



A regional strategy for integrated disease surveillance – overcoming data fragmentation in the Eastern Mediterranean Region

Executive summary

The COVID-19 pandemic has forcefully underlined the need for effective public health surveillance. Public health surveillance – a core component of health information systems and public health intelligence – detects potential public health threats and monitors disease morbidity and mortality to guide prevention and control measures. In addition to saving lives, effective disease surveillance and response offers a high return on financial investment because it may avoid potential large-scale economic disruption from epidemics and pandemics.

Most countries already have systems for disease-specific surveillance in place; however, these are usually not coordinated, and their implementation often leads to redundancies and gaps that make them less effective, particularly in early threat detection. The World Health Organization (WHO) proposes that the Member States of the Eastern Mediterranean Region commit to implementing effective, integrated disease surveillance (IDS) systems by the end of 2025. IDS will improve both the efficiency of health information systems and their effectiveness in the use of data to guide decisions, including for rapid response to epidemics, priority-setting, planning of interventions, resource mobilization and allocation, and monitoring and evaluation.

Effective IDS entails good governance and multisectoral coordination to organize the convergence of disease- and programme-specific systems towards integration; the development of consolidated technical guidance; progressive harmonization of data systems to generate a single master digital platform for the collection and management of data, and their communication; allocation of sufficient and appropriate financial, infrastructural and human resources; consolidation of data collection tools; timely analysis of data and the use of information in decision-making; a national public health laboratory policy to ensure reliable laboratory diagnosis with real-time electronic sharing of results with the data system that hosts epidemiological information; and a monitoring and evaluation framework that includes key performance indicators for regular monitoring, along with formative and summative evaluations.

This paper sets out a proposed regional strategy for IDS in the Eastern Mediterranean Region to guide Member States in strengthening and integrating their national surveillance systems. This will feed into regional and global efforts to strengthen collective public health intelligence. The 68th session of the Regional Committee for the Eastern Mediterranean is invited to consider this draft strategy for endorsement or further revision.

Introduction

1. The COVID-19 pandemic has once again reminded the international community of the enormous potential consequences of emerging infectious disease threats to global health, livelihoods, economies, communities and societies. It has also highlighted the central role of public health surveillance in preventing, detecting and responding to epidemics and pandemics.

2. Public health surveillance is a core component of health information systems and is vital to public health intelligence. The International Health Regulations (IHR) (2005) define surveillance as the systematic ongoing collection, collation and analysis of data for public health purposes, with timely dissemination for assessment and public health response as necessary (1). The two objectives of surveillance are central to ensuring resilient health systems and promoting the health and well-being of populations: (a) detect potential public health threats to ensure that outbreaks are rapidly detected, investigated and controlled; and (b) monitor disease morbidity and mortality to guide prevention, control, elimination and eradication programmes (including allocation of resources) and impact monitoring.

3. In addition to the COVID-19 pandemic, many other epidemics have taken major tolls across the Eastern Mediterranean Region over the past 20 years, including those due to cholera, Middle East respiratory syndrome and arboviruses (dengue, chikungunya, yellow fever, Rift Valley fever and Crimean-Congo haemorrhagic fever). Endemic infectious diseases (HIV/AIDS, sexually transmitted infections, malaria, measles and other vaccine-preventable diseases) also remain a major source of morbidity and mortality. A number of factors increase the vulnerability of the Region to these threats, including major humanitarian crises in 10 countries and territories (45%) that have led to disruption of health systems and programmes, population displacement and overcrowding in poorly equipped settlements. Moreover, intense cross-border movements, increased livestock trade, tourism and migration for work further increase these risks. In addition, climate change leads to drought, heavy rains and floods, which increase interactions between humans, animals and vectors.

4. Three review panels for the response to the COVID-19 pandemic, which each reported their findings and observations to the Seventy-fourth World Health Assembly in 2021, stated that effective disease surveillance was essential to managing these risks:

- The Review Committee on the Functioning of the International Health Regulations (2005) during the COVID-19 response found that well-integrated reporting and surveillance systems were a precondition to identifying disease events early, and highlighted the important role of digital technology for gathering information more rapidly and detecting signals from sources outside the health sector (2).
- The Independent Panel for Pandemic Preparedness and Response recommended that the World Health Organization (WHO) establish a new global system for surveillance, based on full transparency by all parties, using digital tools (3).
- The Independent Oversight and Advisory Committee for the WHO Health Emergencies Programme concluded that there was an urgent need to improve surveillance systems, considering that the pandemic has resulted in total or partial disruption of essential health services in fragile, conflict-affected and vulnerable settings (4).

5. In addition to their contribution to the prevention and control of disease, there are compelling socio-economic arguments for investing in strong surveillance and response systems (5). The pandemic has exacerbated inequalities, destroyed livelihoods and pushed up to 124 million people into extreme poverty (6). COVID-19 is projected to cost the world economy US\$ 10 trillion by the end of 2021 (7). By contrast, the early detection of and effective response to initial cases of Ebola virus disease in 2014 prevented a communitywide outbreak in Nigeria and subsequent worldwide spread, thereby averting mortality, morbidity and economic losses that are almost impossible to quantify (8).

