Research prioritization for pandemic and epidemic intelligence

Technical brief
Research prioritization for pandemic and epidemic intelligence

Technical brief
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>iv</td>
</tr>
<tr>
<td><strong>Background</strong></td>
<td></td>
</tr>
<tr>
<td>Why prioritize research for pandemic and epidemic intelligence?</td>
<td>1</td>
</tr>
<tr>
<td>What is the scope of this research prioritization?</td>
<td>1</td>
</tr>
<tr>
<td>How was this research prioritization conducted?</td>
<td>3</td>
</tr>
<tr>
<td><strong>Research statements by priority rank</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Summaries of research statements by theme</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Next steps</strong></td>
<td>14</td>
</tr>
<tr>
<td><strong>References</strong></td>
<td>15</td>
</tr>
</tbody>
</table>
Acknowledgements

The World Health Organization (WHO) gratefully acknowledges the many individuals and organisations who contributed to the development of the WHO research prioritization for pandemic and epidemic intelligence technical brief (referred to hereafter as technical brief).

Leadership and coordination

This technical brief was developed by the WHO Division of Health Emergency Intelligence and Surveillance Systems, led by Assistant Director-General Chikwe Ihekweazu, under the overall strategic leadership and technical supervision of Oliver Morgan, Director, WHO Department of Pandemic and Epidemic Intelligence, with technical lead and coordination from Barbara Tornimbene, Consultant, WHO Department of Pandemic and Epidemic Intelligence Systems, and Isabel Redies, Consultant, CPC Analytics / WHO Division of Health Emergency Intelligence and Surveillance Systems. The research prioritization process was developed in close collaboration with Anna-Laura Ross, Head, Emerging Technologies, Research Prioritization and Support Unit, WHO Science Division. Awuor Ouma, SEEK Development, and Emily Wymer, SEEK Development, led the first phase of the prioritization exercise, defining its framework and the structure of the first experts’ survey.

WHO contributors and reviewers

The following staff of the WHO Division of Health Emergency Intelligence and Surveillance Systems reviewed the initial problem statements and checked data and evidence, and/or provided technical support: Adedoyin Abiola Awofisayo-Okuyelu, Stephane Ghozzi, Raquel Medialdea Carrera, Patricia Ndumbi Ngamala. Reviewers also included Christian Franz (CPC Analytics / WHO Division of Health Emergency Intelligence and Surveillance Systems), and Rithika Sangameshwaran (CPC Analytics / WHO Division of Health Emergency Intelligence and Surveillance Systems).

Technical advisory

WHO appreciates the guidance of all technical working group (TWG) members: Philip Abdelmalik (WHO Division of Health Emergency Intelligence and Surveillance Systems), Nora Anton (Charité University Hospital Berlin), Julia Fitzner (WHO Division of Health Emergency Intelligence and Surveillance Systems), Amina Haouala (WHO Science Division), Sara Hersey (WHO Division of Health Emergency Intelligence and Surveillance Systems), Beate Kampmann (Charité University Hospital Berlin), Gerard Krause (WHO Division of Health Emergency Intelligence and Surveillance Systems), Rebecca Sophia Lais (Charité University Hospital Berlin), Olivier Le Polain (WHO Response Division), and Alice Norton (Global Research Collaboration for Infectious Disease Preparedness).

Participants in the research prioritization process

WHO gratefully acknowledges the many experts who contributed to the surveys and workshops related to the research prioritization exercise. All the experts were asked to submit a declaration of interest (DOI) form to WHO. On review of the completed DOIs, all of them were assessed as non-significant by the TWG members and all candidates were allowed to participate in the exercise.

Funding

The WHO acknowledges early support from Wellcome Trust via contract to SEEK Development and expresses gratitude to Wellcome Trust staff, Julia Abernethy, Josie Golding, Natsuko Imai, and Mariska Van der Zee, for acting as observers during the overall process.
Background

Why prioritize research for pandemic and epidemic intelligence?

Robust evidence obtained from high-quality research is an essential foundation of pandemic and epidemic intelligence. It is the basis for strengthening collaborative surveillance which equips countries with evidence-based tools that can help minimize the impacts of pandemic and epidemic threats. Pandemic and epidemic intelligence thus involves integrating information from different surveillance methods, including traditional, event-based, participatory, and community-based approaches, along with contextual data, to assess public health risks. Such intelligence can contribute to better public health decisions.

Since the COVID-19 pandemic began, innovations in public health surveillance, particularly in data science and laboratory sciences, are transforming our ability to detect, assess, and respond to new public health threats. However, research on surveillance methods, tools, and implementation approaches still requires greater coherence, as well as more efficient ways to translate research findings into day-to-day surveillance. Moreover, a solid evidence-base is needed to assess the effectiveness of pandemic and epidemic responses in pandemic and epidemic intelligence.

