada is working within the federal goals as outlined within the Open Government, Roadmap for Open Science, Canada's open government, open science, Digital Charter and the data Strategy Roadmap for the Federal Public Service to formulate the use of AI for public health. Canada has established several initiatives that frame its approach to AI, including an Advisory Council on AI, an AI source list for streamlined procurement of services, and an algorithmic impact assessment tool, among others.

Main activities: The Office of the Chief Science Officer at the Public Health Agency of Canada is approaching AI in public health from multiple angles:

- An environmental scan of AI-related activities in public health was conducted in 2019. It collected experiences of and challenges to the adoption of AI in public health and an inventory of existing projects was developed showing existing use of machine learning, natural language processing, or deep learning.
- A white paper on the use of AI in public health is being developed. This white paper will focus on the potential impacts of AI technologies on population health, on applications of AI in the public health practice, and on critical considerations for the implementation of AI in public health.
- There is a concerted effort to exchange ideas and lessons with stakeholders. Several initiatives established dialogue on specific relevant topics, including conversations with the private sector, discussions on the ethics and policy, and community-based workshops on the future of Canadian public health systems.
- Community and capacity building is taking place through establishment of a community of practice for AI in public health a research fellowship through Canadian Institute for Health Research, Canada School of Public Service, and a training programme for AI in public health.
- Work is ongoing to build, through participatory methods, a Pan-Canadian strategy for AI in public health, which will center on partnership, equity and interdisciplinarity.

Lessons learned and/or highlighted projects and use-cases: The activities aim to develop capacities and expertise, foster multidisciplinary approaches, connect public health functions that often work in silos, and address challenges in data access and quality. The inventory of current AI for PH projects is diverse and spans across infectious disease (analysis of earth observation data, geomatics, prioritisation of illness clusters, analysis of risk of exposure, analysis of emerging threats and related risks), substance-related harms (detection and analysis of signals in media and social media) , building of chatbots (immunisation), non-communicable disease prevention (mortality risk prediction of dementia mortality), and use of data trusts for health data.

Sources consulted:

This case example was developed by consulting the following sources: [3, 16, 17]

Case example: European Medicines Agency (EMA) Data Analysis and Real World Interrogation Network (DARWIN) Project

Plain-language summary: EMA's DARWIN EU Project is attempting to establish a cross-EU network bringing together evidence on medicine use and performance from real-world healthcare databases. The project adopts a distributed and federated approach to data access, the focus of which is to ensure interoperability while also enabling data to remain stored locally and to be queried remotely.

Background: Established in 2021 following a recommendation from a joint European Medicines Agency (EMA) and Heads of Medicines Agencies 'Big Data Task Force', the DARWIN Project seeks to create a coordinated network providing timely and reliable evidence on medicine use and performance from real-world healthcare databases across the EU. The Project aims to support better regulatory decision making by EMA and national competent

authorities within the European medicines regulatory network by enabling rapid access to high-quality, cross-EU data which is used to assess the benefits and risks of medicinal products, including vaccines.

Key characteristics: Key features of the DARWIN Project include:

- A distributed, federated approach to data access in which data remains in the hands of local data collectors, rather than stored in centralised databases, and is queried remotely.
- A common data model and common protocol enabling fast analysis across datasets.
- Common governance, standards, and service levels with respect to studies and analysis of data.
- The anonymisation of data exchanged within the network.
- A third-party coordination centre acting as the entry point into the federated network and managing the network on behalf of EMA and the European Medicines Regulatory Network (EMRN).

The DARWIN project is currently under development and will be implemented as part of EMA's network strategy running to 2025. While the early stage of the project makes it difficult to draw lessons learned, DARWIN demonstrates the use a distributed and federated approach to data access, with various potential benefits in terms of interoperability, standardisation, and data strategy and governance.

Lessons learned and/or highlighted projects and use-cases: The DARWIN project is currently under development and will be implemented as part of EMA's network strategy running to 2025. While the early stage of the project makes it difficult to draw lessons, DARWIN demonstrates the use a distributed and federated approach to data access, with various potential benefits in terms of interoperability, standardisation, and data strategy and governance.

Sources consulted:

This case example was developed by consulting the following sources: [7, 18–20].

Case example: Health Level Seven (HL7) Fast Healthcare Interoperability Resources (FHIR)

Plain-language summary: FHIR is a standard describing the data formats and elements for exchanging electronic health records (EHRs) at an international level. FHIR is intended to support interoperability of health data through an internet-based approach based on the treatment of individual data elements as 'resources' retrievable through an API. In developing FHIR, HL7 has adopted a collaborative and participatory approach, engaging stakeholders and building understanding of how to implement the FHIR standard.