6. In many countries, surveillance systems are fragmented across disease-specific programmes, weakening their detection function. They are often donor-driven and rely on earmarked resources, including from international global health initiatives (for example, Gavi, the Vaccine Alliance, and the Global Fund to Fight

AIDS, Tuberculosis and Malaria). These systems are effective within their mandates, but their implementation and management are usually not coordinated, and this fragmentation leads to many problems. Limited human, financial and information technology (IT) resources are not used efficiently, leading to inconsistencies, duplications and gaps. Procedures, case definitions and data systems are not standardized, resulting in weaknesses, particularly for the early warning function. Outbreaks are therefore rarely detected early enough to provide rapid response.

7. WHO proposes an integrated approach to disease surveillance for the Eastern Mediterranean Region that will use a single electronic platform to improve both the efficiency of health information systems and their effectiveness in the use of data to guide decisions, including for early detection of epidemics, priority-setting, planning, resource allocation, monitoring and evaluation. The process will start with improving the interoperability of the current systems, using minimal data standards and dictionaries with progressive conversion toward one single surveillance platform.

8. This regional initiative will link to and benefit from related initiatives at the global level. These include the WHO Global Hub for Pandemic and Epidemic Intelligence (WHO Hub), which was recently launched at the Seventy-fourth World Health Assembly. The WHO Hub will improve the global capacity for early detection and management of epidemics through innovations in data analytics to predict, prevent, detect, prepare for and respond to worldwide health threats. The WHO Hub will enable partners from around the world to collaborate in creating the tools and data access that all countries need in order to prepare for, detect and respond to pandemic and epidemic risks. This will have clear benefits for the Eastern Mediterranean Region.

Situation analysis

Global context

9. Disease surveillance regroups data collected from individual health facilities and populations, as well as from sources not initially designed for public health. It generates information to assist decision-makers at all levels of the health system. Uses of the information are multiple and include identification of problems and needs, evidence-based decision-making and policy-making, research and optimal resource allocation (9). In May 2021, a number of key stakeholders from WHO and national and regional centres for disease control outlined a vision for effective disease surveillance based upon five core principles: (a) systematic, consistent population monitoring; (b) laboratory confirmation; (c) use of digital data; (d) data transparency; and (e) adequate financing (10).

10. Seven of the 22 countries/territories of the WHO Eastern Mediterranean Region are located on the African continent. The WHO African Region is facing challenges that are similar to those faced by the Eastern Mediterranean Region, including multiple infectious disease outbreaks, displacement of populations due to conflict or climate change, and disrupted health systems. The WHO Regional Office for Africa developed a regional Integrated Disease Surveillance and Response (IDSR) strategy in 1998. Since then, three revisions have been undertaken; the most recent version of the IDSR strategy, launched in 2019, emphasizes the interlinkages within the strategy as an integral part of health system strengthening to achieve universal health coverage (11).

11. The WHO regional offices for South-East Asia and the Western Pacific have jointly developed the Asia Pacific Strategy for Emerging Diseases (APSED) – a common strategic framework for countries to strengthen their capacity to manage and respond to emerging disease threats. One of its eight focus areas is surveillance, risk assessment and response, with the objective of strengthening the capacity of Member States for early detection of outbreaks of emerging diseases and public health emergencies (12).

12. Lessons learned from the implementation of these strategies have informed the design of the proposed strategy for the Eastern Mediterranean Region.

Regional situation: current response and challenges

13. The Eastern Mediterranean Region recognized the need to develop an IDS strategy during the 49th session of the Regional Committee for the Eastern Mediterranean in 2002. In 2012, a consultation led by the WHO Regional Office for the Eastern Mediterranean to identify key issues for implementation of an IDS strategy in the Region recommended development of a regional framework on IDS that would give countries the flexibility to make adjustments according to their priorities while developing their own policy framework (13). In 2017, during the 64th session of the Regional Committee, Member States recognized the need for strategic guidance and proposed that Member States establish IDS systems and upgrade all surveillance systems for communicable diseases at all levels utilizing available electronic platforms such as the District Health Information System 2 (DHIS2) (14). Member States also requested WHO to provide advocacy and strategic guidance on the establishment of IDS systems.

14. After 2017, the Regional Office followed up with several preliminary activities: a scoping review of published experience on IDS, mapping of surveillance activities sponsored by the Regional Office, the establishment of a Regional Office cross-departmental technical working group with a first meeting held in April 2021, a regional consultative meeting on implementing the SCORE for Health Data Technical Package (15), and comprehensive assessments of national health information systems and surveillance systems in several countries that pointed to missed opportunities to integrate these systems.

15. In early 2019, WHO developed the One Health operational framework for action for the WHO Eastern Mediterranean Region with a focus on zoonotic diseases. It includes surveillance, preparedness and response among its seven components and clearly states that establishing a joint integrated disease surveillance system

with operational plans, guidelines, standard operating procedures and needed facilities is crucial to enable countries to prevent, detect and control zoonotic diseases (16).