The WHO Pandemic Hub, in collaboration with the Research and Policy Team of the Global Research Collaboration for Infectious Disease Preparedness (GLoPID-R), the Charité University Hospital Berlin, and the WHO Science Division, with initial financial support from Wellcome Trust, has coordinated a research prioritization process for pandemic and epidemic intelligence that should be particularly relevant for routine public health surveillance practices.

In this technical brief, we outline priorities for research in pandemic and epidemic intelligence identified through the prioritization process. Our aim was to identify the most important questions that will generate high-quality evidence and methods to better inform decision-making in global health emergencies. By doing this WHO seeks to (Fig. 1):

- Prioritize research efforts that address the needs and priorities of public health practitioners, ensuring that surveillance systems are strengthened for real-world applications
- Offer a guiding framework that sets the scope of the research landscape for the research community
- Encourage a multi-disciplinary approach to address complex challenges
- Guide funding resources, including for national governments, to overcome fragmentation and ensure directed and sufficient financial support for key research priorities
- Increase attention on efforts to integrate pandemic and epidemic intelligence into public health policy and decision-making systems, enhancing the relevance and utility of surveillance data in guiding informed decisions and day-to-day surveillance approaches

What is the scope of this research prioritization?

The research priorities are relevant to diverse groups of researchers spanning public, private, and non-governmental sectors around the world. They are designed to be inclusive and to avoid narrow thematic focuses and methodologies.

The intention is to provide overarching guidance while allowing for flexibility and creativity in the exploration of various research avenues. Rather than imposing strict boundaries, the aim is to inspire innovative thinking and different approaches to critical issues in pandemic and epidemic intelligence. This approach recognises the complex, multifaceted nature of global health challenges, while emphasising the need for interdisciplinary efforts to address them effectively.

This research prioritization should catalyse engagement and collaboration across sectors and geographies, empowering researchers to advance our collective understanding of pandemic and epidemic threats.
Prioritize research efforts that address the needs and priorities of public health practitioners, ensuring that surveillance systems are strengthened for real-world applications.

Offer a guiding framework that sets the scope of the research landscape for the research community.

Encourage a multi-disciplinary approach to address complex challenges.

Guide funding resources, including for national governments, to overcome fragmentation and ensure directed and sufficient financial support for key research priorities.

Increase attention on efforts to integrate pandemic and epidemic intelligence into public health policy and decision-making systems, enhancing the relevance and utility of surveillance data in guiding informed decisions and day-to-day surveillance approaches.
How was this research prioritization conducted?

The research prioritization was conducted in accordance with WHO guidelines using a framework adapted from the Child Health and Nutrition Research Initiative (3), in collaboration with a cross-disciplinary expert group on pandemic and epidemic intelligence.

WHO staff together with stakeholders, the GLoPID-R Research and Policy Team, and the Charité University Hospital Berlin formed the technical working group (TWG). The role of the TWG was to provide expertise, support, and technical guidance throughout all phases of the exercise. Welcome Trust, as the initial funding body, served as observer during the TWG meetings and was invited to comment and provide feedback on the overall process.

In the first stage (Fig. 2), groups of experts were consulted on the development of the framework, as well as the overall agenda, objectives, and scope. The framework is aligned with the mission of the WHO Pandemic Hub, which is to strengthen pandemic and epidemic intelligence globally through better data, better analytics, and better decisions. The research statements are sorted under the three corresponding pillars: Better Data, Better Analytics and Better Decisions. Sub-categories were defined for each pillar according to a value-chain approach to surveillance in order to facilitate the analysis. The sub-categories Detection, Verification, Notification and Response were included under the pillar Better Data. Integration, Analysis and Reporting were included under Better Analysis, and, finally Decision-making, Evaluation, and Governance under the pillar Better Decisions. The value chain approach is also in accordance with the core capacity requirements in Annex 1 of the International Health Regulations (IHR 2005) (4).

In the second stage (Fig. 2), a list was compiled of a group of 160 experts in pandemic and epidemic intelligence. The selection criteria for participants were multi-layered, emphasising a blend of professional expertise and representational balance. Experts were sought across several key areas, including infectious disease surveillance, epidemiology, data science, systems thinking, and the broad field of One Health, which integrates animal, environmental, and human health.