Background: With the increasing digitisation of healthcare records, there is a need for greater standardisation of these records, as well as interoperability between healthcare systems. Established by HL7, and building on previous HL7 standards for exchange of EHRs, FHIR provides a new standard for exchanging EHR data between legacy health systems and to enable third-party developers to develop medical applications which can be integrated into wider systems. Initially drafted in 2011, FHIR 4, the first normative draft of the FHIR standard was published in 2019.

Key characteristics: FHIR adopts a new, internet-based approach to data exchange, a key feature of which is the concept of 'resources'. Under this approach:

- All exchangeable data elements (e.g. patient data) within an EHR are defined as 'resources', with all resources having a common way to define and represent them, a common set of meta-data, and a human readable text representation.
- FHIR directly 'exposes' these resources through a FHIR API. Basic data elements can each be retrieved by users via their own URLs.
- Resources can be treated separately or grouped into collections depending on user requirements.
- The FHIR standard is suitable for incorporation into a wide range of eHealth applications, from mobile phone apps to large institutional healthcare systems.

Following publication of FHIR, HL7 held listening sessions bringing together thought leaders, academics and stakeholders from different levels of public health to understand how the standard can help address their needs. A FHIR accelerator programme has also been launched to assist public health communities around the world in the creation and adoption of FHIR implementation guides.

Lessons learned and/or highlighted projects and use-cases: The FHIR standard demonstrates the potential for new, internet-based approaches to ensuring interoperability and health information exchange. The development and roll-out of FHIR also demonstrates a collaborative and participative approach to digital health intervention.

Sources consulted:

This case example was developed by consulting the following sources: [21–23].

Case example: French Health Data Hub and MyHealthSpace

Plain-language summary: In France, a national Health Data Hub is in the process of being established, together with a personal digital health space for every citizen. The digital health strategy of the Ministry of Social Affairs and Health (MoSH) surrounding these interventions emphasises the importance of a holistic approach combining learning, combined technical, ethical and security standards, collaboration with the private sector, stakeholder engagement, and digital skills.

Background: Under a new healthcare act adopted in 2019, based on the government's 'My Health 2022' plan, the MoSH has established plans for a Health Data Hub and personal digital health space ('*Mon Espace Santé*'). The Health Data Hub aims to bring all French data together in one place, thereby facilitating its use by researchers, health professionals, industry and other stakeholders. The digital health space was launched in April 2020, with the aim of providing all citizens with a shared medical file; a secure messaging system with healthcare professionals; a health agenda for booking and tracking of medical appointments; and a catalogue of services with which users may choose to share their health data.

Key characteristics: In its approach to developing and implementing the Health Data Hub and personal digital space, the MoSH strategy has adopted the following characteristics:

- A learning approach focused on factors that have caused previous failures in eHealth.
- An emphasis on the role of the state as a 'platform' with responsibility for meeting the user experience expectations of citizens and of health professionals and research communities.
- A focus on developing key standards and norms. In addition to technical standards to facilitate exchange of data across the health ecosystem, this also includes security and ethical standards such as digital data protection.
- Embracing the role of the private sector in the development of the digital health space.
- Engaging citizens, private sector and health professionals in the roll-out of the strategy, including through the establishment of the Guichet National de l'Innovation et des Usages en e-Santé (G_NIUS) programme encouraging innovation and collaboration in the digital health space.
- An emphasis on the development of digital skills.

Lessons learned and/or highlighted projects and use cases: Under development, the digital health strategy demonstrates a holistic approach to the implementation of digital health interventions, incorporating learning, standards development (including technical, ethical, and security standards), digital skills, collaboration, and engagement.

Sources consulted:

This case example was developed by consulting the following sources: [24-27].

Case example: EUPHA – Europe Vaccines ICT Strategy

Plain-language summary: EUPHA, through the sections on digital health (EUPHA-DH) and Infectious Diseases Control (EUPHA-IDC), initiated the Europe Vaccines ICT Strategy (EUVIS) research project. EUVIS collected best practice examples from experts in Europe on the impact and use of information and communications technologies (ICT) and digital tools for vaccine uptake increase and to achieve vaccination coverage in Europe. EUVIS demonstrates a collaborative approach to information gathering, as well as the need for digital interventions suited to local contexts and needs.