16. Also in 2019, WHO, in consultation with Member States in the Region, developed a strategic framework for the prevention and control of emerging and epidemic-prone infectious diseases in the Eastern Mediterranean Region 2019–2023, which highlighted surveillance capacity gaps and recommended that countries of the Region make efforts to strengthen routine surveillance as soon as possible with the integration of the Early Warning, Alert and Response Network (EWARN) into national surveillance systems (17).

17. Moreover, since the start of the pandemic in 2020, several COVID-19 intra-action review missions have been conducted to assess the quality of the COVID-19 response. Common shortcomings identified included fragmentation of surveillance between disease-specific programmes, absence of clear procedures for early warning, weaknesses in event-based surveillance, inadequate digitalization, and insufficient integration of surveillance with health management information systems.

18. In 2021, a mapping of data collection and surveillance activities in the Region by WHO revealed a fragmented landscape with diverse standards, procedures, tools and technologies used by different programmes, and data rarely exchanged among them. The mapping highlighted that while each programme had specific needs for data collection and management, most activities and resources used were similar and could be integrated. The following actions were proposed: regular mapping of data collection and management activities and of available expertise in data collection, data management and data analysis; use of existing WHO tools to facilitate data collection and data management activities; merging of redundant tools to simplify their maintenance and reduce dispersion of data; and development of internal, user-friendly platforms to facilitate access to existing data.

Progress made by countries of the Eastern Mediterranean Region

19. The Eastern Mediterranean Region is characterized by disparities between countries, whether in terms of income level or health system status. However, in the absence of a regional IDS strategy, some countries/territories of the Region have already made progress towards the adoption of an integrated approach:

- Nine have adopted IDS as the national surveillance strategy.
- Seven have initiated IDS: in Pakistan, for example, a pilot was initiated in seven districts in 2017, and since 2020 the Regional Office has been providing technical support to extend the IDS nationwide.
- Fifteen have adopted a national electronic surveillance system: in Egypt, the National Electronic Disease Surveillance System allows timely reporting of all diseases from district to central level; and in Lebanon and Pakistan, IDS is supported by DHIS2.
- Five have established linkages between their various electronic systems; in Oman, the Hospital Management Information System automatically transmits information on notifiable diseases to the National Surveillance System.
- Eight have complemented their indicator-based surveillance with event-based surveillance, and seven countries with complex emergencies have implemented an early warning disease surveillance network.
- Eighteen have conducted a joint external evaluation that includes a surveillance component, and eight countries have evaluated their health information management and surveillance systems. State Party self-assessment annual reporting (SPAR) to monitor IHR (2005) core capacities represents an additional information source.
- Nineteen have developed a national action plan for health security that includes recommendations for priority actions from the joint external evaluation.
- Twenty communicate results of surveillance through bulletins, situation reports or dashboards.

20. Several IT systems are already in use in countries of the Eastern Mediterranean Region, including proprietary applications and open-source systems such as DHIS2, which has been deployed to support health information management in eight countries of the Region as of June 2021. In Jordan, the Integrated Electronic

Reporting System was developed with the support of WHO. Saudi Arabia has established the Health Electronic Surveillance Network, which is a comprehensive and flexible system that can accommodate all public health programmes, and the integrated Public Health Information System, which acts as a one-stop platform that encompasses all public health aspects to better prevent, detect, respond to and control diseases and injuries, in addition to monitoring the population's health status (18). The Gulf Health Council is planning to establish an integrated system that will enhance capacity for early warning and response to outbreaks. The United Arab Emirates (Dubai) launched the Hasana system to link governmental and private medical laboratories to manage vaccinations, report diseases and respond to infectious disease outbreaks (19).

Strategic issues

21. An effective surveillance system should have the following attributes: simplicity, flexibility, acceptability, sensitivity, positive predictive value, representativeness and timeliness (20).

Governance

22. At the national level, fragmentation of funding sources often leads to different programme-specific surveillance systems. These are rarely grouped under a national health information system that provides direction on normative approaches, roles and responsibilities, resource identification, pooling and mobilization, and IT solutions. Given that 75% of emerging infectious diseases affecting humans originate from animals (21), the need for a multisectoral approach within the governance structure is clear – but rarely recognized. At global and regional levels, collaboration among WHO, the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE), established through the One Health approach, is essential and can support national governance.

23. The tripartite collaboration between FAO, OIE and WHO reflects a longstanding and successful partnership in taking a One Health approach to address the challenges to public health, animal health (both domestic and wildlife) and the environment facing the world today and advocates for effective multisectoral, multidisciplinary and transnational collaboration at the local, national, regional and global levels (22).

Technical guidance

24. Technical guidance may be absent or heterogeneous or may suffer from inconsistencies. It should address all steps of surveillance, including detection, data collection, management, analysis, interpretation, generating reports and communication for use, and must reconcile the combined use of indicator-based surveillance and event-based surveillance.

Information sources

25. New diseases, including COVID-19, might emerge without being detected by disease-focused surveillance systems, as these systems rely mainly on indicator-based surveillance. Other sources of information can detect the emergence of these new diseases or any public health event early in the community before it reaches health facilities later. These sources are grouped under event-based surveillance and include sources of information not initially designed for public health surveillance (for example, community informants) and media scanning. Event-based surveillance relies on multisectoral collaboration between various organizations that have staff deployed in remote areas and communities, which may include animal health authorities, security forces or the educational sector. Community-based surveillance – the systematic detection and reporting of events of public health significance within a community by community members (23) – has been used in disease eradication programmes, including for smallpox, guinea-worm disease and polio (24), as well as during the west African Ebola virus disease outbreak of 2014–2015, where community health workers and volunteers played a role in early detection and timely reporting to the health system (25).

