

Table 1. Mission, Vision, and Key Performance Indicators of the NHCC Zones and Centres

Unit	Mission	Vision	Key Performance Indicators
Panoramic Wall Zone	<ul style="list-style-type: none"> -Offer a view of the health status of the entire healthcare system in Saudi Arabia -Empower leaders in the MOH to take immediate action 	-Build a Panoramic Wall for each regional health command center	<p>-Sixteen tiles on the Panoramic Wall represent an integrated feed of all NHCC units in the healthcare system. Indicators get updated regularly with a clear view of:</p> <ol style="list-style-type: none"> (1) The current situation (e.g. COVID-19 situation tiles, weekly increase in COVID-19 cases, deaths by region, cases in ICUs, lab capacity usage, the vaccinated population, and fever clinic visits) (2) Pre-hospital service tiles (e.g. PHC appointment slots and availability) (3) Hospital service tiles (e.g. ER and ICU occupancy rates, waiting times for elective surgery, referral acceptance rate, supply and resource availability, and COVID-19 situational awareness) (4) Post-hospital services (e.g. patient satisfaction, patient experience and mystery shopper)
Situational Intelligence Zone/Health Business Intelligence Unit (HBIU)	<ul style="list-style-type: none"> -Digitize and unify data platforms across multiple internal and external data sources -Continuously track several KPIs coupled with an event-based surveillance system to reflect the current state of the healthcare system -Process and valorize data and create predictive insights and media intelligence information using machine learning and artificial intelligence (AI) 	-Be at the global forefront of using AI and, more specifically, machine learning to detect and understand health risks, predict risk progression, and enable data-based health interventions to improve health outcomes	<p>-Twenty tiles on the HBIU executive wall. The unit uses data from several KPIs that are not available in the stakeholders' e-platforms, coupled with an event-based surveillance system. Examples of the tiles include:</p> <ol style="list-style-type: none"> (1) An overview tile (e.g. PHC patients and emergency cases, communicable diseases, total outpatient visits, total no. of ER patients, increases in the average no. of cases in the last 14 days by final diagnosis and ER diagnosis, daily new COVID-19 cases per 100,000 population per region, daily cases per population, and daily positivity rate) (2) Outpatients and drugs tile (e.g. total no. of outpatients, average no. of visits and wait time per patient, changes in the no. of visits in the last 14 days by diagnosis, no. of outpatients by demographic data, total drug consumption, drug consumption per patient, changes in drug consumption in the last 14 days for the 10 most commonly prescribed drugs, and drugs by region) (3) Communicable diseases tile (e.g. no. of tests conducted, no. of positive cases, changes in the no. of positive cases in the last 14 days by region, the no. of prime cases vs. positive cases, total no. of beds, no. of available beds, % of ICU beds available, changes in bed occupancy rate in the last 14 days by region, and ICU occupancy rate in the last 14 days by region) (4) Calls and appointments tile (e.g. emergency and non-emergency calls, toxicology and community calls, lifesaving calls, Red Crescent calls, changes in the no. of calls in the last 14 days for the 10 most common toxicology categories, no. of calls by age, hospital category, Seha and 937 calls, total no. of appointments, changes in the no. of appointments in the last 14 days for the 10 most commonly used services, % of walk-in patients, and no. of booked slots for the next 5 days and per population) (5) Emergency cases tile (e.g. total no. of ER cases, variance in the no. of ER cases in the last 14 days compared to the biweekly average for the last 12 months; and changes in the no. of ER cases in the last 14 days by diagnosis, region, and facility)

