Genomic sequencing for epidemic and pandemic preparedness and response: EMRO's vision and strategic interventions

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Whole-genome sequencing (WGS) is an approach for studying and analysing the entire genomic sequence of pathogens. It provides the most comprehensive characterization of an organism's genetic make-up *(1)*. In January 2020, scientists used next-generation sequencing (NGS) as one of several sequencing technologies to study severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and to reveal the first genetic makeup of this new virus only 11 days after the first cluster of cases due to the COVID-19 pandemic was reported *(2)*. This crucial information was vital to the subsequent rapid development of test kits *(3)*, vaccines *(4)* and treatment regimens *(5)* to respond to the pandemic. The sequencing information, later as the pandemic evolved, became essential for informing public health policies through monitoring and characterization of SARS-CoV-2 variants *(6)*.

In May 2021, the World Health Assembly (WHA74) encouraged Member States to increase their capacities to detect new public health threats, including through genomic sequencing *(7)*. Recognizing the global momentum and critical need for stronger crosscutting pathogen sequencing and bioinformatics, WHO introduced a global sequencing strategy in March 2022 *(8)*, which provides a vision for strengthening and scaling up genomic surveillance and aims to strengthen epidemic and pandemic response.

At the time of detection of the first COVID-19 case in the WHO Eastern Mediterranean Region (EMR) on 29 January 2020 *(9)*, only 11 out of 22 EMR countries had developed SARS-CoV-2 NGS capacity. By 2021, the number of countries with sequencing capacity had increased to 15. These countries strengthened and expanded their use of WGS by investing in sequencing equipment, digital infrastructure, personnel training, and data management and sharing. In the remaining 7 countries, there was the challenge of lack of capacity to carry out genomic sequencing, and some of the countries were not equipped to ship samples to international or regional laboratories for downstream processing. This happened primarily due to the absence of representative courier services to transport samples, the logistic challenges in transferring samples at the required cooler temperatures, and the limited informatics infrastructure. Therefore, WGS capacities and capabilities remained unequally distributed among EMR countries.

Developing domestic genome sequencing capacity for all countries has been a priority for the WHO Regional Office for the Eastern Mediterranean (WHO/EMRO) as part of the EMR Vision 2023. Through its health emergencies programme, a comprehensive genome sequencing strategy *(10)* was developed to guide the expansion and strengthening of the regional sequencing and bioinformatic capacities to use genomic data in the response to outbreaks, epidemics and pandemics. The strategy promotes the establishment of a sustainable regional pathogens genomic surveillance network with epidemic and pandemic potential and integrated within the public health systems. This includes contributions by genomics and bioinformatics experts who have the capacity to work with Member States and to share resources, tools, expertise, and data.

Currently, 21 countries have the capacity to carry out SARS-COV-2 genomic sequencing at their respective national reference public health laboratories. These include all 5 low-income countries and 7 of 8 lower-middle-income countries across the region, demonstrating what can be achieved with sufficient resources, political will and technical support – even in the middle of a major emergency. However, there still remains a need to establish additional, and sustain in-country, genomic surveillance systems that will not only be able to detect, investigate and respond to the evolving COVID-19 pandemic, but that can also be used for other emerging and re-emerging infectious diseases that have epidemic and pandemic potential.

The COVID-19 pandemic has highlighted the importance of genomic-based surveillance data and more broadly the need to always share actionable health data in the EMR and beyond *(11)*. In the region, SARS-COV-2 WGS results have not yet been consistently integrated into national surveillance systems and are not being used extensively for public health response in several countries that have the genomic sequencing capacity. The capacity to interpret sequencing data as well as epidemiological and clinical information needs to be strengthened to expand and optimize the use of WGS for public health response *(12)*. It is therefore important

that clinicians in the field, public health officers and laboratory specialists in human and animal health sectors in the region are given the opportunities to share information collaboratively. Doing so will require better coordination and information-sharing for quality, timely and appropriate public health actions, not only locally but also globally *(13,14)*.

The EMR genomic strategy defines actionable priorities and capabilities required to deliver on the use of genomics and standardized bioinformatics tools for early detection and prevention of future pandemics including the use of a trained workforce that can conduct genomic sequencing and additional metrics that track sequencing outcomes. In view of the public health significance of sequencing, WHO/EMRO and partners are already in the process of establishing 3 regional reference laboratories for genomic sequencing to support other countries and facilitate linkage with international networks. We are establishing sustainable genomic surveillance for countries experiencing complex emergencies and building national capacities for genomic sequencing through training, twinning initiatives, and regular mentorship. Through consistent efforts to strengthen sustainable NGS capacity of Member States, WHO/EMRO and partners look forward to realizing health security in EMR *(15)*.

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