Information technology

26. Information technology (IT) and data systems are tools that can improve the efficiency and effectiveness of surveillance activities. Unfortunately, surveillance often suffers from a suboptimal application of IT and data systems. For example, some countries lack IT or data systems and rely on paper-based systems; disease- or programme-specific surveillance systems may use different IT applications with limited skilled human resources; and some of the existing electronic reporting systems are non-interoperable, and therefore cannot exchange data with other systems.

27. Lack of common standards in data models is another barrier. Different systems fail to apply international standards, including definition of diagnosis or conditions (using standard definitions such as the coding of the International Classification of Diseases, 11th Revision); they have different data dimensions or data dictionaries; and they lack unique identifiers for metadata such as geographical location, and uniformity in data collection periods. Across countries (and sometimes even within a country), the monitoring of specific diseases occurs on the basis of different case definitions and case reporting principles (such as case-based versus aggregated, or zero reporting versus reporting of cases only). These factors hinder unified analyses and data linkages between systems, which are essential for planning and decision-making: for example, separate IT systems for epidemiological and laboratory data can decrease the usefulness of the data for decision-making.

28. To support IDS, the electronic system needs to meet minimum requirements, which can be categorized into functional and non-functional requirements. Functional requirements comprise the electronic system requirements, including capability in data exchange standards for case-based, aggregate and event-based surveillance data. The IT system should also provide a high level of data mining and analysis and offer business intelligence tools such as dashboards and scorecards. Non-functional requirements can be defined as quality of service requirements, including identification of data exchange channels, total cost of ownership, scalability, procedures for data storage and procedures for end user accessibility, depending on the working environment.

Financial resources

29. Countries should expect to spend about US\$ 1–4 per capita annually on disease surveillance infrastructure and personnel (26). In fact, in most cases this investment is already made in a fragmented manner in disease-specific systems. Fragmentation of health financing is another problem that affects health system performance in general: disease programmes benefiting from specific funding sources implement dedicated surveillance systems that leave gaps, duplicate efforts, waste resources and lead to inefficiencies in the use of national or donor funding.

Human resources

30. From a quantitative point of view, fragmented financing leads to efficiency losses in the use of human resources. Dedicated programmes or disease-specific surveillance systems may employ different staff members in a redundant way to implement the same function. They can also rely on the same staff to implement the same tasks repeatedly in different systems (for example, training in surveillance).

31. From a qualitative point of view, the fragmentation of surveillance systems is an obstacle to the creation of a single system of professional competencies that could be built through pre-service or in-service training in a consistent fashion. Identical staff members may have to undergo separate training programmes focusing on IT system-specific skills instead of acquiring cross-cutting competencies in surveillance that include all the required knowledge, skills and attitudes. The absence of a career path for epidemiologists can result in high staff turnover, preventing the building of a strong workforce. As a result, insufficiently trained and supervised staff at the national and subnational levels may lack the competencies that are required to collect and analyse data so as to inform and guide a rapid and adapted response.

32. Field epidemiology training programmes (FETP) are a major source of trained staff through training for different levels (frontline, intermediate, advanced). FETP competencies, including for the human–animal–environmental interface, need to be well identified and rolled out to FETP programmes in the Region to allow for earlier detection of public health threats.

Duplication of collection tools and forms

33. At the very base of the health system, where primary data are collected, insufficient coordination and sharing of tasks leads to a waste of time in filling multiple, inconsistent forms that were designed with different rationales (27). Identical health care workers collect and transmit comparable information sent several times through different channels or data systems because information is not shared or communicated between programmes.

Verification and data analysis

34. Lack of availability of data analysis skills at the different levels of the surveillance system limits its effectiveness. At the peripheral level, it leads to delays in verifying signals and investigating events in order to trigger a rapid and timely response. At the subsequent levels, data are not appropriately analysed so they can be converted into information that can be adequately presented by time (for example, figures and graphs), place (for example, maps) or persons (for example, tables) that clarifies the magnitude of the existing threat and affects its related control measures. While IT systems can address some of the data analysis issues through automation, they are not a surrogate for epidemiological analysis and critical thinking in the preparation of an analysis plan or the interpretation of data that require skilled personnel to take over.

Presentation, dissemination and use

35. Following data analysis, the information generated needs to be presented in a clear and understandable manner, reviewed, and interpreted to permit decision-making. In the case of integrated systems, explicit mechanisms for data-sharing and use are needed so that the ultimate users of the data can exploit the information and close the loop in terms of (a) taking public health action, and (b) improving the sources of information with feedback on data quality when applicable.