Additional expertise in collaboration science, social and behavioural science, and translational science was also required. Beyond expert knowledge, candidates were expected to have experience at the intersection of health research and practical policy implementation, including in the management or analysis of human health data and/or the application of research findings in policy-making. Representation was also a critical factor; participants had to collectively encompass a balance of gender and sectors such as government bodies, the private sector, academic institutions, and philanthropic organisations and, most importantly, of geographical regions as defined by the WHO, ensuring a rich diversity of insights and experiences. Once the list was compiled, the experts were invited to a survey to identify gaps in research for each of the defined sub-categories and to formulate those gaps as problem statements. Eighty-three participants responded and generated around 900 problem statements. Those underwent qualitative analysis and after removing duplicates and considering language and clarity, the iterative approach resulted in 190 problem statements.

Based on the problem statements, research statements were then formulated and reviewed internally by WHO to be further consolidated into a total of 70 research statements. These 70 research statements were then given to the TWG for validation and further consolidation. (Fig. 2). This validation step produced 25 research statements for prioritization. The TWG also defined five weighted prioritization criteria (5): 1) the research fills a key knowledge gap, 2) it can have impact and inform effective interventions, 3) it is feasible for implementation, 4) its outcomes can be translated to policy, and 5) it can lead to interventions that ultimately increase equity. The same 160 experts identified for the initial survey were then asked to rank and prioritize the research statements based on their compliance with the prioritization criteria (Fig. 2).

Overall, 45 participants agreed to contribute and assessed 25 statements against the five priority criteria using an evaluative set of questions. This resulted in each research statement receiving multiple intermediate scores, each pertaining to a criterion relevant to the prioritization. The intermediate scores were then adjusted to account for the weighting of the criteria defined by the TWG. The final scores served as the basis for ranking competing research statements, leading to the inclusion of the top 23 research priorities in this technical brief (Fig. 2).
The prioritization exercise identified (Table 1) the top 23 priorities across all pillars (Better Data, Better Analytics, and Better Decisions) and the key research priorities by thematic areas: AI and technological advances, data preparedness, quality standards, analytical frameworks, multisectoral approaches, community-centred approaches, governance, evidence to policy.

Table 1. Pandemic and epidemic intelligence research statements among all three pillars by priority rank

<table>
<thead>
<tr>
<th>Priority rank</th>
<th>Pillar</th>
<th>Theme</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AI and technological advances</td>
<td></td>
<td>Develop innovative, cost-effective, multi-pathogen laboratory diagnostic methods for pathogen detection, especially at the point of care, to increase access and timeliness of diagnostics of pathogens with epidemic and pandemic potential</td>
</tr>
<tr>
<td>2</td>
<td>Multisectoral approaches</td>
<td></td>
<td>Explore methods to improve detection, verification, and notification of epidemics and pandemics data through multidisciplinary data integration</td>
</tr>
<tr>
<td>3</td>
<td>Quality standards</td>
<td></td>
<td>Identify rapid evaluation methods to assess the effectiveness of surveillance efforts and public health interventions during epidemics and pandemics</td>
</tr>
<tr>
<td>4</td>
<td>Community-centred approaches</td>
<td></td>
<td>Identify methodologies to effectively integrate information on societal perspectives, public sentiment, and community-specific concerns into the decision-making processes for pandemics and epidemics</td>
</tr>
<tr>
<td>5</td>
<td>Community-centred approaches</td>
<td></td>
<td>Identify approaches to effectively collect and integrate community-sourced data into public health surveillance and intelligence systems</td>
</tr>
<tr>
<td>6</td>
<td>Evidence to policy</td>
<td></td>
<td>Investigate communication strategies to effectively convey health risk information and uncertainty to policy-makers for pandemic and epidemic preparedness and response</td>
</tr>
<tr>
<td>7</td>
<td>Analytical frameworks</td>
<td></td>
<td>Explore analytical techniques and modelling methodologies to enhance the understanding of pathogen emergence and re-emergence</td>
</tr>
<tr>
<td>8</td>
<td>Quality standards</td>
<td></td>
<td>Explore and assess methods for data oversight, standardisation, and regulation to ensure consistency and quality in data generation for epidemic and pandemic intelligence</td>
</tr>
<tr>
<td>Priority rank</td>
<td>Pillar</td>
<td>Theme</td>
<td>Statement</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------</td>
<td>-------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>9</td>
<td>Data preparedness</td>
<td></td>
<td>Explore social science approaches to investigate practices that affect the development of a globally trusted data-sharing architecture for epidemic and pandemic intelligence</td>
</tr>
<tr>
<td>10</td>
<td>Governance</td>
<td></td>
<td>Explore frameworks that address ethical and legal considerations to improve public health surveillance data sharing across disciplines, sectors, and administrative levels</td>
</tr>
<tr>
<td>11</td>
<td>Data preparedness</td>
<td></td>
<td>Explore the use of federated systems to facilitate data access and sharing for pandemic and epidemic intelligence</td>
</tr>
<tr>
<td>12</td>
<td>Governance</td>
<td></td>
<td>Investigate diverse data governance models and infrastructures to meet data requirements for surveillance and pandemic and epidemic intelligence</td>
</tr>
<tr>
<td>13</td>
<td>Analytical frameworks</td>
<td></td>
<td>Develop methods and frameworks for real-time infectious disease forecasting, ensuring the rapid recognition, validation, and scaling of statistical models for pandemic and epidemic intelligence</td>
</tr>
<tr>
<td>14</td>
<td>Community-centred approaches</td>
<td></td>
<td>Explore approaches to effectively integrate diverse socio-economic and health equity indicators into public health surveillance to assess and account for vulnerable populations</td>
</tr>
<tr>
<td>15</td>
<td>AI and technological advances</td>
<td></td>
<td>Explore AI methods to enhance outbreak detection and improve outbreak data management</td>
</tr>
<tr>
<td>16</td>
<td>Evidence to policy</td>
<td></td>
<td>Identify enablers and barriers to evidence-based decision-making using pandemic and epidemic intelligence insights for health intervention design</td>
</tr>
<tr>
<td>17</td>
<td>Governance</td>
<td></td>
<td>Investigate how different governance mechanisms enable the use of pandemic and epidemic intelligence findings for policy making, at the national and sub-national levels</td>
</tr>
<tr>
<td>18</td>
<td>Data preparedness</td>
<td></td>
<td>Explore the use of Open Data to verify or complement data for pandemic and epidemic intelligence</td>
</tr>
<tr>
<td>19</td>
<td>AI and technological advances</td>
<td></td>
<td>Develop validation processes to strengthen the consistency and accuracy of data obtained through AI scraping or generative AI techniques for pandemic and epidemic intelligence</td>
</tr>
<tr>
<td>20</td>
<td>AI and technological advances</td>
<td></td>
<td>Identify strategies to leverage automation and machine learning techniques to optimise data analytics for surveillance of epidemics and pandemics</td>
</tr>
<tr>
<td>21</td>
<td>Multisectoral approaches</td>
<td></td>
<td>Evaluate approaches to multisectoral coordination for effective, evidence-based decision-making for pandemic and epidemic preparedness and response</td>
</tr>
<tr>
<td>22</td>
<td>Data preparedness</td>
<td></td>
<td>Investigate the structure of data value chains, within and beyond the health sector, to explore the potential for generation and use of data from diverse sources for epidemic and pandemic intelligence</td>
</tr>
<tr>
<td>23</td>
<td>AI and technological advances</td>
<td></td>
<td>Explore the use of AI to support complex decision-making for pandemic and epidemic preparedness and response</td>
</tr>
</tbody>
</table>
Summaries of research statements by theme