Background: Established in 2015, EUVIS was a three-year project coordinated by the University of Parma in Italy and implemented for EUPHA. The project aimed to gain an understanding of data on challenges and opportunities of digitalising immunisation in Europe, and the how these challenges and opportunities play out in different country contexts. Specifically, the project aimed to assess: (i) computerised immunisation registries and their implementation in Europe; (ii) how health authorities apply ICT to educate the public on immunisation, as well as to provide a contrast to increasing vaccine hesitancy; and (iii) how ICT are applied in interventions that are community-based and provider-based to increase vaccine uptake.

Key characteristics: Key features of the EUVIS project are:

- A series of systematic reviews to pool available evidence from experimental studies on the impact of ICT-based interventions (such as personal health records, email reminders, etc.) to improve vaccine uptake and other outcomes associated with vaccine uptake.
- Conducting a European-level survey to obtain original data on practices and the impact of ICT on immunisation programmes in certain countries.[16]
- Disseminating findings, models and best practices in Europe.

[16] This tool was development-based on findings from the first phase and an experts' consultation and consisted of a 55-item questionnaire. The survey was distributed to public health professionals who worked in health agencies, institutions, and academia. Questions that were asked of health professionals included if there were any health strategies in place (or that were in the process of being approved), the number and levels of digital tools specifically in place for immunisation, digital interventions in place to support vaccination providers, the impact of digital-based immunisation campaigns, and the challenges and opportunities of interventions.

Lessons learned and/or highlighted projects and use-cases: EUVIS demonstrates how a collaborative approach that involves health professionals can facilitate understanding of digital public health challenges and opportunities. EUVIS also provides an example of how projects can be suited to the specific contexts in which digital technologies are being applied as 'ICT and immunisation' profiles have been established for different countries. Data collected through the different phases also aimed to inform planning and implementation of ICT-based models that aim to increase vaccination uptake in Europe.

Sources consulted:

This case example was developed by consulting the following sources: [28–31].

Case example: The European Health Data Space

Plain-language summary: A European Health Data Space has been created to promote the better exchange of and access to the collection of data from a range of sources, such as genomics data, EHRs, and data from patient registries. The aim of the data space is to support healthcare delivery (or the primary use of data) and to inform health research and heath policy-making (or the secondary use of data). Efforts to create the data space underscore the importance of the data quality and interoperability as factors considered necessary to deliver public health impact.

Background: Creating a European Health Data Space is a priority for the European Commission in the period 2019-2025. The aim is to create a data space that was built on transparent systems that can provide full protection for the data of European citizens, as well as to strengthen the transferability of health data. Together with Member States, the Commission is undertaking preparatory work and development of the space. The new 'Joint Action for European Health Data Space' has been established to support Member States and the European Commission to share health data for the purposes of research and innovation, public health, and treatment. The data space will be built on three pillars:

1. A system that can support data governance and rules for data exchange;
2. Data quality; and
3. Infrastructure and operability that are strong.

Key characteristics: Key features of a European Health Data Space include:

- Creating a framework for the primary and secondary use of health data in Member States. The framework is focused on mapping how the health sector implements the General Data Protection Regulation (GDPR), as well as the technical modalities that are in place to share health data for both primary and secondary purposes in the EU. It also provides an overview of the governance structures that are already in place for the secondary use of health data in EU countries. Finally, the framework provides recommendations for potential non-legislative and legislative actions at the EU level that can facilitate data-sharing across the EU.
- The space aims to make full use of digital health for healthcare that is of a high quality and can reduce inequalities.
- The data space emphasises the need to ensure access to health data for several different purposes, including research and innovation, prevention, diagnosis and treatment, and policy-making and legislation.
- The data space facilitates the right of individuals to control their own personal health data as one of its core principles.
- As part of the work, the European Commission supports mapping to identify existing health data registries and other data sources that are 'findable, accessible, interoperable, and reusable' (FAIR). The aim is to create common data sets to exchange data for health research and policy-making.
- The infrastructure for the data space in Europe follows the overarching strategy for the European Data Space, while also focussing on the specificities of the health sector.

Lessons learned and/or highlighted projects and use-cases: The European Health Data Space is currently under development and will be fully implemented as part of the European Commission's priorities for 2019-2025, which includes the health sector. As the data space is still under development, it is difficult to draw lessons learned. However, the European Health Data Space emphasises the importance of data quality and interoperability to fully take advantage of the potential of health data and to ensure that different sources of data can communicate with each other. It highlights the need for interoperability both in terms of the language that is used and the technical infrastructure and framework. The data space also focusses on making health data 'findable, accessible, interoperable, and reusable' (FAIR).