Laboratory diagnosis

36. Effective integrated surveillance requires an endorsed, resourced and implemented national laboratory policy (28, 29) that ensures that the key elements are in place for: (a) specimen transport and referral; (b) rapid, safe and accurate rapid diagnostic or laboratory-based testing; and (c) quality management systems. The national laboratory policy must harness the different types of laboratory in the country into a network. Epidemiological data and laboratory findings are complementary and mutually essential for the generation of information for decision-making, and have to be consolidated within a unified system. Unfortunately, poor linkages between laboratory information systems and disease surveillance systems results in fragmented information, leading to major gaps that prevent interpretation and public health action.

Quality assurance and monitoring and evaluation

37. Surveillance needs to meet several attributes to be useful in driving decision-making (30). The implementation or strengthening of IDS should be facilitated by an initial assessment of the existing surveillance system or systems. Supportive internal supervision is required. At the implementation stage, key performance indicators need to monitor the main functions of the surveillance system in critical domains (such as timeliness and completeness). Corrective actions must be deployed as needed. In addition, formative and summative evaluations need to be conducted at regular intervals so that readjustments can be made as required.

Proposed way forward

38. The proposed regional strategy for IDS in the Eastern Mediterranean Region aims to guide Member States in strengthening and integrating their national surveillance systems. The strategy will allow Member States to clarify the objectives of their national surveillance systems and guide them in the adoption and application of standardized procedures and tools. It will also feed into regional and global efforts to strengthen collective public health intelligence.

39. The strategy proposes simple methods to progressively converge the various existing surveillance systems towards integration and consolidate the existing fragmentation. It will help identify the capacities needed for the generation of good-quality data. WHO will provide guidance on making the best use of available resources to eliminate duplication, avoid gaps and achieve efficiency gains. The strategy highlights the need for collaborative, multisectoral and transdisciplinary collaboration, particularly through the One Health approach. It calls for strengthening all components of surveillance systems, including event-based surveillance. It promotes the use of electronic tools for surveillance and emphasizes the need to ensure the interoperability of existing systems. It ensures that information collected at country level that is shared with WHO can inform actions at regional and global levels, in particular for strengthening public health intelligence. Overall, it has been developed with the IHR (2005) requirements in mind.

40. The strategy identifies key actions to be taken at country level to develop, strengthen and implement IDS in the following domains: governance; guidance; information technology; financing; infrastructure; human resources; tools and forms; data analysis and dissemination; public health laboratory support; and quality assurance and monitoring and evaluation. It also identifies key WHO outputs, country outcomes and indicators to measure progress (see Annex 1).

Recommended actions for Member States and WHO

Recommended actions for Member States

41. Member States are encouraged to take the necessary steps to achieve effective, integrated national surveillance systems that share information collected with WHO and partners on a timely and transparent basis, consistent with obligations under the IHR (2005), including:

- establishing governance and coordination along with a legislative framework and implementation roadmap;
- developing or updating national guidance, including for indicator and event-based surveillance;
- organizing progressive convergence of epidemiological and laboratory data towards a reference electronic system, starting with interoperability between existing systems;
- mobilizing sufficient financial resources, including mapping resources, estimating needs, allocating budgets and pooling financial resources;
- establishing the required infrastructure at all levels;
- assigning necessary skilled human resources;
- mapping, revising, simplifying and harmonizing data collection tools;
- establishing mechanisms to analyse, interpret and make use of the results of the surveillance in decision-making;
- securing effective laboratory diagnosis capacity through a national public health laboratory policy and a single system to consolidate laboratory and epidemiological data; and
- implementing a mechanism for supervision, monitoring and evaluation.

Recommended actions for WHO

42. To support Member States in the above, WHO will:

- consolidate surveillance programmes within the Organization through a working group under a steering committee;
- provide countries with guidelines, guidance, procedures and tools to support integrated collection, management, analysis and dissemination of surveillance information;
- facilitate convergence of data systems through data catalogues, identifiers, evaluations of platforms, mapping and proposals;
- mobilize technical and financial partners to support the integration, address fragmentation and secure allocation of necessary financial, infrastructural and human resources;
- make an inventory of existing paper and electronic forms;
- build capacity for data analysis and use of laboratories for public health surveillance;
- provide tools for monitoring, evaluation and supervision; and
- report on progress to the Regional Committee in 2023 and 2025.

43. Implementation of these actions by Member States and WHO should be guided by the outputs, country outcomes and indicators set out in Annex 1.

Conclusion

44. The COVID-19 pandemic has been a wake-up call. It has signalled that we can no longer delay the implementation of effective surveillance systems. This can be achieved through consolidation of disease-specific systems into a single, effective system that is supported by a digital platform connected with the public health laboratory network. This will require an annual investment of around US\$ 1–4 per capita in infrastructure, staff and operations. However, integration should result in increased efficiencies that could allow a significant proportion of the needed resources to be mobilized from existing programmes.

45. The 68th session of the Regional Committee for the Eastern Mediterranean is therefore invited to consider the proposed strategy for integrated disease surveillance in the Eastern Mediterranean Region for endorsement or further revision.