AI and technological advances

Develop innovative, cost-effective, multi-pathogen laboratory diagnostic methods for pathogen detection, especially at the point of care, to increase access and timeliness of diagnostics of pathogens with epidemic and pandemic potential

_Pillar: Better Data
Priority rank: 1_

Rapid and accurate diagnostics, particularly at the point of care, can significantly shorten the time between disease exposure, diagnosis, and the initiation of treatment and public health intervention. Further, diagnostic tools capable of detecting multiple pathogens can simultaneously reduce the time and resources needed for testing and, when affordable, can become widely accessible. For example, the generation and incorporation of genomic data and access to a diversified global genomic database can bolster the ability to monitor multiple pathogens, while tracking their evolution and spread in real time and securing representation from diverse populations and geographical areas. The resilience and user-friendliness of these diagnostics are critical to their successful deployment in varied settings, and the effective integration of data into centralised data systems optimises the use of information for broader public health surveillance and response.

Explore AI methods to enhance outbreak detection and improve outbreak data management

_Pillar: Better Data
Priority rank: 15_

Artificial Intelligence (AI) technologies, especially machine learning algorithms and natural language processing, offer significant advances in enhancing the speed, accuracy, and efficiency of data management for disease surveillance and outbreak response. These tools enable the automation of data collection, reducing the time required to identify and respond to health threats. Moreover, AI can sift through a vast amount of structured and unstructured data to extract relevant information about emerging health issues. While recognising the limitations and biases that may affect its broader applicability to global health needs, AI can help to streamline outbreak data management, making information more accessible and actionable.
Develop validation processes to strengthen the consistency and accuracy of data obtained through AI scraping or generative AI for pandemic and epidemic intelligence

_Pillar: Better Data
Priority rank: 19_

Robust validation procedures for data collected and interpreted by AI are critical to ensure reliability and impartiality, which are fundamental to effective pandemic and epidemic intelligence. Effective validation procedures are crucial as they help to detect and correct biases in AI-generated information, improving the accuracy, precision, and overall trustworthiness of the data. This improved data quality is critical for a timely and appropriate public health response. By ensuring that AI results are not only accurate but also relevant, these processes help avoid misinformation that can hinder public health efforts. In addition, reliable AI data builds public trust by ensuring that health interventions are based on the most credible and useful information. This, in turn, leads to better health outcomes as it enables a more targeted and efficient deployment of resources during health crises and ultimately increases the effectiveness of response strategies in dealing with public health emergencies.