Sources consulted:

This case example was developed by consulting the following sources: [32–36]

Annex 2. Workshop agenda

The presentations from the workshops are available on ECDC's website here.

Session 1 – Wednesday, 5 May 2021

Digital technologies for key public health functions Technologies with potential to improve or disrupt key public health functions • Key public health functions that could benefit most from use of technology • Technologies with potential to improve or disrupt key public health functions	
13:30-13:45	Welcome and introduction of participants
13:45-14:15	Short introduction to overall project scope and objectives of the consultation Key results of scoping reviews, glossary of digital technologies and key public health functions, ECDC logic model
14:15-14:30	Icebreaker and first live poll
14:30-14:55	Presentations • Piotr Kramarz, ECDC - ECDC mandate and key functions • Julien Beauté, ECDC - EU/EEA surveillance today and in the future
14:55-15:00	Walk-through tool for breakout session
15:00-15:05	Break
15:10-16:00	Breakout session Technologies with potentially large impact (beneficial or disruptive) on public health, currently and over the next years Key public health functions which probably would benefit most from use of technology/investments
16:00-16:05	Break
16:05-16:55	Reporting back from breakout session, plenary discussion
16:55-17:00	Wrap up

Session 2 – Tuesday, 25 May 2021, 13.30-17.00 CET

Digital technologies for key public health functions Last time, we described the important role of digital technologies to improve access to data for public health. • How can public health institutions such as ECDC maintain and further improve access to relevant and reliable epidemiological and scientific data and information to fulfil their mandate? How can we further strengthen collaboration and data exchange without compromising security, privacy, and trust? • Going beyond enablers and blockers we brainstormed last time, think of successful scale-ups of digital health for public health you know of. What policies and approaches do you know of have helped to successfully adopt digital technologies at scale to support public health interventions and achieve public health goals?	
13:30-13:45	Welcome and introduction to Session 2
13:45-14:15	Case studies (short presentations and Q&A) • Laura Espinosa, ECDC - Epitweetr: early warning tool using Twitter data • Stefan Jensen, European Environment Agency (EEA) - EEA-Eionet digitalisation framework
14:15-14:45	Breakout session - small group discussions
14:45-15:15	Reporting back from breakout session, plenary discussion
15:15-15:20	Break
15:20-15:50	Case studies (short presentations and Q&A) • Marifé Lapeña, MSCBS, Spain - COVID-19 case study Spain • Luis Lapão, IHMT, Portugal - Digital public health framework 2.0
15:50-16:20	Breakout session - small group discussions
16:20-16:50	Reporting back from breakout session, plenary discussion
16:50-17:00	Wrap up

Session 3 – Tuesday, 15 June 2021, 13.30-17.00 CET

Digital technologies for key public health functions	
13:30-13:45	Welcome and introduction to Session 3
13:45-15:20	Presentations, panel discussion • Anna Odone, Stefan Buttigieg, EUPHA - The rise of Digital Public Health in Europe: the principles and perspective of the European Public Health Association • Rita Finley, PHAC, Canada - AI in Public Health in Canada • Isabelle Zablit, Ministry of Health, France - Accelerating e-health implementation with MyHealthSpace and the renewed role of the state as a Platform • Paula Braun, US CDC - HL7 FHIR and Public Health: Examples from the US
15:20-15:30	Break
15:30-16:50	Plenary discussion and polls
16:50-17:00	Wrap up

Annex 3. List of participants

EU institutions	
Ermanno Cavalli	European Food Safety Authority
Jerome De Barros	European Commission - DG Research & Innovation
Athanasios Demiris	European Chemicals Agency
Stefan Jensen	European Environment Agency
Licinio Kustra Mano	European Commission - DG SANTE
Blanca Martinez De Aragon	European Chemicals Agency
Luis Pinheiro	European Medicines Agency

International partners	
Paula Braun	Centers for Disease Control and Prevention, US
Rita Finley	Public Health Agency of Canada, Canada
Clayton Hamilton	World Health Organization Regional Office for Europe