References

1. International Health Regulations (2005). Part I: Definitions, purpose and scope, principles and responsible authorities. In: WHA58.3: Revision of the International Health Regulations, Fifty-eighth World Health Assembly, 2005. Geneva: World Organization; 2005 (https://www.who.int/ipcs/publications/wha/ihr_resolution.pdf, accessed 31 July 2021).
2. Report of the Review Committee on the Functioning of the International Health Regulations (2005) during the COVID-19 response. In: WHO's work in health emergencies. Strengthening preparedness for health emergencies: implementation of the International Health Regulations (2005), Seventy-fourth World Health Assembly, May 2021. Geneva: World Health Organization; 2021 (https://apps.who.int/gb/ebwha/pdf_files/WHA74/A74_9Add1-en.pdf, accessed 31 July 2021).
3. COVID-19 response. Main report of the Independent Panel for Pandemic Preparedness and Response. In: Seventy-fourth World Health Assembly, May 2021. Geneva: World Health Organization; 2021 (https://apps.who.int/gb/ebwha/pdf_files/WHA74/A74_INF2-en.pdf, accessed 31 July 2021).
4. Report of the Independent Oversight and Advisory Committee for the WHO Health Emergencies Programme. In: Independent Oversight and Advisory Committee for the WHO Health Emergencies Programme, Seventy-fourth World Health Assembly, May 2021. Geneva: World Organization; 2021 (https://apps.who.int/gb/ebwha/pdf_files/WHA74/A74_16-en.pdf, accessed 31 July 2021).
5. A healthy humanity: WHO investment case for 2019–2023. Geneva: World Health Organization; 2018 (<http://apps.who.int/iris/bitstream/handle/10665/274710/WHO-DGO-CRM-18.2-eng.pdf>, accessed 31 July 2021).
6. Lakner C, Yonzan N, Gerszon Mahler D, Castaneda Aguilar RA, Wu H. Updated estimates of the impact of COVID-19 on global poverty: looking back at 2020 and the outlook for 2021 [website]. Washington (DC): World Bank; 2021 (<https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty-looking-back-2020-and-outlook-2021>, accessed 21 June 2021).
7. Gopinath G. A long, uneven and uncertain ascent. IMF Blog, 13 October 2020 [website]. Washington (DC): International Monetary Fund; 2021 (<https://blogs.imf.org/2020/10/13/a-long-uneven-and-uncertain-ascent/>, accessed 31 July 2021).
8. Holding M, Ihekweazu C, Stuart JM, Oliver I. Learning from the epidemiological response to the 2014/15 Ebola virus disease outbreak. *Journal of Epidemiology and Global Health*. 2019;9:169–75. doi:10.2991/jegh.k.190808.002.
9. Health information systems: toolkit on monitoring health systems and strengthening. Geneva: World Health Organization; 2008 (https://www.who.int/healthinfo/statistics/toolkit_hss/EN_PDF_Toolkit_HSS_InformationSystems.pdf, accessed 31 July 2021).
10. Disease surveillance for the COVID-19 era: time for bold changes. *Lancet*. 2021;397:2317–9. doi:10.1016/S0140-6736(21)01096-5.
11. Regional strategy for integrated disease surveillance and response 2020–2030: report of the Secretariat. In: Sixty-ninth session of the Regional Committee for Africa, Brazzaville, Republic of Congo, 19–23 August 2019. Brazzaville: WHO Regional Office for Africa; 2019 (<https://apps.who.int/iris/handle/10665/332926>, accessed 31 July 2021).
12. Asia Pacific Strategy for Emerging Diseases and Public Health Emergencies (APSED III): advancing implementation of the International Health Regulations (2005). Manila: WHO Regional Office for the Western Pacific; 2017 (<https://iris.wpro.who.int/handle/10665.1/13654>, accessed 31 July 2021).
13. Report on the consultation to identify key issues for implementation of integrated disease surveillance and response strategies in the Eastern Mediterranean Region: Cairo, Egypt, 23–25 July 2012. Cairo: WHO Regional Office for the Eastern Mediterranean; 2012 (http://apps.who.int/iris/bitstream/handle/10665/116136/IC_Meet_Rep_2012_EN_14836.pdf?sequence=1&isAllowed=y, accessed 1 August 2021).