Identify strategies to leverage automation and machine learning techniques to optimise data analytics for surveillance of epidemics and pandemics

_Pillar: Better Analytics
Priority rank: 20_

Automation and machine learning techniques have the potential to revolutionise the way data analytics are used for surveillance by enabling the processing of huge data sets faster and more accurately than humans can process them. Automation and machine learning are helping to refine data analysis processes in public health surveillance through algorithms designed to recognise patterns and anomalies that indicate possible health threats. Machine learning can also be used to improve predictive modelling and provide forecasts that can guide preventive action. These techniques must be transparent and interpretable to public health officials, and strategies should be put in place to protect data privacy, and ensure the ethical use of data. These cutting-edge techniques support resilient surveillance systems that can better adapt to and manage the complex nature of global health threats.

Explore the use of AI to support complex decision-making for pandemic and epidemic preparedness and response

_Pillar: Better Decisions
Priority rank: 23_

Rapidly evolving AI technologies have the potential to support and facilitate decision-making processes for pandemics and epidemics. This is particularly true in contexts where data and information from different sources need to be rapidly synthesised for decision-making. Decision-making can be supported by the development and validation of algorithms that use machine learning, natural language processing and large language models. For example, tools could be developed that continuously integrate incoming data and dynamically adjust risk assessments. This could enable decision-makers to adapt response strategies based on changing circumstances and new insights, improving the flexibility and effectiveness of response measures. There is a need to evaluate and refine AI approaches to create simulations that illustrate the effects of different interventions before and during health emergencies, including user-defined scenarios. Research and development of such data-driven approaches must always adhere to global guidelines for the ethical use of AI and consider potential biases that may arise from the data, the analysis, and its operationalisation.
Data preparedness

Explore social science approaches to investigate practices that affect the development of a globally trusted data-sharing architecture for epidemic and pandemic intelligence

*Pillar: Better Data*

*Priority rank: 9*

From a social science perspective, the incentives for data sharing lie in building social capital, adhering to ethical imperatives, and achieving broader societal benefits. Trust and academic recognition, as well as the fulfillment of ethical obligations, are important incentives for data sharing. These incentives, which are deeply embedded in social behaviours and institutional norms, are critical to fostering a culture of open and collaborative data sharing, especially in public health scenarios. Social and behavioural science methods that analyse human behaviour and societal structures help identify what motivates individuals and organizations to share data in the context of epidemics and pandemics. Understanding these motivating factors is critical to promoting effective data sharing and ensuring that vital information is available at the right time and place to effectively address and mitigate global health crises.

Explore the use of federated systems to facilitate data access and sharing for pandemic and epidemic intelligence

*Pillar: Better Analytics*

*Priority rank: 11*

The use of federated systems significantly improves public health response by enabling secure, decentralised data sharing across multiple jurisdictions and organisations. This setup facilitates real-time access to various critical data sets essential for timely outbreak response and research, while maintaining the autonomy of individual databases. When tailored specifically to the needs of public health practitioners, these systems enable secure, efficient, and ethical cross-platform data sharing and analysis and support real-time surveillance while maintaining privacy standards and complying with varying regional data protection regulations. This improves the agility and coordination of global responses to infectious disease outbreaks, enabling faster and more informed decision-making and a proactive approach to managing health threats.

Explore the use of Open Data to verify or complement data for pandemic and epidemic intelligence

*Pillar: Better Data*

*Priority rank: 18*

Open Data refers to data that is freely available for use and republishing under an Open Data or Open Content Licence. The use of Open Data can help address the limitations of epidemiological data, which can be fragmented or delayed, by providing additional insights and data points. For example, Open Data sources could include real-time mobility trends, population density maps, or public health indicators, all of which could help to verify and enrich the epidemiological understanding of disease patterns and spread. The use of Open Data can lead to more robust and transparent public health responses, better resource allocation, and improved strategies for managing health emergencies.