			(6) Diagnosis and mortality tile (e.g. Hesn diagnosis, total no. of diseases and diagnoses, diagnosis accuracy rate, changes in the no. of cases in the last 14 days by final diagnosis, lowest accuracy from preliminary diagnosis, and no. of cases by age)
Public Health Operation Center (PHOC)	<ul style="list-style-type: none"> -Monitor and assess the utilization and quality of care of PHCs and dental and vaccination programs - Monitor public health KPIs and assess preparedness -Provide predictive measures to Hajj programs -Ensure ease of access to healthcare services 	<ul style="list-style-type: none"> -Create a unified database of all public health KPIs from all sectors (public and private) in the Kingdom -Create training programs for staff to have standardized skills for reviewing indicators in the PHOC 	<ul style="list-style-type: none"> -Sixteen tiles on the PHOC wall represent PHC operating rooms and dental and vaccination KPIs. Examples of tiles include: <ol style="list-style-type: none"> (1) Outpatient PHC optimizer (e.g. regional distribution of scheduling among PHCs, active services, services utilized, availability rate, and no. of slots per day) (2) Tetamman fever clinics (e.g. immediate referrals; appointment confirmation; morning, night, and evening appointments; no. of visits; and working hours). (3) Dental composite KPIs (e.g. clinic utilization, available appointments, appointment scheduling, working clinics, and overall composite) (4) Saudi Arabia COVID-19 vaccination progress (e.g. slots open; appointments; daily target [200,000]; week-by-week changes; total consumption of supplies at premium sites; total waste; no. of vaccinations by outlet; total no. of COVID-19 vaccination registrations; no. of patients with chronic diseases or immunodeficiency; no. of vaccinated individuals over 60 years, in the total population, and by region) (5) Mawid* well-baby vaccination clinics (e.g. regional distribution of scheduling, nearest available appointments, scheduling across well-baby clinics and facilities, total no. of slots, rate of available slots, rate of available appointments, and history of appointments in Mawid).
Secondary-Tertiary Healthcare Operation Center (STOC)	<ul style="list-style-type: none"> -Ensure timely access, assess readiness, and monitor the quality of secondary and tertiary care -Provide empowerment with predictive information and operational alignment to allow stakeholders to take immediate actions 	<ul style="list-style-type: none"> -Establish a monitoring database to assess and coordinate the provision of advanced services, such as extracorporeal membrane oxygenation 	<ul style="list-style-type: none"> -Eight tiles in the STOC wall represent access to and readiness of secondary and tertiary care services. Examples of tiles include: <ol style="list-style-type: none"> (1) Bed occupancy management (e.g. total no. of available beds in hospitals and regions) (2) Ada'a, OR, and OPD weekly reports (e.g. specialty with the most operations, surgeries performed, waiting times, estimated time needed to clear backlog by week, % of patients with virtual appointments, and total no. of future appointments booked) (3) Readiness reports for ICUs and EDs in the MOH (4) Ehalati referral program (e.g. total no. of referrals; no. of accepted, rejected, and pending referrals; average processing [hours] and patient transfer time [hours]; type of referral; reason for referral; referral date; referral number; sending and receiving directorates, sectors, and hospitals) (5) Saudi Red Crescent (e.g. total no. of hospitals, patient acceptance and rejection rates, and average length of stay) via the Sahab program (6) Hayat program (e.g. pregnancy, delivery, and infant rates; 90 KPIs)
Supply Chain Operation Command Center (SOC)	<ul style="list-style-type: none"> -Track, predict, and coordinate the supply chain (drugs and medical and laboratory devices) including planning, demand, supply, purchase, storage, and transportation 	<ul style="list-style-type: none"> -Build a comprehensive tracking database using digital barcodes for all supply chain items used in MOH, non-MOH governmental and private sector facilities, including hospitals and pharmacies 	<ul style="list-style-type: none"> -Eight tiles in the SOC wall represent oversight of the healthcare system supply chain. Examples of tiles include: <ol style="list-style-type: none"> (1) No. of zero items for drugs, medical and laboratory devices, and blood and emergency bank supplies in warehouses by health region (e.g. health directorate region warehouses; no. of zero items; warehouse with less than 100 items out of stock, 100-180 items out of stock, and over 180 items out of stock)

	-Continuously refine and update supply chain data		(2) Comparison index and % change in the no. of zero drug items (e.g. % and no. of zero drug items over time) (3) Stock replenishment index at the hospital level (e.g. health directorate region, no. of hospitals, and hospital names) (4) Direct supply purchase rate by region health directorate (5) Classification index for medical and laboratory supplies (e.g. % of items, health region directorates, no. of zero items, items almost out of stock, items at optimal stock, and items overstocked). (6) Drug supply response index (e.g. average lead time with NUPCO stakeholder) (8) Sharek index for transferring supplies between regions
Lab Operation Center (LOC)	-Enhance and monitor laboratory capacity preparedness including infrastructure, supplies, workforce, and training -Coordinate and manage laboratories based on testing demand, utilization, and community transmission/viral spread -Build and monitor KPIs for laboratory capacity and utilization -Implement advanced technology solutions and platforms to monitor daily laboratory workflows and reports for timely decisions and actions	-Build a sustainable lab capacity that provides innovative, timely, and quality medical laboratories services.	-Twelve tiles in the LOC represent the preparedness of laboratories in the entire healthcare system. Examples of tiles include: (1) Lab performance (e.g. cumulative turnaround time [TAT]) for mass testing laboratories, regional labs, and the Kingdom overall. Red, TAT > 24 hours from swab to results; yellow, TAT = 24 hours; brown, TAT ≤ 18 hours; green, TAT ≤ 14 hours (2) Kingdom of Saudi Arabia map - laboratory segmentation (e.g. MT, mass testing [red], primary healthcare [yellow], and regional [green] laboratories) (3) Laboratory utilization (e.g. average no. of daily tests for the MOH and mass testing laboratories and the % change in the no. of daily tests) (4) The cumulative no. of tests for all laboratories (e.g. MOH, non-MOH, and the month-to-month % increase) (5) Pending samples (e.g. correlation between the no. of pending samples and the no. of 937 complaint calls received; yellow line: pending time > 24 hours, red line: pending time > 48 hours) (6) Daily reports from the five dedicated COVID-19 mass testing laboratories and regional laboratories (e.g. achieved capacity, inflow, outflow, reprocessing rate [%], rejection rate [%] for each laboratory and overall) (7) Supply chain dashboard (e.g. for mass testing laboratories, the number and status of critical supplies/equipment to avoid shortages). Green indicates a “working equipment” status, and red indicates a “down” status (8) Mass testing laboratory quality assurance dashboard (e.g. sensitivity and specificity per region, test results per region and overall; true positive [green] and negative [brown] results and false positive [orange] and negative [red] results)
Analytics Zone/Ada'a	-Develop, enhance, and facilitate access to care in the Kingdom -Advance national healthcare excellence and the efficiency of PHCs and hospitals through integration and the provision of	-Become a reliable national partner and a globally recognized pioneer in driving healthcare performance excellence and efficiency	-Eight tiles on the Ada'a wall represent KPIs of MOH healthcare delivery. Examples of tiles related to the National Transformation Program (NTP) include: (1) ED tile (e.g. door to disposition within 4 hours, % of non-urgent patients, % of patients with disposition as LAMA or DAMA, and mortality rate) (2) OR tile (e.g. % of elective or utilization surgeries, surgical cancellation rate, day of admission to day of surgery, waiting time for elective surgeries, and day surgery KPIs)