14. Report of the 64th session of the WHO Regional Committee for the Eastern Mediterranean: Islamabad, Pakistan, 9–12 October 2017. Cairo: WHO Regional Office for the Eastern Mediterranean; 2017 (https://applications.emro.who.int/docs/RC_final_Rep_2017_16792_en.pdf?ua=1, accessed 1 August 2021).
15. SCORE for Health Data Technical Package [website]. Geneva: World Health Organization; 2021 (<https://www.who.int/data/data-collection-tools/score>, accessed 1 August 2021).
16. Mahrous H, Redi N, Nguyen N, Al Awaidei S, Mostafavi E, Samhoury D. One Health operational framework for action for the Eastern Mediterranean Region, focusing on zoonotic diseases. *East Mediterr Health J.* 2020;26(6):720–725. doi:10.26719/emhj.20.017.
17. Strategic framework for the prevention and control of emerging and epidemic-prone infectious diseases in the Eastern Mediterranean Region 2019–2023. Cairo: WHO Regional Office for the Eastern Mediterranean; 2020 (<https://applications.emro.who.int/docs/WHOEMCSR293E-eng.pdf>, accessed 1 August 2021).
18. MOH launches introductory campaign on HESN program, 6 February 2019 [website]. Ministry of Health, Kingdom of Saudi Arabia; 2021 (<https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2019-02-06-004.aspx>, accessed 1 August 2021).
19. Hasana public health surveillance network [website]. Dubai: Dubai Health Authority; 2021 (<https://www.dha.gov.ae/hasana/Pages/home.aspx>, accessed 1 August 2021).
20. Klaucke DN, Buehler JW, Thacker SB, Gibson Parrish R, Trowbridge FL, Berkelman RL, et al. Guidelines for evaluating surveillance systems. *Morbidity and Mortality Weekly Report (MMWR) Suppl.* May 06, 1988 / 37(S-5);1–18. Atlanta, GA: United States Centers for Disease Control and Prevention; 1988 (<https://www.cdc.gov/mmwr/preview/mmwrhtml/00001769.htm>, accessed 1 August 2021).
21. Preventing the next pandemic: zoonotic diseases and how to break the chain of transmission. Nairobi: United Nations Environment Programme and International Livestock Research Institute; 2020 (<https://unsdg.un.org/resources/preventing-next-pandemic-zoonotic-diseases-and-how-break-chain-transmission>, accessed 1 August 2021).
22. Tripartite zoonoses guide: Operational tools and approaches for zoonotic diseases [website]. Geneva: World Health Organization; 2021 (<https://www.who.int/initiatives/tripartite-zoonosis-guide>, accessed 1 August 2021).
23. Technical contributors to the June WHO meeting. A definition for community-based surveillance and a way forward: results of the WHO global technical meeting, France, 26 to 28 June 2018. *Euro Surveill.* 2019;24(2):1800681. doi:10.2807/1560-7917.ES.2019.24.2.1800681.
24. Ndiaye SM, Quick L, Sanda O, Niandou S. The value of community participation in disease surveillance: a case study from Niger. *Health Promot Int.* 2003;18(2):89–98. doi:10.1093/heapro/18.2.89.
25. Community-based surveillance: guiding principles. Geneva: International Federation of Red Cross and Red Crescent Societies; 2017 (<https://reliefweb.int/report/world/community-based-surveillance-guiding-principles-march-2017>, accessed 1 August 2021).
26. Craven M, Sabow A, Van der Veken L, Wilson M. Not the last pandemic: investing now to reimagine public-health systems. May 21, 2021 [website]. McKinsey & Company; 2021 (<https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems>, accessed 1 August 2021).
27. Maji D, Hutin Y, Ramakrishnan R, Hossain S, De S. Strategies to improve the performance of female health workers in West Bengal: a cross-sectional survey. *Natl Med J India.* 2010;23(3):137–42.
28. Konings F, Barakat A, Hutin Y, Hajjeh R. COVID-19 highlights the need for a strong health laboratories foundation for infectious disease surveillance and control in the Eastern Mediterranean Region. *East Mediterr Health J.* 2020;26(6):633–5. doi:10.26719/emhj.20.074.
29. Strategic framework for strengthening health laboratory services 2016–2020. Cairo: WHO Regional Office for the Eastern Mediterranean; 2016 (<https://apps.who.int/iris/handle/10665/259657?search=>

result=true&query=EM%2FRC63%2FR.4&scope=&rpp=10&sort_by=score&order=desc, accessed 1 August 2021).

30. Baker MG, Fidler DP. Global public health surveillance under new International Health Regulations. *Emerg Infect Dis.* 2006;12:7:1058–1065. doi:10.3201/eid1207.051497.

Annex 1. Strategic directions, WHO outputs, country outcomes and indicators for implementation of the strategy for integrated disease surveillance in the Eastern Mediterranean Region

Domains/topics		Strategic directions	Key WHO outputs	Country outcomes	Indicators	
					Baseline	Target
Governance		Adoption of governance mechanisms (Ministry of Health and non-Ministry of Health)	<ul style="list-style-type: none"> - Integrated disease surveillance (IDS) regional strategy developed - National IDS steering committee - Annual update on progress and challenges 	<ul style="list-style-type: none"> - Sustainable governance structure for IDS - Law and decrees promoting integrated surveillance approach - Coordination with broader health information system (HIS) - Road map for IDS implementation 	<ul style="list-style-type: none"> - Surveillance fragmented across programmes - Fragmentation of funding sources 	<ul style="list-style-type: none"> - IDS steering committee - Road map for IDS implementation - IDS included in HIS governance
Operations	Technical guidance	Consolidated guidance for event based-surveillance (EBS) and indicator-based surveillance, with a scope that includes the private sector and animal surveillance	<ul style="list-style-type: none"> - Standard operating procedures for IDS, including case definitions - Mapping EBS structures and sources (e.g. media, community) - Consolidated technical guidance for early warning, EBS and indicator-based surveillance (IBS) 	<ul style="list-style-type: none"> - National guidance for IDS - Enhanced early warning, EBS and IBS components of the national surveillance system - Pilot project for scaling up 	<ul style="list-style-type: none"> - Absence or diverging of technical references for different surveillance components (IBS, EBS) - Dysfunctional early warning system 	<ul style="list-style-type: none"> - Consolidated EBS and IBS guidelines that include animal surveillance and the private sector
	Information technology	Progressive convergence of systems, starting with interoperability (e.g. data exchange between electronic medical records, laboratory data, mortality registration and surveillance) and aiming at consolidation	<ul style="list-style-type: none"> - Consolidated data catalogues and identifiers - Evaluation of the current IT surveillance platforms - Data flow description and analysis with a proposal for short-, medium- and long-term convergences - Mapping of available IT platforms for surveillance 	<ul style="list-style-type: none"> - Interoperability and data exchange mechanisms between existing electronic systems - Progressive convergence of existing electronic systems - Linkages with laboratory information management systems 	<ul style="list-style-type: none"> - Stand-alone electronic platforms - Lack of common code standards and definitions, such as ICD-coding - Absence of linkages between epidemiological and laboratory data 	<ul style="list-style-type: none"> - Interoperable IT platforms - Consolidated single IDS platform