Investigate the structure of data value chains, within and beyond the health sector, to explore the potential for generation and use of data from diverse sources for epidemic and pandemic intelligence

*Pillar: Better Data*

*Priority rank: 22*

The data value chain represents the series of steps that data undergo from initial gathering to their ultimate application, describing the transformation of raw data into useful insights. A broader perspective and knowledge on data value chain structure not only improves data management practices but also encourages and enables the use and repurposing of data from diverse origins, combining traditional with non-traditional sources. For example, data not initially intended for public health use, such as transportation statistics or economic data, can be repurposed to enhance public health intelligence, strengthening the ability to predict and manage pandemics and epidemics. This approach not only extends the utility of existing data but also contributes to a sustainable framework for generating intelligence, which is crucial for effective public health preparedness and response.
Summaries of research statements by theme

**Quality standards**

**Identify rapid evaluation methods to assess the effectiveness of surveillance efforts and public health interventions during epidemics and pandemics**

*Pillar: Better Decisions*

*Priority rank: 3*

Rapid and continuous evaluation of the effectiveness of surveillance efforts and public health interventions is crucial amidst the complex and dynamic trajectories of pandemics and epidemics. Timely feedback to decision-makers facilitates strategic adjustments to optimise surveillance and response and, thereby, minimise the impact of disease outbreaks. Research should explore and identify appropriate methodologies for this rapid evaluation. Further, rapid evaluation methods could assess the cost-effectiveness of interventions and investments. For example, evidence on the effectiveness of genomic and wastewater surveillance technologies could guide policy decisions during disease outbreaks and influence long-term policy and funding.

**Explore and assess methods for data oversight, standardisation, and regulation to ensure consistency and quality in data generation for epidemic and pandemic intelligence**

*Pillar: Better Data*

*Priority rank: 8*

Clear guidelines and protocols for the collection, processing, verification, and dissemination of data that apply to both public and private sector actors, interoperable formats for data exchange, and robust legal frameworks are essential for maintaining data integrity and protecting privacy. Technology plays a critical role in supporting these mechanisms. Optimising data oversight is essential to keep pace with the rapidly evolving landscape of health threats. For example, implementing validation processes and establishing minimum standards for outbreak data collection are critical to verifying the authenticity and accuracy of infectious disease data sources. In addition, assessing the resilience of modelling tools helps to ensure their ability to accurately predict global health threats, improving overall preparedness and response strategies.

**Analytical frameworks**

**Explore analytical techniques and modelling methodologies to enhance the understanding of pathogen emergence and re-emergence**

*Pillar: Better Analytics*

*Priority rank: 7*

The (re-)emergence of infectious disease pathogens is influenced by a combination of biological factors and a complex set of climate variations, human behaviour, socio-economic conditions, geographical distribution, and population mobility. Integrating these diverse data sets provides a fuller understanding of how pathogens spread and what circumstances favour their emergence, especially in the context of zoonotic spillovers. Data accessibility standards also ensure that these vast and varied data streams are timely, reliable, and interoperable, facilitating analysis and decision-making. Advanced analytical techniques and modelling methodologies that can handle the diversity and scale of these data sets and incorporate interdisciplinary approaches such as geospatial analysis, help identify patterns and correlations within the data. These models not only help to predict potential outbreaks, but also provide important insights for preventive measures.

**Develop methods and frameworks for real-time infectious disease forecasting, ensuring the rapid recognition, validation, and scaling of statistical models for pandemic and epidemic intelligence**

*Pillar: Better Analytics*

*Priority rank: 13*

Real-time forecasting enables the rapid validation of statistical models that predict the spread of diseases, which is essential for early warning systems and timely interventions. Accurate forecasting models help public health officials and governments make data-driven decisions, regarding resource deployment, implementation of containment measures and planning of healthcare needs. Frameworks for real-time forecasting are designed and refined to quickly adapt to emerging data, recognise patterns indicative of outbreaks, and validate the reliability of these models in various scenarios. This involves not only the statistical models themselves, but also the infrastructure and protocols that enable the assimilation of real-time data from multiple sources, the ongoing training of models to improve accuracy, and the ability to scale these models across different populations and geographies. Such frameworks are essential for building responsive health surveillance systems that can anticipate and mitigate the impacts of infectious diseases, saving lives and resources.
Multisectoral approaches

Explore methods to improve detection, verification and notification of epidemics and pandemics data through multidisciplinary data integration

*Pillar: Better Analytics*
*Priority rank: 2*

The integration of diverse data sources, including information on socio-economic and political contexts, along with One Health perspectives, which consider the interconnection of human, animal, and environmental health, is essential to grasp the complexities of disease dynamics. Improved detection, verification and reporting procedures through multidisciplinary data integration enrich epidemic intelligence by enabling a more comprehensive, nuanced understanding of outbreaks. This integration helps detect health threats earlier, assess their potential impact more reliably and initiate faster communication with health authorities and the public. Overall, it can lead to more effective coordination of containment strategies, resource allocation and ultimately a reduction in the spread and severity of infectious disease outbreaks on a global scale.