	accurate data to support decision making	-Build a portal system for Ada'a to reduce data-processing time and move to data automation	(3) Critical care tile (e.g. ALOS, physician-to-bed ratio, nurse-to-bed ratio, % of long-stay patients, and bed occupancy rate) (4) Inpatient department tile (e.g. % of patients seen on the first day, ALOS, % of weekend discharges, and % of long-stay patients) (5) OPD tile (e.g. waiting time for appointment, third available appointment, % of new patients, and no-show rate)
Resource Operation Center (ROC)	-Manage inventory and assess medical equipment -Provide preventative and corrective maintenance for medical equipment -Monitor the utilization of medical equipment -Monitor human resources	-Build inventory management database and an asset performance management system for all medical equipment and spare parts in the MOH, including utilization, maintenance, and coordination for the entire healthcare system	-Eight tiles on the ROC wall represent resource monitoring and utilization. Examples of tiles include: (1) Ventilators monitoring tile (e.g. working status, manufacturer, and operability by organization and region) (2) Dental units' tile (e.g. working status, facility type, and region) (3) Anesthesia, dialysis, CT, and MRI equipment utilization tiles (e.g. region, operating room, no. of items of equipment, equipment type, working status, manufacturer, no. of sessions, operational hours, serial numbers, type of therapy provided, and hospital) (4) Total human resources tile (e.g. specialty, region, cluster, service type, status, gender, and nationality) (5) Infected MOH healthcare workers tile (e.g. job category, total number, active cases, age, nationality, gender, region, and source of infection)
Ticketing Zone (TT)	-Identify, trigger, and escalate issues from the NHCC units to the appropriate MOH department or facility -Enhance the performance of NHCC units and MOH facilities -Support decision makers in the MOH with data-driven interventions	-Build and expand the TT center to all regions of Saudi Arabia, with the provision of supervision and mentoring for regional TT sub-centers and of digitized and automated triggers for ticketing requests	-Eight tiles on the TT wall represent tickets issued by all relevant NHCC units. Examples of tiles include: (1) Total no. of tickets per week tile (e.g. teams, no. of opened/solved/closed/reopened tickets, and no. of tickets with low/medium/high/critical priority level by region/cluster) (2) Ticketing tiles for different programs (e.g. supply chain, labs, HR, TeleHealth, Mawid, mass testing, and ICU bed management) (3) Vaccine ticketing platform tile (e.g. digital, operations, supply chain clinical care, communication, customer experience, no. of critical patients with a ticket less than 3 days old, closed/returned ticket status, ticket requester, and solved/unsolved ticket status by region/cluster)
Cybersecurity Operation Center	-Identify, monitor and analyse continuously cybersecurity incidents on NHCC databases -Ensure availability of protective solutions (i.e. defending, investigating and reporting) for potential security incidents	-Develop cybersecurity strategies and implement protective measures for NHCC databases.	Generally, the Cybersecurity Operation Center monitors for threat alerts, identify internal and external security breaches.

Abbreviations: (ALOS) average length of stay, (CT) computed tomography, (DAMA) discharge against medical advice, (ED) emergency department, (ER) emergency room, (ICU) intensive care unit, (LAMA) leave against medical advice, (NUPCO) National Unified Procurement Company, (OR) operating room, (OPD) outpatient department, (PHCs) primary healthcare centers and (MRI) magnetic resonance imaging.

Terms Definitions: (Ada'a) an MOH performance program for PHCs and hospitals, (Ehalati) an e-system referral program that facilitates the referral of patients between hospitals within the region or between health affairs directorates across the Kingdom, (Hayat) a pregnancy-related program, (Hesn) the Health Electronic Surveillance Network serves as a national communicable disease surveillance platform, (Mawid) an appointment program that facilitates appointment reservation, rescheduling, or cancellation, (Mystery Shopper App) an application that enables the user to evaluate the offered services from a patient's perspective to and seek improvements for in medical services, (Sahab) a program to determine and manage the geographical location of callers and ambulance service seekers and to connects them directly to the operating rooms through mobile networks, (Sharek) a program to transfer supplies between regional healthcare centers, (Seha) a virtual medical consultation via text, voice messages, images and videos, (Tetamman) an application that enables users to book appointments for COVID-19 tests and follow -up on their cases and provides protection and health care for individuals referred to quarantine.