National health authorities	
Milan Blaha	Institute of Health Information and Statistics, Czechia
Alexandre Canarelli	Santé publique France
Yves Dupont	Sciensano, Belgium
Mario Fafangel	Communicable Diseases Centre, Slovenia
Maria Fe Lapeña	Ministry of Health, Spain
Ivo Georgiev	National Centre of Infectious and Parasitic Diseases, Bulgaria
Laëtitia Huiart	Santé publique France, France
Daniel Klimeš	Institute of Health Information and Statistics, Czechia
Paul-Henri Lampe	Santé publique France, France
Mathias Leroy	Sciensano, Belgium
Elena Vanessa Martínez Sánchez	Ministry of Health, Spain
Marcello Melgara	On behalf of the Ministry of Health, Italy
Teemu Mottonen	Institute for Health and Welfare, Finland
Nasser Nuru Mahmud	Public Health Agency, Sweden
Robert Scharinger	Federal Ministry of Social Affairs, Health, Care and Consumer Protection, Austria
Vladimíra Těšitelová	Institute of Health Information and Statistics, Czechia
Alexander Ullrich	Robert Koch Institute, Germany
Isabelle Zablit-Schmitz	Santé publique France, France

Individual experts in their own capacity	
Luís Lapão	Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Portugal
Daniela Paolotti	Institute for Scientific Interchange Foundation, Italy
Pedro Pereira Rodrigues	CINTESIS - Centre for Research on Health Technologies and Services and at the LIAAD - Artificial Intelligence and Decision Support Laboratory, University of Porto, Portugal

Representatives of European interest organisations	
Rob Brisk	Nvidia, representing DIGITALEUROPE
Stefan Buttigieg	European Public Health Association
Michael Edelstein	European Public Health Association
Sascha Marschang	European Public Health Alliance
Tino Marti	European Health Telematics Association
Anna Odone	European Public Health Association
Ray Pinto	DIGITALEUROPE
Georgios Raptis	Standing Committee of European Doctors
Maurizio Sanguinetti	European Society of Clinical Microbiology and Infectious Diseases
Paul-Etienne Schaeffer	Association of the European Self-Care Industry
Alex Settels	Philips, representing DIGITALEUROPE

Observers	
Bonnie Cai	Public Health Agency of Canada
Alexandria Clark	Public Health Agency of Canada
Simone Martineau	Public Health Agency of Canada
Patricia Ndumbi Ngamala	World Health Organization

ECDC	
Julien Beaute	Public Health Functions Unit
Mike Catchpole	Scientific Methods and Standards Unit
Stanislav Danchev	Digital Transformation Services Unit
Laura Espinosa	Public Health Functions Unit
Rodrigo Filipe	Public Health Functions Unit
Finbarr Geaney	Scientific Methods and Standards Unit
Joana Gomes Dias	Scientific Methods and Standards Unit
Jari Kallela	Digital Transformation Services Unit
Piotr Kramarz	Disease Programmes Unit
Spyros Ktenas	Digital Transformation Services Unit
Vicky Lefevre	Public Health Functions Unit
Gaetano Marrone	Scientific Methods and Standards Unit
Francois Mestre	Digital Transformation Services Unit
Egle Obcarskaite	Disease Programmes Unit
Pasi Penttinen	Disease Programmes Unit
Ines Steffens	Scientific Methods and Standards Unit
Marieke Van der Werf	Disease Programmes Unit
Phillip Zucs	Public Health Functions Unit

Organisation and facilitation	
Cristian Avram	Digital Transformation Services Unit, ECDC
Helena de Carvalho Gomes	Scientific Methods and Standards Unit, ECDC
Joe Francombe	RAND Europe
Salil Gunashekar	RAND Europe
Luciana Muresan	Scientific Methods and Standards Unit, ECDC
Petronella Nyakundi	Resource Management Services Unit, ECDC
Tina Purnat	Digital Transformation Services Unit, ECDC
Emily Ryen Gloinson	RAND Europe

European Centre for Disease Prevention and Control (ECDC)

Gustav III:s Boulevard 40
169 73 Solna, Sweden

Tel. +46 858 60 1000
Fax +46 858 60 1001
www.ecdc.europa.eu

An agency of the European Union
www.europa.eu

Subscribe to our publications
www.ecdc.europa.eu/en/publications

Contact us
publications@ecdc.europa.eu

Follow us on Twitter
@ECDC_EU

Like our Facebook page
www.facebook.com/ECDC.EU

ECDC is committed to ensuring the transparency and independence of its work

In accordance with the Staff Regulations for Officials and Conditions of Employment of Other Servants of the European Union and the ECDC Independence Policy, ECDC staff members shall not, in the performance of their duties, deal with a matter in which, directly or indirectly, they have any personal interest such as to impair their independence. Declarations of interest must be received from any prospective contractor(s) before any contract can be awarded.
www.ecdc.europa.eu/en/about-us/transparency