Evaluate approaches to multisectoral coordination for effective, evidence-based decision-making for pandemic and epidemic preparedness and response

*Pillar: Better Decisions*
*Priority rank: 21*

Multisectoral coordination and collaboration has the potential to improve data exchange, analytics, evidence-based decision-making and response effectiveness at national, regional, and global levels. A thorough evaluation of different approaches for multisectoral coordination, involving actors from the private sector, civil society, and non-traditional collaborators can be used to improve collaboration across the whole health emergency cycle. This could entail an assessment of the effectiveness of existing coordination mechanisms, such as interagency task forces or public-private partnerships, in facilitating information sharing, resource allocation and response management. To enhance the efficiency and/or scalability of coordination structures, their adaptive capacity to face emerging challenges and leverage new technologies needs to be evaluated. For instance, the impact of multisectoral coordination in all-hazards early warning systems at the national level on factors such as data access, completeness and quality, timeliness of detection and provision of actionable insights for decision-making is largely unclear.
Community-centred approaches

Identify methodologies to effectively integrate information on societal perspectives, public sentiment, and community-specific concerns into the decision-making processes for pandemics and epidemics

*Pillar: Better Decisions*
*Priority rank: 4*

Pandemics and epidemics take place in diverse cultural, socio-economic, and political contexts. Understanding public sentiment, communities’ perspectives and concerns around health risks and mitigation strategies is key for informing decision-making for contextually appropriate and effective pandemic preparedness and response planning. Context-specific, effective public health and social measures (PHSM) can be designed to ensure more equitable health outcomes, by actively listening to, acknowledging, analysing, and responding to societal concerns. Further, risk communication and community engagement plans that are tailored to community-specific needs enhance both trust and PHSM compliance, as well as counter misinformation within societies. Social listening strategies and (digital) tools can facilitate the analysis of public opinion and concerns for better risk assessment and decision-making. There is a need to explore community engagement strategies ranging from community surveys to participatory decision-making approaches, actively involving citizens and communities in the design of response strategies.

Explore approaches to effectively integrate diverse socio-economic and health equity indicators into public health surveillance to assess and account for vulnerable populations

*Pillar: Better Analytics*
*Priority rank: 14*

Socioeconomic factors such as income, education, employment and living conditions, as well as health equity indicators such as access to health care and disparities in health outcomes across population groups, play a central role as determinants of health and are crucial for identifying populations at increased risk in health crises. Incorporating these socioeconomic and health equity indicators into surveillance systems through tailored data collection tools, analytical frameworks and cross-sectoral partnerships that integrate data from health, social services, and community organisations provides a detailed understanding of health inequities. This comprehensive view is an important basis for targeted interventions and informed policy decisions aimed at reducing health inequities and strengthening the resilience of communities to pandemics and epidemics. By emphasising the social determinants of health, public health strategies can achieve greater effectiveness, leading to better health outcomes across all demographic groups.

Identify approaches to effectively collect and integrate community-sourced data into public health surveillance and intelligence systems

*Pillar: Better Data*
*Priority rank: 5*

Community-sourced data is information that is collected by the general public or community groups. It relies on the contribution of individuals who voluntarily share their knowledge, observations, experiences, or resources. These data can come from social media posts, online surveys, mobile health apps, and other digital platforms where users share information related to their health status, symptoms, or observations of illness in their community. Examples are self-administered diagnostics data or citizen science for early detection of health threats. The effective collection, verification, and integration of these data into public health surveillance and intelligence systems improves accuracy and timeliness in identifying and responding to potential epidemics or pandemics.
Governance

Explore frameworks that address ethical and legal considerations to improve public health surveillance data sharing across disciplines, sectors, and administrative levels

Pillar: Better Decisions
Priority rank: 10

The basis of evidence-based decisions on pandemic and epidemic risks is the timely availability of diverse data across disciplines, sectors and administrative levels. Hence, understanding barriers that hinder data sharing is critical for effective pandemic and epidemic intelligence. Ethical and legal considerations related to data sharing include data security and privacy risks, challenges around data accessibility and inclusivity, user ownership and empowerment, as well as fair and ethical use of AI in data generation and sharing. There is a need to investigate best practices in applying ethical and legal frameworks to ensure rapid data access, while safeguarding data privacy, security, confidentiality, and addressing concerns around data ownership. Further, the impact of applying robust legal mechanisms for confidential data sharing (for example, under the International Health Regulations) on access to critical data during health emergencies could be evaluated. Additionally, shaping strategies for fair sharing of benefits arising from data insights requires investigation into data inequities and disparities in data access.