Resources: Financing	Identification of sustainable financing	<ul style="list-style-type: none"> - Mapping of existing financial resources for surveillance - Estimates of needs for comprehensive IDS - Coordination of donor support 	<ul style="list-style-type: none"> - Mapping of existing resources for surveillance - Needs estimates for comprehensive IDS - Appropriate proportion of national budget allocated for surveillance - Pooling of financial resources 	<ul style="list-style-type: none"> - Fragmentation of health financing - Duplicated efforts and wasted resources leading to inefficiencies - Low proportion of domestic financing for surveillance 	<ul style="list-style-type: none"> - Appropriate national budget allocation to IDS - Available resources and donor support pooled and allocated according to needs
Resources: Infrastructure	Strengthening/development of needed infrastructure	<ul style="list-style-type: none"> - Mapping of the current surveillance infrastructure - Gap analysis 	<ul style="list-style-type: none"> - Establishment of required infrastructure at all levels of the surveillance system 	<ul style="list-style-type: none"> - Unequal geographical distribution of infrastructure 	<ul style="list-style-type: none"> - Well-developed and equally distributed surveillance infrastructure
Resources: Human	Human resources plan	<ul style="list-style-type: none"> - Mapping of human resources for IDS - Competency framework and training curricula - Gap analysis 	<ul style="list-style-type: none"> - Available human resources for surveillance mapped - Human resources needs for IDS estimated - Human resources plan (qualitative and quantitative) adopted 	<ul style="list-style-type: none"> - Inappropriate distribution of human resources throughout programmes and geographically - Redundancies - High turn-over of surveillance staff - Insufficient trained (data analysis) and supervised surveillance staff at all levels of the surveillance system 	<ul style="list-style-type: none"> - Revised human resources structure - Career path for surveillance staff - Well-trained surveillance staff according to required competencies at all levels of the surveillance system
Tools and forms	Consolidation of data tools and forms to minimize load on health care workers	<ul style="list-style-type: none"> - Inventory of existing paper and electronic forms 	<ul style="list-style-type: none"> - Tools and forms mapped, revised and simplified/ harmonized. - Appropriate data collection tools in health care facilities 	<ul style="list-style-type: none"> - Multiple, inconsistent data collection tools and forms 	<ul style="list-style-type: none"> - Simplified, harmonized and digitalized data collection tools and forms
Data analysis and dissemination	Timely analysis of data at all levels for action feedback at all strata	<ul style="list-style-type: none"> - Capacity-building on data analysis, production of dashboards, situation reports and bulletins 	<ul style="list-style-type: none"> - Data analysis training at all levels of the surveillance system - Regular analysis and communication of surveillance data through reports, dashboards and bulletins 	<ul style="list-style-type: none"> - Suboptimal data analysis capacity 	<ul style="list-style-type: none"> - Regular analysis of data at all levels - Use of new technologies to automate data analysis and create dashboards - Public health intervention and response triggered/based on surveillance data

Laboratory support	Laboratory services supporting the surveillance system through data exchange	<ul style="list-style-type: none"> - Capacity-building on laboratory for public health surveillance 	<ul style="list-style-type: none"> - Standard operating procedures for the sharing of information between epidemiological surveillance and laboratory - Linkage (electronic/digital) of laboratory tests results with epidemiological information 	<ul style="list-style-type: none"> - Absence of system for transport, referral, use of rapid diagnostics and quality management - Absence of linkage between epidemiological and laboratory data - Insufficient genomic epidemiological surveillance 	<ul style="list-style-type: none"> - Established procedures between laboratory and epidemiological data i.e. electronic link - Use of laboratory data for public health decision-making
Quality assurance and monitoring and evaluation	Monitoring and evaluation towards quality improvement	<ul style="list-style-type: none"> - Monitoring and evaluation framework with indicators - Surveillance evaluation guidance - Guidance on approach to supervision 	<ul style="list-style-type: none"> - Evaluation of the national surveillance system - Regular monitoring of surveillance activities - Supervisory mechanisms in place 	<ul style="list-style-type: none"> - Absence of effective monitoring of surveillance activities - Insufficient active supervision from higher levels - Fragmentation of available evaluations 	<ul style="list-style-type: none"> - Initial assessment of the existing surveillance system(s) - Regular supervision visits - Periodic formative and summative evaluations - Automatized monitoring of surveillance activities