Investigate diverse data governance models and infrastructures to meet data requirements for surveillance and pandemic and epidemic intelligence

Pillar: Better Decisions
Priority rank: 12

A thorough analysis of existing data governance models and infrastructures is critical to identify gaps, inefficiencies, and areas for improvement in meeting data requirements for contemporary surveillance practices and evidence-based decision-making. In this, data governance models encompass policies, procedures, roles, and responsibilities for data management within an organisational entity and provide guidance for data collection, storage, and processing. To identify the most suitable approaches for managing data for surveillance in each given context, different data governance models including centralised, decentralised, federated, agile and regulatory data governance models implemented by relevant government agencies need to be examined. Data infrastructures encompass the technological and organisational framework that supports the management and processing of data. Investigating the role of technologies in ensuring data integrity and privacy in surveillance systems also offers promising avenues for research.

Investigate how different governance mechanisms enable the use of pandemic and epidemic intelligence findings for policy making, at the national and sub-national levels

Pillar: Better Decisions
Priority rank: 17

The configurations of existing governance mechanisms (for example, legislative and regulatory bodies and executive agencies) at national and sub-national levels have a substantial effect on how insights from the epidemic intelligence process may influence decision-making. This pertains not only to the consideration of insights in general, but also to the decision for which insights are accepted as legitimate evidence. There is a need to investigate, compare, and evaluate how different governance structures, processes, and institutions enable or hinder evidence-based decision-making. The effectiveness of different crisis management mechanisms, including the ad-hoc establishment of additional expert committees, decision-making groups within the executive branch, and procedures within legislative bodies, needs to be investigated. This could include examining legal frameworks and emergency powers during health crises and their influence on decision-making and public deliberation. Further, the role of government-funded and independent advisory bodies, including scientific advisory committees and experts from National Public Health Agencies, in providing evidence-based recommendations to policy-makers needs to be explored.
Evidence to policy

**Investigate communication strategies to effectively convey health risk information and uncertainty to policy-makers for pandemic and epidemic preparedness and response**

*Pillar: Better Decisions*
*Priority rank: 6*

Optimised preparedness and response efforts to minimise the impact of pandemics and epidemics require clear and timely communication of health risk information to policy-makers across government bodies. It remains challenging for data analysts and modelers to convey analytical scenarios and uncertainty in models to policy-makers with varying levels of health data literacy, given the complexity of disease outbreak trajectories. The provision of information to policy-makers can further be complicated by cultural differences. Investigating and evaluating communication strategies, techniques, and tools for data analysts across sectors could help to confront these challenges and ensure timely communication of actionable, context-specific insights to policy-makers. Communication can be facilitated through the development of user-friendly data visualisation techniques and interactive tools, such as infographics and dashboards.

**Identify enablers and barriers to evidence-based decision-making using pandemic and epidemic intelligence insights for health intervention design**

*Pillar: Better Decisions*
*Priority rank: 16*

To minimise the impact of pandemics and epidemics, it is crucial to ensure that decisions on health measures are evidence-based and consider the likely course of disease outbreaks. Complex decision-making processes at sub-national, national, regional, and global levels are often difficult to comprehend as they involve multiple stakeholders and have varying degrees of transparency. There is a need to decode the decision-making processes and identify factors that enable or hinder decision-makers to use pandemic and epidemic intelligence insights in the design of health interventions. Both structured decision-making frameworks and decision support tools as well as robust indicators and metrics for decision-making can be considered to facilitate the management of health risks at sub-national, national, regional, and global levels.
Next steps

The research priorities will be revised after 2027 to be re-aligned in case of new strategic objectives in global and regional health. Operational follow-up mechanisms to ensure take-up and implementation of prioritized areas will be established. Iterative feedback processes will be set up to help refine and improve the research statements.

Leveraging on GLoPID-R’s Pandemic PACT programme (6), a comprehensive monitoring and evaluation process will be established in line with the agenda’s objectives. Pandemic PACT serves as an innovative resource designed to monitor information regarding funding and evidence gaps for research across various diseases with outbreak potential, as well as wider readiness efforts, consistent with the diseases prioritized by the WHO. This evaluation process aims to measure the effectiveness of research initiatives and their contributions to enhanced pandemic and epidemic intelligence worldwide. The process will be iterative, with periodic reviews and adjustments to ensure relevance and responsiveness to emerging challenges.
References

1. Defining collaborative surveillance: A core concept for strengthening the global architecture for health emergency preparedness, response, and resilience (HEPR) [Internet]. [cited 2024 May 1]. Available from: https://www.who.int/publications/i/item/9789240074064


4. International health regulations [Internet]. [cited 2024 May 1]. Available from: https://www.who.int/health-topics/international-health-regulations#tab=tab_1

